HOME-BUILT MECHANICAL RECEIVERS

# Television and SHORT-WAVE WORLD

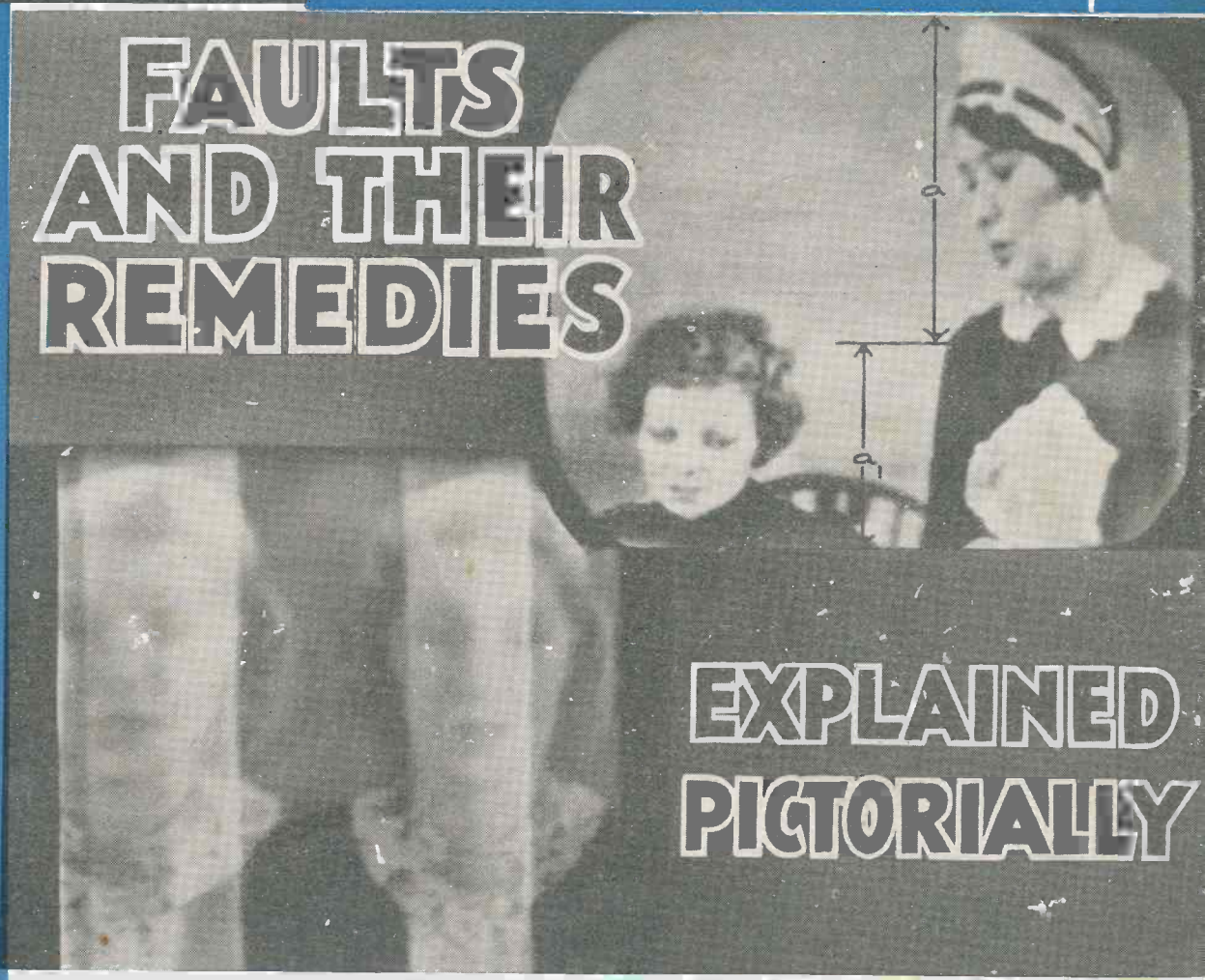
DECEMBER 1938
No. 130. Vol. Xi.
1/-

SIMPLE RECEIVER FOR TELEVISION SOUND

SUPER-SONIC LIGHT VALVE INCREASING RANGE

SHORT WAVES

## FAULTS AND THEIR REMEDIES EXPLAINED PICTORIALLY




MAKING A CHEAP ROTARY-BEAM ANTENNA
AN A.C. MAINS S.W. RECEIVER USING THE 801 VALVE

BERNARD JONES PUBLICATIONS LTD.
CHANSITOR HOUSE. CHANCERY LANE
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THE FIRST TELEVISION JOURNAL IN THE WORLD

No. 130 VOL. XI DECEMBER, 1938

# TELEVISION and SHORT-WAVE WORLD

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TELEVISION AND SHORT-WAVE WORLD

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# COMMENT OF THE MONTH

## O.B. Successes

THE much increased number of outside broadcasts of the past month have had the effect of greatly accelerating rceeiver sales. We have definite proof of this in the large number of inquiries which we have had respecting receivers and the references made to these special programmes. We have repeatedly stressed the desirability of this type of transmission and we congratulate the Alexandra Palace staff on the resource it has shown in allowing no topical event of any importance to escape the television camera. They have included the Lord Mayor's Show, the Cenotaph Ceremony, the arrival of King Carol, Ice Hockey, Boxing and lastly transmissions from the actual stages of two London theatres.

In our opinion, the importance of these last two transmissions cannot be overstressed for they open up wonderful possibilities. For the first attempts of this nature it was inevitable that a certain amount of inconvenience would be caused to the theatre management, and possibly the audience, but this is a trouble that will soon be overcome. Obviously, there is now no reason whatever why the B.B.C. Variety broadcasts from St. George's Hall should not be a regular feature of the television programmes and we suggest this as the next move.

There is a suggestion that we should like to make with regard to these outside broadcasts. This is that on every occasion there should be a few minutes' studio transmission both at the beginning and end of each outside broadcast. The reason is that on these occasions the transmissions are seen by large numbers of people who are new to television and as, owing to unsuitable or difficult conditions, quality may suffer, such people get a wrong idea of the quality possible. A direct studio transmission with an announcement of the quality of picture that should have been receivable (observed on a check receiver at Alexandra Palace) would correct this, and, in the case of definitely bad transmissions, which in some circumstances are unavoidable, remove doubt from viewers' minds that their receivers were faulty.

## C.W.R.

OVER 800 active members have now been accepted out of the large number of amateurs who applied for enrolment in the recently formed Civil Wireless Reserve. The scope of this Reserve has now been increased by the formation of two Experimental Sections for those who wish to undertake technical work rather than to do Morse operating. The first of the Experimental Sections was formed to consider Air Ministry work only, while the second section will handle problems which may arise during the running of the C.W.R.

In the first group most of the members are qualified radio engineers and so far radio amateurs with specialised knowledge are being included in the second Experimental Section. We consider that this Reserve presents an excellent opportunity to amateurs who wish to extend their radio knowledge which will be of use to them in peace time, and enable them to be of service to their country in time of emergency.

# HOME CONSTRUCTION OF MECHANICAL RECEIVERS

## RECEPTION OF A.P. TRANSMISSIONS ACHIEVED WITH SIMPLE APPARATUS

IN recent articles the problems were discussed which confront the amateur who desires to receive the present transmissions by optical-mechanical scanning methods, and some arrangements were suggested that it was thought would make this possible with simple apparatus. These were suggestions for experiment based on sound theoretical considerations.

Further experiments with these arrangements have shown that they do receive the television programmes according to prediction, both as regards size of picture received and degree of definition. These it will be remembered were not ambitious, but nevertheless they are sufficient for interesting results. Moreover, owing to the possibility of relying on the time-controlled 50-cycle mains for synchronisation, which has proved, up to a point, to be practicable, and owing also to the reduced frequency response of the receiver necessary, it has been possible to get pictures even in a rather poor location, with a receiver using a total of only six ordinary type valves (excluding power packs).

This, in all probability, represents the simplest way in which it is possible to receive pictures on the present transmissions.

At the moment our experiments have not yet reached the point where really satisfactory reception can be guaranteed, but they are being continued and it is hoped that very soon we shall be able to present to our readers the design of a very simple and cheap receiver.

We may recapitulate the description given in earlier articles, as follows:—There is a light source consisting of a small filament lamp of the "exciter" or motor headlamp type, overrun above its normal voltage, from a transformer or accumulator. The light is modulated by a supersonic relay (quartz crystal and liquid) and passes to a simple line scanner. The simple cylindrical lenses and a second (frame) scanner made from plate glass suffice to project a picture on to a ground glass screen. Both scanners can be driven from the controlled 50-cycle mains by suitable synchronous motors.

Suitable scanners and motors are commercially available, and were kindly provided for our experiments by H. E. Sanders & Co., whose assistance we acknowledge.

### *Synchronising*

Our experiments have shown that ordinary transmissions (i.e., not outside broadcasts, which are sometimes not tied to the mains) give pictures which for the greater part of the time remain fairly steady, without other than mains control. As a final standard of reception such a state of affairs could not, of course, be tolerated, and therefore development of a suitable unit, for providing the necessary extra control of scanner speed from the received signals is proceeding.

### *Radio Arrangements*

The light relay has to be operated by a modulated oscillator, which can employ either suppressor grid or plate type of modulation. With the latter, a positive signal is required. The present arrangement is not required to deal with a wide frequency band and a receiver can therefore be built simply and cheaply.

We have, therefore, evolved a simple type of vision receiver comprising one R.F. stage, reactive detector and two V.F. stages, followed by modulator and oscillator valves, which suffices for distances of 30 miles or so from Alexandra Palace. Where strong signals are received, the H.F. stage could be dispensed with, or alternatively, instead of plate modulation in two V.F. stages it would be possible to use suppressor grid (type) modulation with only one V.F. stage.

Assuming that our further experiments are successful, as we have every reason to believe they will be, we hope to present to our readers a complete simple and cheap design of receiver employing mechanical-optical methods.

## Television Festival Dinner

The Duke of Kent presided at the first television dinner at the Dorchester Hotel on November 3 in support of the appeal for the new premises fund of the Royal Photographic Society. About 550 guests, watching forty televisors, saw and heard Beverley Nichols replying from Alexandra Palace to the toast of "The Guests," proposed by the Rt. Hon. Leslie Burgin, the Minister of Transport. Afterwards, a special programme, which included Gracie Fields, Oliver Wakefield, Jean Colin and Douglas Byng, was transmitted from Alexandra Palace, and excellent reception was obtained at the Dorchester. Special aerial arrangements were installed for the occasion, which comprised a tilted wire anti-interference aerial on the roof of the Dorchester with a feeder to an aerial amplifier. The output from this amplifier to the various receivers was then taken by co-axial feeder.

Twelve makes of receiver were used, these being Ferranti, H.M.V., Marconiphone, Pye, G.E.C., R.G.D., Burndept, Cossor, Ultra, Murphy, Baird and Invicta. Receiver position was balloted for and pride of place was secured by Ferranti's.

## Burndept Reunion Dinner

Plans have been made to have a Reunion Dinner of the old officials and employees of the original Burndept and subsidiary companies which were formed before 1928. This dinner is to be held on Friday, January 20, 1939, and the Reunion Secretary, Mr. W. H. Higgs, of 73 Madeira Avenue, Bromley, is desirous of getting into touch with any old members of the works or office staffs (either male or female) of the Burndept companies who up to the present have not been acquainted with the arrangements made for this reunion.

# TELEVISION PICTURE FAULTS AND THEIR REMEDIES—I

*By S. West*

*This short series of articles will deal with some of the more generally experienced television picture faults. The treatment is rather unusual inasmuch as photographs have been secured of actual images wherein a fault or faults is depicted. The cause for each of these is dealt with and then the procedure necessary to adopt in order to clear the fault is outlined. The survey of faults will be most comprehensive and the series of articles should be of great value to owners of either commercial or home-constructed receivers.*

IT is a fact that any person whose knowledge of television receiver design is at all complete can, in the majority of cases, by examining a defective image, at once state the probable cause and the necessary cure for the defect, or briefly, he can with expedition place the apparatus in good order.

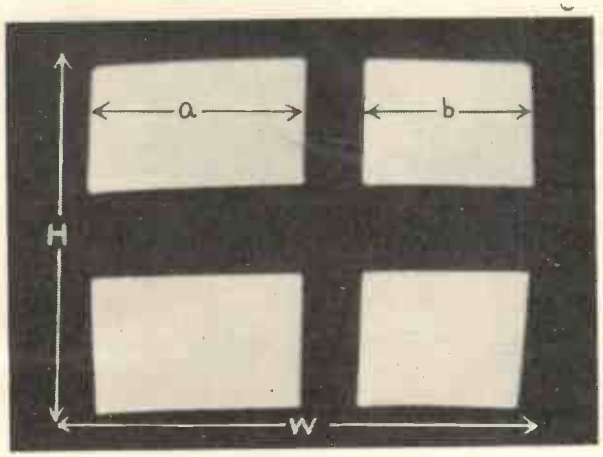



**Fig. 1. Appearance of cruciform pattern due to non-linear line sweep voltage.**

It is the writer's opinion that for the less knowledgeable person it is only necessary to show him pictures of faulty images, mutually agree which of these is truly representative of the fault experienced, then to detail the circuit changes necessary to effect a cure, and he is almost as well equipped as the more experienced worker to correct television image faults. The photographs to be reproduced in this series of articles were therefore obtained for this purpose.

It should perhaps be added that such photographs are not by any means easy to make. In the first place they were all secured in the writer's laboratory about 100 miles from the transmitter, which fact alone rendered the task intricate. Secondly, it is one of the anomalies of such apparatus that a specific fault that can occur entirely unintentionally, and when it is not wanted, often is difficult to invoke to order; moreover certain minor faults cannot be photographed at all. Despite these difficulties, it is believed the complete series will be representative.

## *Raster Faults*

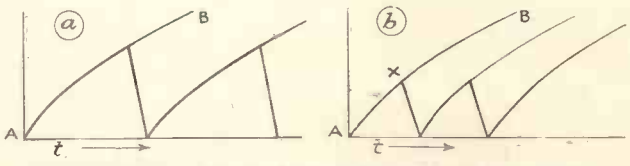
If we adopt a logical order of faults we find that we are firstly concerned with the plain raster, for obviously we must have this right before tackling the remedy of actual picture reproduction defects.

The most commonly experienced fault in a raster is that due to anon-linear scan in either the vertical or horizontal direction or both concurrently.

Figs. 1, 3 and 5 depict the familiar cruciform pattern radiated by the transmitter prior to the commencement of the programme. Let us consider the image of Fig. 1. It is seen that the distance *a* is greater than *b*. This is due to the production of a non-linear sweep voltage by the line time base. The desired wave form for the oscillation is shown in Fig. 2a. The wave-form responsible for the non-linearity is likely to have a form resembling that shown in Fig. 2b.

Now it is important fully to appreciate the following.

The saw-tooth oscillation is produced by the charge, through a resistance, and the discharge, through an electronic device (i.e., a gas relay), of a condenser. The charge current is of the form indicated by the curve AB in Figs. 2a and 2b. This curve has an exponential shape but it is seen that if we arrange the discharge to take place at *x*, Fig. 2a, that this portion of the curve is reasonably linear. Consequently for a linear scan, we must arrange for the discharge cycle to occur at this point or earlier. It should be mentioned parenthetically there is an alternative, namely, to employ a constant current device (pentode or diode valve) through which the condenser is charged. It is not proposed to deal with such arrangements, however, for they render the apparatus more complex. To achieve this end, that is to ensure linearity of charge, the time base H.T. must be high (usually over 1,200 volts for a 12 in. tube), for it is obvious we only employ a very small part of the complete charge curve.




**Figs. 2a and 2b. Correct and incorrect time base wave forms.**

Assuming the H.T. is adequate, then the point *x*, in the case of a time base employing gas relays, is chosen by the value of bias for this valve and will have adequate amplitude for our needs. Precisely similar procedure is involved for other forms of time base, the main point being that the condenser must discharge at *x* or earlier.

# PICTURE RATIO FAULTS

## *Time Base Speed*

This brings us to another consideration, namely, the nearer to A that our discharge takes place, the higher will be the frequency of the saw-tooth oscillations. Obviously this is so for the discharge takes place earlier on the curve AB, which is plotted against time. So that, if in our efforts to ensure linearity, we have caused our time base to operate at an incorrect frequency we must remedy the matter.

This is simply achieved. It is assumed that the capacity of the charge condenser has the conventional value for the position in which it is used and it only requires to increase the value of the charge resistance to reduce the frequency of the oscillations.

Condensing the above information for a specific case, that of a time base employing a gas-relay saw-tooth oscillation generator, if non-linearity of scan exists, reduce the bias of the relay by reducing in value the cathode resistance, or make similar changes to whatever biasing arrangement is employed, then, restore to the correct operating frequency by increasing the value of the charge resistance.

## *Picture Ratio*

In Fig. 3 we have the cruciform pattern once more. Note that the line sweep is again non-linear but a more unpleasant effect obtrudes, namely, the aspect ratio is entirely incorrect, the ratio of height to width being disproportionate.

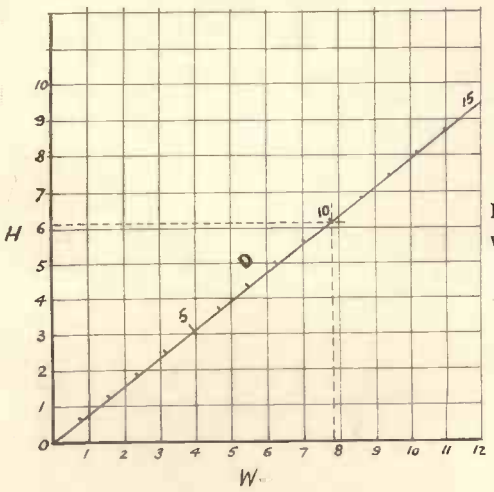



**Fig. 4. Height-width picture dimensions.**

The correct aspect ratio for pictures transmitted from Alexandra Palace is 5:4. From Fig. 4 the correct picture dimensions can be obtained. The diameter of the tube is given by the diagonal D. Knowing this the correct height and width is easily secured.

For example, the W/H ratio for a tube having a 10 in. diameter screen is seen to be $7\frac{3}{4}$ in. by $6\frac{1}{4}$ in. In practice it is permissible to exceed these dimensions but the proportions must be retained.

Now within the limitations imposed by the requirements for linearity of scan, we can adjust this aspect ratio with the bias on the discharge valve and this is the correct course to adopt.

It is necessary to interpose a word here concerning time bases that employ a balanced output system (electrostatic deflection). Whilst the picture shape can be controlled to a certain extent by varying the input to

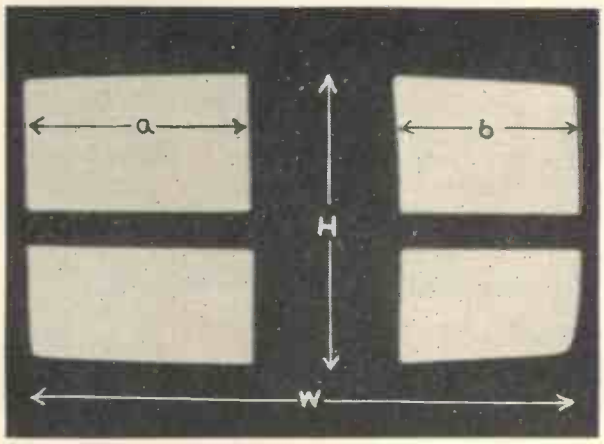



**Fig. 3. Another effect of non-linear line sweep voltage producing incorrect aspect ratio.**

the second amplifying stage, such procedure is unwise. This point will be dealt with later in some detail but for the time being it can be assumed that with the paraphase valve removed, the picture should be approximately half the width or height, as the case may be. It is seen then that the correct aspect ratio is mainly determined, once the amplifying stages are designed, by the amplitude of the oscillation generated by the gas relay.

Fig. 5 is again of the cruciform pattern. For all practical purposes the aspect ratio and linearity can be deemed satisfactory. There is shown slight non-linearity in both the frame and line bases but for various reasons it is difficult entirely to remove this defect.

An examination of this photograph reveals the distance *a* to be slightly greater than a1 (slight non-linearity in the line base). Similarly *b* is greater than b1 (slight non-linearity in the frame base). The aspect ratio R, that is H/W, is substantially correct. Note also the good contrast, namely, black and white and not an indeterminate contrast.

Figs. 6 and 7 show the effect of applying an oscillatory voltage to either the C.R. tube or the V.F. valve grid. If no oscillator is available it is worth while setting up temporary gear for this test.

A frequency of approximately 400-1,000 cycles per second is entirely satisfactory for the vertical test and approximately 150-200 kilocycles per second for the horizontal. A simple dynatron oscillator serves admirably. Alternatively most service oscillators will readily furnish these frequencies. As a matter of interest the writer used the scan voltage of a high-frequency oscilloscope.

# LINEARITY

This test pattern is of particular value for determining the linearity or otherwise of the scan when no transmission is available. One point requires observing otherwise the tests are completely valueless. The time bases must be operating at substantially the correct speeds for there is little object in achieving linearity at entirely incorrect operating frequencies.

The simplest way of ensuring this is to adjust the time bases accurately to the correct frequency during a transmission. Greater accuracy is ensured by making

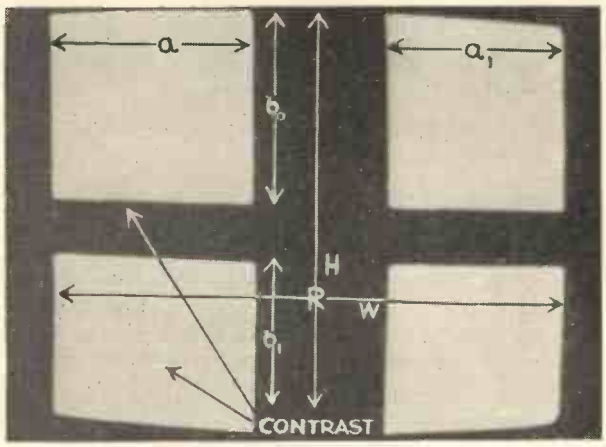



**Fig. 5. Cruciform pattern with slight non-linearity in both line and frame sweep voltages.**

the sync. pulses amplitude very small, then, by applying signals in the manner indicated, the number of bars and the frequency to produce these can be noted, and these settings repeated at any time. Of course, if the frequency of the modulating voltage is fairly accurately known it is a simple matter to calculate the number of bars that should be produced when the time base frequencies are correct, and this is an alternative adoptable scheme.

## *Linearity*

Now to ensure linearity, adjustments are made until the spacing of the bars is even over the whole screen. The photograph, Fig. 6, shows the test pattern for linearity in the vertical (frame) time base and is secured by feeding a low-frequency signal to the modulating electrode. Actually slight non-linearity is indicated, but is not serious. Fig. 7 shows the same scheme employed for checking linearity in the horizontal sense (line). Even spacing of the bars should be striven for.

Finally, Fig. 8 shows the unpleasant effect secured with a non-linear frame (vertical) scan. The distances *a* and *a*1 should be equal. It is seen that the picture is badly distorted, the servant girl's face dominating the picture whilst the other character's features are compressed. The rounded corners of the picture are due, of course, to the cathode-ray tube bulb curvature. The corners of the raster should not be permitted to wander much over the screen's periphery for apart from the loss of picture subject, particularly in captions, this rounded edge distortion becomes objectionable.

Before we leave this question of non-linearity of sweep voltage it is as well to mention that included in this category are the following faults:

Overload of the scan voltage amplifiers. As the types of valve normally specified for such positions can

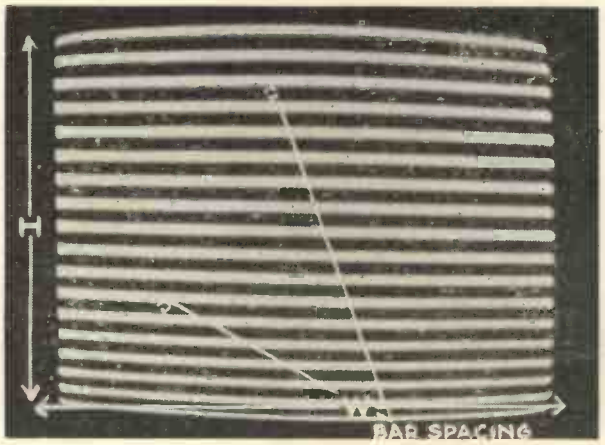



**Fig. 6. Test pattern for linearity of frame time base.**

handle easily the grid signals involved it is not proposed to deal with the question in any detail.

The question of balance in a push-pull deflector plate feed system has also been remarked. If the balance is not reasonably good an asymmetrical scan will result. This effect is a form of non-linearity, though in the writer's experience other defects thus caused are more deleterious. It has already been pointed out that the balance should be such that each valve contributes approximately one half the scan. If this requirement is observed then no trouble from this source will be experienced. The condition is satisfied by making the paraphase tap at 1/Mth. of the anode resistance. M is the magnification of the stage.

These conditions are usually catered for as is also that of freedom from amplitude, phase and frequency distortion for the amplifiers design. From a designer's

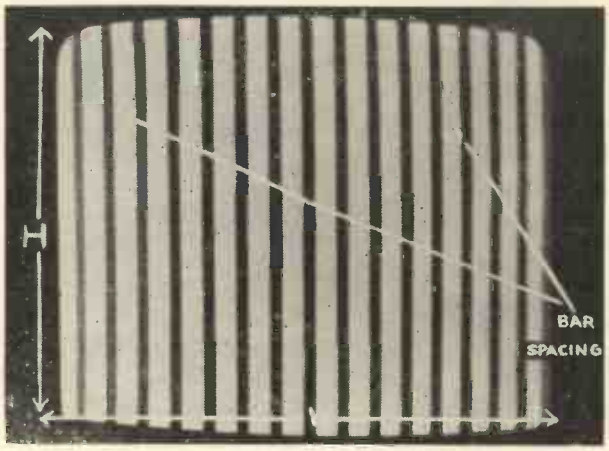



**Fig. 7. Test pattern for linearity of line time base.**

viewpoint they are important however and should receive due attention.

Incidentally the frequencies involved can be deemed

to be of the order of 20 times the fundamental operation frequency of this time base.

A study of all these photographs will reveal one fundamental fact. Any non-linearity of the scan voltage developed by the saw-tooth oscillator is revealed as a compression of the right-hand or the bottom picture edge.

No attempt to cure picture distortion occurring as a compression of the left-hand picture edge should be made in the manner outlined above. This defect will be dealt with later. It is due either to non-linearity of the flyback, though this is rare, or to the line retrace occurring with insufficient rapidity. Actually the first effect is often a corrollary of the second and in any case is not important unless the interval occupied is greater than a certain percentage of the line time.

In the next article of this series trapezium distortion and also actual picture defects will be dealt with.

*(To be continued)*


**Fig. 8. Effect due to non-linear frame scan.**

## Baird Cinema Television

The Baird Company gave further demonstrations of their big-screen cathode-ray projection system at the Tatler Theatre on the occasions of the Lord Mayor's Show and Cenotaph Ceremony. Since the Derby and Trooping the Colour demonstrations were given, new equipment has been installed which includes a special tube with a screen measuring 5 in. by 4 in. instead of 4 in. by 3 in. as formerly. Good as were the results obtained at the time of the Derby, they were surpased at this latest demonstration—in fact they were amazing. Later comparison with small screen pictures proved that such defects as there were were due to the transmissions, and that results on the large screen were the equal of those obtainable on home receivers. Both definition and brilliancy were exceedingly good and a few minutes of the studio transmission showed that they were almost up to cinema standard. The Baird Company are to be congratulated on this remarkable development work.

## Book Review

*Testing Television Sets,* by J. H. Reyner, B.Sc., A.M.I.E.E. (Chapman and Hall, Ltd,). This book is primarily intended for the wireless service man who in the near future will be called upon to test and repair television receivers in addition to broadcast receivers. The author has therefore assumed that the reader has a general knowledge of television receiver principles and the entire book is devoted to an analysis of receiver faults, their location and remedy.

So far as has been possible, treatment has been sectionised and faults due to tube, time base, synchronising, receiver and interference are dealt with separately. Additional chapters deal with test apparatus and laboratory technique. Much of the information is of a general character which will be helpful to the non-professional reader, and the serviceman will undoubtedly find the book a very valuable help. It is well illustrated by photographs showing the appearance of faults on the screen and with many diagrams. The price is 9s. 6d.

## Cathode-ray Tube Holders

Constructors and experimenters who are using the small cathode-ray tubes fitted with an 8-pin octal base, find that the ordinary octal valve holder is not completely satisfactory owing to the high voltage connections being exposed.

We were very glad to see that Messrs. A. F. Bulgin & Co., Ltd., of Abbey Road, Barking, Essex, have produced a special base for this type of cathode-ray tube. The base is a modification of the octal but is completely shrouded so that the high-voltage connections cannot be accidentally touched. The base of the holder is also covered, with a single hole left through which the connections can be taken.

deliveries can be obtained from 64

Supplies of these tube holders are now available at 1s. 3d. each, the type number being VH58. For the convenience of readers in London, deliveries can be obtained from 64 Holborn Viaduct, E.C.1.

## A New Q C.C. Crystal Holder

Amongst the large number of components that have been introduced this season by the Quartz Crystal Company, Ltd., of Kingston Road, New Malden, Surrey, is a new type of enclosed holder, designated type U, which is for use with the S5, P5 and Q5 frequency-control units. It is of modern design and appearance as can be seen from the illustration. This holder, made of a Keramot body, ground stainless steel electrodes, resilient contact pins, with a ¾ in. spacing so that it is suitable for use with standard American 5-pin valve


**The new Q.C.C. crystal holder fits American type valve holders.**

holders. It is 1½ in. in diameter and ½ in. deep This holder is priced at 6s. fitted with a plate which is stamped with the frequency of the crystal.

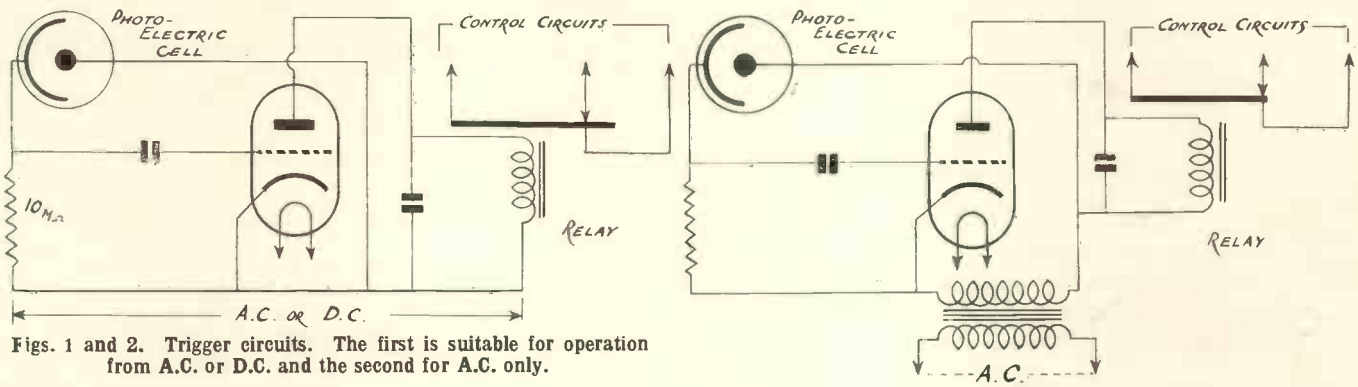
An entirely new crystal of the low temperature co-efficient type is also available for 27s. 6d. This is the Q5 unit with a temperature co-efficient of less than 4 cycles per mc. per degree centigrade change. Maximum R.F. crystal current 150 mA.

We advise all readers to get in touch with the Quartz Crystal Company for full information not only on their new crystals but on new components in general.

# THE PHOTO-ELECTRIC CELL IN PRACTICAL USE

## A SERIES OF CIRCUITS SHOWING LIGHT CELL APPLICATIONS

*This comprehensive series of photo-cell circuits has been collected from various sources and we acknowledge particular indebtedness to "Electronics."*




Figs. 1 and 2. Trigger circuits. The first is suitable for operation from A.C. or D.C. and the second for A.C. only.

TWO trigger arrangements are shown by the drawings above, Figs. 1 and 2. Fig. 1 is suitable for operation on either A.C. or D.C. Fig. 2 is for A.C. operation only. No grid leak is provided, and there is no necessity for maintaining any particular potential on the grid) the grid assumes its own negative potential. This circuit is probably the most sensitive combination possible for any three-electrode valve. If used on A.C. a condenser must be shunted across the relay to prevent chatter, but if used on D.C. this is unnecessary.

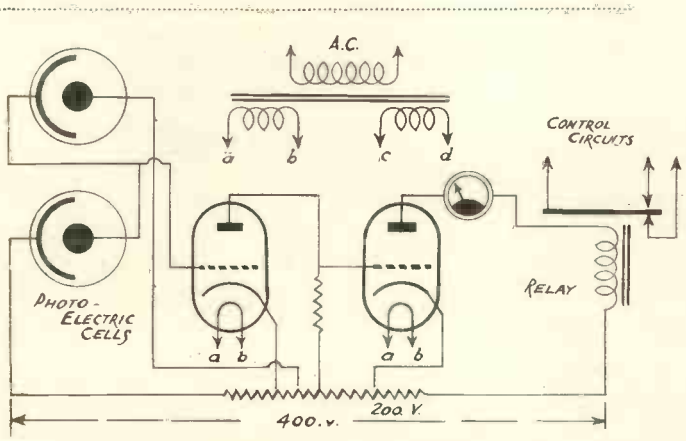



Fig. 3. Two stages direct coupled.

When two or more stages are used there are three types of coupling which can be employed, namely, resistance coupling, transformer coupling and direct coupling. Fig. 3. (above) shows an example of direct coupling. It will be noted that the plate of the first valve is connected directly to the grid of the second, therefore, the potential of the plate will maintain the potential at the grid of the second valve at the same value. The various voltages employed are taken from the voltage divider shown. The proper voltage conditions on the elements of both valves must be maintained.

Supposing that the plate of the first valve receives its potential from the mid-point of the divider, which is 200 volts ; resistor R, then serves as the plate load and its value should be about 50,000 ohms. The potential of the plate will then be approximately 100 volts (100 volt drop in potential existing across the resistor R). The grid of the second valve also has a potential of 100 volts. The grid bias of the first valve is taken directly from the voltage divider. The characteristic of the first valve should be such that the cathode should be approximately 15 volts positive with respect to the grid. Since the grid of the second valve is at 100 volts potential, the cathode is then connected to the voltage divider at approximately 115 volts, which will be on the positive side of the plate tap for the first valve as shown.

Very minute changes in the light intensity falling on either of the cells shown, will result in large changes in the anode current of the second valve. As far as the action is concerned, the output of the second valve will be exactly the same as the output of a one-valve amplifier, except that it will have this added sensitivity.

If applied to a colour matching device, this arrangement is capable of detecting differences in colour or in light intensity, which are far beyond detection by the human eye. It is important that a separate voltage supply be provided for the two filaments, otherwise a leakage will occur between cathode and filament which can cause breakdown in the tube.

The arrangement shown by Fig. 4, acts as an "integrator," adding up, say, a large number of small flickers of light on the cell or a few large flickers (or even a combination of the two).

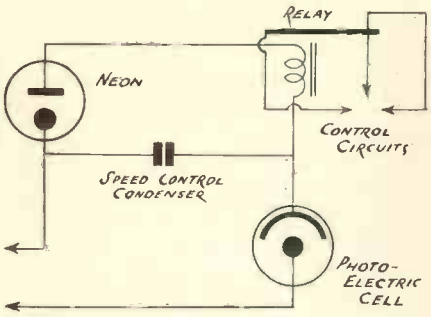



Fig. 4. An integrator circuit employing a neon tube.

As will be seen a neon tube is employed. The cell is connected in series with a source of supply and a condenser, which may be of any value depending on the speed of operation desired.

As the condenser in the circuit receives its charge, the potential across it increases until it reaches the spill-over voltage of the neon tube. At this instant current passes though the tube, thus energising the relay which is connected in series with it and, at the same time, discharging the condenser, thus causing the cycle to repeat.

The speed with which this pulsation takes place is dependent on the capacity of the condenser, and the value may range from .005 mfd. to 1 mfd. or more ; it is also dependent on the resistance of the cell. The intensity of the light striking the cell may, therefore, be measured by the speed of pulsation of the neon tube and relay.

If the condenser value in this circuit is small, its ability to store current is likewise small and it may not be capable of operating a heavy relay.

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Fig. 5 illustrates two simple impulse circuits connected in push-pull, both operating the same relay. The fulcrum of the relay armature should be at the centre. A magnetic coil in each circuit exerts attraction on opposite ends of the armature.

With the arrangement shown, both coils are continually energised unless there is an instantaneous change in the light flux, one or the other coils will release, providing both cells are not simultaneously affected. Since both are energised, the armature will remain against that coil to which it is nearer.

This principle is often applied in instruments, the motion of the indicating needle intercepting the light striking the cells as it moves from low to high, or vice versa. If the apparatus is arranged to control whatever the needle is giving indication of, then an automatic control between the limits as determined by the spacing of the cells, is obtained.

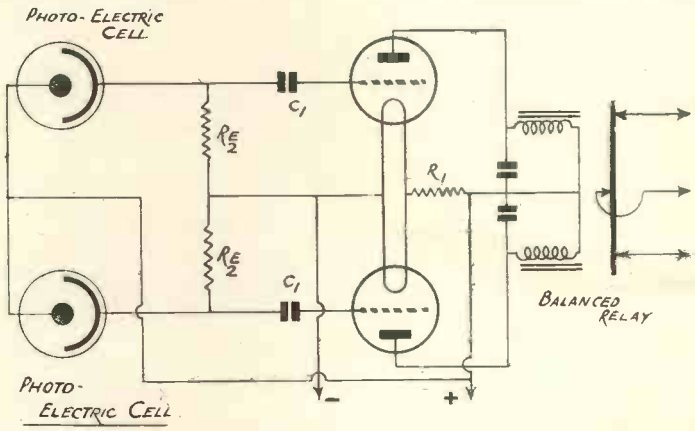


Fig. 5. Circuit for push-pull operation of relay.

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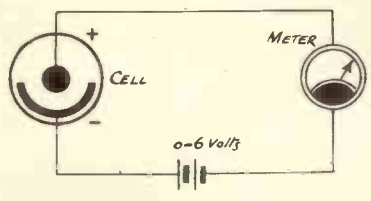



Fig. 6

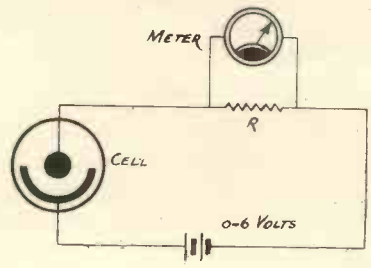



Fig. 7

The circuits shown by Figs. 6 to 15 employ self-generating cells. With these circuits, it is immaterial which type of cell is used and either dry or wet cells may be employed.

Figs. 6 and 7 show cells of these types used in series with applied potentials. In Fig. 7, the cell is connected in series with an e.m.f. up to, say, 6 volts supplied by batteries. In Figs. 8 and 9 a bucking potential is utilised to balance out the "dark current" so that it will not interfere with the proper working of the circuit, or reading of an instrument.

The circuit of Fig. 10 is due to R. A. Fessenden (U.S. Patent 1,899,026, February 28, 1933), and is intended to eliminate lag in a selenium cell. The inventor claims that if a current of very high frequency (50,000 cycles is referred to in the patent) is connected to the circuit, its rate of flow will depend upon the

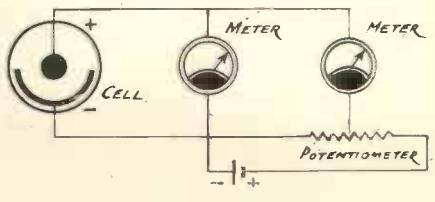



Fig. 8

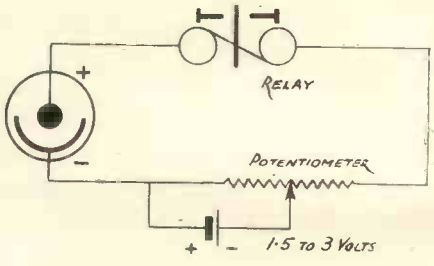



Fig. 9.

capacity of the cell which varies with light intensity. But the flow of current will be much greater than if a D.C. circuit is used,

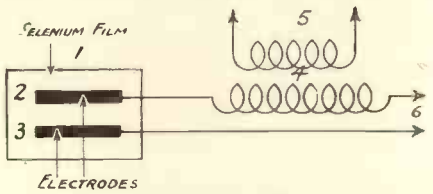



Fig. 10.

and there will be far less time lag (1/100,000 second or less).

Various attempts have been made to amplify the voltage or current variations produced in the output of the self-generating type of cell, Fig. 11 taken from Geffken and Richter's book, "Lichtempfindlioche Zelle," is a typical circuit.

A method of using these types of cells with amplifier circuits for audio frequency purposes has been shown by Roe. The circuit he recommends is shown by Fig. 12. The values of capacity, resistance and inductance while a function of the frequency response desired. Below frequencies of 1,000 cycles, the capacity of C is 20 mfds.

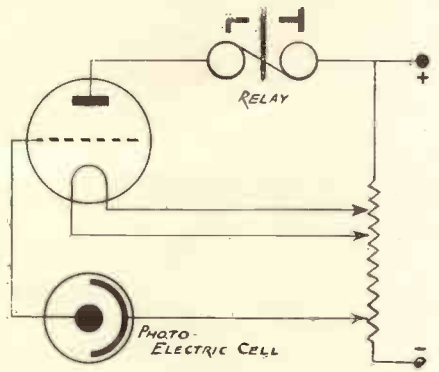



Fig. 11.

The circuits, Figs. 13 to 15 are for the amplification of direct currents and require continuous potentials; no condenser or chokes can be used. The heating of filaments may be by means of individually insulated transformers, although for stability accumulators are recommended.

In general, the selection of valves, resistances and voltages should be such as to give the largest possible amplification with reasonable stability. A ½-megohm resistance is shown in series with the cells; this reduces the gain slightly but serves to safeguard the cell.

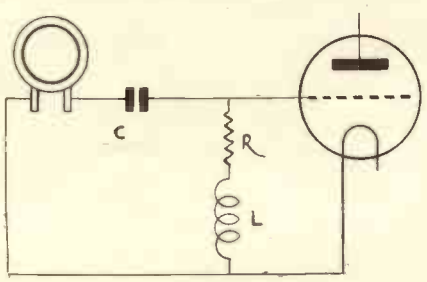



Fig. 12.

## CIRCUITS FOR SELF-GENERATING PHOTO-CELLS

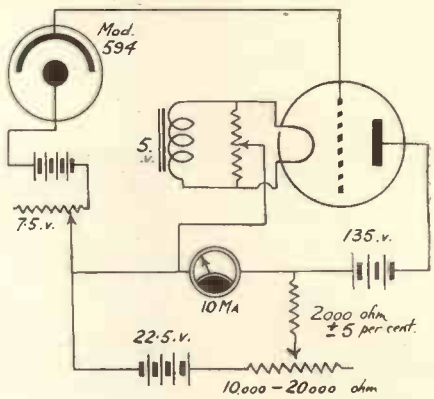



Fig. 13.

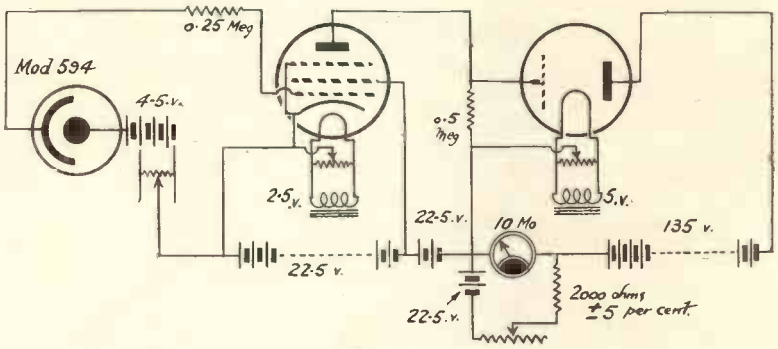



Fig. 14.

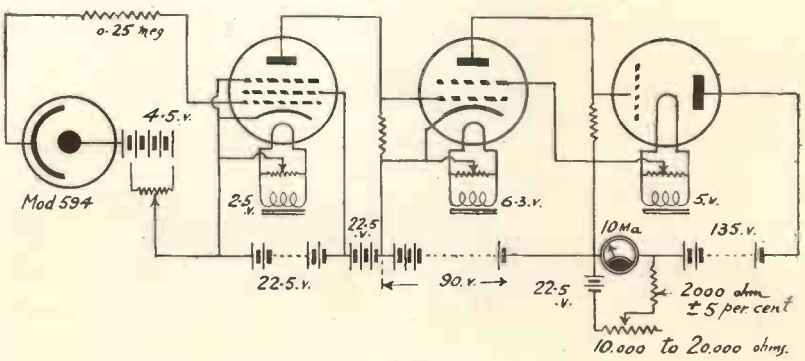



Fig. 15.

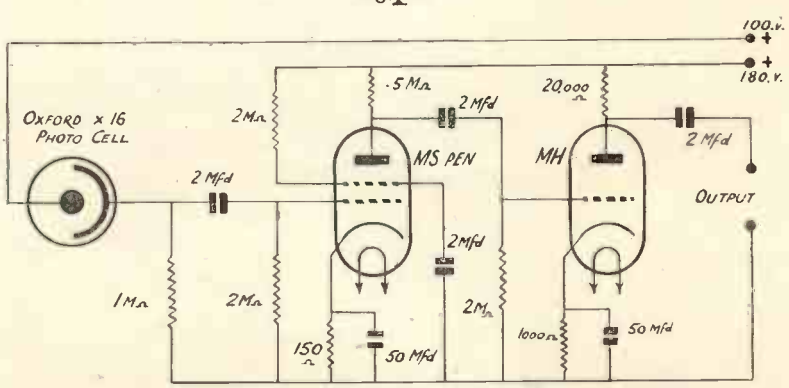
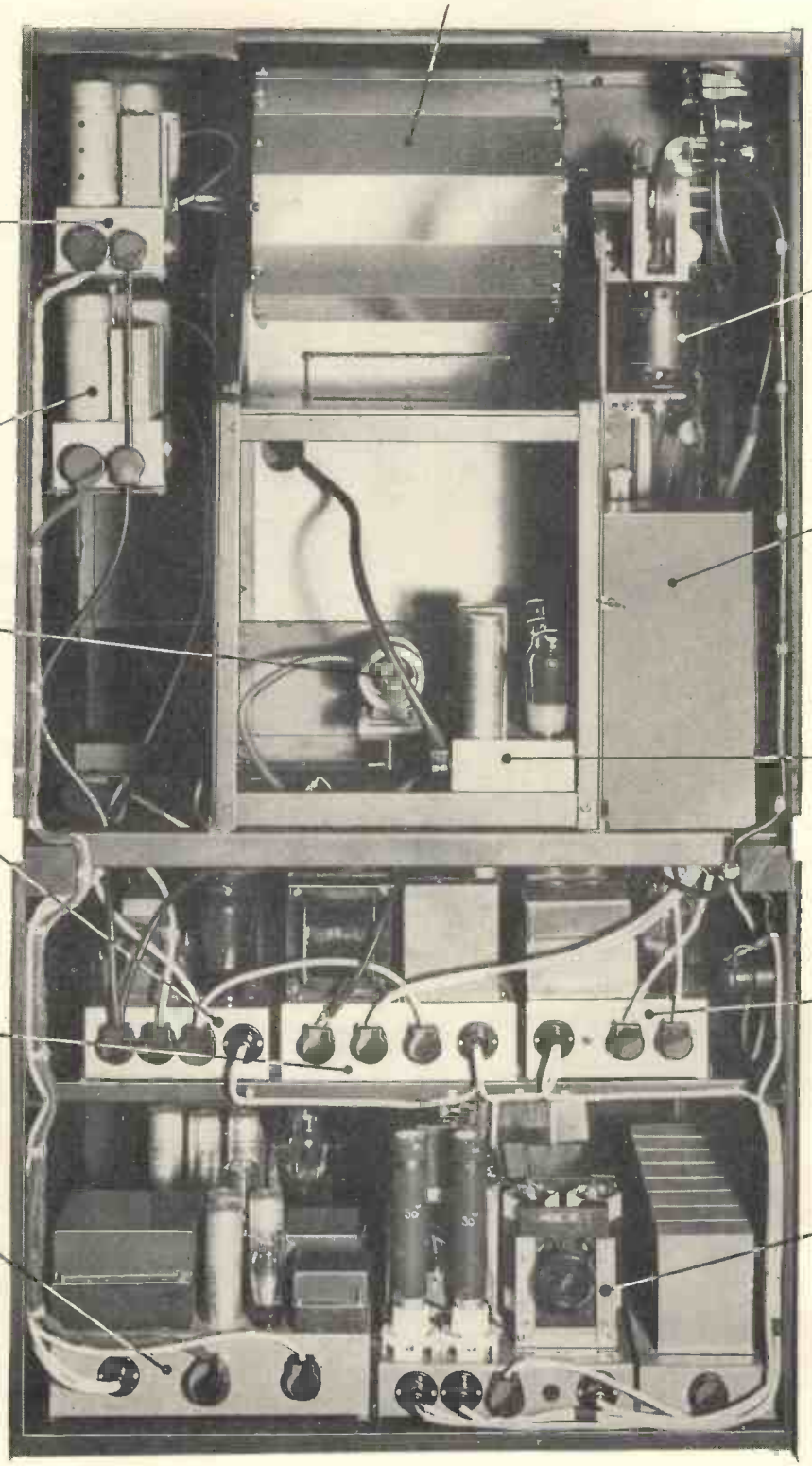



Fig. 16. A simple amplifier with good characteristics from 10 to 20,000 cycles.

# INTERIOR (BACK) VIEW OF SCOPHONY MECHANICAL-OPTICAL HOME RECEIVER SHOWING ARRANGEMENT OF UNITS



# THE SCOPHONY HOME RECEIVER

## AN OUTLINE OF ITS CONSTRUCTION

ON the opposite page we show a photograph of the interior of the Scophony home receiver which, of course, is a mechanical-optical type. This receiver provides a picture size 24 in. by 22 in. and the following are the brief particulars.

### *Radio Apparatus*

For the reception of the two transmissions on the ultra-short waves from Alexandra Palace, two separate receivers are used.

For the sound, six valves are employed, utilising tuned radio-frequency amplification at carrier frequency. Anode-bend rectification is employed and is fed to two output valves which work the 10-in. loudspeaker.

Tuned radio frequency amplification is also used to receive the vision signals. Eight valves are employed of which four are R.F. amplifiers and two are diodes for rectification and synchronising separation.

### *Light-control Modulator*

The output from the radio receiver is via a low-impedance output valve and co-axial cable to the modulated oscillator driving the light control. The quartz crystal in the light control has a high fundamental frequency and the driving unit consists of video amplifier, oscillator R.F. amplifier, and D.C. reinsertion valve.

The R.F. amplifier valve is connected to the quartz crystal on the light control and is grid modulated by the video amplifier.

### *High-speed Scanner*

A high-speed motor rotates a small mirror polygon which produces the line scanning of the picture. It runs at a synchronous speed of 30,375 r.p.m. The motor itself consists of two separate sections built in one case. One section is an asynchronous motor to bring the motor quickly up to the required speed, and the other a synchronous motor to which are fed the synchronising signals suitably amplified from the vision radio receiver.

### *Low-speed Scanner*

A low speed scanner produces the frame scan of the picture. There are twelve mirrors on the scanner and this is driven by a synchronous motor running at 1,500 r.p.m. through a reduction gear to a final speed of 250 r.p.m. The power to drive the motor is obtained by amplifying the frame synchronising pulse obtained from the vision radio receiver.

### *Light Modulator*

The light control consists of a container, filled with a liquid, at one end of which is a quartz crystal. When the quartz is actuated by a modulated carrier frequency, the fundamental frequency of which is the same as that of the quartz, supersonic waves are set up at a speed corresponding to the velocity of the sound waves in that particular liquid. The container has on either side of it a lens, and when light is passed through the container and focused on to a scanner and from the scanner on to a screen with suitable lenses, an image of the light control itself can be formed on the screen, the width being the width of one line of the picture and the length is determined by the length of the light control liquid column. When modulation is applied to the quartz crystal nothing will be seen on the screen until the scanner which is between the screen and the light control is rotated at such a speed that it follows the speed of the ultra sonic waves in the liquid exactly. The modulation then becomes visible on the screen. A large number of scanning spots can thus be used simultaneously.

### *Light Source*

The light source is a super high-pressure mercury lamp which is operated from a D.C. source of 80 volts with a consumption of 3½ amperes; the total power consumption is approximately 300 watts. The brilliancy of this light source is more than treble that of a carbon arc using the same power.

The mercury lamp is focused on to the light control, from the light control to the high speed scanner (a stainless steel polygon) and from there on to the low speed scanner which gives the picture repetition frequency, and finally through a projection lens on to the 2 ft. screen.

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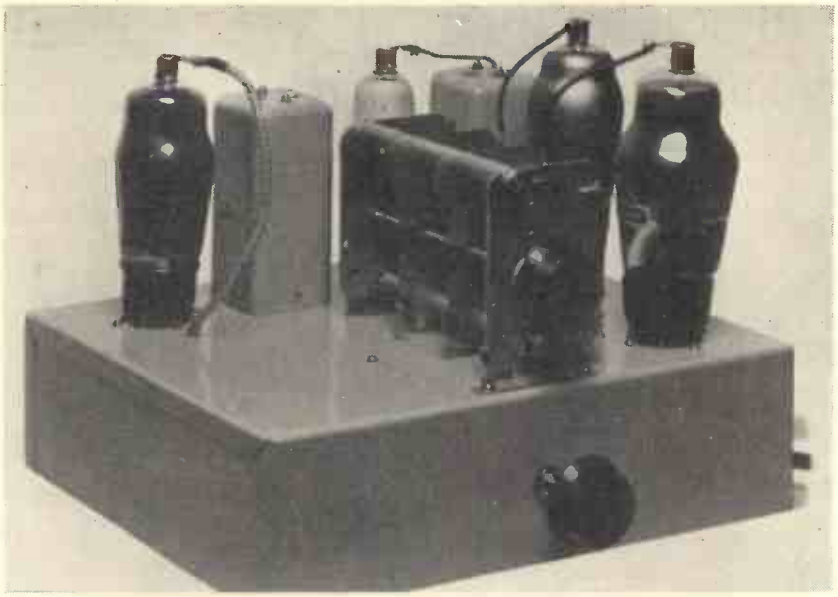
## Book Review

*Principles of Electricity and Magnetism*, by Gaylord P. Harnwell (The McGraw Hill Book Co., Aldwych House, London, W.C.). From the title of this book it might be assumed that it is a text-book on magnetism and electricity of the type with which everyone is familiar. It is a text-book, but it differs so widely from forerunners that its title does not in any way convey an idea of its scope. Whilst it is theoretical, it is also experimental and the subjects with which it deals are presented in a manner which has not been attempted before. The book provides a link between theory of the past and modern theory and practice. A brief résumé of the main subjects will indicate the scope of the work and these are as follows:—Electrostatics, Electrostatic Energy and Dielectrics, Physical Characteristics of Dielectrics and Conductors, Direct-Current Circuits, Nonohmic Circuit Elements and Alternating Currents, Chemical, Thermal and Photoelectric Effects, Thermionic Vacuum Tubes, Electrical Conduction in Gases, Electromagnetic effects of steady currents, changing electric currents and electromagnetic Reactions, Magnetic Properties of Matter, Electromagnetic Machinery, Simple Circuits Containing Inductance, Capacitance and Resistance, Coupled Circuits, Filters and Lines, Vacuum Tube Circuits, Radiation, and they are all dealt with in the light of present-day knowledge.

The book will be found invaluable to the student who desires to obtain a knowledge of the whole conception of modern electrical development irrespective of any particular branch of the science. In all there are over 600 pages and the price is 30s. It is a book that can be highly recommended to the serious student.

*This receiver has been designed to have a good frequency response and details are given showing how it can be modified to include a good quality push-pull output*



*stage. It only covers the television sound channels and adjacent frequencies, and is not intended for amateur use on five and ten metres. The designer is R. K. Budge.*

# A FOUR-VALVE SUPER-HET FOR TELEVISION SOUND

MANY of our readers have built vision receivers but so far have not constructed the sound section or at the best have made use of temporary superhet convertors. While this is satisfactory, inasmuch as sound broadcasts can be received, there is no possibility of taking advantage of the high quality that is possible with the Alexandra Palace transmissions with this type of apparatus.

It will be appreciated that unless a receiver is designed with the I.F. amplifiers having a wide band width and with little top note attenuation on the low-frequency side, the quality received from Alexandra Palace will be little or no better than that received from an ordinary broadcast station.

It is essential that constructors have a suitably designed receiver for picking up the 7.23-metre sound transmissions which accompany the 6.6-metre vision transmissions.

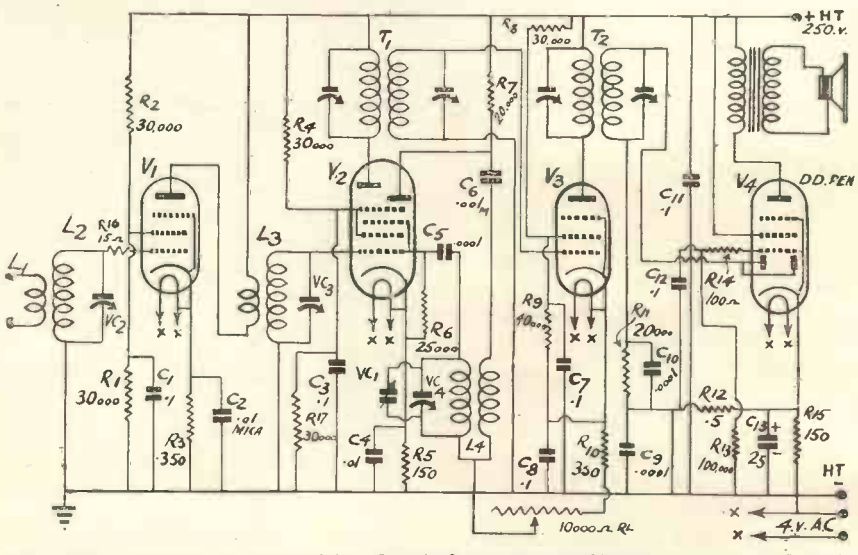
A receiver for these transmissions departs from normal in that high selectivity is undesirable, especially when the receiver is a superhet. Normally, the selectivity of a superhet receiver is dependent upon the gain and band width of the I.F. amplifier employer, and if it is high, any slight changes in oscillator frequency will, of course, detune the receiver with resulting poor quality.

The receiver to be described is a superhet with a wide band width I.F. amplifier operating at 2 megacycles using I.F. coils specially designed to provide this band width.

## The Circuit

On this page is shown the theoretical circuit finally chosen for this receiver. It consists of a high-slope R.F. pentode with a fixed grid base, in the grid circuit of which is a conventional tuned circuit with the contional loosely coupled primary, so making it suitable for use with a di-pole aerial. Also notice resistor R16 in series with the grid of this valve which has a value of 15 ohms. This resistor is not generally necessary but as it it possible for parasitic oscillation to be present it was considered necessary to include this refinement in order to prevent any possibility of trouble in this respect.

It is also important that the correct voltage be applied to the screen of this pentode, otherwise there is possibility of instability and/or loss in stage gain. This voltage must be steady so for this reason a fixed




**The receiver includes one stage of tuned radio frequency amplification to provide adequate volume when used outside the recognised service area.**

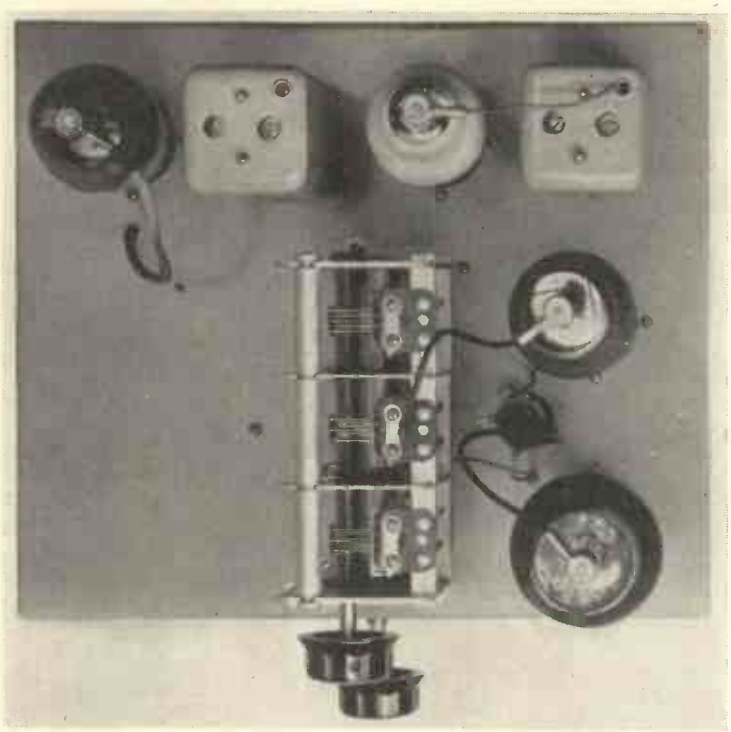
potentiometer network has been included, and is made up of R1 and R2 both of which have a value of 30,000 ohms. In this way, the voltage applied to the grid is 100 volts, provided of course the power supply gives approximately 250 volts.

Also notice the inclusion of R3, a cathode bias resistor having a value of 350 ohms which is by-passed by C2, a mica condenser having a capacity of .01 mfd. This cathode bias resistor supplies sufficient bias to the R.F. pentode so that it operates on the correct portion of its characteristic curve and works under optimum conditions.

The R.F. stage is coupled to the triode hexode frequency changer by a tuned transformer which has proved to be most satisfactory on the higher frequencies. It is to be recommended in preference to the popular tuned grid arrangement whereby most of the efficiency is governed by the choke employed.

The secondary of this transformer is tuned by VC3 which is the second section of the three-ganged condenser. Each section of this condenser is especially made for this receiver and has a capacity of 30 mmfds.

While on the question of tuning, it is interesting to note why a three-ganged condenser of this type has been included in a receiver designed for the reception of one station. It is common practice in commercially-built receivers for television sound permanently to tune the signal circuits with pre-set condensers and to have a small variable condenser for the oscillator. The fact that a variable is required for the oscillator shows at once the advantage of the ganged condenser.



**A special three gang condenser is used, each section having a maximum capacity of 30 mmfds. The valve in the left-hand corner is the output pentode and double diode detector. To the right is the intermediate-frequency pentode and this is followed by triode-hexode frequency changer and pentode R.F. amplifier.**

A modified form of Colpitt's oscillator is employed and in this arrangement, as can be seen from the theoretical circuit, both the grid and anode coils have one side at earth potential; this enables VC4 to be grounded along with VC3 and VC2. Connected in parallel with VC4 across the oscillator grid circuit is VC1, a small postage-stamp type of trimmer having a maximum capacity of 30 mmfds. The position of this trimmer can be seen from the illustration as it is actually fitted across the former on which is wound L4.

Component values in the detector-oscillator stage are also important and should be strictly adhered to. The screen voltage for the hexode section of V2 is again obtained by means of a fixed potentiometer network made up of R4 and R17, both of which have a value of 30,000 ohms. The junction of these two resistors is by-passed to earth by means of C3, a condenser having a value of .1 mfd.

No variation can be made in the value of C5, the oscillator grid condenser, and R6, the grid resistor in this circuit. C5 has a capacity of .0001 mfd. and is of the mica type, while R6 is 25,000 ohms and is of the half-watt type.

Voltage to the anode of the oscillator section in V2 is fed through a resistance of 20,000 ohms, while the anode coil L4. is coupled to the anode of V2 by means of C6, a mica condenser having a capacity of .001 mfd.

That completes the circuit of V2. Next comes an interesting point in the intermediate frequency transformer, T1, which, as previously mentioned, is tuned to 2 megacycles and has a band width in excess of 20 kc. This transformer has been specially built for the receiver and the trimmer condensers across primary and secondary are mounted as an integral part of the coil unit.

The earthy side of the secondary of T1 is taken directly under the chassis and the other end of this winding is connected directly into the control grid of V3. This valve is another R.F. pentode but has variable-mu characteristics so that the gain in the I.F. stage can be controlled. This control takes the form of a potentiometer varying the cathode bias voltage to the I.F. valve. This potentiometer is not of the normal pattern obtained by constructors as much as it is of the reverse log type. With this type of volume control as it is adjusted in an anti-clockwise direction a gradual control of voltage is obtained so that the volume is reduced gradually and not abruptly as with volume controls in many short-wave receivers.

In order that the valve operates under optimum conditions there is a fixed bias always applied by means of R10, a resistor having a value of 350 ohms. This particular valve, an MVS/PEN/B, does not give maximum amplification with zero bias. Although the correct bias can be obtained by means of the volume control potentiometer; without the cathode bias resistor R10 a maximum gain would be obtained before the control had reached the full clockwise position.

The second I.F. transformer, T2,

is identical in construction with T1, except that the hot end of the secondary is also taken through the bottom of the chassis with the remainder of the connections. The primary is connected in exactly the same manner as the primary of T1, but with the secondary, as it is, feeding into a diode rectifier, there is a slight change in circuit.

Notice in particular the resistance R11 and its associated by-pass condensers C9 and C10 which are included as a filter to prevent I.F. reaching the output circuit via the diode rectifiers.

Next comes the diode load resistance, R12 which has a value of .5 megohm, this value having been found to be the most satisfactory. It will be seen that this is returned to the cathode of the double-diode pentode in order to provide the correct operating voltage for the diodes.

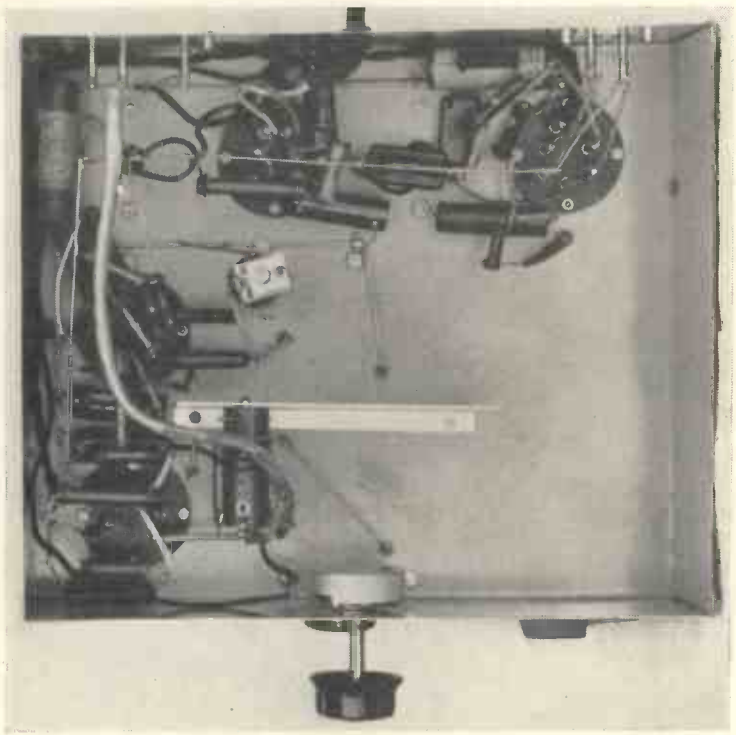
V4, which is actually a diode rectifier and pentode output valve combined, has been used in order to reduce the number of valves employed. Readers will appreciate that it would have been quite normal procedure to use a double-diode rectifier with a separate pentode output stage. This would have meant two valves instead of one and two valve holders.

At this point it is well worth mentioning that space has been left on the chassis with a definite object in mind. Arrangements have been made with the manufacturers to drill two additional valve holder holes on the left-hand side of the chassis in order that an extra audio amplifier can be included by those readers who require an additional gain or who live a considerable distance from Alexandra Palace.

Field strength even at 10 to 15 miles from Alexandra Palace may not always be sufficient and therefore extra amplification may be required. Should constructors find that they have difficulty in fully loading the pentode from the double-diode, then the extra triode amplifier should be included. In this case, the diodes in the output pentode are ignored and rectification effected in the double-diode triode. Then the only additional components required would be the valve, one condenser, two resistors and the valve holder.

Alternatively, it is quite an effective scheme to use a push-pull output stage using a double-diode triode as the first audio stage. In this way, excellent reproduction would be assured with quite a high wattage output. It should be remembered, however, that the additional push-pull valves call for a power unit which will supply sufficient anode current for the two valves employed. This raises one small problem if the 250-volt power unit will only supply 60 mA. In such circumstances a 350-volt power unit which would give 120 mA. should be used the excess 100 volts being dissipated through a 1,250-ohm D.C. type moving-coil loudspeaker.

However, those who construct the receiver strictly to specification will find under normal circumstances that there is ample gain for those living in the service area and also at considerable distances from Alexandra Palace when local conditions are favourable.



**View of underside. Mounted on the small screen is the grid coil for the R.F. amplifier, around which is coupled the winding for the dipole aerial. Notice that the leads to the dipole coil are fully screened.**

### Components for A 4-VALVE SUPERHET FOR TELEVISION SOUND

**CHASSIS.**
1—Steel 10¾ × 9 × 3 ins. drilled and finished grey (Peto-Scott).

**COILS.**
1—Aerial coil with primary winding (L1 and L2) (Peto-Scott).
1—R.F. coupling coil (L3) (Peto-Scott)
1—Oscillator coil (L4) (Peto-Scott).

**CONDENSERS, FIXED.**
1—.1-mfd. type 4603/S (C1) (Dubilier).
1—.01-mfd. type 691W (C2) (Dubilier).
1—.01-mfd. type 691W (C3) (Dubilier).
1—.01-mfd. type 691W (C4) (Dubilier).
1—.0001-mfd. type 690W (C5) (Dubilier).
1—.001-mfd. type 690W (C6) (Dubilier).
1—.1-mfd. type 4603/S (C7) (Dubilier).
1—.1-mfd. type 4603/S (C8) (Dubilier).
1—.0001-mfd. type 690W (C9) (Dubilier).
1—.000-mfd. type 690W (C10 (Dubilier).
1—.1-mfd. type 4603/S (C11) (Dubilier).
1—.1-mfd. type 4603/S (C12) (Dubilier).
1—25-mfd. 25 volt working type 3016 (C13) (Dubilier).

**CONDENSERS, VARIABLE.**
1—30-mmfd. type 340120 (VC1) (Dubilier).
1—3-gang U.H.F. condenser (VC2, VC3 and VC4) (Jackson Bros).

**CONNECTORS. VALVE,**
4—Type P41 (Bulgin).

**HOLDERS, VALVE.**
4—7-pin chassis type V1 less terminals (Clix).

**RESISTANCES, FIXED.**
1—30,000 ohm 1 watt (R1) (Erie).
1—30,000 ohm 1 watt (R2) (Erie).
1—350 ohm 1 watt (R3) (Erie).
1—35,000 ohm 1 watt (R4) (Erie).
1—150 ohm 1 watt (R5) (Erie).
1—25,000 ohm ½ watt (R6) (Erie).
1—20,000 ohm 1 watt (R7) (Erie).
1—30,000 ohm 1 watt (R8) (Erie).
1—40,000 ohm 1 watt (R9) (Erie).
1—300 ohm 1 watt (R10) (Erie).
1—20,000 ohm ½ watt (R11) (Erie).
1—.5 megohm ½ watt (R12) (Erie).
1—100,000 ohms ½ watt (R13) (Erie).
1—100 ohm ½ watt (R14). (Erie)
1—150 ohm 1 watt (R15) (Erie).
1—15 ohm ½ watt (R16) (Erie).
1—30,000 ohm ½ watt (R17) (Erie).

**RESISTANCE, VARIABLE.**
1—10,000 ohm potentiometer (Reverse log) (Erie).

**SUNDRIES.**
2—1½ in. knobs with ¼-in. insets. (Peto-Scott).
1—Aerial Earth strip (Peto-Scott).
1—Loudspeaker strip (Peto-Scott).
1—4-wave cable with plug (Peto-Scott).
2—Feet screened cable (Peto-Scott).
½—lb. 16 gauge tinned copper wire (Peto-Scott).
10—Feet sustoflex (Peto-Scott).

**TRANSFORMERS, I.F.**
2—Special type 2.0 Mc. frequency (T1 and T2) (Peto-Scott).

**VALVES.**
1—41MPT (V1) (Cossor)
1—TX4 met. (V2) (Tungsram).
1—MVS/Pen/B met. (V3) (Cossor).
1—AC/ZDD (V4) (Hivac).

A complete kit of components or a completely wired receiver can be obtained from Messrs. Peto-Scott Ltd., Pilot House, Church Street, Stoke Newington, N.16.

# BAIRD RECEIVERS SET A PERFORMANCE STANDARD BY WHICH OTHERS ARE JUDGED

Model T.18 is a complete Television Receiver combined with a very selective and high quality All-wave Radio, yet the compact cabinet housing the complete equipment is little larger than the usual Table Radio. The most recent developments in Television design are included, yet the price is below that of many modern Radio-gramophones. The set is easy to operate—and without any technical knowledge you can be confident of good results.

**TELEVISION CONTROLS :** These have been reduced to one which operates the Picture Contrast, and this will only need very occasional adjustment.

**TELEVISION SOUND AND RADIO :** The sound receiver is a super-heterodyne covering the Television sound waveband, and three bands for Radio programmes (Short : 16.5—51 metres ; Medium : 198—550 metres ; and Long : 850—2,000 metres). It is possible to receive the sound on the Television waveband either with or without the Picture by means of a switch integral with the Picture Contrast control. For Radio, stations are calibrated by name, and each waveband is individually illuminated. The reproduction is exceptionally fine since the set is capable of delivering an 8 watt quality output.

**PICTURE SIZE :** 10 in. wide by 8 in. high. Viewed direct.

**POWER CONSUMPTION :** 150 watts.

**CABINET :** The cabinet measures approximately 25 in. high, 18 in. wide and 16 in. from back to front. It is attractively designed as illustrated and is standard in walnut.

**PRICE 44 GNS.**

# DEMONSTRATIONS ARRANGED

**PRICE 35 GNS.**

Model T.20 proves that Television for home installation need be neither a complicated nor a costly business, for here is a complete receiver no larger than a Radio set, yet capable of giving an excellent picture with all that wealth of detail for which Baird receivers are known, together with quality sound reproduction. Controls have been reduced to a minimum and no skilled technical knowledge is needed to operate the set and get the best out of it.

The very attractive price should make this model the means of bringing Television into many homes where the interest of this most modern source of entertainment has as yet not been enjoyed.

**CONTROLS :** The T.20 has two main controls on the front of the cabinet. Picture Contrast and Sound Volume.

**POWER CONSUMPTION :** 150 watts.

**SOUND :** A superhet radio receiver is fitted and this is pre-set to receive Television sound.

**PICTURE SIZE :** 7¾ in. wide by 6¼ in. high. Viewed direct.

**CABINET :** The Walnut Cabinet measures approximately 22 in. high, 18 in. wide and 13 in. from back to front. It is beautifully made and well finished.

*Send for full descriptive literature. Post Free.*

# BAIRD TELEVISION LTD.

## Lower Sydenham, London, S.E.26

*Telephone:* HITHER GREEN 4600. *Telegrams:* TELEVISOR, FOREST, LONDON.

# Scannings and Reflections

## THE RELAY AERIAL

THE St. Pancras Highways Committee has recommended the Council to approve the erection by the B.B.C., of a 150 ft. ultra-short wave receiving mast for television relays on a site on the north-east corner of Swain's Lane and Bisham Gardens.

There has been considerable local opposition to this project on the part of residents and owners of property and a letter in the local Press says: "The only consolation is that in due course interference to transmission caused by vibration from passing traffic and the working of an existing machine motor within a few yards may result in the television mast being moved to a less conspicuous and more suitable site."

## TELEVISION MURDER CLUE

Television was used last month for the first time to help to trace a murderer in Berlin. A picture of an overcoat belonging to a man who is wanted was televised on behalf of the Berlin police in an attempt to trace the owner. The coat was found lying beside the body of a taxi driver who was murdered last month in a lonely suburb on the outskirts of Berlin. The coat showed marks of a struggle and as it did not belong to the murdered man, it was assumed to belong to his assailant. The public were shown the coat, which has unusual padding on one shoulder and tailors were asked to attend Berlin's television booths to see if they could identify it.

## A NEW LIGHT RELAY (?)

An American has been granted a patent for a new television screen which consists of plate glass to which millions of short hairs are attached. It is claimed that ordinarily the hairs lie at different angles and form an effective screen which will not allow light to pass. A brilliant uniform source of light is to be provided and the hair coated glass scanned by a cathode beam in the ordinary way. The hairs receive varied charges, depending on the intensity of the beam and the inventor claims that electrically charged hairs have a tendency to stand erect and the effect is as though valves are opened to varying degrees, allowing light of various intensities to pass through the glass screen.

## TELEVISION'S SECOND BIRTHDAY

Wednesday, November 2, was the second anniversary of the regular television service from Alexandra Palace. The Television Festival Dinner was arranged for the same day, and as described elsewhere in this issue, was the occasion of a special programme which was witnessed by H.R.H. The Duke of Kent.

## WTMJ AND TELEVISION

The Journal Company, New York, which publishes the *Milwaukee Journal,* and operates radio station WTMJ Saturday has filed with the Federal Communications Commission an application for a licence to operate a television station for the purpose of transmitting a regular schedule of programmes. The Journal says that it acts at this time because experiments and investigation have shown that television has developed beyond the laboratory stage and is now ready as a service to the public, and it is planned thoroughly to study television and its programme technique by broadcasting programmes of every conceivable type and kind, and determine the degree of service which television has to offer to the public.

Fifty television sets of various types are to be installed in homes and public places where the programmes may be viewed at the Journal's expense. A power of 1,000 watts is to be used.

## TELEVISION AT CHRISTMAS

Television's Christmas season of studio productions will open with Gordon Daviot's historical drama, "Richard of Bordeaux," in the evening of December 18, with Gwen Ffrangçon-Davies in her original part as the Queen. The play will be produced by Michael Barry.

On the following afternoon, Stephen Thomas will present "The Knight of the Burning Pestle," by Beaumont and Fletcher, an Elizabethan comedy which stages a play within a play, with interruptions from the audience. A high-flown drama of thwarted love is thus reduced to something which has been described as "period panto."

In the evening of December 19, Reginald Smith will present "Review of Revues," featuring Phyllis Monkman, Edward Cooper, Queenie Leonard and other stars of the "Re-view" shows, which have now reached their seventh edition.

Edgar Wallace's detective play, "The Ringer," will be televised in the afternoon of December 21 and evening of December 27. In the evening of December 21 Spike Hughes' burlesque pantomime, "Cinderella," will be presented by Dallas Bower. This was originally broadcast last Christmas.

In the evening of Christmas Day Noel Coward's comedy, "Hay Fever," will be presented by Reginald Smith, with Kitty de Legh playing Marie Tempest's original part of Judith Bliss.

In the afternoon of Boxing Day, "Once in a Lifetime," the brilliant comedy of Hollywood life, by Moss Hart and George Kaufmann, will be presented by Eric Crozier, with Joan Miller and Charles Farrell in the leading parts. This is the first television play to run into five performances.

In the afternoon of December 28, Denis Johnston will present his own play, "The Moon in the Yellow River."

## G.E.C. (AMERICA) TO STUDY BRITISH TELEVISION

E. H. Vogel, manager of the radio division of the General Electric Co., of New York, is now in Europe for the purpose of studying television facilities, developments, and experience in Europe, particularly in England, France and Germany. He expects to be here for six weeks, and will not only investigate transmitting and receiving equipment but will

# MORE SCANNINGS

discuss commercial television experience and plans with various European agencies and G-E affiliated companies. "We are not primarily interested at this time in engineering or scientific developments related to television," said Mr. Vogel. "What we want to know is how British audiences react, for instance, and how television is set up economically, both for transmitting and for receiving equipment—also what are its effects on radio and motion pictures."

## WIRELESS RETAILERS AND TELEVISION

The Wireless Retailers' Association National Council at a meeting held on October 26 discussed the future policy to be adopted towards television. It was decided to call meetings of dealers in the television area to discuss matters relating to television and decide the future policy after these discussions.

## TELEVISION IN ITALY

In the plans for Italy's new Broadcasting Headquarters at Milan provision is made for television, and three studios have been designed for visual broadcast.

## BRITISH TELEVISION FOR THE EIFFEL TOWER

Extensive changes are to be made in the transmitting equipment at the Eiffel Tower, for a decision has been made to instal the Marconi-E.M.I. system as used at the Alexandra Palace. The apparatus, however, will be supplied by the French Thomson-Houston Co., which controls the rights in France of the E.M.I. Co. The cost is estimated to be £90,000.

## AMERICAN FILM COMPANIES AND TELEVISION

Three major film companies in the U.S.A. are linked up with television development. These are RKO-Radio Pictures with R.C.A. Television, Warner Bros. with Trans-American Broadcasting and Television Corp., and Paramount Pictures with Allen B. Du Mont Labs., Inc.

Paramount now owns half of the Du Mont concern and supplies finances for furtherance of Du Mont patents and developments. A Du Mont receiver which it is expected can be sold at a little over $100 was demonstrated recently.

## WIRELESS LICENCES STILL INCREASING

The Post Office issued 1,115,794 wireless receiving licences during October, 1938. This figure represents a net increase of 71,241 in the number of licence holders during the month, after making allowance for expored licences and renewals. This is the greatest monthly increase since January, 1937.

The approximate total number of licences in force at the end of October, 1938, was 8,828,200, as compared with 8,370,410 at the end of October, 1937, an increase during the year of 457,790.

## "AN ELEPHANT IN ARCADY"

On December 4 the whole of the cast of "An Elephant in Arcady," Eleanor and Herbert Farjeon's musical play now running at the Kingsway Theatre, will give a television matinée. The large cast includes Irene Eisinger, Frederick Ranalow, Percy Parsons, Elizabeth Darbishire, Eric Starling and Linda Gray.

## SCOTLAND YARD AND TELEVISION

As a result of the use of television by the Berlin police in the hope of tracing a murderer it is stated that officials at Scotland Yard are studying its possibilities in the location of "wanted" persons.

## TELEVISION EXPENDITURE

On November 14 the Postmaster-General (Major Tryon) in a written reply to Mr. Rostron Duckworth, said he was informed by the B.B.C. that the capital expenditure incurred on the television service up to September 30, 1938, less depreciation written off, was approximately £126,000, and that the revenue expenditure up to that date, including depreciation and programe, engineering, and staff costs, was approximately £660,000.

The question of introducing a special licence was reviewed from time to time by the Television Advisory Committee, but they did not consider that such a course would be desirable at the present stage of development of the service.

Major Tryon further said he had no precise information regarding the number of television receivers in existence, but understood, however, that the Television Advisory Committee received confidential information, from time to time, from the Radio Manufacturers' Association concerning the total number of sets sold by members of the association.

## CINEMA TELEVISION

Mr. Wolfe Murray, the new public Relations Officer for the B.B.C. Television Service, speaking on television at the Women's Advertising Club dinner, said: "As far as I know, the Corporation does not envisage anything in the way of a cinema end to it. We do not envisage large halls where people will look at a television on 24 ft. screens. It is purely a service where people look at television by their own fireside. And for that type of entertainment the individual artist rather than large companies is eminently suited."

We understand, however, that a special demonstration is to be given to the Television Advisory Committee.

## TELEVISION TALKS IN THE U.S.A.

The latest developments in television in the United States, and particularly the results of experiments and research by the Radio Corporation of America and the National Broadcasting Company, will be described for short-wave listeners during the week commencing December 11 over N.B.C. station W3XAL.

Dr. Fernando de Sa will be heard on Tuesday, December 13, from 5.45 to 6 p.m., EST, speaking in Portuguese, and Roberto Gatica on Friday, December 16, from 6.45 to 7 p.m., in Spanish. Both speakers are members of the N.B.C. International Division staff.

Their talks will be of particular interest in view of the fact that manufacturers in the United States now believe that television programme service, a field in which N.B.C. has pioneered, has reached a stage that will prove satisfactory to the public, and consequently expect to begin manufacturing television receivers for public distribution by next spring.

## AUSTRALIA AND TELEVISION

Proof of the interest in television in Australia is furnished by the experience of the British General Electric Co. (Pty.), Ltd., at Sydney. The company recently imported two types of television sets consigned by the parent company, the G.E.C. of England. The object was primarily to

## . . . . AND MORE REFLECTIONS

exhibit them for prestige purposes—as evidence of the important contribution made to television progress by the G.E.C.

Instead of confining an exhibition of the two sets to its own spacious showroom windows, the B.G.E.C. sought the co-operation of one of Sydney's largest emporiums. A display was staged which attracted large crowds day after day. Both sets were shown. In the case of the larger one, television reception was simulated by projecting on to the screen, from a hidden source, a sub-standard motion picture film. The chasis of the smaller set was removed from its cabinet to show the interior. Numerous photographs of the British television service being recorded and transmitted, with explanatory captions, were also shown. The interest of the public in these exhibits showing what is being done in England has been so great that the B.G.E.C. has decided to display the two television sets for various periods in many important towns throughout Australia.

### TELEVISION IN WAR

It has been known for some time that experts in Germany have been studying the use of television in time of war and on this account for a considerable period there was a great deal of reticence regarding television development in that country.

American experts, it is now stated, have also turned their attention to the matter. Television cameras installed in planes and balloons, or on hills overlooking enemy territory, it is thought, would be able to transmit to staff headquarters information of enemy activities.

### SCOPHONY IN U.S.A.

Considerable interest has recently been shown in Scophony large-screen television developments by some leading American radio and film interests. In this connection Mr. S. Sagall, founder and managing director of Scophony, Ltd., is now in America with the object of negotiating for a company there to take over the Scophony U.S.A. patent rights.

Incidentally, Mr. Sagall has been trying hard to get the Board of Trade to sponsor a representative British television exhibit in the British Pavilion at the New York World Fair; patent difficulties, however, affecting the majority of the proposed television exhibitors have apparently arisen, and the project has fallen through. Mr. Sagall will try while in New York to arrange for an independent Scophony exhibit at the World Fair.

### DON LEE BROADCASTING SYSTEM SELLS PATENTS RIGHTS TO R.C.A.

The General Manager of the Don Lee Broadcasting System has announced the sale of certain patents to the Radio Corporation of America. The patents cover inventions made by Harry R. Lubcke, Director of Television for the network, and include rights in the United States, Canada, Germany and Great Britain. The Don Lee System has reserved a licence to make, use or sell equipment embodying the principles of the patents in the several countries. The inventions involved are chiefly concerned with synchronising and cover means utilised at both transmitter and receiver.

The Don Lee television transmitter W6XAO has been on the air daily except Sundays and holidays since 1931. Ten and a half million feet of motion picture film has been televised and now, with a power of one kilowatt both studio and film broadcasts are made on regular schedule.

### THE VALUE OF LOW TRANSMITTING POWER

The well-known British amateur, G8MX, has been proving in no uncertain manner that the higher frequencies can be used for long-distance communication with very low power. With an input of 1 watt using a 100-volt dry battery he has been having two-way contacts with American amateurs on a wavelength of 10 metres.

On November 20th he contacted W8DST and received a QAS4 R5 report using a supply of 48 volts at 6 mA. equal to an input of .28 watt. Several other 10-metre stations have been worked on inputs of 2 watts while telephony has been used in each case.



### ALEXANDRA PALACE IN CHICAGO

Despite the fact that the Alexandra Palace sound transmissions on 7.23 metres are supposed to be quasi-optical, reports are still being received from long distances. The latest verified report is from near Chicago where W9ZHG is claiming consistent reception with a signal level of about 78 db. and free from noise. This reception has been consistent for the past three weeks so that now the Alexandra Palace transmissions are used as a marker and should they be received at good strength W9ZHG knows that the U.H.F. bands are open.

It is hoped that W9ZHG will be able to record these transmissions and to relay them back to Europe on the 28 mc. band.

### MICRO WAVES FOR ALTITUDE MEASUREMENTS

The normal system of measuring the height above ground of an aeroplane is not strictly accurate for if the plane is 500 ft. above a mountain of 2,000 ft. it shows the altitude of 2,500 ft. Two Japanese engineers have designed a direct reading radio-wave reflector calibrated in feet. This meter registers the height of the plane above the nearest surrounding objects so that it is invaluable when the plane is flying in mountainous country. A completely continuous indication of altitude by a steady pointer and dial is easily accomplished and altitude variations occurring during time intervals of a few milliseconds are clearly detected. It is accurate down to a height of only 14 ft. and the power consumption is only 3.9 watts.

### CINEMA TESTS

The Television Advisory Committee were recently shown a demonstration of large screen television installed by the Baird Company at the Tatler Theatre, London.

This is an initial step in the hope of removing the ban which now prevents the public showing of the television programmes in places of public entertainment.

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The study of television, broadcasting and film stagecraft is to be introduced at the Guildhall School of Music and Drama.

TELEVISION AND SHORT-WAVE WORLD

DECEMBER, 1938

# THE SUPERSONIC LIGHT VALVE SIMPLY EXPLAINED

*By M. J. Goddard, A.R.C.S., M.Sc., D.I.C.*

## AN ARTICLE DESCRIBING THE FUNCTIONING AND CONSTRUCTION OF THE SCOPHONY LIGHT MODULATOR

*This article describes in simple language the method of operating the supersonic light relay and gives details of its construction.*

DURING the last few years a form of light valve has been developed which is particularly suitable for use in television reception. Its action depends firstly on the diffraction effects produced in a beam of light by the presence in its path of a body possessing periodic structure, and secondly on the properties possessed by certain crystals of giving a mechanical response to electrical stresses.

The first of these effects is exemplified by the well-known diffraction grating. In this the beam of light

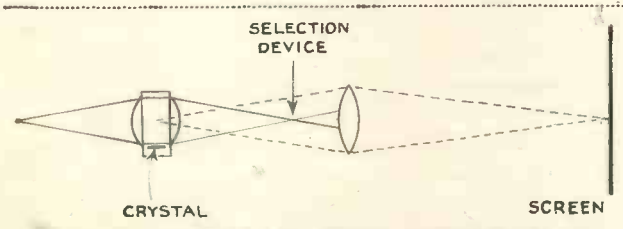



**Fig. 1.—Arrangement of optical system and selection device.**

is allowed to fall on a structure consisting of regular bands, alternate bands being opaque and transparent (or reflecting). The transparent bands act as separate sources of light, the waves from which mutually interfere, so that the light leaving the grating consists of a central beam of white light surrounded by coloured bands, known as diffraction bands. The angular displacement of the bands depends on the separation of the elements of the grating. The amount of light travelling in the central beam and in the diffraction bands respectively, depends on the structure of the grating and can be calculated for gratings of simple structure. The sum total in the central beam and all the diffraction bands is (neglecting absorption by the grating) equal to the amount of light incident on the grating.

Those familiar with the theory of microscopy will be aware that a similar effect is produced if the ordinary diffraction grating is replaced by a body possessing a structure of periodically varying refractive index. The explanation of this effect is slightly more complicated than that produced by the simple grating. It depends on the fact that the light passing through the parts of the medium having higher refractive index travels more slowly than that passing through parts having lower refractive index, which means that the phase of the light passing through the more refractive parts is retarded with respect to that passing through the less refractive parts. This causes diffraction bands whose angular separation is determined by the spacing of the grating elements, the magnitude of which may be called the " grating constant," exactly as in the case of an ordinary diffraction grating, but the quantity of light in the bands and in the central beam now depends on the magnitude of the variations of refractive index which constitute the grating.

The incident light may be transmitted entirely in the central beam if the variations are suitable, while on the other hand the light travelling in the central beam may be reduced to zero, so that all the incident light is transmitted in the various diffraction bands. If the magnitude of the variations of refractive index can be varied, then the amount of light travelling respectively in the central beam and in the diffraction bands can be controlled, although the sum total of the two amounts is always constant.

### *How the Light Valve Functions*

This provides the basis for a light valve. The beams of light are brought to a focus, thus forming a central white band with diffraction spectra on either side. At the focus a selection device is placed. This consists either of a slit which blocks out the diffraction bands and allows the central beam to pass, or of a wire which blocks out the central beam and allows the diffraction bands to pass. In either case the amount of light which gets past the selection device can be varied from zero

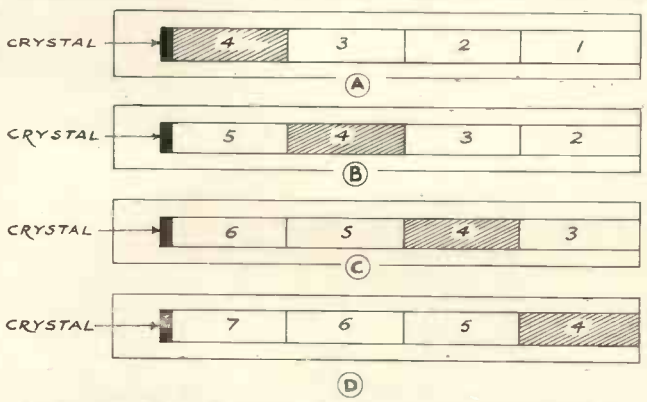



**Fig. 2.—Diagram showing the cell at consecutive element periods.**

to equality with the amount incident on the grating (neglecting absorption losses) by varying the magnitude of the variations of refractive index constituting the grating.

We must now turn to see how such a grating with variable variations of refractive index can be produced.

It is well known that, if an electric potential is ap-

# CONSTRUCTION OF THE LIGHT VALVE

plied across a crystal, such as quartz or tourmaline, the crystal will either expand or contract in proportion to the electric potential applied. If an alternating potential is applied, the crystal will vibrate, and if the frequency of the alternating potential corresponds to the mechanical resonance frequency of the quartz crystal, vibrations of considerable magnitude may be produced.

These vibrations are partially transmitted to the medium surrounding the quartz in the form of supersonic " sound " waves of compression and rarefaction travelling through the medium. If the medium is transparent to light, the refractive index of the compressed portions will be higher than that of the rarefied portions. If the medium is a liquid, the waves may travel for several centimetres without serious attenuation.

A grating of the form required has then been set up

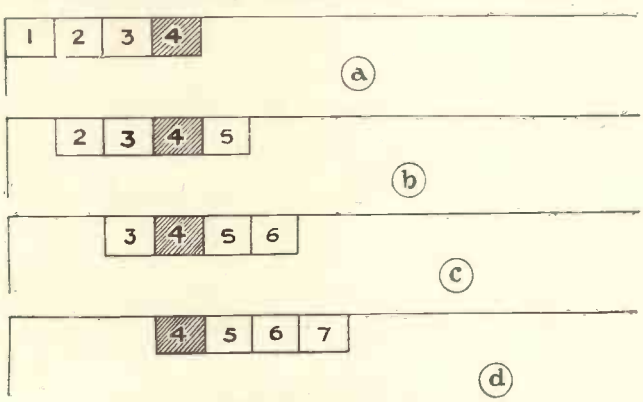



**Fig. 3.—Diagram showing screen at consecutive element periods.**

in the liquid, and the magnitude of the variations of refractive index can be controlled by varying the electric potential applied across the quartz crystal. This effect was first demonstrated by Debye and Sears in 1932.

We may now recapitulate, and show how these phenomena are used to construct a television light valve. This was first suggested by Karolus in German Patent No. K 126,231 VII/21a¹ (32/50) of July 13, 1932.

A quartz crystal is immersed in a liquid, and subjected to an alternating electric potential, the amplitude of which can be varied but the frequency of which is the resonance frequency of the quartz crystal. Vibrations are set up in the crystal, which produce waves in the liquid, these waves constitute in effect a moving grating consisting of alternations of higher and lower refractive index. A beam of light from a suitable light source is rendered parallel and passed through the liquid at right angles to the direction of propagation of the supersonic waves. Diffraction bands are produced, and are focused on to a selection device, which eliminates either the central beam or the diffraction bands. The grating influences only the angular direction of the diffraction bands, and not the position of the images, so that the motion of the grating has no influence on the effects produced in the image plane at the selection device. As the electric potential across the quartz is varied, so the amount of light passing the selection device is varied.

Suppose now a lens system is placed after the selection device to form an image of the liquid containing the grating (henceforth termed the " cell ") on a screen (Fig. 1).

If the potential on the quartz is such that all the light passes the selection device, then the image is bright on the screen; if it is such that none of the light passes the selection device, then the image on the screen will disappear; if it is intermediate between these values, the image will be illuminated, but less brightly than it is when all the light is passing the selection device. These three cases correspond to white, black, and grey respectively in a television picture.

If now the potential corresponding to white is applied, and is then suddenly changed to that corresponding to black, the wave-train in the cell corresponding to white is replaced by that corresponding to black, the latter following the former across the cell with a sharp line of demarcation between the two. On the screen a black patch appears at one end of the white image, and spreads across until the image has disappeared.

## *Immobilising the Spots*

The time taken for this to occur is, of corse, only a fraction of a second owing to the high velocity of the waves in the cell (about 1 kilometre per second). The velocity at which the waves travel across the cell is equal to the velocity of sound in the liquid because the electrical waves have now been converted into " sound " waves of inaudibly high frequency—hence the term supersonic waves.

Now if a television signal superimposed on a carrier of suitable frequency is applied to the quartz, then in the cell, a succession of short wave-trains passes through the liquid, each wave-train corresponding to one element of the picture. On the screen, a succession of illuminated elements, corresponding to the elements of the original picture passes across, at any instant a certain number of elements being visible simultaneously corresponding to the number of short wave-trains present simultaneously in the cell.

It is just as if in the plane of the cell a continuous film were passing, the elements of the original picture being recorded in succession on the film, and a certain finite number of these being illuminated and projected at any one time in the aperture of the cell.

With the system as described, any one element of the picture will move rapidly across the screen. This is useless for producing a picture. Accordingly a moving optical system—such as a system of mirror drums —must be set up to move the light beam in such a way that a given picture element remains at one fixed point on the screen. The function of this system is to counterbalance the motion of the waves in the cell, so that the image of any one wave is fixed on the screen. The result is that the image of the cell as a whole moves across the screen, and in fact behaves exactly like an enlarged scanning spot in a Kerr cell mechanical optical receiver.

To make this clearer it will be well to illustrate it by means of diagrams. Suppose for the sake of definiteness that there are four short wave-trains, each corres-

# OPTICAL EFFICIENCY OF THE SUPERSONIC LIGHT VALVE

ponding to one picture element, in the cell at any one time (in practice there are upwards of 50 in the cell). For shortness let us call the time taken to scan one picture element "one period." At a certain instant suppose the crystal is just beginning to produce picture element No. 1. Then four periods later it will have just finished producing element No. 4. The cell will then be as in Fig. 2a. Each division corresponds to one picture element, and consists of a comparatively small number of compression waves, or grating elements, of amplitude corresponding to the brightness of the picture element in question. The appearance of the screen is now as shown in Fig. 3a.

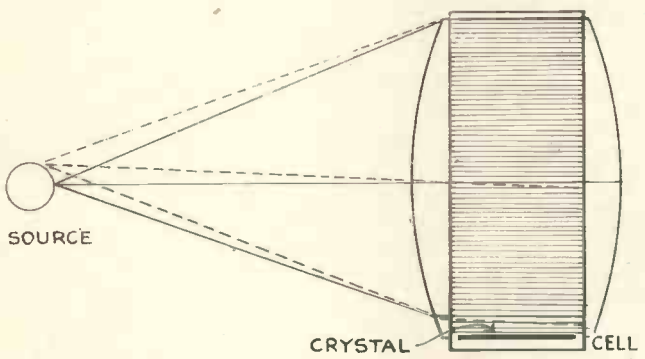



**Fig. 4.—Diagram showing how the light rays from different parts of the source deviate from the planes of the wave-fronts in the cell.**

One period later the cell will be as in Fig. 2b and the screen as in Fig. 3b. At the end of the two periods next following, the cell will be as shown in Fig. 2c and Fig. 2d, respectively, and the screen as shown in Fig. 3c and Fig. 3d., respectively, This should make quite clear how the system works.

So far we have considered the basic principles underlying the action of the supersonic light valve. We may now consider some of the finer details which govern the efficient working of the device as a television light-control.

## *Optical Efficiency*

Let us first consider the *optical efficiency* of the device, and the factors which limit this, we can here consider separately the plane parallel to the wave-fronts of the supersonic waves, and the normal plane parallel to the direction of propagation of the waves. In the former plane there is no limit to the amount of light which can be transmitted by the cell apart from the height of crystal which can conveniently be operated. The light in this plane need not be parallel in the cell, and an image of the light-source can be formed in this plane in the cell by means of a cylindrical lens. The angle of the cone of rays can be the maximum which can be handled by the lenses, and the image height can be equal to the crystal height. The latter is limited at high operating frequencies by the fact that the electrical capacity of the plates operating the crystal is proportional to the height, and a low capacity is required if an efficient circuit is to be produced.

In the other plane a completely different set of conditions prevails.

Let:

$V$ = velocity of waves in cell (velocity of sound in liquid).

$N$ = frequency of waves in cell.
= frequency of electric forces applied to quartz.

$\lambda$ = wavelength of light in cell.

$W$ = width of cell in direction of propagation of supersonic waves.

Then the light transmitted by the light-valve is proportional to $\frac{WN\lambda}{V}$, or to $\frac{WN}{V}$ as $\lambda$ is a factor over which we have almost no control. The width W of the cell is limited by the attenuation of the waves. For high efficiency we therefore require to use a liquid in which the waves travel as far as possible without appreciable attenuation, and which has a low sound velocity, and to apply a high frequency carrier to the crystal.

Unfortunately these factors are not independent. If the operating frequency is increased, the attenuation is also more pronounced, so that the two effects tend to cancel one another. The most satisfactory operating frequencies are of the order of 10 to 20 megacycles. The cell width which it is possible to use in such cases without excessive attenuation is of the order of 5 cms.

There is another factor, which must also be considered, and that is frequency response; that is the range of frequencies to which the crystal will respond without appreciable loss of amplitude. This should be at least 2 megacycles. The frequency response depends on the damping, which is greater for more viscous and heavier liquids; but in such liquids the attenuation is greater, and the sound velocity also usually greater. Thus liquids giving good frequency response are usually optically inefficient.

In practice a compromise must be made between the various factors. A liquid with moderate properties in all senses seems to be the best, and at the present time the most satisfactory of various liquids which have been tested seems to be ordinary commercial paraffin (kerosene). Water has certain advantages, but it is essential that the liquid should be electrically insulating, and water very readily becomes a conductor if traces of impurity have access to it, so that it is undesirable from this point of view.

So far we have taken into consideration the finite size of the source of light. If we consider rays from the centre of the source, then, after they are rendered parallel by the collimating lens, they all travel parallel to the wave-fronts in the cell (Fig. 4).

Rays from the edges of the source, however, do not travel strictly parallel to the wave-fronts. Thus, while each ray from the centre of the source passes through a region of the cell having constant refractive index, one from the edge passes through a region having variable refractive index. This alters the retardation of a ray passing through a wave-crest with respect to that passing through a trough, since these rays do not lie completely in a crest or trough respectively throughout the whole of their paths.

*(To be concluded next month)*

# SIR NOEL ASHBRIDGE (CHIEF ENGINEER B.B.C.) ON THE FUTURE OF TELEVISION

*On November 4 Sir Noel Ashbridge gave the Thomas Hawksley Lecture before the Institution of Mechanical Engineers and the following is an abstract of the concluding part in which he dealt with the future possibilities of television.*

SIR Noel opened his lecture with a brief historical survey of the development of television and then went on to explain the principles and apparatus used. He concluded by surveying future possibilities and probable trend of progress.

In any consideration of the lines on which television is likely to develop in this country, he said, one should perhaps begin by reviewing the results obtained under present conditions. One of the most important questions is, of course, the extent of the territory which can be covered. The Television Committee originally estimated that the London station would be effective up to a range of about 25 miles. The map shown here gives a rough indication of what might be considered the limiting range, based on measurements, and from this it will be seen that the committee's estimate has been materially exceeded. Not merely has it been exceeded on a basis of average range, but it has been found possible, under favourable circumstances, to obtain reception at very much greater ranges, of the order of two or three times that originally estimated. Various points where good reception has been obtained beyond what might be called normal range are indicated on the map. In any case it is clear that a population of some ten million people at least now have the opportunity of receiving regular television programmes, if they are able to provide themselves with receiving sets.

With regard to the probable range of future stations, this must depend to a large extent on three factors. First, the maximum power which it will be possible in use, second, the nature of the country which has to be served, and third, the wavelength channels which will be available.

## *Effect of Increased Power*

With regard to maximum power there seems no reason to doubt that it would be possible to erect a station with three or four times the power of the existing station, but it must be remembered that this only means that the strength at any equivalent point would be at the most double what it is with the existing power. Nevertheless it would increase the range by an appreciable distance. Then with regard to the nature of the country, in most of the densely populated areas in the provinces the country is more hilly than in the neighbourhood of London, and the extent to which this would adversely affect the performance of a station is at present difficult to estimate, but it must to a large extent prevent too optimistic an estimate particularly as applied to, say, Scotland, or the North of England.

Available wavelengths are the subject of international agreement, and briefly, the position at the moment is that one more station could be operated on a wavelength of a similar length to that now used, namely, 6 to 7 metres, but distinct from that employed at the Alexandra Palace. There is a possibility that, by agreement with neighbouring countries, a third separate channel of this type might be used. For any further stations beyond this number, however, it will be necessary either to place more than one station on the same channel, or at any rate on overlapping channels, or else to use a considerably shorter wavelength, which it may be expected would give a more or less limited coverage.


**Map of Service Area of London Television Station.**

**—·—·— Outer limit of normal reliable service area.**

**× Localities outside service area where good television reception has been experienced.**

# POSSIBILITY OF RELAYS

According to the new wavelength agreement which comes into force in September, 1939, it would be permissible to use one channel in the neighbourhood of 5 metres, and two more in the neighbourhood of 3 metres, and some five more in the neighbourhood of 1½ metres. This is, of course, in addition to the two or three channels in the neighbourhood of 6-7 metres already mentioned. According to present knowledge it would seem probable that satisfactory results could be obtained in the neighbourhood of 5 metres.

The outside broadcast link transmitter works on such a wavelength, and good results are obtained, but there is no doubt that when using such wavelengths it would be even more necessary to ensure placing the station on high ground, using a high mast. When lower wavelengths still are considered it must be expected that more screening from buildings and hills will be experienced, and it seems perhaps doubtful whether wavelengths as short as 1½ metres will be found to be usable for a broadcast service, except perhaps for comparatively restricted services where practically a visual path can be obtained.

## *Relay Stations*

Another highly important question is the means of linking one station with another. It would be perfectly possible to operate a number of stations entirely independently of each other, by radiating separate programmes from each, or by using film material produced in central studios. Here one must consider the financial and practical aspects, and the high cost of separate programmes on the one hand and the inconvenience of recording all television programmes on films on the other, would seem to point to the fact that linking between stations will be essential if a country-wide service is to be operated on a reasonably economical basis.

There are two possible ways of linking stations separated by a considerable distance, that is to say of the order of 100 miles or so. One is by special cable, and the other is by some form of wireless link. One type of special cable (balanced twin type) has already been mentioned in connection with outside broadcasts; there is, however, another type of air-spaced cable, which has been developed primarily for multi-channel telephony. This is known as the concentric cable and it consists essentially of a conductor within a metallic tube and insulated from it by air spacing.

For transmission over such a cable it is necessary to use a high-frequency carrier which is modulated by the modulation voltages in exactly the same way as for wireless transmission. It is not necessary, however, to use high power—in fact a power of a few watts is sufficient. Any convenient frequency may be used for the carrier since no disturbance in the ether can result from cable transmission. The difficulty of cable linking generally is not only the high cost of the cable itself, but also the frequent repeater points and the relatively complicated apparatus which is necessary at such points, and at each end of the cable. There are also technical difficulties in providing for the wide band of frequencies.

On the other hand, there are great advantages in that no ether space is occupied, and the success of the transmission is not subject to interference from motor cars or some other cause. It may even prove impracticable, however, to transmit the necessary wide frequency band over long cables with absence of phase distortion, particularly with the concentric type of cable using a carrier current.

## *Wireless Link*

The wireless link method has certain advantages from the point of view of simplicity and the faithful transmission of a wide frequency band. On the other hand it may be difficult to find a suitable waveband in which to place the linking transmitters. Again, the selection of sites for stations might be a matter of considerable difficulty if very short wavelengths were to be used. There is also the danger that under certain atmospheric conditions distortion of the picture might result from some kind of fading effect arising from reflections of the transmitted signal.

It would, of course, be necessary to confine transmission for linking purposes to a method employing narrow beams rather like a searchlight projector, and one may visualise the system as consisting of a number of transmitting and receiving stations each working from one hilltop to another about 50 miles apart. Both these methods of linking are now under active consideration, but considerable experimental work will be necessary before either can be used on a practical basis.

## *Picture Size*

The next question to consider is the fundamental one concerning the quality of the picture which can be produced. At the present time an excellent picture can be obtained of a size measuring, say, 10 in. by 8 in., using apparatus which is available commercially. The degree of definition (which depends, of course, on the number of lines used, as already explained) is such as to allow this picture to be viewed at a distance of 5 or 6 ft., without the imperfections due to lack of definition being objectionable to the average viewer. The definition, however, is not equivalent to what is obtained on the cinematograph screen and, owing to the wide popularity of the cinema, this fact is inclined to put television at a disadvantage, although one cannot regard the two forms of entertainment as being in competition.

To produce television with the same order of definition would necessitate the use of something like 1,000 lines, which in turn would mean the employment of a very much wider band of frequencies, introducing severe difficulties in the design of the transmitting and receiving apparatus. But what is perhaps even worse, it would necessitate the setting apart of a very much larger space in the ether. It must be remembered that there is now very severe competition between the various wireless services for permission to use wavelengths of the kind suitable.

The Television Committee has announced that the present standards will remain in operation for at least three years. One may, therefore, look upon present standards as being permanent for some considerable time to come. Moreover, there is some possibility of a gradual increase of definition up to a certain limit by improvements both at the transmitting and receiving ends, without any alteration in the number of lines. It is important to note, also, that such

(*Continued on page* 740)

# Television Digest

*Interesting Abstracts from the World's Television Literature*

## *The Electron Microscope*
## *Electronics (New York)*

THE great importance of the electron microscope lies in the fact that it extends the magnification and resolving power considerably beyond that obtainable with the visual or even the ultra-violet microscope.

The practical limit of magnification with the visual microscope is about 2,000×, whereas with the ultra-violet microscope, magnifications of 6,000× have been attained. Magnifications of as much as 30,000× have been obtained with the electron microscope, and the resulting photographs are sufficiently sharp and clear to permit an additional optical enlargement of 3×. Thus is it possible to obtain magnifications of the order of 100,000× and thereby make visible the form and outline of bacteria, viri, colloids and other very small particles which, up to now, could be detected only by the effects they produce.

The *modus operandi* of the electron microscope is indicated in the diagram which also shows the corresponding optical analogue. The essential elements consist of a source of radiation, the electron-optical system composed of properly constructed electric or magnetic fields which refract the electron beam, and the necessary screens or photographic plates for making visual or photographic observations.

The source of electron radiation, corresponding to the light source in the visual microscope, may be either a hot or a cold cathode. The emitted electrons are accelerated with voltages which may be as high as 100,000 volts. The high-voltage electron beam is necessary to obtain the high resolving power and magnification which is the main advantage of the electron microscope. The useful portion of the beam passes through an aperture in the anode after which it is acted upon by a condensing coil which condenses the beam in a manner similar to the collimation of the light rays in the optical system.

The condensed beam then impinges upon the object under observation which is held in a special locking and adjusting chamber since the object is contained within the vacuum system of the microscope. The electron beam is then refracted to form an image on a fluorescent screen in the intermediate image plane. This intermediate image is specially useful when making preliminary adjustments, since it is observed and accurately focused at relatively low magnification. In the Siemens' instrument, the magnification in the intermediate plane is about 80×.

By means of an object shifting device, that part of the image which is to be further magnified is brought over an opening in the centre of the intermediate screen. The electron rays for this part of the image are then condensed by a projection coil in such a way that the intermediate image is further magnified as much as 350×. The resultant magnification is the product of the magnification of the individual electron-lens systems. The final image, which may be magnified as much as 30,000×, may be photographed directly from a fluorescent screen which also makes the image visible, or, as is done in the Siemens' instrument, a photographic plate may be introduced within the vacuum system of the microscope and an image can then be formed by the electron beam falling directly on the photographic plate.

The most important parts of the microscope are the electron lenses, for the refraction of the electron beams in traversing the electric or magnetic fields provides the basis for electron microscopy. Unlike light optical lenses, the refractive indices of electron lenses are not constant for a given medium. The electron lenses may consequently be regarded as possessing varying indices of refraction, depending upon the electric or magnetic constants of the system. As a result, the focal length of the electron lenses is not fixed, but may be adjusted by varying the electric or magnetic fields of the electron lens.

It is customary, where large magnifications are required, to use magnetic fields for bending the electron beams. Lenses of short focal length,

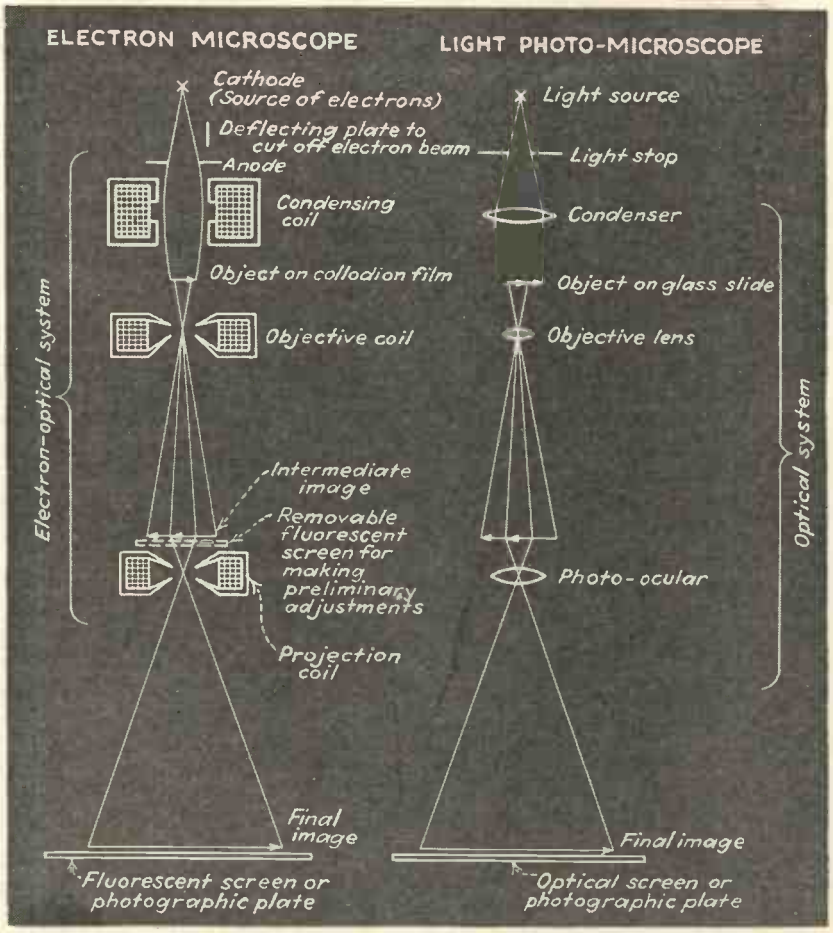



**Diagram showing the geometric optics of the two-stage electron microscope and its optical counterpart.**

which are required for large magnifications, are obtained by large magnetic fields, i.e., by increasing the current through the coils, or by using coils of many turns of wire. The shape of the ferro-magnetic circuit, and the use of materials of high permeability, with proper distribution of air gaps, is an important consideration in designing a practical electron-optical lens system for electron microscopes. To maintain the focal lengths of the electron-optical system sufficiently constant during the time necessary for the exposure of the photographic plate, the current through the various coils must be maintained to a high degree of precision, for current variations would produce various types of aberrations and distortions.

Due to the large magnifications obtained, great care is required in the design and construction of the component parts of the microscope. Since the object may be magnified as much as 30,000×, a horizontal displacement caused by vibration and amounting to only $10^{-4}$ mm. would result in displacements or variations of as much as 3 mm. on the photographic plate; such swings would make it impossible to obtain sharp images of the object.

In order that the form and mass distribution of the object may be determined, it is necessary that the object be suspended on some electron-optically transparent substance, much as the object in a light microscope is placed between transparent glass slides on the mechanical stage. The medium selected for the electron microscope should be characterised by low absorption of the electron beam, ability to withstand the effects of the beam for fairly long periods of time, and appreciable mechanical strength. These requirements can be met by selecting a high accelerating potential for the electrons, and employing a very thin membrane of only 1/100,000 mm. thickness for the support of the object under observation. Highly satisfactory membranes may be made of a weak solution of collodion in amyl-acetate which is dripped on a large surface of water. The amyl-acetate evaporates quickly and leaves a thin film of collodion on the water. Then the water is drained from the bottom of the container and the collodion is allowed to set over an aperture of perhaps 0.03 to 0.3 mm.

The object to be observed is placed on the extremely small surface of the stage. Then the microscope is focused by means of a suitable trial object or fine wire mesh so that after inserting the real object through the locking chamber, only a slight amount of further adjustment is required.

## *Those Lines (Murphy News)*

Should " lines " be visible in the television picture?

All television pictures received from Alexandra Palace must be made up of the 405 lines which are transmitted, and the only factor that can be controlled at the receiving end is the size of the scanning spot. If now we consider the spot size to be more than 1/405th of the picture height in diameter the inter-line spaces will be filled up and the lines themselves will be much less visible. Unfortunatey, an inevitable disadvantage crops up here, as in many other things, in that the definition will be correspondingly less.

What really has to be decided, then, is a compromise between picture definition and line visibility. Means for the user to settle this compromise are provided by the focusing control by which he can vary the spot size.

## "THE FUTURE OF TELEVISION"

(*Continued from page* 738)

improvement would not cause any upheaval in design or method of working, and would not render existing receivers obsolete.

Frequently the question of a much larger picture has been discussed, and it has even been said that it is essential to have larger pictures for viewing in comfort. It is felt, however, that this is not by any means a sound argument. Since we must assume that the practical minimum limit to the distance at which a picture is viewed depends to a large extent (although not, of course, entirely) on the degree of definition, there is no reason why a picture of 10 in. by 8 in. should not be viewed at a distance of, say, 2 or 3 ft., if the definition allows, as when looking at an ordinary photograph. On this basis, it does not seem likely that one would wish to look at a picture in the home measuring, say, 2 ft. by 3 ft., any more than one would wish pictures in an illustrated magazine to be of this size.

On the other hand, were large pictures made available there is no doubt that some people would prefer them, but they would probably find it necessary to place themselves at a correspondingly greater distance. It does not seem sound, therefore, at any rate scientifically, to say that television will not be satisfactory until a large picture is available. It would be more logical to say that the definition was insufficient to convey sufficient information

Finally, the rate of development of the service must perhaps be considered, and it should not be regarded as a reflection on the possibilities of television that development has not been so rapid as that of sound broadcasting. In the case of the latter, a large service area could be covered with a single small transmitter of very low capital and maintenance costs, while on the programme side there is no equivalent in television for the simple inexpensive type of programme such as can be produced by a small orchestra.

For television a great deal of rehearsal is necessary for practically every programme, while the artists must both learn and look the part they are playing. Still more important, however, is the cost of receivers. Sound broadcasting was built up largely on the use of crystal receivers costing £2 or £3, whereas the cost of a television receiver cannot be expected to approach such a low figure.

There is one aspect of television development which must be recorded with regret and that is that there seems no likelihood of international standardisation with regard to definition and picture frequency standards. It is true that no serious attempt has been made so far to bring this about, but the unfortunate fact remains that in the following countries the standards at the moment are as follows, although there is as yet no public service:—

| | Lines per picture. | Pictures per second. | Modulation |
|---|---|---|---|
| America | 441 | 30 | negative |
| Germany | 441 | 25 | positive |
| France | 455 | 25 | positive |

It may be that in the distant future international television cables may become available and then the absence of a common standard for European countries might become a serious matter.

There is no doubt that this new development of entertainment in the home will, in the course of time, reach the same degree of importance that sound broadcasting has done.

TELEVISION AND SHORT-WAVE WORLD

# HOW THE PICTURE IS SYNCHRONISED—II

*In the second article of this series, G. Parr describes the method of separating the line and frame pulses and gives further examples of synchronising circuits*

AN observant reader has pointed out that the diagram of Fig. 5 in last month's article was not strictly correct, in that the connection to the diode synchronising separator was made from the cathode of the video amplifier. The grid is returned to the -ve H.T. line, with the result that there will be "negative feedback" and the output will be negligible. This is quite true, and the revised diagram, with additions, appears in Fig. 1 on this page.

The cathode bias resistance proper is the one marked AB, the grid being returned to the lower end, while an additional resistance BD provides the necessary potential drop for the synchronised signal. It should be noted that the screen current flows through this resistance and that therefore any fluctuation in potential, such as is caused by the synchronised pulse, is liable to affect the screen potential. This can be minimised by connecting a condenser across the resistance as shown. The value of this condenser must not be too high, or the shape of the pulse developed across the resistance will be affected, and .0005 is ample.

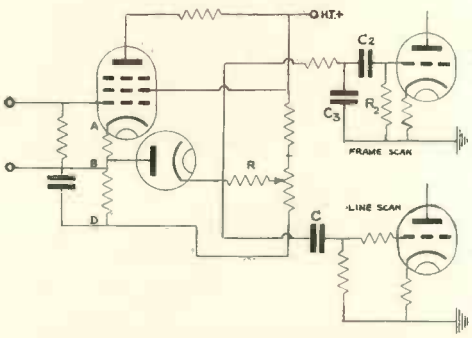



**Fig. 1.—Completed diagram showing how the synchronising pulses are applied to the scanning generators.**

We can now consider the remainder of the circuit which feeds the pulses to the grids of the scanning generators. The pulses, free from picture content, appear across the load resistance of the diode R. The value of this resistance is also important, as it is common to both the line and frame pulses and if it is too high there will be a tendency for the line pulse to affect the frame scanning generator. About 20,000 ohms is a usual value.

From the cathode end of the resistance a connection is made to the grid of the line scanning generator through a small condenser C of .00005 mfd. The grid circuit of the thyratron has the usual leak to H.T. -ve and a stopping resistance of 50,000 ohms connected to the grid itself. The object of this is to prevent any pulse developed in the grid circuit from affecting the frame scanning circuit. When a thyratron strikes there is a momentary "kick" of grid current which would be quite sufficient to feed back into the frame scan circuit via the common coupling resistance.

## Frame Pulses

The pulse for operating the frame scanning generator is derived from the half-line pulses which occur at the end of each frame, and the circuit for applying theses to the scanning generator is slightly different from that just described. Since both the line and frame pulses appear across the load resistance R they will be both applied to the grid of the frame scan generator, and it will be necessary to arrange the circuit so that it will discriminate between them. One method of doing this is to use the so-called "integrating" circuit, in which the half-line pulses are built up or integrated in a condenser. The grid of the frame scanning circuit is connected to the load resistance R through a large condenser $C^2$ of 0.1 mfd., the grid leak $R^2$ being 100,000 ohms.

Across this combination a condenser $C^3$ acts as a by-pass for the line synchronised pulses, its value being .001 mfd.

Referring to Fig. 2, the pulses at the end of the frame are shown in the lower part of the diagram. The potential across the resistance $R^2$ will depend on the charge of the condenser $C^2$ and this will receive a pulse of voltage at each synchronising pulse during the operation of the line scan. The upper curve, marked "Volts across $R^2$" shows these pulses occurring during the last few lines of the frame. At the end of the frame the line synchronising pulses become broader and the condenser potential begins the rise, with a corresponding rise in potential across $R^2$. This is shown by a sudden climb upwards of the voltage curve. During the pauses between the half-line pulses the potential drops slightly, but continues its upward climb until the value is sufficient to trip the discharge of the thyratron. This discharge point may occur anywhere on the "climbing" curve, as it is governed by the bias of the thyratron grid. If the bias is too high the curve will be nearly at the maximum before the discharge takes place, but there are still five or six black lines in the frame before the picture starts again and the frame scan will have time to recover from the discharge.

## Interlacing

Provided that the frame and line pulses arrive at the grids of the scanning generators at the correct time intervals and are not appreciably distorted, the frames should interlace satisfactorily.

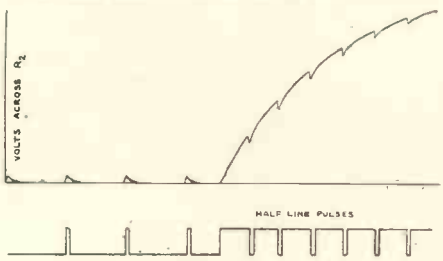



**Fig. 2.—The operation of an "integrating" circuit for frame synchronising pulses.**

Failure to interlace is usually attributable to interaction between the scanning circuits or to mains interference. The latter is most commonly a cause, owing to the fact that the transmission is on a controlled frequency supply and the majority of television receivers operate on the same mains. If there is sufficient

ripple in the H.T. supply to the scanning generator the frame will be tripped at the same point each time owing to a rhythmic drop in H.T. voltage at the end of the frame. The remedy for this is obvious—extra care in the smoothing of the H.T. supply, and protection from hum pick-up in the leads from the receiver. The

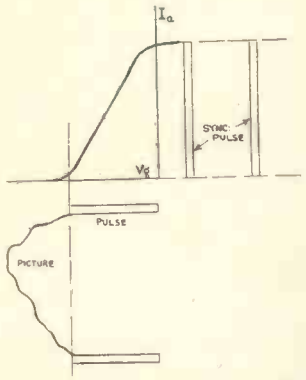



**Fig. 3.—A screen grid valve can be used as a synchronising separator, but the D.C. level must be maintained.**

interaction between the two scanning generators is inevitable to a certain extent if a common coupling resistance is used in the separator circuit, such as the one described, and the only method of reducing the coupling is to keep the resistance as low as possible consistent with sufficient potential being developed.

A better method of ensuring complete separation is to use separate diodes for the line and frame impulses, but this is extravagant. Special forms of valve have been developed by the Cossor Co. in which two anodes are used, one for the line and one for the frame circuit and these will be considered under amplitude limiters.

## *Amplitude Limiters*

Before the importance of the D.C. component was fully appreciated, it was common practice to use a screen-grid valve as a sync. pulse separator, the picture content being separated from the sync. pulse by adjusting the signal so that the anode current only flowed during the sync. pulse. A common arrangement was that shown in Fig. 3. By setting the anode potential of the valve at a lower value than that of the screen, the characteristic was given a sharp cut-off at the top as well as the bottom, and anode current was limited to a definite value whatever the value of swing applied to the grid.

If the combined picture and synchronising signal is applied to the grid of such a valve it is possible to separate the sync. pulses by ensuring that the picture signal carries the grid bias beyond the cut-off point, as shown in Fig. 3. This arrangement, however, is only satisfactory if the D.C. level of the signal is maintained. If the D.C. level is absent, it is possible to include part of the picture signal in the sync. pulse as shown in Fig. 4.

To understand this, it must be remembered that the condenser feeding the grid of the valve will alter its mean potential according to the average level of the signal and if the preceding line signal is full white the amount of pulse applied to the grid is altered. This method of deriving the sync. pulse frequently gave rise to irregular running of the scanning generator, the synchronising depending on the content of the previous line.

If the grid of the screen-grid valve is directly connected to the video output valve, or to the diode load resistance, the D.C. level is maintained, and the pulses are separated correctly as in Fig. 3. This method of separa-

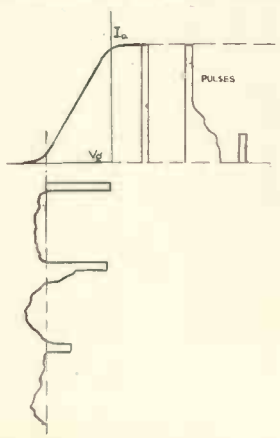



**Fig. 4.—If the valve is used without D.C. level the pulses will not be uniform as their amplitude will vary with the picture content**

tion is in some respects superior to that using the diode as there is the additional gain introduced by the S.G. valve and the amplitude of the pulse is greater.

The Cossor valve mentioned previously is of the S.G. type with two anodes, one serving the line scan and the other the frame scan.

The possibility of interaction between the scanning generators is thus minimised and the circuit is no more expensive than one using two diodes.

## The Physiology of the Eye

A LECTURE of particular interest to all concerned with motion picture production was given to the British Kinematograph Society on November 7 by Prof. D. T. Harris, M.D., D.Sc., Professor of Physiology at the London Hospital Medical College. His subject was "The Physiological Aspect of Motion Pictures."

Prof. Harris' talk made it clear that electrical impulses were the motive source of the nervous system. He commenced with a demonstration of the actual current, with a voltage of about 0.1 millivolt, which a frog's heart generated at each beat; the optic nerve generates similar impulses, which it transmits to the brain.

The eye, said Prof. Harris, is about 300,000 times more sensitive than the finest radiometer. It can deal with a range of visibility of from 1 to 20 billion. The greatest diameter of the pupil is 8 mm. and the smallest 2 mm.; a mean diameter of 3.5 mm. corresponds to an aperture of $f/5$ on a camera lens.

Prof. Harris described the construction of the eye, and especially of the retina. In the fovea or centre of vision there are 3½ million out of the eye's five million cones, which provide colour and detail vision. The rods, which predominate in the periphery of the retina, are responsible for grey vision.

## *Visual Lag*

The dilation of the pupil is of interest to the kinematograph engineer. Going into the dark, the eye wastes a fifth of a second, then it gradually opens out; during the first 20 seconds there would be appreciable opening, but it will take three minutes to become fully dilated. The sensitivity of the eye may vary by 300,000 times.

Curves were shown of the response of the eye to sudden stimulation, leading to a consideration of flicker perception. With a light intensity of 100 lux about 45 pulsations per second are needed to eliminate flicker; at lower levels 16 per second is adequate.

Prof. Harris concluded his talk by a consideration of the emotional response to films, and showed a film as a test.

# Telegossip

## A Causerie of Fact, Comment and Criticism

*By L. Marsland Gander*

DURING October 1,800 television sets were sold in the London area. This is the biggest fillip television has had since the B.B.C. began transmitting in the autumn of 1936, and incidentally they are the first authentic figures of televisor sales that have ever been published.

The trade, for some reason, has always concealed the figures relating to televisor sales or lack of sales. No one was ever deceived for a moment by this ostrich policy. After Alexandra Palace had beeen transmitting for eighteen months it was revealed that fewer than 2,000 sets had been sold to the public. Now nearly as many are being bought in a single month, and the sales graph is climbing steeply.

New York is starting a public service next spring, coinciding with the opening of the World's Fair, and Transatlantic interest in television is bound to have a stimulating effect here. American experts sent over here to study British television put the question to me: "What has caused the London public to change its mind over television and to start buying?"

### *Television Finance*

The answer I make is, "Better programmes, cheaper sets, improved picture quality, and the overcoming of small screen prejudice." The B.B.C. must now be spending nearly £400,000 a year on its television service, and I exclude capital expenditure. This outlay is at last beginning to bring returns to the set manufacturers. Soon it will be paying dividends.

But I find it remarkable, in face of the ever mounting cost, that the Television Advisory Committee should still be boggling over the question of an extra ten shillings licence fee for television. Few persons ready to pay from £30 to £80 for a televisor would resent another ten shillings a year and there is already the precedent of the car radio licence. When provincial stations begin to sprout the commitee may be forced to do something to find more money, and then it may be too late to propose an increase of the licence fee without risk of an outcry.

People are seldom willing to pay for what they have once had for nothing. It is one thing to increase the licence fee at the outset when there are only a handful of viewers and quite a different proposition to attempt to do so when there are 50,000 or 100,000 televisors in use.

Another problem due for early consideration by the Television Advisory Committee is the site of the first provincial transmitter. The choice should fall on Manchester. In a recent lecture Sir Noel Ashbridge commented on the possibility of a station using much higher power than Alexandra Palece. He did not envisage any great extension of the service area, but even the conservative B.B.C. engineers must now admit that the 25 miles estimate was too cautious. The importance of higher power is not so much an extension of the range as the provision of a stronger signal, less subject to interference, in the service area. In my opinion the best site for England's second station lies on the high ground between Manchester and Leeds, where the transmissions could cover the most populous districts of Yorkshire and Lancashire—Bradford, Barnsley, Huddersfield, Halifax, Rochdale and Wakefield, besides Manchester and Leeds. Go to it, B.B.C.

### *Making History*

After the first television transmission from a theatre the B.B.C. Television Director was Mr. Gerald Cock a Whoop. He and Mr. Basil Dean, the enlightened producer who gave permission for the transmission, received several hundred letters of congratulation. On the day after the transmission the Queen visited St. Martin's Theatre and one wonders whether Her Majesty had seen the play on the television screen.

At any rate, since then the advance bookings have been exceptionally heavy, and the B.B.C.—Theatre axis has been greatly strengthened. This is fortunate, for everything points to the fact that plays and outside broadcasts are the most successful programme features. In fact, during these winter months drama is leading the topical outside broadcast in popularity.

The transmission of "When We Are Married" from St. Martin's had enormous publicity and "stunt" value but it must be admitted that the play could have been done better from the studios and with far less trouble. Forty kilowatts of extra lighting had to be installed in the theatre. Rows of seats had to be moved to set the camera platforms in the front of the stalls and the centre of the dress circle.

Mr. Basil Dean said there was too much interference with the normal routine of the theatre to allow such experiments frequently. Still, apart from the distant booming of a set in the bar, a faint buzz of instructions that could be heard coming from the headphones of the camera men, and a shuffling to and fro at the back of the theatre I doubt whether the audience was greatly inconvenienced. And it was the audience, whose warmly spontaneous applause made a living contact with the actors, that provided the important difference between this and a studio show.

Anyhow, a play a night till further notice is the B.B.C.'s ideal and so long as sales go up it will be abundantly justified. The theatres are cooperating by permitting the performance of many current plays in the studios. In the meantime there is not the slightest possibility of an increase in studio hours of transmission in the near future. Such increases as we may have will be accomplished by the mobile units.

### *The Questionnaire*

While on this topic of programme preferences I am reminded that in the early days of A.P. Transmissions forms were circulated to any who asked for them to take a census of opinion. Only about seventy forms were filled in because the inquiry was premature. To-day there would be several thousand replies and I suggest that the B.B.C. revive the idea.

One of the best compliments paid to British television is the purchase by the French Post Office of the Marconi-E.M.I. system of transmission for broadcasts from the Eiffel Tower. Most of the apparatus has been made in France by the French Thomson-Houston Company. The pity is that it adds to the international definition muddle, for Eiffel Tower will not be using the B.B.C.'s 405 lines nor the 441 lines of Germany and America.

# INCREASING RANGE

## —WITH A SECOND VIDEO-FREQUENCY STAGE

By S. West

*Last month a simple method of increasing reception range by the addition of a V.F. stage was described. In continuation of that article the addition of a second V.F. stage is explained below.*

HAVING explained the effect of adding a single V.F. stage (November issue) we can now consider the addition of a second. For the anode circuit the data already given will apply. The only elaboration desirable is to include additional decoupling. This is provided by the 3,000-ohm resistance and the 25-mfd. condenser in Fig. 4. It will also be seen from this diagram that when two V.F. stages are employed, the connections of the detector diode are reversed. The need for this is obvious, for otherwise a negative picture would be provided.

The signal at the grid of the first valve now therefore makes positive excursions and the operating point on the valve curve that was satisfactory for a single stage will require to be re-chosen.

In general it can be taken that the cathode resistance will require to be doubled in value but care should be taken to ensure that the operating point chosen does not fall on the curved part of the valve's characteristic. The new value for the cathode resistance is best ascertained from the valve data sheet.

The two stages, it is seen, are capacity coupled, consequently the D.C. component is lost in the coupling. Fortunately it is easily restored again and this point will be dealt with later.

If the D.C. component is absent at the grid of the second valve this valve would, of course, require to be capable of handling twice the signal applied to it.

### Component Values

In the meantime let us consider the coupling condenser and grid leak C1 and R2, Fig. 4.

Though normal values for these components are entirely satisfactory as far as the low frequency response is concerned, the question of phase shift is also of considerable importance. It is not necessary to go into the question in detail here but it is desirable where two stages are to be used to keep the phase shift as low as possible for the effect is cumulative.

Satisfactory values for C1 and R2 are 0.5 mfd. and 1 megohm respectively.

For certain types of valve it may be necessary to reduce the value of R2 in which case C1 must be correspondingly increased.

Suitable values for C2 and R3 are 0.2 mfd. and 1 megohm. The main point to observe is that the C1R2 product is kept greater than is that for C2R3.

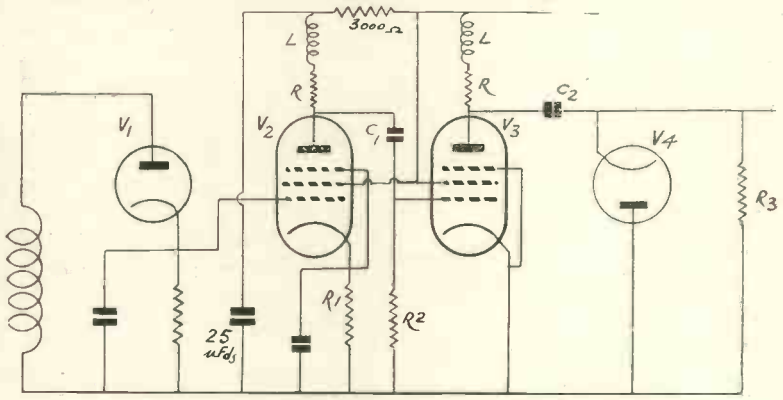



**Fig. 4.—Circuit employing two video-frequency stages.**

### D.C. Restoration

It was remarked earlier that the D.C. component was easily restored for the second stage. This is achieved in the following manner.

Reference to Fig. 4 will show that the cathode of the second V.F. valve V3 is connected directly to earth. The grid circuit is completed through the resistance R2. The grid is therefore at zero potential with respect to the cathode.

When, however, picture modulation is applied, grid current will flow causing a volt drop across R2. A negative bias is therefore provided for the valve. This developed bias adjusts itself in such a way that the sync. pulses at all times assume a common datum line.

The action is essentially analogous to that of the conventional diode D.C. restorer as is plain when it is remembered that if a diode restorer were to be interposed at this point it would be connected as are the grid and cathode section of the V.F. valve.

It must not be thought that a diode D.C. restorer is thus rendered unnecessary after this stage. Obviously this is not the case and where a coupling condenser is employed after the second V.F. valve, such as for example to isolate the sync. filter section, a diode D.C. restorer is required.

It remains only to deal with the question of any changes to the power supply units that may be entailed.

It is assumed, of course, that the power pack is capable of furnishing the extra amp. or so of L.T. current and also the 20 milliamps. or so of H.T., and it is a question only of ensuring that the amount of smoothing is adequate in view of the greater post detector gain.

However, if the amount of smoothing proves inadequate, it is a simple matter to include an additional choke and condenser in the power supply unit. Alternatively it might prove feasible to arrange the existing smoothing as a tuned filter, though then the variations in current brought about by changes to the gain control and the effect of these current changes to the inductance of the choke might prove troublesome.

# RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

*Specially Compiled for this Journal*

*Patentees: Baird Television, Ltd., and A. J. Brown :: Baird Television, Ltd., and J. L. Baird :: A. D. Blumlein and C. O. Browne :: Telefunken Ges fur drahtlose Telegraphie m.b.h. :: E. Michaelis :: Marconi's Wireless Telegraph Co. Ltd. :: The General Electric Co. Ltd., L. C. Jesty and J. Sharpe*

### Television Transmitters

(Patent No. 489,716.)

IT is usual in transmitting a television programme to superimpose the picture signals on the carrier wave after the latter has been modulated by the synchronising impulses, because this tends to prevent loss of the higher-frequency pictures, particularly in the latter stages of amplification.

Since the synchronising signals occupy a much smaller frequency band than the picture signals, it is found more economical, so far as power is concerned, to superimpose the synchronising impulses upon a wave of a lower frequency than the normal carrier.

Accordingly the "timing" signals are applied to a comparatively low-frequency oscillation, and this is then passed through a frequency-multiplier before the picture signals are added to it.—*Baird Television, Ltd.*, and *A. J. Brown.*

### Kerr Cells

(Patent No. 489,964.)

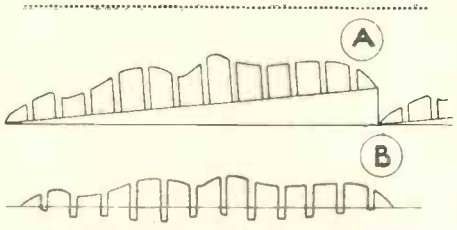
In order to attain a strong electrostatic field, it is necessary to place the electrodes of a Kerr cell close together. It then becomes difficult to direct the ray of light to be controlled through this narrow space, and at the same time to prevent it from striking against the electrodes, where it is liable to be reflected or "scattered."

To overcome the difficulty, the electrodes are both made transparent so that any light that strikes against them passes clean through and does not interfere with the ray to be controlled. The transparent surface is obtained by depositing an extremely thin layer of platinum or tungsten upon a backing-plate of glass or mica.—*Baird Television, Ltd.*, and *J. L. Baird.*

### Preventing "Tilt"

(Patent No. 490,205.)

One effect of low-frequency interference on a cathode-ray television transmitter is to produce what is known as "tilt." In other words each scanning line is given a false "boost" towards one end, so that the resulting signals have the form shown at A instead of that shown at B. The result in the receiver is to cause the picture to appear "lop-sided" in the sense that it seems definitely brighter at one end than the other.




Method of preventing tilt, Patent 490205.

In order to compensate for this, the picture is cut up into vertical strips by a grid-like member, which is placed in front of the mosaic screen at the transmitter. The strips are separated by dark lines—actually the shadows thrown by the grid. In the scanning operation, the dark lines disappear, so far as the received picture is concerned, though they produce a series of "control" currents, which are used to cancel out the false brilliance due to "tilt." The grid is preferably made to vibrate to and fro, so that the dark lines thrown on the mosaic screen do not retain the same position but are "interlaced." This prevents any risk of their being reproduced on the viewing screen at the receiving end.—*A. D. Blumlein* and *C. O. Browne.*

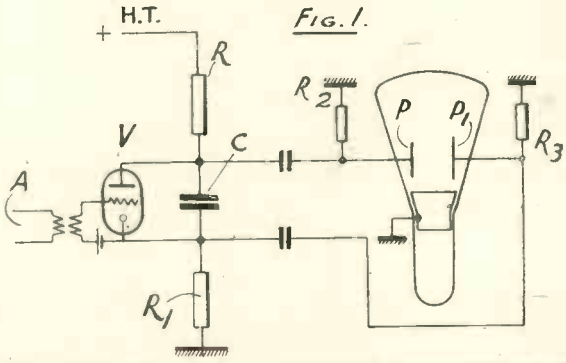
### Time-base Circuits

(Patent No. 490,529.)

Scanning voltages of equal and opposite polarity are applied to the deflecting plates P, P1 of a cathode-ray tube by the discharge of a condenser C through a gas-filled tube V. The condenser C is connected in series with equal resistances R, R1, across a single D.C. supply.

When the valve V is "flashed" by synchronising impulses applied at A, the condenser C discharges, and causes the voltages on the deflecting plates P, P1 to vary in "push-pull."

It will be noticed that both the deflecting plates are connected to earth through resistances R2, R3, the time constant of these resistances and the blocking condensers C1, C2 being larger than the saw-toothed period.




New time base arrangement Patent 490529.

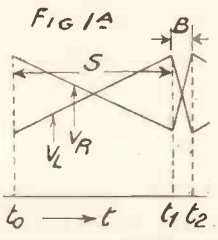



Fig. 1A shows the relative changes of voltage on the deflecting plates. As the condenser C charges up, the potential on the left-hand plate P gradually rises to approximately that of the positive terminal of the H.T. supply. Similarly, the voltage on the right-hand plate P1 falls towards zero or earth voltage, both crossing an intermediate value to give the

push-pull effect. This represents the scanning pulses. As the condenser discharges, the original voltages are restored to give the rapid fly-back stroke B.—*Telefunken Ges fur drahtlose Telegraphie m.b.h.*

### Cathode-ray Tubes

(Patent No. 491,050.)

The whole of the " lens " or focusing system of a cathode-ray tube is made from a single piece of insulating material, suitably shaped into one rigid structure. The parts which are to serve as electrodes in the path of the stream are then metallised; either by spraying or by a silver-plating process.

This avoids the necessity for separately mounting the various electrodes, which, on account of the small tolerances permissible, calls for highly-skilled labour and accounts to a large extent for the initial cost of the tube. —*E. Michaelis.*

### Preventing Loss of Definition

(Patent No. 491,413.)

The figure shows a cathode-ray tube of the Iconoscope type, where the picture to be televised is projected from a lens L on to a "mosaic-cell " screen S, which is scanned by an electron stream from the gun G of the tube, so that signal voltages are developed across a resistance R.

It is found, rather contrary to what might be expected, that when a brilliant picture is being transmitted there is sometimes a noticeable falling-off both in definition and tone-contrast. The explanation is that with a high value of illumination there is a tendency for some of the light to be reflected from the metallic coating of the electrode system on to the glass walls of the tube, and from there back on to the sensitive surface of the screen. Since this reflected light is naturally diffused, it adds an out-of-focus component to the currents produced by the original picture, and so tends to blur the details of the latter.

To prevent this, the mica sheet which carries the sensitive " cells " forming the mosaic screen S is covered with a layer of graphite or carbon, which blocks out any light reflected from the sides of the tube and so preserves the original definition of the picture.—*Marconi's Wireless Telegraph Co., Ltd.*

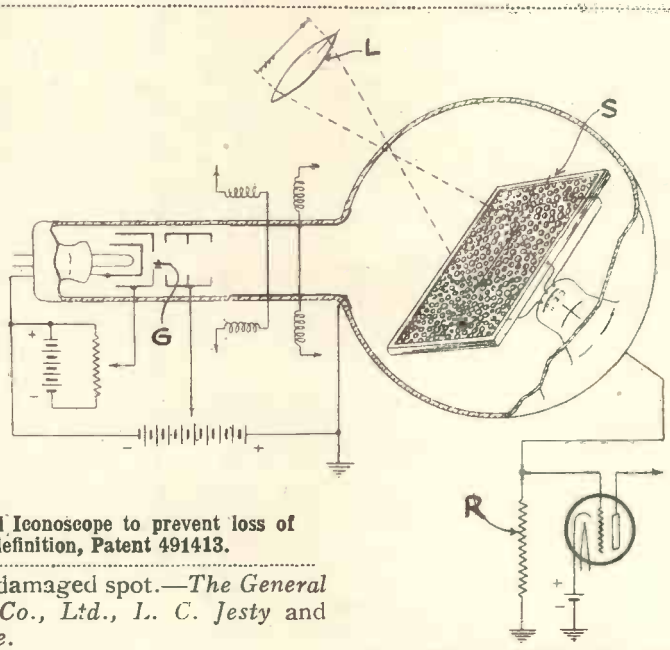
### Fluorescent Screens

(Patent No. 491,748.)

Instead of applying a fixed coating of fluorescent material to the glass end of a cathode-ray tube, the screen is formed by pouring a loose mass of finely-powdered material on the bottom of the bulb and then forming it into a level surface by shaking or tapping the tube.

As against the disadvantage of having to operate the tube in an inverted position, so that the picture must be viewed through a reflecting mirror, the arrangement possesses certain definite merits.

For instance a much thicker layer of fluorescent material can be used, and no " binder " is necessary. A loose layer 1 millimetre thick will produce several times the amount of light that can be obtained from the usual thin layer of adherent material. Again, if by any chance a part of the material is burnt by the scanning stream, a fresh surface can be formed by tapping or shaking fresh powder over the damaged spot.—*The General Electric Co., Ltd., L. C. Jesty* and *J. Sharpe.*




**Modified Iconoscope to prevent loss of definition, Patent 491413.**

### Summary of Other Television Patents

(Patent No. 489,666.)

Generating flat-topped synchronising impulses for " framing " in television.—*Marconi's Wireless Telegraph Co., Ltd.*

(Patent No. 489,715.)

Valve circuit for " mixing " the synchronising impulses and picture signals in a television transmitter.—*Baird Television, Ltd.*, and *A. J. Brown.*

(Patent No. 489,717.)

Method of " fading-out " part of one televised picture and replacing it by an " inset " from another.—*Baird Television, Ltd., V. A. Jones,* and *T. C. Nuttall.*

(Patent No. 490,203.)

Transmission system which permits the insertion of advertising or other " insets," and the production of " composite " or built-up pictures. —*Marconi's Wireless Telegraph Co., Ltd.*

(Patent No. 490,391.)

Means for preventing the "blurring " of rapidly moving objects in a television transmitter.—*Fernseh Akt.*

(Patent No. 490,396.)

Method of adjusting the amplitude of the picture signals independently of the synchronising impulses.—*E. L. C. White* and *O. L. Ratsey.*

(Patent No. 491,011.)

Producing a photo-electric mosaic from a coating of caesium laid on a sheet of insulating material and cut through in criss-cross fashion.—*A. M. Low.*

(Patent No. 491,425.)

Iconoscope tube in which a number of electron multipliers are symmetrically mounted about the mosaic screen and used to amplify the output current.—*Marconi's Wireless Telegraph Co., Ltd.*

(Patent No. 491,611.)

Method of driving the piezo-electric crystal used in a supersonic type of light-modulator.—*Scophony, Ltd., J. Sieger* and *S. H. M. Doddington.*

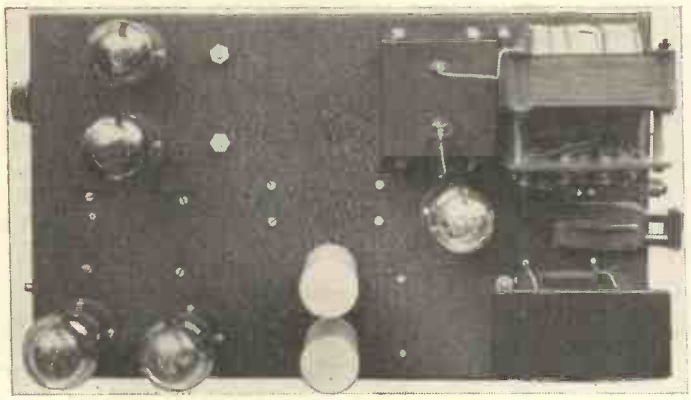
(Patent No. 491,873.)

Time-base circuit in which faulty synchronisation is avoided when receiving television signals with interlaced scanning.—*The British Thomson-Houston Co., Ltd.*, and *D. S. Watson.*

# A 2-XP Gramophone Amplifier

*This amplifier has been built by J. H. Appleby, M.I.E.E., in order to obtain good reproduction from gramophone records. The average output is approximately 5 watts, with a maximum of 8 watts, at which volume total distortion is approximately 5.6 per cent.*

MOST commercial radio receivers are fitted with sockets for a gramophone pick-up. They also include volume and tone control in order that the output level can be adjusted and some of the needle scratch removed. Despite this, the reproduction from gramophone records except with the more expensive instruments does not always come up to the expectations of those who are keen on really high quality.



**This plan view shows the layout of the components in the main unit. The four valves in the amplifier circuit are to the left of the chassis.**

It is hardly to be expected that a cheap commercial receiver with its small energised loudspeaker will handle a wide band of frequencies without a certain amount of distortion creeping in. Also, while many users are content with reasonable quality, on the radio side, there is also a certain amount of criticism should there be any flaws in reproduction when using the gramophone pick-up.

### Response Faking

The designer of this amplifier, although using a well known commercial receiver for radio reception, found that the only way to obtain good reproduction from gramophone records was to build a separate amplifier with its own loudspeaker which could then be "doctored" in order to give the required degree of reproduction.

It is practically impossible to fake a commercial receiver to give greater bass or high note response as required, for different constants are necessary for gramophone reproduction as compared with radio reproduction.

The amplifier to be described has been built with the object of obtaining pleasing quality such as would be appreciated by the ordinary listener rather than super-high fidelity which is only understood by a comparatively small number of enthusiasts.

The first consideration was the amount of audio-ouput required and it was decided that 5 watts with a maximum of 8 watts would be sufficient for the average room, but for those who are restricted to a much lower level, as the output is decreased that there is not that noticeable falling off in quality which so often occurs with amplifiers of poor design.

### Pick-up Considerations

The next point in question was the choice of a pick-up and although the needle armature type is extremely good as regards stability the low output makes the design of the amplifier rather more complicated.

A crystal type pick-up appeared on the surface to be a satisfactory solution but the designer was not in agreement with this owing to the rather noticeable predominance of top notes which also accentuated needle scratch.

Finally, the new H.M.V. Hypersensitive pick-up was tried, and this proved excellent in every respect. The weight of the needle point on the record is only 1¼ oz., which greatly improves the life of the record. Provided the special needle designed for this pick-up is used, there is practically no surface hiss at all. The mechanical energy taken from the stylus point driven by the record groove is transmitted to the armature for conversion to electro-magnetic energy without radiation from stylus or body of the pick-up.

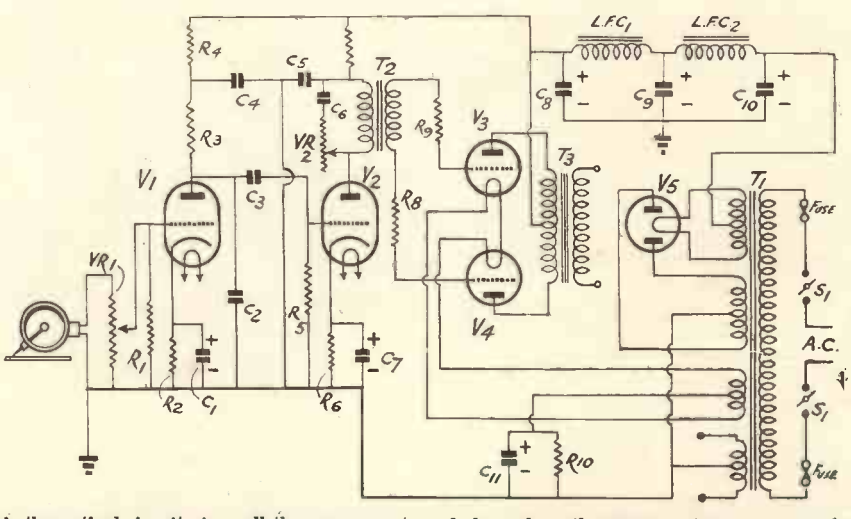
There is also a noticeable absence of mechanical resonances in both the unit and its mounting so that faithful reproduction is obtained.

### Loudspeaker

A final point to be determined before the amplifier itself was designed was the choice of a loudspeaker at a reasonable price to give good reproduction, for it would be a sheer waste of time and money to build a good amplifier and to use a high quality pick-up unless the loudspeaker is capable of accurately reproducing everything that is applied to it. The new energised moving coil loudspeaker recently produced by Premier Supply Stores was ultimately selected. It is quite inexpensive, has a 10 in. cone freely suspended, handles 10 watts quite comfortably, and is supplied without a matching transformer.

Provided the accessories mentioned are used, then the amplifier can be built exactly to specification and extremely good quality will be assured.

Maximum gain is not the objective, so for this reason each stage is rather under run and with the pick-up recom-




**This theoretical circuit gives all the components and shows how the various stages are coupled. Notice the way in which the filaments of the output valves are wired.**

# Component Considerations

mended cannot be overloaded. The pick-up is connected across the volume control having a resistance of 500,000 ohms, and this value is important, otherwise there can be a loss of gain and a deterioration in quality. The grid of the first valve is also tied down to earth by a resistance of 100,000 ohms. It will be noticed that this prevents a slight hum level arising when the volume control is set to give a low level output. The first valve is the Mazda AC/HL, which is of the medium impedance type having a gain of 35 with an applied voltage of 250 and a cathode resistor of 500 ohms.

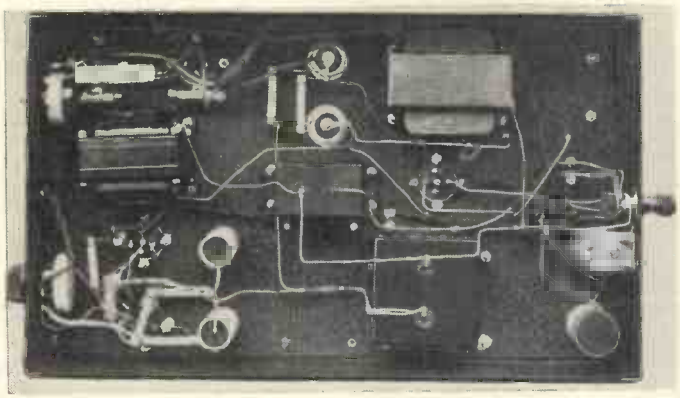
The value of R3 is comparatively important and this should be approximately 50,000 ohms. This can be increased to 80,000 ohms should increased gain be required with a low output pick-up.

Decoupling in the first stage merely consists of R4 with a resistance of 10,000 ohms and condenser C4 having a capacity of 4 mfd. and a working voltage of 400. The output from V1 is fed into the grid of the ML4 in the second stage by means of a .05-mfd. condenser. The combination of R3 and C3 chosen gives a very level response with ample bass. The succeeding resistor R5 should have a value of 250,000 ohms with a half-watt rating. Although the anode current of the ML4 is high, tests show that the Ferranti inter-valve transformer AF5C could be connected directly into the primary circuit and the high current would not cause too great a loss of inductance. Also in this circuit is R7, a 10,000-ohm 2-watt resistor for de-coupling purpose with C5 another 4-mfd. 400-volt working condenser.

The tone correction is carried out in the anode circuit of V2 and consists of C6 .01-mfd. condenser, plus VR2, a 25,000-ohm variable resistance, across the primary of the transformer. The final valves are a pair of new Cossor triodes, type 2-XP. These valves have 2-volt 2-amp. directly-heated filaments and consequently, owing to the high filament current, hum level is negligible.

It is intended by the manufacturers that these 2-volt valves be run off 2-volt transformer windings, but this means having a special transformer built. To overcome this difficulty, the heaters have been connected in series across a 4-volt winding so that a standard transformer can still be employed. Bias is obtained by means of a pre-set resistor having a total value of 1,000 ohms between the mid point of the filament transformer and the chassis. Actually only 350 ohms of bias are required, but the bias should be adjusted so that the total anode current to the two valves is approximately 100 mA. Resistors R8 and R9, having a value of 5,000 ohms each, are important to prevent any possibility of oscillation. These resistors need only be of the half-watt type.

It was decided to dispense with the output transformer normally supplied with commercial loudspeakers and to use a Ferranti component of high inductance so as to make quite sure that there will not be any noticeable loss in quality in the output stage. This transformer, shown as T3, should have a ratio of 15/1 to match up with the B1650 Premier loudspeaker.

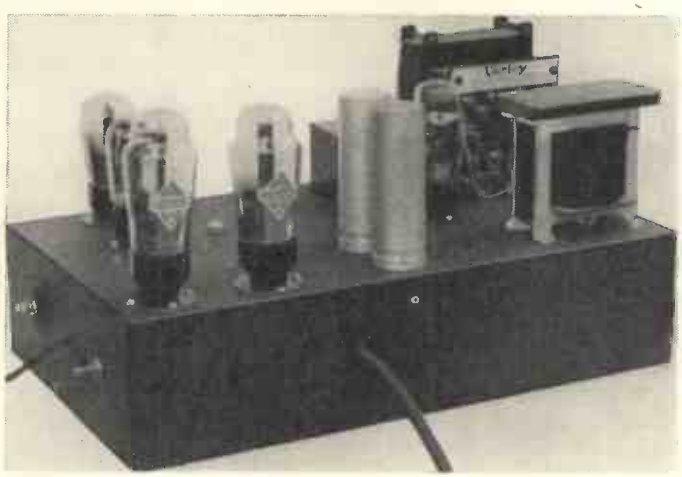


**Most of the smaller components are under the chassis with the amplifier section to the left-hand side.**

The next point is the power unit. As hum cannot be tolerated and as the bass response of the amplifier is particularly good, every precaution had to be taken to prevent an A.C. ripple filtering into the amplifier itself. Unless the components are arranged in the manner suggested, which can be seen from the illustrations, there is every possibility of there being an appreciable hum level despite the very complete smoothing.

The power unit which uses an MU12 indirectly-heated rectifier, has the H.T. feed through by two low-resistance chokes plus two 8 mfd. electrolytic condensers and one 4 mfd. paper condenser. This type of condenser is quite satisfactory for the surge voltage does not rise to a figure approaching the maximum that can be handled by these condensers.

Next comes the construction, which is rather important. Refer to the plan view of the completed amplifier. The mains transformer, an LFC2, is mounted on top of the chassis. Between this choke and the transformer is the mains plug and fuses. Next to this plug is the MU12 rectifier. C10 is mounted alongside the mains transformer. C8 and C9 are also mounted on top of the chassis so that with the exception of LFC1 the whole of the power unit is separated from the amplifier section by the aluminium chassis itself. Now refer to the illustration showing the under side. LFC1 is almost in the centre of the chassis close to condensers C8 and C9. The variable bias resistance and its associated shunt condenser is on the right-hand lip of the chassis close to the earth terminal.



**This method of construction allows the experimenter to build an amplifier having quite a professional appearance. The output valves are of a special type with high heater currents in order to minimise hum level.**

It will be noticed that practically the whole of the amplifier section that is included in the power unit is towards one end of the chassis. All the grid

# 8-watts Output

leads have been kept short while the connections to the volume control are screened. Resistors and condensers, wherever possible, are inter-connected in the wiring while the two bias condensers, C1 and C2, which are the single pole fixing type, are inverted and fixed to the top of the chassis.

**A special pick-up is employed in this amplifier manufactured by H.M.V. and it is recommended that constructors make a special point of employing this pick-up. The weight on the record is only 1¼ ozs. while needle scratch is practically non-existent.**

The position of the inter-valve transformer is very important and it is advisable not to fix this component until the amplifier is ready for testing. It should then be rotated and fixed in the position which gives the lowest hum level. Actually, in the position shown the hum is negligible, but in the case of component variation it is well to know which part of the circuit might be causing unnecessary pick-up.

The variable resistance in the tone correction circuit is mounted on the edge of the chassis on the opposite side to the volume control. This means a fairly long lead to the primary of the intervalve transformer, but there is no need for this connection to be screened.

All wiring has been carried out with push-back wire but where connections carry high voltage go through the metal chassis, extra sleeving has been used.

The power unit which gives 350 volts is not too large for the 2XP valve as 72 volts are dissipated in the bias circuit. Although 5-watts output is a comfortable average the maximum output is actually 8 watts with only 5.6 per cent. distortion so that with a sensitive moving coil loudspeaker able to handle this output the amplifier is more than suitable for use by those interested in outdoor public address equipment.

When testing, the anode current in V1 circuit is approximately 3 mA., in the V2 circuit approximately 12 mA., and in V3 and V4 circuits 100 mA. It will be seen from this that the power transformer gives more than sufficient output for four valves and even should greater volume be required, the anode current to V3 and V4 can still be increased by 10 per cent. or so.

## *Special I.D.H. Rectifier*

Owing to the weight of the components in the power unit, the chassis should be of fairly heavy gauge; 16 gauge aluminium is recommended for this does not bend, but at the same time can quite easily be drilled. If, however, a chassis is obtained from the manufacturers already drilled, then it is advisable to substitute a light steel chassis for the aluminium.

It is also important that the specified valves be used, particularly as regards V5, for this is of the indirectly-heated type. The time delay is sufficient to allow V1 and V2 fully to heat up before any H.T. voltage is applied, This also removes any possibility of stress on the fixed condensers in the smoothing circuit which would be caused by temporary high voltage surging.

The output transformer T3 is mounted on a loudspeaker baffle and a heavy gauge three-cord cable used to connect the output circuit to the loudspeaker. If, however, the loudspeaker is to be used in the same cabinet that houses the amplifier, then it will have to be carefully sprung and mounted on a heavy baffle board in order to minimise vibration and rattle.

In such circumstances, the output transformer should be mounted on the main amplifier chasis, care being taken to see that no hum is induced.

### Components for A 2-XP GRAMOPHONE AMPLIFIER.

**CHASSIS.**
1—Aluminium finished black, 17 in. by 8 in. by 4 in. (Peto-Scott).

**CONDENSERS, FIXED.**
1—10-mfd. 50 volt type 401 (C1) (Dubilier).
1—.0005-mfd. type 690W (C2) (Dubilier).
1—.05-mfd. type 4602/S (C3) (Dubilier).
1—4-mfd. type LEG 400 volt (C4) (Dubilier).
1—4-mfd. type LEG 400 volt (C5) (Dubilier).
1—.01-mfd. type 691W (C6) (Dubilier).
1—10-mfd. 50-volt type 401 (C7) (Dubilier).
1—8-mfd. 500 volt type 0281 (C8) (Dubilier).
1—8-mfd. 500 volt type 0281 (C9) (Dubilier).
1—4-mfd. 650 volt type LEG (C10) (Dubilier).
1—10-mfd. 100 volt type 3016 (C11) (Dubilier).

**CHOKES, LOW-FREQUENCY.**
1—120m/A. 30 H. (L.F. C1) (Premier Supply Stores).
1—120 m/A. 30 H. (L.F. C2) (Premier Supply Stores).

**HOLDERS, VALVE.**
3—4-pin chassis mounting, less terminals type VI (Clix).
2—5-pin chassis mounting, less terminals type VI (Clix).

**HOLDER, FUSE.**
1—Twin type 1114 (Belling-Lee).

**JACK.**
1—Type J2 (Bulgin).

**LOUD-SPEAKER.**
1—Special type B1650 (Premier Supply Stores).

**PLUG.**
1—Type P15 (Bulgin).

**PICK-UP.**
1—Type Hypersensitive (H.M.V.).

**RESISTANCES, FIXED.**
1—100,000-ohm type 1-watt W.E.9 (R1) (Bulgin).
1—500-ohm type 1-watt W.E.10 (R2) (Bulgin).
1—50,000-ohm type 1-watt W.E.7 (R3) (Bulgin).
1—10,000-ohm type 1-watt W.E.2 (R4) (Bulgin).
1—250,000-ohm type 1-watt H.W.28 (R5) (Bulgin).
1—750-ohm type 1-watt (R6) (Erie).
1—10,000-ohm type 2-watt (R7) (Erie).
1—5,000-ohm type H.W.10 (R8) (Bulgin).
1—5,000-ohm type H.W.10 (R9) (Bulgin).
1—1,000-ohm type R.V.5 (R10) (Bulgin).

**RESISTANCES, VARIABLE.**
1—500,000-ohm potentiometer (VR1) (Reliance).
1—25,000-ohm variable resistance (VR2) (Reliance).

**SWITCH.**
1—Type S81T (Bulgin).

**TRANSFORMER, INTER-VALVE.**
1—AF5C (T2) (Ferranti).

**TRANSFORMER.**
1—Type 350 volts 120 m/A. (T1) (Varley).
2-0-2 v. 4 amp.
2-0-2 v. 2 amp.
2-0-2 v. 2.5 amp.

**TRANSFORMER OUTPUT.**
1—15/1 ratio (T3) (Ferranti).

**VALVES.**
1—AC/HL (V1) (Mazda).
1—ML4 (V2) (Osram).
2—2XP (V3 and 4) (Cossor).
1—MU12 (V5) (Osram).

# Making the Most of the Johnson "Q" Matching System

*The Johnson "Q" matching system is applicable to many types of aerial and not merely for half wave radiators as is generally considered. Effective aerial arrays are discussed in this article.*

If all the available R.F. energy supplied by the final amplifier can be efficiently fed into the aerial, the simple di-pole is most effective. Amateurs however, still experience considerable difficulty in matching the aerial to the tank coil, but most of this difficulty was removed with the introduction of the Johnson "Q" matching system, which has stood the test of time. However, now that amateurs are in need of aerial systems having an appreciable power gain, many are in doubt as to whether the Johnson "Q" arrangement can be used in any other way than with the conventional centre fed half-wave aerial.

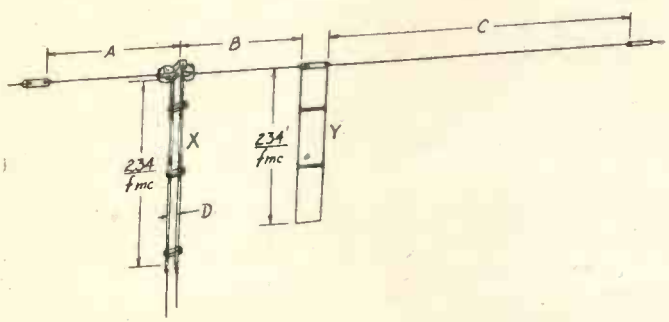



Fig. 1.—One of the most popular amateur aerials is two half-waves in phase, which gives a concentrated broadside radiation. This aerial can be used with "Q" bars connected in this manner.

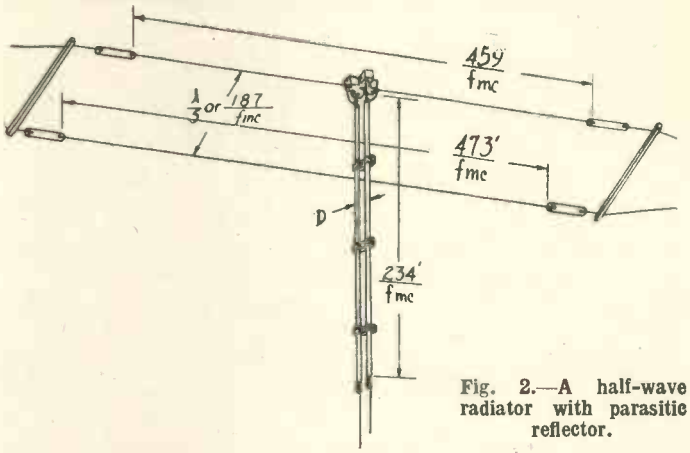



Fig. 2.—A half-wave radiator with parasitic reflector.

TWO HALF WAVES.—A widely used aerial system with a good power gain is the two half-waves in phase arrangement shown in Fig. 1. This type of aerial can be fed with the "Q" matching section in the manner shown. Lengths A and B are each one quarter wave; X is the usual "Q" quarter wave matching section, while Y is the quarter-wave phasing stub made up of 14-gauge wire and spaced 6 in. This phasing stub is shorted at the bottom in order to obtain the necessary phase relation between AB and C. The stub should be tuned for maximum current in the shorted bar by moving this bar up and down the stub. The bar should only be soldered into position when the maximum current point is found. Since the radiation resistance of two half waves in phase is approximately 172 ohms, the spacing required between the two bars and the quarter wave matching section X is 3⅝ in. with a transmission line of 600 ohms. The gain of this aerial over a single half wave is approximately 2.5 db.

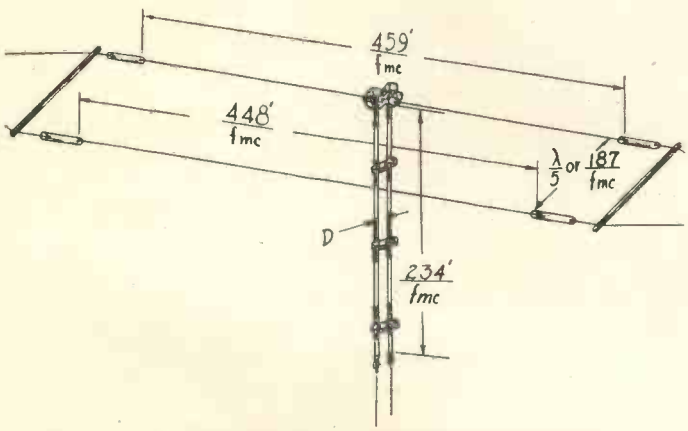



Fig. 3.—A half-wave radiator with director which gives a gain of slightly less than 4 DB. The front to back discrimination is better than with the system shown in Fig. 2.

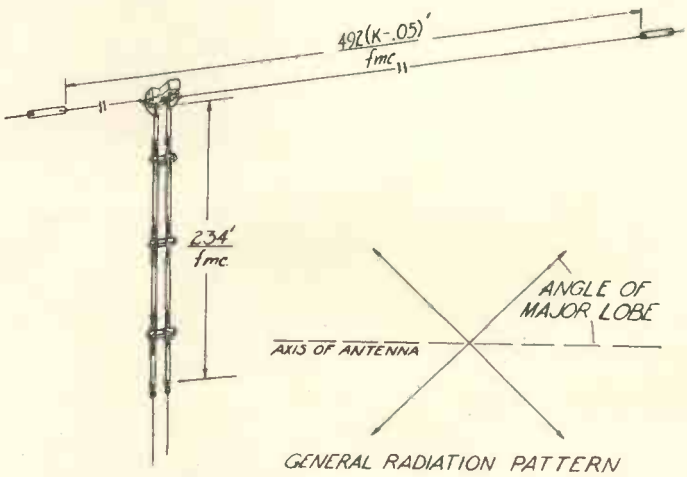



Fig. 4.—A popular long wire aerial for harmonic operation.

A REFLECTOR.—When radiation is desired in one direction only, the "Q" system can be applied to a half-wave radiator and parasitic half-wave reflector. The front to back discrimination is good and the gain more than 4 db over a single half-wave unit. These characteristics

# Feeding "V" Beams

may be used to better advantage if the array is made rotatable. The points mentioned are also advantageous in receiving as well as transmitting since the signal strength of interfering stations off the line of the array is greatly reduced. Fig. 2 shows the method of construction and also gives the formulae for computing the length and spacing of the various elements. It will be seen from this that amateurs already using a Johnson "Q" antenna can very easily add a reflector. The changes necessary in the half-wave radiator consist of reducing the total length and the spacing between the "Q" bars. The actual spacing between the "Q" bars should be 1 in.

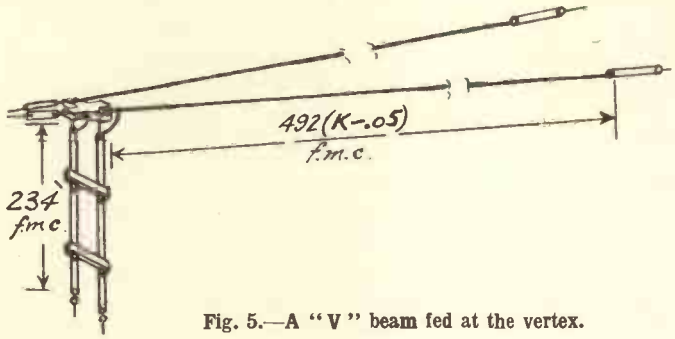



Fig. 5.—A "V" beam fed at the vertex.

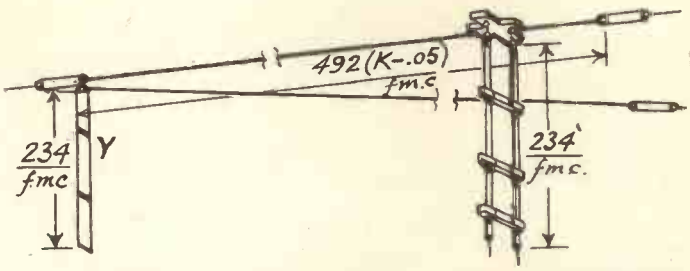



Fig. 6.—Another method of feeding the "V" beam. The length of each leg is discussed in the text.

**DIRECTORS.**—Another means of securing radiation in one direction consists of a half-wave radiator with "Q" matching section plus a parasitic director. The gain of the radiator-director system is slightly less than 4 db but the front to back discrimination is distinctly better than that of the arrangement shown in Fig. 2. The constructional details and formulae are shown in Fig. 3 and it is suggested that the "Q" bars be fed with a transmission line having an impedance of 600 ohms.

**LONG WIRE AERIALS.**—One of the most popular amateur aerials is the harmonic or long wire type. It is certainly one of the most simple and inexpensive directional aerials to erect. The gain is not as great as with some of the more complicated arrays but it has a low angle of radiation which makes it very effective for long-distance communication. To be used in connection with the "Q" matching system, the radiation should be any number of half-waves long up to a total of twenty-six. As the number of half waves in the system is increased, the gain and directivity are also increased. The greatest portion of radiation is concentrated in four lobes which approach the axis of the wire as the length of the aerial increases. There are, however, minor lobes making various angles to the wire, the total number being twice the number of half-waves in the system.

If the aerial is an odd number of half-waves long it can be fed with the "Q" matching system at the centre or at a point an odd number of quarter waves from either end. If the entire system is an even number of half-waves long it must be fed with an odd number of quarter-waves from one end.

To determine the length of aerial substitute the known values in the formula in Fig. 4. L is the length in feet, K the number of half-waves in the system and f the frequency in megacycles. Spacing between "Q" bars for different aerial lengths and different transmission lines has also to be carefully considered, but these points are covered very fully in the data sheet supplied by the manufacturers.

Unlike the aerials previously described, with which the "Q" system may be used, it is very difficult to compute the radiation resistance of a "V" beam. As a point of departure, the "Q" bars should be spaced the distance normally used for a harmonic aerial having a number of half-waves equal to the total in both legs of the V. In all probability this spacing will be somewhat greater than that required. This can be checked by testing transmission line for standing waves in the usual way. A point will be reached when the standing waves will disappear indicating a match between the aerial and the transmission line. If the aerial is to be fed at the vertex of the "V," each leg must be an odd number of quarter-waves long. Suitable methods of feeding the "V" beam are indicated in Figs. 5 and 6. The arrangement in Fig. 5 is very suitable for amateur use as the pole will take most of the weight borne by the two bars.

In the October issue on page 622 was described the "Q" beam which is a two-band matched impedance aerial for two adjoining harmonically related bands. It consists of two "Q's" for the lower frequency of two required, spaced one-fifth of a wave and fed 180 degrees out of phase with a 600-ohm line. When operated at the fundamental frequency the radiation resistance at the centre of each half-wave radiator is approximately 23 ohms. This is lower than a conventional half-wave aerial with its 73-ohm impedance and is due to the mutual impedance between the two radiators. The "Q" sections are adjusted to provide a match between 23 and 1,200 ohms and since two 1,200-ohm impedances are connected in parallel at the bottom the result is an impedance of 600 ohms, so matching the normal line.

When operated on the second harmonic the two radiators are two half-waves in length. Consequently, the centre of the radiators where the matching sections are attached is a high voltage point having a resistance of about 1,200 ohms.

Since the matching sections are one half wave length long at this frequency the resistance at their lower end is also 1,200 ohms. The two sections being in parallel the resulting resistance is 600 ohms so matching the transmission line. Radiation is broadside on both bands, the effective lobe being approximately 60 degrees wide on the fundamental and 45 degrees wide on the second harmonic.

We have made arrangements for the Johnson "Q" bars and other special fittings to be stocked by Webbs Radio of 14, Soho Street, London, W.1.

# The Hallicrafter HT-1 Transmitter

*This description of the new Hallicrafter transmitter should be of particular interest to amateurs; not only those who are contemplating the purchase of a ready-built transmitter, but also those who are keen on modern designs. From information supplied by G2NO.*

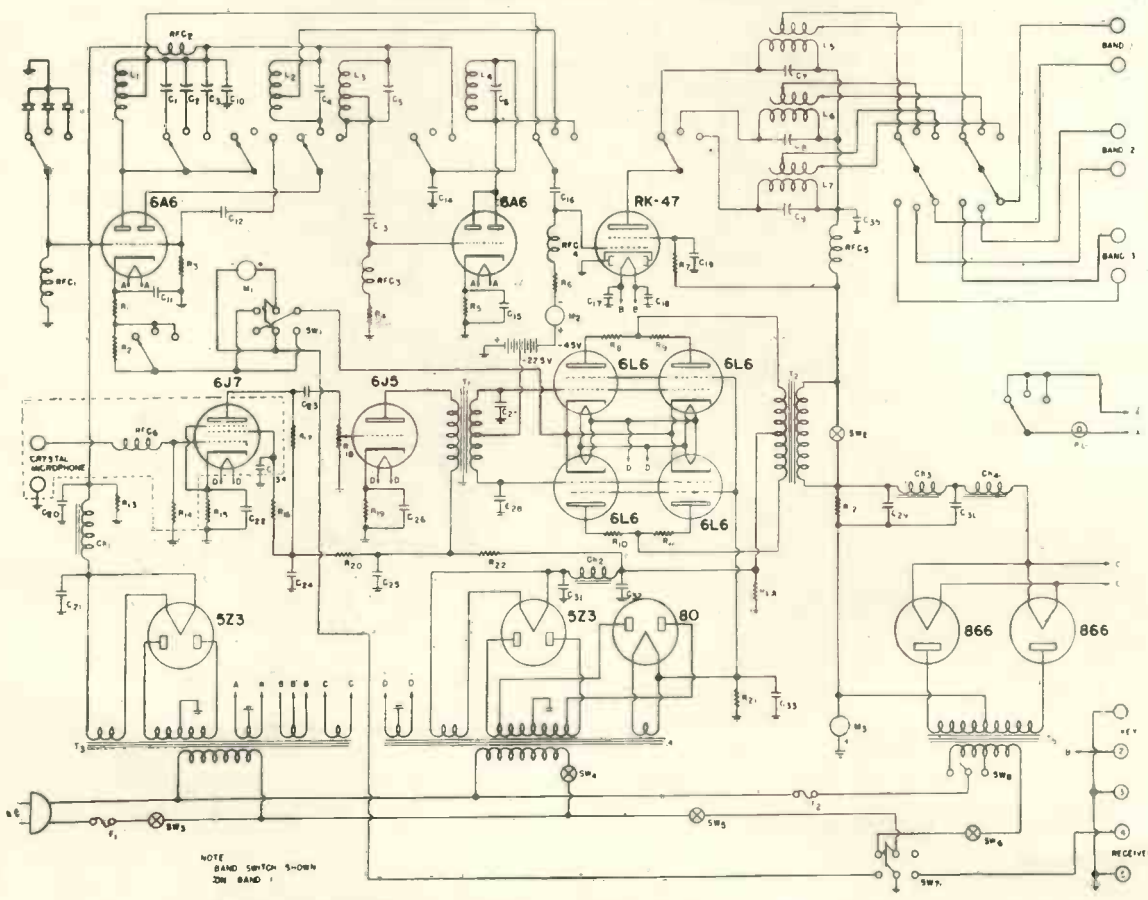
MOST amateurs are familiar with the complete range of receivers designed by Hallicrafters. Their transmitting equipment, however, is not so widely used in this country as it should be. This is probably due to the fact that only one of their transmitters is completely suitable for use by all amateurs. This is the model HT-1, which is conservatively rated for a 50-watt phone carrier or a 100-watt C.W. carrier on any amateur band except 10 metres where there is an unavoidable reduction in carrier.

## The Circuit

The transmitter, a circuit of which appears on this page, is completely self-contained with modulator, power unit and meters so arranged that there is ample audio available for complete modulation at the full rated carrier.

In the R.F. portion there are two 6A6 type valves in cascade providing sufficient excitation to the grid of the RK47 output tetrode. One section of the first 6A6 valve is used as a 40-metre oscillator and provision is made for switching into the grid circuit any one of three crystals. The second section of this valve is used to double to 20 metres for 20 or 10-metre operation. Both sections of the second 6A6 valve are connected in parallel and this valve is used when doubling to 10 metres. The anode circuit of the output valve, tuned by one of three tank circuits, is provided with adjustable aerial coils for each aerial connection. Individual tank circuits are provided for each stage and all the tank circuits are preset by adjustable condensers. The single band switch has sufficient sections to switch all the circuits including the crystal, oscillator, doubler, output and aerial and is controllable from the front panel. In the speech amplifier circuit, a type 6J7 valve is used as a high-gain amplifier and is followed by a 6J5 speech amplifier, in the grid circuit of which is the audio volume control. The modulator consists of 4 type 6L6G valves connected in push-pull parallel, coupled into

SCHEMATIC DIAGRAM — MODEL HT-1 — TRANSMITTER




**No less than 14 valves are used in the transmitter and two of these are of the double triode type. Carrier power of 100 watts is obtainable on C.W. operation or 50 watts for telephony. The transmitter is switchable over three bands.**

# 3-band Switched Coils

the H.T. supply lead of the RK47 by the modulation transformer.

Three power supplies are provided, the first furnishes filament power to the two 6A6 valves and the RK47 as well as H.T. power to the 6A6 exciter through a 5Z3 rectifier and filter. The second delivers filament and H.T. power to the speech amplifier and modulator tubes and includes a 5Z3 rectifier delivering 400 volts. A type 80 rectifier is also used to furnish screen voltage for the 6L6 modulators. Due to the fact that good voltage regulation is needed in order to obtain high output from the 6L6G's. This 80 rectifier receives its anode and filament supply from the same transformer, which provides H.T. and filament power to the remainder of the speech amplifier and modulator.

The third power supply provides the high voltage to the anode and screen of the RK47 and employs two type 866 rectifiers with a two-section filter.

Three meters are included to read anode currents for adjustment and checking operations. Meter M1 is arranged to be switched into the cathode circuit of the first 6A6 valve for tuning the oscillator and first doubler or into the cathode circuit of the 6L6 modulator for checking operating level. Meter M2 is connected so as to read the grid current of the RK47 while M3 reads the anode and screen current of the same valve. Several switches are provided so as to allow for rapid and flexible operation. Switch SW3 controls all filaments of the R.F. portion as well as H.T. power to the excitation valves. Switch SW4 which is located on the modulator gain control is used for turning on and off all power to the speech amplifier and modulator. Switch 5 controls the high voltage power and is so connected that voltage cannot be applied unless filament voltage has previously been switched off. Switch 8 when in its lower position provides 900 volts D.C. to the RK47 anode circuit for 50 watt phone or C.W. operation. When in its upper position, this switch increases the H.T. voltage to 1,250 for C.W. operation only.

## *Mechanical Lay-out*

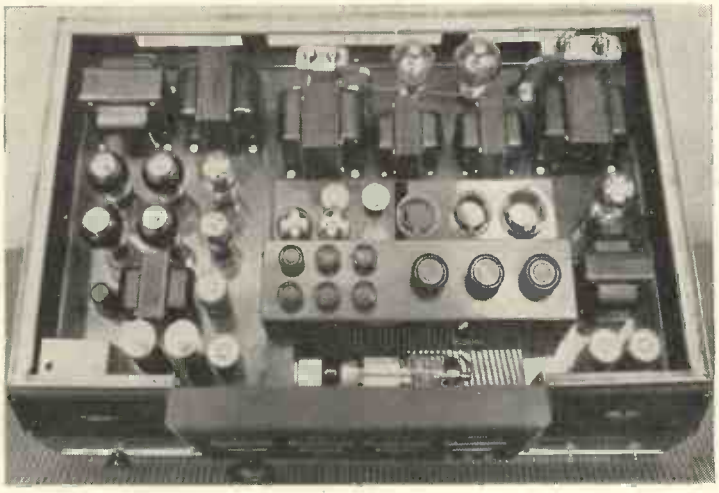
The various features of the mechanical arrangement can be seen by referring to the illustration of this transmitter. Looking at the top view it will be noticed that the entire R.F. portion is assembled as a single unit in the front centre of the chassis. The enclosed metal box in the centre of the assembly houses the band switch, the exciter coils and all the R.F. tuning condensers. The 6 knobs to the left control the excitation adjustment and the 3 knobs to the right control the output anode tuning. At the front of the tuning assembly is suspended the RK47 which is mounted horizontally to provide short leads for both grid and anode circuits. At the rear of the unit is suspended a small deck carrying the two 6A6 valves and sockets for three crystals.

At the rear centre of the chassis are the high voltage H.T. transformers, the 866 rectifier valve plus filter choke and condensers. The entire modulator with its power supply is situated in the left-hand section of the chassis. In the front corner and mounted in a metal shield is the 6K7 input stage, behind which is the first 6J5 speech amplifier, then the 4 6L6G modulators and finally the modulation transformer. To the right of the modulation transformer is the 6L6G power transformer in front of which are the 5Z3 and type 80 rectifiers.

The centre section of the front panel carries the three meters, anode and filament switches, C.W.-phone switch and knob and indicator scale of the band switch. Provision is made on the indicator scale for writing in the exact frequency used at each set in the band switch. At the rear of the transmitter are located three recessed terminal boxes, the centre of which contains 6 terminals for connection to three aerials.

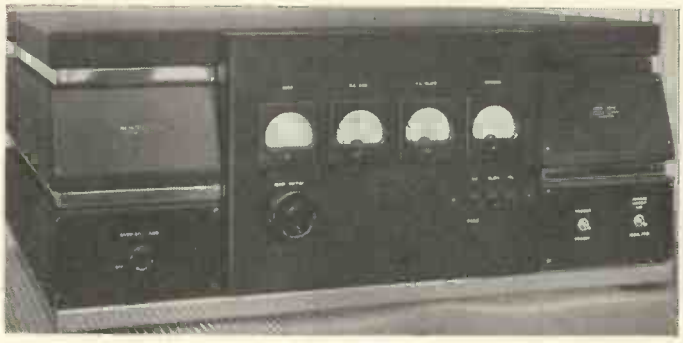
For aerial connection a separate pick-up coil is provided for each anode coil and both anode and pick-up coils are of the air-spaced type. In this way, the transmitter can be used on three wave-bands with three correctly-tuned aerial systems which are brought into circuit by merely rotating the switch to the correct position.

Since the portion of the pick-up coil in use is quite closely coupled to the anode coil at all times and the LC ratio of the anode tank is never so great as to require an excessively high impedance to be reflected into the anode coil to obtain the correct loading, satisfactory coupling may be obtained into resistive loads varying from a low resistance Marconi or doublet aerial to high resistance loads presented by maximum impedance, single wire and two-wire fed aerials. No provision is made to tune aerials which are not of the proper dimensions for the frequency used, and therefore present a reactive load. If the aerial requires inductance or capacity loading to tune to the operating frequency this must be done with an external coil or condenser.

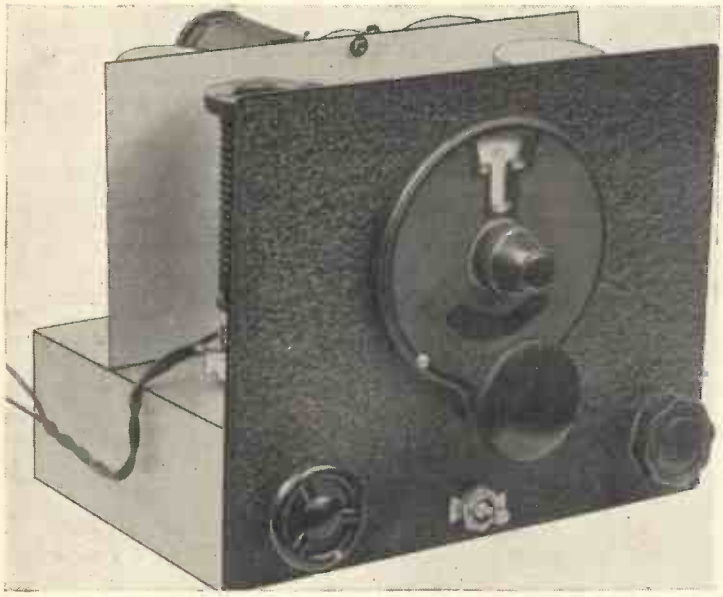


**This plan view shows the entire transmitter, power units, speech amplifier and modulator. Main tuning controls in the R.F. section are preset but the band switch is operated from the front panel.**

**The price is £73**



**The simplicity of the apparatus can be gauged from this illustration for the only important controls are the band switch, stand-by switch, and trimmers.**



The left-hand control is a tone corrector, and the right hand is for regeneration.

# A 3-valve Receiver for A.C. Mains

*This 3-valve receiver has a particularly impressive performance and operates well from 160 metres down to 10 metres, thus including the C.W.R. wavelength.*

A POPULAR receiver has always been a 3-valver with an efficient radio-frequency stage, and for some years there has not been very much opportunity to improve on the conventional designs of such a type of receiver. However, there have been modifications in layout, in methods of obtaining band spread and regeneration, but broadly speaking, the gain obtainable has always been governed by valve gain and noise level.

However, the introduction of a new series of valves by the Mullard Company put quite a different complexion on the design of this popular receiver, so much so that the available gain can be drastically increased coupled with a reduction in noise level.

Also, as these valves are of considerably smaller physical dimensions than normal and have grid connections to the top cap, the total size of the receiver can be reduced while the method of connection can also be improved.

## C.W.R.

This receiver has been built to cover all amateur frequencies with the maximum possible efficiency and will in particular be suitable for use on approximately 116 metres, the C.W.R. allocation.

In order to make the receiver suitable for the majority it is straightforward in design and construction and is capable of giving a good account of itself on the ordinary broadcast bands such as 13 and 19 metres. In this way, readers who are interested in the reception of short-wave programmes as distinct from the reception of amateur transmissions, will find the receiver distinctly above the general run of 2- or 3-valve receivers.

## A.C. Operation

Another interesting feature is that the receiver is designed for operation from A.C. mains and from such a supply is hum-free while regeneration is smooth even on the lower wavelength bands.

The circuit of the receiver is shown on this page, from which it can be seen that provision has been made for di-pole input or a conventional Marconi aerial with earth connection if required. VC1 and VC2 are coupled together to form a two-gang condenser and each have a capacity of 15 mmfd. This is quite small and only gives a limited coverage but it merely means using a large number of coils and dispenses with the band-setting and spreading condensers that would normally be required.

The first valve is one of the new Mullard "E" series type EF8 which has suitable characteristics for radio-frequency amplification, has a particularly low noise level and operates with the same potential on the anode as on the screen. This overcomes the need of a complicated screen-voltage potentiometer. It is essential, however, in order to obtain maximum gain that it be biased by means of cathode resistor R1 which has a value of 300 ohms. Its associated shunt capacity is .01 mfd.

The most satisfactory R.F coupling system for this valve is the tuned transformer with a tapped secondary to allow for regeneration in the detector stage. The tuned transformer in practice gives quite a high gain and as L3 is adjustable as regards inductance, the selectivity for any given band of frequencies can be adjusted for individual requirements.

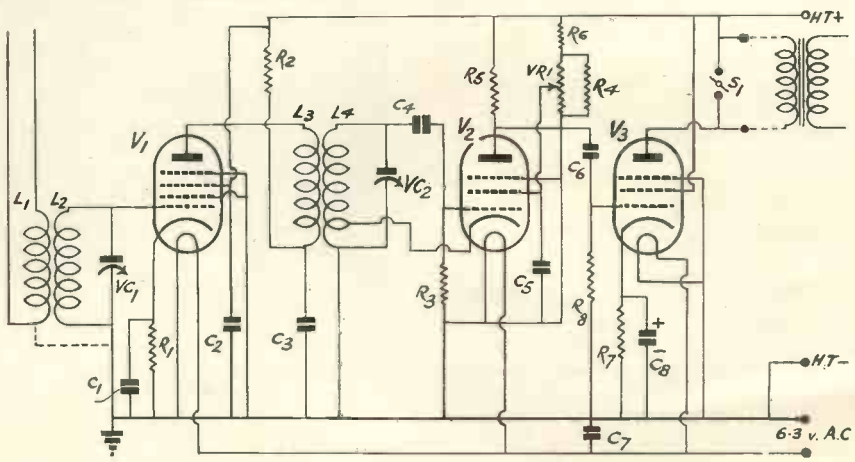
This is a distinct improvement over the tuned grid arrangement where the gain depends very largely on the efficiency of the choke and selectivity can only be obtained by reducing input and/or tapping the grid coil.

While decoupling is not essential in the R.F. stage it is advisable to include R2 and C3 which have a value of 500 ohms and .001 mfd. respectively, in order to prevent any possible instability.

## The Detector

The second valve is another Mullard, type E, and is an EF6 R.F. pentode used as a leaky grid detector. Provided C4 and R3 are strictly adhered to, this valve is exceedingly satisfactory. The regeneration control is obtained by connecting the cathode to ground via a small portion of the grid coil and varying regeneration by means of VR1, a variable potentiometer having a value of 50,000 ohms. In order that this control should not be too wide, in series with the high potential end is a resistor of 100,000 ohms.

It is always a problem to decide upon




This is th e complete circuit, which is self explanatory; all values are given in the text.

# Circuit Details

the best compromise value for the anode impedance in a resistance capacity coupled valve. To obtain high gain, one should have a high value of resistor, which also calls for a high anode voltage. If the voltage available is kept down to 250, then the resistance must also be reduced if sufficient voltage is to reach the anode of the valve. However, a combination of theory and practice shows that in this instance, the anode resistance should be 100,000 ohms with an inter-stage coupling condenser of .006 mfd. and a grid leak of 1 megohm.

The final valve is quite straightforward but it is still of the E series type and in this circuit provides an audio output of 2½ watts with only a very moderate grid voltage.

The cathode bias resistor has a value of 150 ohms and this is most important for owing to the high slope of the valve a small change in cathode resistor makes a big change in anode current. The output transformer is external and is part of the loudspeaker. On the other hand, if headphones are used, a 1/1 ratio transformer should be obtained in order to prevent D.C. current overloading the headphone windings.

Notice also the switch across the primary of the transformer. This is rather unusual but the receiver is used in conjunction with a transmitter having a relay removing the aerial connections to the receiver. Occasionally, however, there are traces of feed-back when using telephony and it is advisable to short-circuit the loudspeaker to prevent this. Readers, of course, may have their own ideas of killing the receiver during periods of operation.

The chassis is a new type produced by Eddystone. It is of die-cast aluminium and is very easy to cut. The panel of thin steel is also fairly tractable.

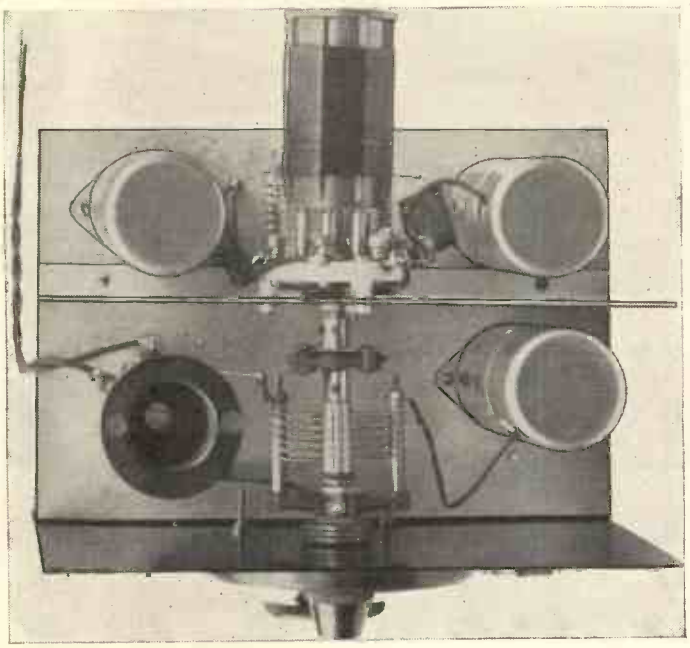
When the chassis is supplied the holes for the rear holes for the aerial and earth strip are already cut so removing the biggest difficulty confronting the constructor. As most slow-motion drives take up about two inches behind the panel it is essential that a drive be used of the specified type which fits on to the front panel, otherwise a considerably longer chassis will have to be employed.

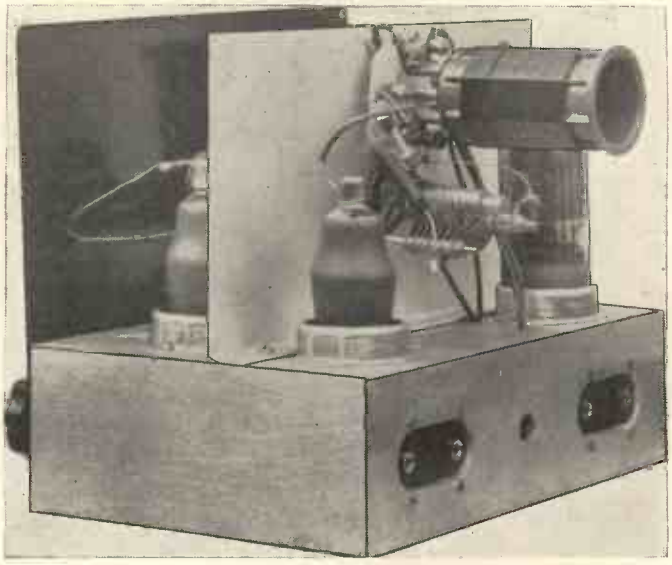
The dividing screen of light aluminium is held in place very rigidly by means of the two condensers although there is a ½ in. turnover for fixing.

It is also important to use the recommended Bulgin side contact valve holders for these fit quite comfortably the valves used. It will be noticed that the valve holders are mounted under the chassis and the screens above the chassis in order still further to save space.

The H.F. transformer made up of R3 and R4 is mounted on the dividing screen, while the aerial coil is mounted on top of the chassis so as to give complete screening.

In our next issue will be given full wiring and coil constructional details, also full specifications for a satisfactory power unit.





**How the components are mounted can quite clearly be seen from the plan view shown on the left. Above is a view which shows the R.F. transformer, detector and audio valve.**

## The Yorkshire Television Assoc.

Associate membership of the above association is open to genuine radio and television enthusiasts at an annual subscription of 10s. 6d., entrance fee 2s. 6d. Particulars from Hon. Secretary, A. Buckley, 110 Finkle Lane, Gildersome, near Leeds.

### Components for A 3-VALVE RECEIVER FOR A.C. MAINS

**CHASSIS.**
1—Type aluminium No. 1117 8½ × 5¾ × 2¾ (Eddystone).

**CONDENSERS, FIXED.**
1—.01 mfd. type tubular (C1) (Premier).
1—.01 mfd. type tubular (C2) (Premier).
1—.001 mfd. type tubular (C3) (Premier).
1—.0001 mfd. type mica (C4) (Premier).
1—.006 mfd. type tubular (C5) (Premier).
1—.006 mfd. type mica (C6) (Premier).
1—.005 mfd. type tubular (C7) (Premier).
1—25 mfd. 25 volt electrolytic (C8) (Premier).

**CONDENSERS, VARIABLE.**
1—Type VC15X (VC1) (Raymart).
1—Type VC15X (VC2) (Raymart).

**COIL FORMS.**
1—CF6 (Raymart).
1—CF4 (Raymart).

**DIAL.**
1—Type Indigraph (Peto-Scott).

**HOLDERS, VALVE.**
3—Type VH24 (Bulgin).

**HOLDERS, COIL.**
1—Type SW21 (Bulgin).
1—Type SW51 (Bulgin).

**HEADPHONES.**
1—Pair supersensitive (Ericsson).

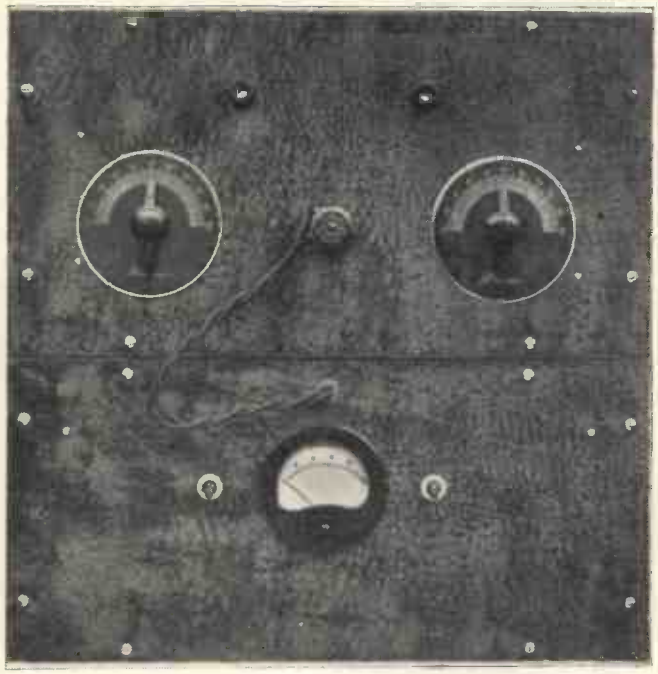
**PLUGS, SOCKETS, ETC.**
2—Top cap anode connectors type T41 (Bulgin).
4—Parallel sockets (Clix).
4—Plugs, type 3 (Clix).

**RESISTANCES, FIXED.**
1—300 ohm type 1 watt (R1) (Erie).
1—500 ohm type WE10 (R2) (Bulgin).
1—250,000 ohm type HW28 (C3) (Bulgin).
1—40,000 ohm type HW22 (R4) (Bulgin).
1—100,000 ohm type HW25 (R5) (Bulgin).
1—100,000 ohm type HW25 (R6) (Bulgin).
1—150 ohm type 1 watt (R7) (Erie).
1—1 megohm type HW23 (R8) (Bulgin).

**RESISTANCE, VARIABLE.**
1—50,000 ohm potentiometer (VR1) (Reliance).

**SWITCH.**
1—Type S80T (Bulgin).

**VALVES.**
1—Type EF8 (V1) (Mullard).
1—Type EF6 (V2) (Mullard).
1—Type EL3 (V3) (Mullard).
A complete kit of components can be obtained from Messrs. Peto-Scott, Limited, Webbs Radio, Limited, and Premier Supply Stores.



This two-tier rack takes both R.F. sections and power unit. A single meter is used to check both circuits.

# A 6L6G-801 Transmitter

*This simple transmitter using two stages will provide a carrier power of 50 watts. By removing one of the output valves it is suitable for use with 10 watts input. It was designed by the well-known amateur Hugh Fricker B.R.S. 1636.*

ONE of the most popular valves in recent years is the type 10 triode, which will stand gross overloading and provide quite a high carrier power with very simple equipment. Probably the main reason for the popularity of this valve has been its robustness and ability to withstand rough usage.

It is, however, rather out of date, has not the efficiency required of the modern valve, and at the same time, has too high inter-electrode and grid input capacity to make it of much use on high frequencies. However, this valve has been modified, improved and brought completely up to date and called the 801. The characteristics of this triode are very similar to that of the 10, so that amateurs can inter-change these two valves by merely altering the anode connection, bias voltage and neutralising setting.

The following characteristics should be noted for reference.

Filament voltage, 7.5 volts.
Filament current, 1.25 amps.
Grid-anode capacity, 6.0 mmfd.
Amplification factor, 8.
Grid-filament capacity, 4.5 mmfd.
Anode-filament capacity, 1.5 mmfd.
Max. anode dissipation, 20 watts.
Max. D.C. anode voltage, 600 volts.
Max. D.C. anode current, 70 mA.
Max. D.C. grid current, 15 mA.

In this circuit 500 volts are applied with a D.C. anode current of 130 mA. Under such conditions the grid driving power required is approximately 4 watts, while there is a bias supply power loss of 2.25 watts. This means that for really efficient working, with ample spare, there should be a driving power of approximately 12 watts. With such a power, an R.F. output of approximately 50 watts is quite easily obtainable, but should it be necessary to decrease the carrier power, the two valves in parallel can be run down to 15 watts or to under 10 watts if one valve is removed.

## 6L6G C.O.

In order to obtain the 12 watts driving power estimated, a 6L6G tetrode is used as a straightforward crystal oscillator at fundamental frequency. This valve, under quite comfortable operating conditions provides 15 watts R.F. output which is more than sufficient for the requirements of the two 801's.

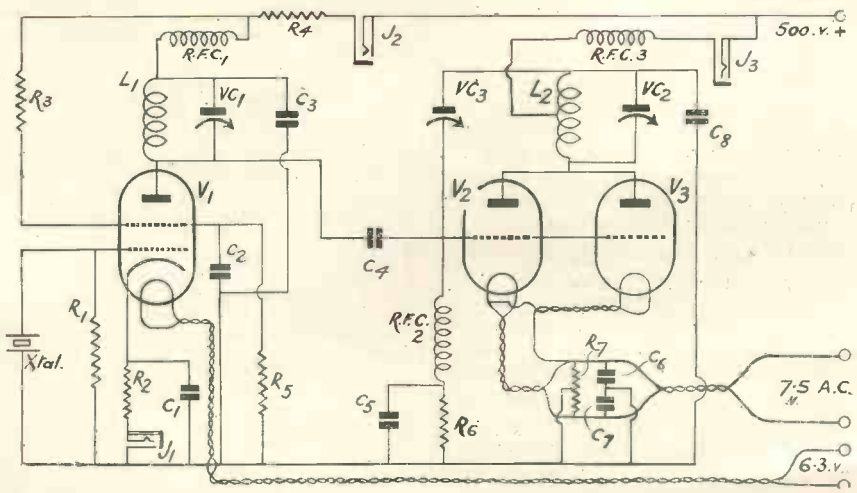
Many constructors who have used the 6L6G complain that they cannot obtain anything like the R.F. output claimed for this valve. This trouble is usually caused by operating the valve under incorrect conditions, such as low screen voltage, wrong grid resistor and cathode resistor values, and the incorrect anode condenser capacity. The values recommended in the theoretical circuit must be strictly adhered to and as the power unit very often gives higher or lower voltage than is estimated in theory, the actual voltages applied to the valve under operating conditions should be checked.

In this circuit the 6L6G requires a steady 275 volts actually at the screen terminal, and 475 volts on the anode. A 50,000-ohm bleeder resistance across the main supply is an improvement should the power unit show signs of not being too stable, and this point should be borne in mind.

## Tank Capacity

Also, the anode condenser, VC1, should have a capacity of 40 mmfd., and the resonant point should be obtained with approximately half this capacity in use. It is essential that the coil be constructed to enable the condenser to tune at midpoint rather than to build the coil and to take up variations by condenser adjustment.

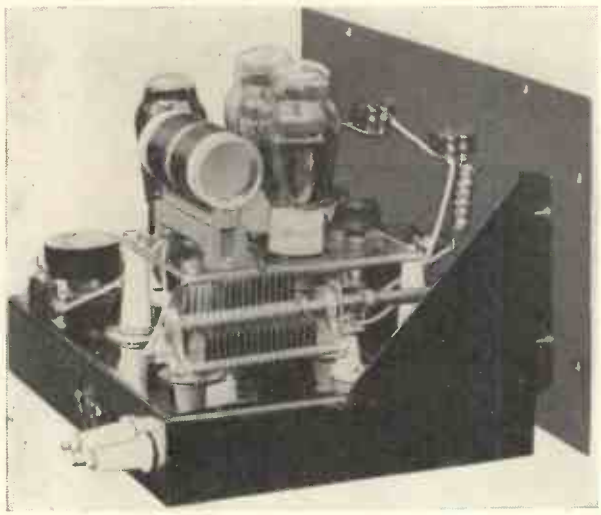
Resistor, R1, provides a certain




Between 12 and 15 watts R.F. output can be obtained from this crystal oscillator providing it is correctly built. Data is given in the text showing how the transmitter can be used on 40, 80 and 160 metres.

# Plug-in Coils

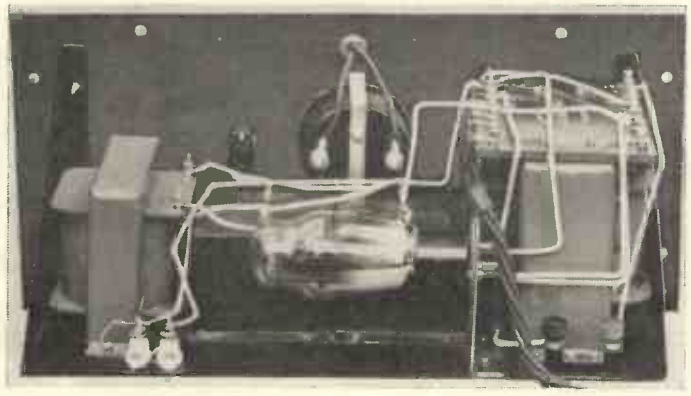
amount of bias and has a value of 50,000 ohms, while the cathode resistor, R2, has a maximum value of 200 ohms. This can be varied, but in no circumstances should the value be less than 100 ohms. The oscillator circuit is keyed in the cathode with a condenser across both key and cathode resistor having a capacity of .001 mfd. With this arrangement key clicks are practically non-existent.



**The final amplifiers are mounted on a strip of Trolitul insulating material with the tank coil and neutralising condenser. In this way the 801's can be partially wired before they are fitted to the chassis.**

## *Screen Network*

The screen voltage remains very constant even when the circuit is being keyed and this is due very largely to a stable power unit and the fact that the screen voltage is obtained by means of a comparatively low resistance potentiometer, made up of fixed resistors, R3 and R5. R3 has a value of 10,000 ohms at 8 watts rating and R4 8,000 ohms with 15 watts rating.



**This power unit provides 500 volts at 200 m°A.**

As the transmitter is designed for multi-band operation, the choke in the crystal circuit should be a particularly good one and free from resonance in the amateur bands. R.F.C.1 is of the Eddystone type 1002, which has an inductance of 1.5 milli-henries, a D.C. resistance of 10 ohms, and will carry up to 250 mA. It operates perfectly between 5 and 180 metres..

Coupling between stages is the next important item. For maximum output, the capacity should not exceed 100 mmfd., but if the transmitter is going to be used for a carrier powers of 25 watts and under, this coupling condenser can be reduced to 50 mmfd. There is then complete freedom from pull between stages so that the transmitter is docile to handle.

## *The P.A. Stage*

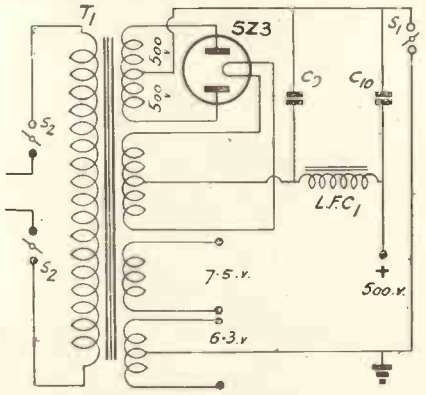
Next comes the construction of the P.A. stage. The two 801 valves are wired in parallel plus the coil former. The neutralising condenser, centre tapped filament resistor R7, and condensers C6 and C7 are all mounted on a strip of Trolitul insulating material which is in turn mounted on four Eddystone insulating pillars In this way the P.A. stage can be partially wired before the stage is actually bolted to the chassis.

The remaining wires are quite easy to connect as they are from the coil former which is on top of the chassis and the grid of the 801.

An R.F. choke in the grid lead to the 801's is essential and this in series with the chassis and bias resistor, R6, which has a value of 7,000 ohms at an 8-watt rating. It is shunted with C5, a condenser having a capacity of .006 mfd. A fairly high capacity is required for neutralising and a 15-mmfd. condenser is just large enough provided the circuit is efficiently wired. As the transmitter was designed in the first instance for operation on the lower-frequency bands, VC2 has the high capacity of 160 mmfd. This is quite satisfactory on 80 metres on the top band, or C.W.R. frequencies, but if the transmitter is to be used mainly on 40 metres, then it is advisable to make VC2 40 mmfd. It is then quite a simple matter, when the transmitter is occasionally used on lower frequencies, to make up the loss in capacity with a small parallel mica condenser across the coils used.

## *Construction*

Construction should not cause any difficulties, despite the fact that a heavy steel chassis is employed. The 6L6G is mounted on a strip of insulating material so that the leads to the socket can be connected before the valve holder is actually fixed into position. The tuning condenser in the anode circuit in both cases is mounted on small steel bracket which is in turn fitted to a miniature stand-off insulator.




**The power unit is in the second deck and has the 5Z3 rectifier mounted horizontally. This is quite satisfactory providing the filaments are arranged so that they cannot sag on to the anodes.**

The crystal holder is made up of two insulated sockets while all high-voltage connections going through the chassis are made via feed-through insulators. The only difficult hole to cut is the one for the valve holder on the back lip of the top chassis for taking the power supply.

Three insulated closed circuit jacks are needed, two for measuring anode current in each circuit and a third for

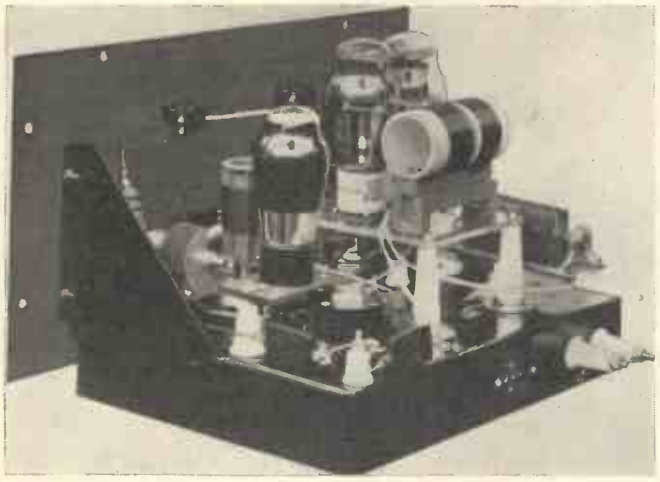
# Carrier Power 25 Watts

keying the cathode of the crystal oscillator. One mA. meter with a flexible lead and plug is used to meter both circuits.

Next comes the construction of the two coils required. For 160-metre operation, 65 turns of 20 gauge enamel-covered wire close wound on a 1½ in. diameter former; this coil is for the oscillator-anode. For 116 metres, that is the C.W.R. wavelength, 46 turns of No. 20 enamel-covered wire close wound, again on a 1½ in. former. For 80 metres, 38 turns of 20 gauge enamel-covered wire close wound, and 40 metres, 24 turns of 16 gauge wire spaced 1 in. diameter. For the tank coil: 160 metres, 46 turns of 16 gauge enamel-covered wire close wound in two equal sections, as are all the coils in this range. For 116 metres, 30 turns of 16 gauge enamel-covered wire, close spaced as for 160 metres, for 80-metre operation 23 turns 16 gauge enamel-covered wire, spaced one diameter. On 40 metres, tuning a 40-mmfd. condenser, use 16 turns of the same gauge wire spaced 1 diameter.

With all coils with the exception of 160 metres there should be a link winding of one turn to couple the tank to the aerial. On 160 metres, it may be necessary to increase this link to three complete turns.

When wiring the heater circuits use heavy gauge wire with sleeving in order to minimise voltage drop along the leads. It must be remembered that in addition to the comparatively long connections in the R.F. chassis, there are also comparatively long leads from one chassis to the other, and the 801 valve in particular will begin to give a low output when the heater voltage is reduced.



**From this illustration it can be seen that the crystal-oscillator is also mounted on its own insulated deck in the same way as the 801's.**

## *Power Unit*

Next consider the power unit. This is illuustrated and is situated in the lower section of the two-tier rack. It is quite straightforward consisting of a combined mains transformer giving the high voltage plus three heater windings. In order to keep the resistance of the unit as low as possible, a special choke has been made by Premier Supply Stores, which will pass 200 mA. has an inductance of 20 henries and an extremely low D C. resistance.

The smoothing circuit is completed by means of C9 and C10, two 4 mfd. type LEG condensers suitable for a working voltage of 650. The meter is also mounted on the power unit section plus two switches, one of the double-pole single-throw type in the main leads and the other of the simple make-and-break type for stand-by operation.

Next comes the testing. The off-tune anode current of the 6L6G is approximately 90 mA. which falls to 30 mA. when tuned to resonance. Directly the heater voltage is applied to the 801's and the coupling condenser C4 connected, there is a grid current flow in the 801 grid circuit of 20 mA. This should be measured in the first case by means of a temporary meter. The anode circuit of the 801's should be tuned to resonance as indicated by a looped lamp without any H.T. applied, after which the neutralising condenser VC3 should be adjusted to remove all traces of R.F. in L2. This can be done by means of a looped lamp but it is far more satisfactory and more accurate to neutralise by means of a grid meter. With L1 and L2 tuned to the same frequency, but without H.T. on V2 and V3, adjust VC2 until the position is found whereby VC2 can be tuned through resonance without effecting the grid current measured on the meter.

With H.T. applied to the V2 and V3 the grid current drops to just under 15 mA. The transmitter is then ready for coupling to the aerial. The simplest way of removing H.T. to individual valves is to have a plug in to J2 or J3 which is not connected. This opens the circuit and does not allow any H.T. voltage to reach the anode of the valve in question.

### Components for A 6L6G — 801 TRANSMITTER.

**CHASSIS AND RACK.**
1—Standard 2-tier rack with panel, chassis and brackets (Premier Supply Stores).

**COIL FORMS.**
1—4-pin (Raymart).
1—Ceramic type National (Webbs Radio).

**CONDENSERS, FIXED.**
1—.001-mfd. type 690W (C1) (Dubilier).
1—.01-mfd. type 691W (C2) (Dubilier).
1—.002-mfd. type 690W (C3) (Dubilier).
1—.0001-mfd. type 4601/S (C4) (Dubilier).
1—.006-mfd. type 691W (C5) (Dubilier).
1—.002-mfd. type 690W (C6 (Dubilier).
1—.002-mfd. type 690W (C7) (Dubilier).
1—.002-mfd. tubular 1,000 v. (C8) (Dubilier).
1—4-mfd. type LEG 650 v. (C9) (Dubilier).
1—4-mfd. type LEG 650 v. (C10) (Dubilier).

**CONDENSERS, VARIABLE.**
1—.00004-mfd. type TRO 40T (VC1) (Premier Supply Stores).
1—.000015-mfd. type TRO15T (VC3) (Premier Supply Stores).
1—.000016-mfd. type TRO160T (VC2) (Premier Supply Stores).

**CHOKES, R.F.**
3—Type 1022 (Eddystone).

**CHOKES, L.F.**
1—200 m/A. 20 H. (Premier Supply Stores).

**CRYSTAL.**
1—Standard type with enclosed holder (Q.C.C.).

**DIALS.**
2—Indicator plates with knobs (Premier Supply Stores).

**HOLDERS, VALVE.**
2—4-pin American chassis type less terminals (Clix).
1—4-pin type V1 (Clix).
1—8-pin type Ceramic Octal (Eddystone).

**INSULATORS.**
4—Type 1049 (Eddystone).
4—Type 1019 (Eddystone).
1—Type 1046 (Eddystone.
8—Feed-through (Johnson-Webbs Radio).

**JACKS.**
3—Closed circuit type J6 (Bulgin).

**KEY.**
1—McElroy amateur type (Webbs Radio).

**METER.**
1—Flush mounting 0-150 mA. (Premier Supply Stores).

**PLUG.**
1—Type P15 (Bulgin).

**RESISTANCES, FIXED.**
1—50,000 type 1-watt (R1) (Erie).
1—200-ohm type 8-watt (R2) (Premier Supply Stores).
1—10,000-ohm type 8-watt (R3) (Premier Supply Stores).
1—2,500-ohm type 15-watt (R4) (Premier Supply Stores).
1—8,000-ohm type 15-watt (R5) (Premier Supply Stores).
1—3,000-ohm type 8-watt (R6) (Premier Supply Stores).
1—75-ohm CT (R7) (Premier Supply Stores).

**SWITCHES.**
1—S81T (S2) (Bulgin).
1—880T (S1) (Bulgin).

**TRANSFORMER, MAIN.**
1—Special type to give—
600-0-600 200 m/A.
2.5-0-2.5 3 amp.
3.75-0-3.75 4 amp.
3.15-0-3.15 1 amp. (Premier Supply Stores.)

**VALVES.**
1—6L6G (V1) (Raytheon-Webbs Radio).
2—801 (V2 and 3) (Radiotron-Webbs Radio).
1—5Z3 (V4) (Triad-Premier Supply Stores).

# The Short-wave Radio World

## A Review of the Most Important Features of the World's Short-wave Developments

### VARIABLE FREQUENCY CONTROL

THERE is a growing tendency for amateur transmitters to make provision for a variable-frequency control in order to use the most suitable part of the band at any given time.

An interesing unit which can be added to practically any transmitter was described in the November issue of the American publication QST and designed by W2OAE. This unit, shown in Fig. 1, consists of a tetrode electron-coupled oscillator in its own cabinet with built-in power unit. In the original circuit all three tuned circuits resonate in the broadcast band. That of the oscillator covering a range of 860 to 1,010 Kc. with a padder condenser correctly set. When the output circuit is plugged into the main transmitter in place of a 160-metre crystal, all frequencies, between 175 and 2,020 Kc. can be covered.

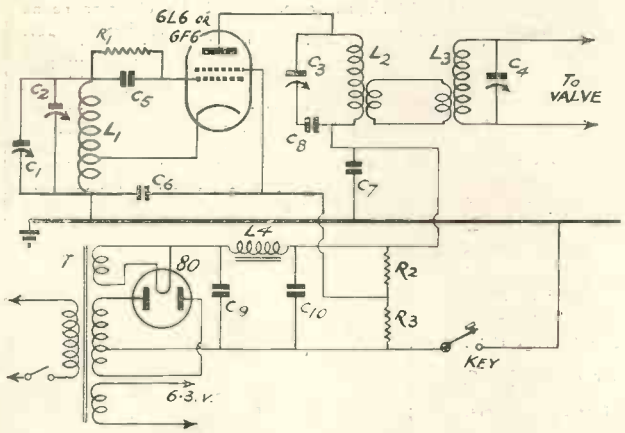



Fig. 1.—This variable frequency control unit is for 160 metre operation with the oscillator section tuned in the broadcast band.

This has been obtained by using a 140-mmfd. band-spread condenser and a 400-mmfd. padding condenser. This high capacity keeps the circuit stable after the valve has completely warmed up. The anode and the output circuit are tuned to different frequencies giving a band pass effect in the output circuit.

The designer emphasises that the unit must be very robustly constructed and wired with heavy gauge wire in order to obtain sufficient frequency stability. There is one unusual feature in the circuit, that is the method employed for keying or stand-by operation. Instead of breaking in the oscillator circuit it was found better to key the H.T. negative feed as one side of this is earthed. It should be noted that the high voltage winding centre tap, the bleeder and negative side of the high voltage condensers are connected together to one side of the key, the other side of the key then goes to chassis. In this way, when the key is up the bleeder load is still across the H.T. supply.

Either a 6F6 or 6L6 tetrode is satisfactory with 250 volts on the anode and 150 volts on the screen. When pentode crystal oscillators are used, the 6F6 will furnish sufficient R.F. output to drive such valves as frequency doublers.

The tuning condenser in the anode circuit is of the mica type with a screwdriver adjustment. The main padding condenser of 400 mmfd. is made up of a two-section broadcast type unit, with the mica trimming condensers removed in order to minimise drift. The two coils in the output circuit are quite interesting for in this way the output from L3 which is link-coupled to L2 can be plugged directly into the normal crystal holder in the main receiver. The frequency stability of this arrangement is such that the coils can be modified for operation on 40 metres, if required. There is no need strictly to follow the data given for 160-metre operation.

W2OAE suggests that the signal shifter should be tested and operated in the following manner. If a closed circuit jack is used, it is not necessary to plug in the key in order for the unit to operate although the circuit must be broken if break in operation is employed. Tune a broadcast receiver to about 860 Kc., set the band-spread condenser at maximum capacity and turn the padder unutil a beat note is heard. By rotating the band-spread condenser to a minimum capacity it should be possible to tune a station at 1,010 Kc. If this cannot be done the capacity of the band-spread condenser is incorrect, or the coil is not of the recommended inductance. The anode circuit should be tuned to resonance near one end of the band and the output circuit near the other end of the band. When this is done, the output is obtained throughout the entire band with two voltage peaks of about average strength. A neon bulb should be used to determine the proper setting of the condensers and every care should be taken not to interfere with other broadcast listeners.

The output circuit must be slightly re-trimmed when it is connected to the crystal socket owing to the added capacity across it. With the constants given, the unit is restricted to transmitters operating with 160-metre crystals. Tests made by W3BJR indicate that a good signal and a chirp-free T9 note can be obtained. A warming up

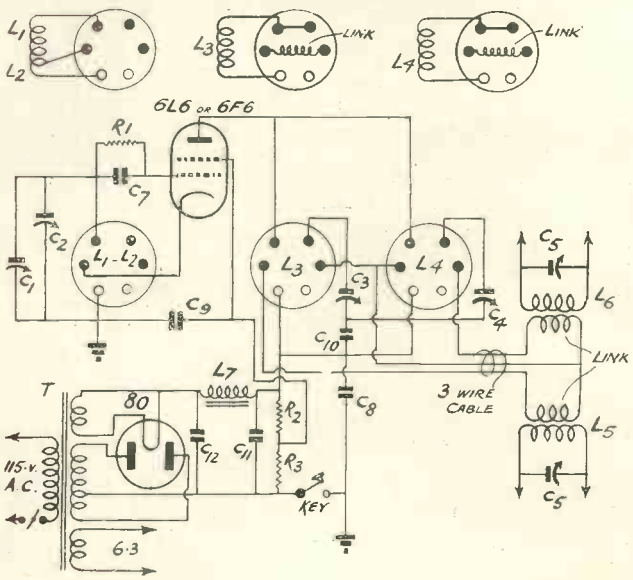



Fig. 2.—A modified version designed for two-band operation has separate coils in this manner.

# A New Receiver for U.H.F.

period of 15 minutes should be allowed, after which drift is a matter of cycles between transmissions.

In Fig. 2 is a variation of the original arrangement inasmuch at it will furnish R.F. output on two bands. This circuit is essentially the same as that in Fig. 1 but two sets of plug-in coils are used. The energy is carried by means of a three-wire cable to two output circuits permanently tuned and plugged into crystal sockets in the transmitter. As this arrangement provides broadcasts on 160-metre output, both 160 and 80 metre crystals are eliminated. Power supply and the oscillatory circuit are the same but the arrangement of the anode circuit in order to provide two-band output without retuning has been slightly modified.

Coils L1, L3 and L5 provide broadcast output, the others furnish 160-metre output. L1 and L2 plug into the same socket, L3 and L4 require separate sockets so that the tuning may be permanently set and the energy transferred to the proper output circuit.

| | |
|---|---|
| Component | values are as follows :— |
| C1 | 140 mmfd. variable |
| C2 | 400 mmfd. bandset |
| 63 and C4 | 220 mmfd. mica trimmers |
| C5 | 100 mmfd. mica |
| C6 and C7 | .01 mfd. mica |
| C8 | .005 mfd. mica |
| C9 and C | 10 8 mfd. 450 volt working |
| R1 | 100,000 ohms 1 watt |
| R2 and R3 | 5,000 ohms 10 watt |
| L4 | 30 H. choke |

The coils are all home constructed, L1 is made up of 45 turns number 28 s.c.c. on 1½ in. former with a cathode tap at the 15th turn from the earth end. Coils L2 and L3 are commercial broadcast type made by Meissner with the primaries removed and a 15 turn link substituted. The power transformer gives 250 volts at 40 mA. with 6.3 and 5 volt filament windings.

Component values for the modified circuit shown in Fig. 2 are very similar. The variations are as follows :—

C5 and C6, 200 mmfd. mica trimmers.
C7, 100 mmfd. mica.
C8 and C9, .01 mfd. mica.
C10, .005 mfd. mica.
C11 and C12, 8 mfd. electrolytic.

The coil dimensions are as follows :— L2 24 turns number 20 s.c.c. on 1½ in. former with the cathode tap on the 6th turn from the earthy end. L3 is made up of 90 turns number 28 s.c.c. on a 1½ in. former plus a 15 turn link coil. 42 turns of number 20 s.c.c. on a 1½ in. former are required for L4. With this coil the link is made up of 10 turns. L5 is a broadcast coil with a 15 turn link, while 50 turns of 28 s.c.c. on a 1 in. former with a 7 turn link are required for L6.

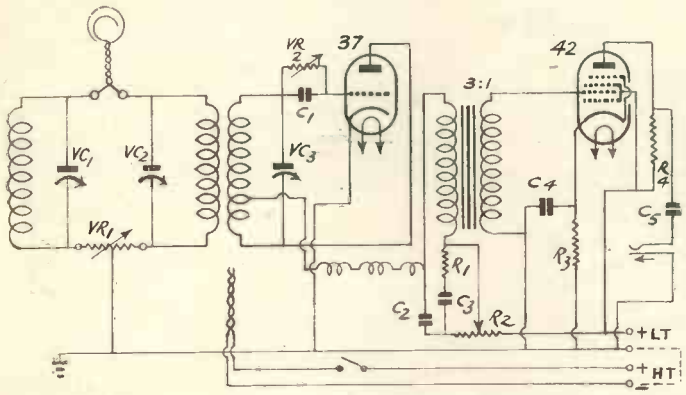



**Fig. 3.—The record breaking pick-up between New Zealand and Australia was made on this receiver. It covers the three most useful U.H.F. bands.**

## A TWO-VALVE U.H.F. RECEIVER

A considerable amount of long distance communication on ultra-short waves has been carried out by the well-known Australian amateur VK2NO and others who have been collaborating with him. Mr. A. P. Morrison, of Wellington, New Zealand, who picked up VK2NO describes his interesting receiver in the Australian publication *Radio World*. This set, shown in Fig. 3 uses only two valves, a triode and a pentode. It can be built to cover the 28, 56 and 112 Mc. bands. Tests on 28 Mc. indicate that it is exceptionally sensitive and over a short period 80 stations were logged at loudspeaker strength.

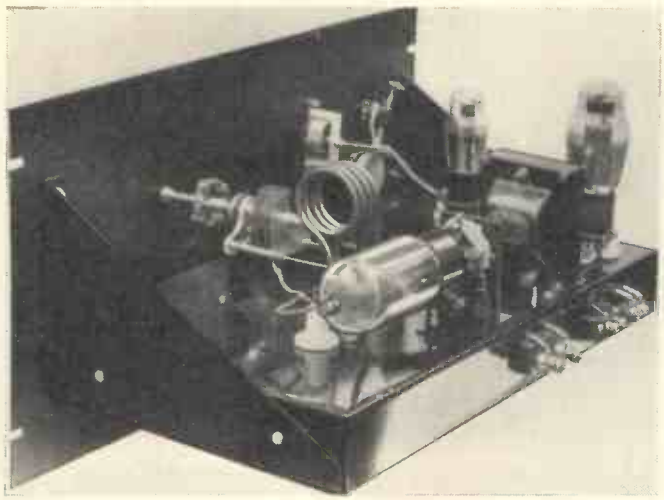
There are only three controls, i.e., the main tuning condenser, regeneration control and filament switch. All leads have been kept as short as possible, while the 37 valve is mounted on a ceramic holder. It is also important that all common earth leads be taken to one point and not allowed to make automatic contact to the metal chassis.

The coil is mounted on stand-off insulators, while the radio-frequency choke is mounted at right angles to this coil. It appears that standard Eddystone plug in ultra-high frequency coils can be used in this receiver so that it can be quickly converted to operate on the band required. One feature of the receiver is that the grid leak runs between the grid and the section of the receiver connected to the positive H.T. supply. This results in improved selectivity and smoother operation than with the grid leak connected to cathode in the conventional manner. This grid leak is variable from 10,000 ohms to 20 megohms, and is adjusted to give the most satisfactory results. Some tests made, however, indicate that a grid leak of 5 megohms is a good average value.

For those who wish to build their own coils, the following data should be carefully noted. 2½ metre coil, 4 turns on ½ in. dowel with a centre tap; 5 metre coil 8 turns similar diameter also centre tapped. On 10 metres, 11 turns are required with a ¾ in. diameter tapped at the 6th turn from the anode end. All coils are wound with 18 gauge tinned copper wire and sprung off the dowels in the usual way. The chassis size is 8 by 5½ by 2 in. with the panel 7½ by 6 in. The type 37 and 42 valves are quite satisfactory, but they can be replaced with British valves having similar characteristics.

The tuning condensers have a capacity of 15 mmfd., but for restricted coverage these can be adapted to have a maximum capacity of 7 mfd. The grid condenser is of the ceramic type having a capacity of 100 mmfd., the bypass condenser on the anode side of the transformer, .005 mfd., on the H.T. side .5 mfd., a conventional cathode condenser and a .5 mfd. filter condenser.

As regards resistances, the decoupling resistance in the transformer circuit has a value of 100,000 ohms, its associated variable resistance 50,000 ohms, and a 250,000 ohms variable in the aerial circuit. Other values are normal.



# An Experimental 5-metre Transmitter

*This experimental transmitter has been built to use the new Mullard 25-watt triode valve. As the results were so satisfactory it is published in its present form for the benefit of constructors interested in 5-metre operation and who do not wish to go to the expense of multi-valve crystal-controlled units.*

**All the components of importance can be seen from this illustration. Notice that the R.F. section in the front of the picture has the valve mounted horizontally.**

A VALVE recently introduced by the Mullard Co., type TZ08-20, has proved to be extremely satisfactory in use. We have produced a simple 5-metre transmitter for the purpose of roughly testing the efficiency of this valve and it has proved so satisfactory that we are publishing this description of the experimental hook-up. It is simple, very straightforward and provides 15 watts of R.F., which is more than enouugh to give quite wide coverage on 5 metres. It has actually been used during A.R.P. experiments and during trials gave good coverage. Provided the modulation level is not excessive, the quality is extremely good without too much frequency change.

The illustration on this page gives a very good idea as to the layout of this hook-up. The radio-frequency portion is simplicity itself for it consists merely of the single valve with one tuned circuit and the absolute minimum of components.

## The R.F. Circuit

Consider first of all the TZ08-20 circuit in which there is one coil connected between anode and grid with a grid condenser in series with one side and a leak, R1, between grid and the mid-point of the heater circuit.

The whole coil is tuned by VC1, a condenser having a capacity of 15 mmfd. which has more than sufficient capacity for this circuit. The mid-point of the coil is tapped and H.T. fed into the circuit via a radio-frequency choke.

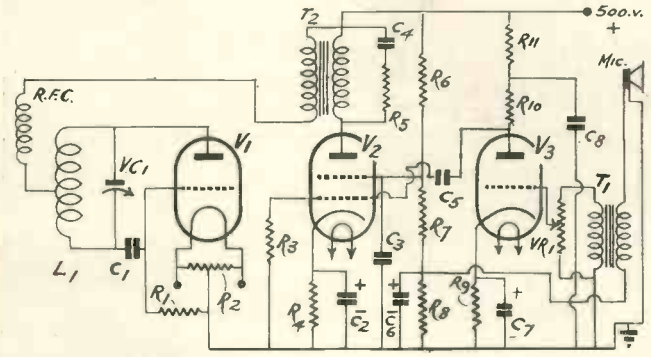
It is better to complete the building of the R.F. unit before considering modulation. The valve is mounted horizontally and is arranged so that the heater cannot sag on to the anode. Midway along the side of the valve is fitted a single coil and mounted on a pair of Bulgin stand-off insulators with a feed-through insulator taking the high-voltage lead to the chassis.

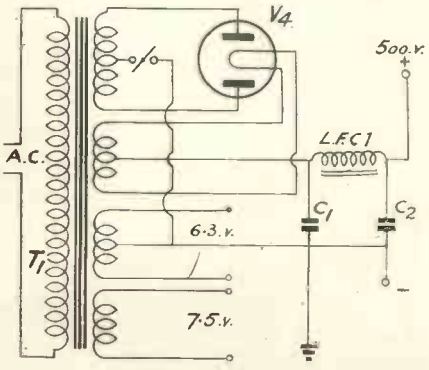
Close to the ends of this coil comes the tuning condenser mounted on an adjustable and insulated bracket so that the leads are all extremely short. It must be remembered that the anode to the valve is on the top cap which goes straight to one side of the coil and condenser. The grid at the other end connects to the blocking condenser, C1, and then straight to the coil and variable condenser.

Directly underneath the valve holder is R2, the centre-tapped resistor to which is taken one side of the grid resistor, R1. This grid resistor should have a value of 10,000 ohms at 2 watts rating. The blocking condenser has a capacity of .002 mfd. and must be capable of withstanding 600 volts.

## Tuning Troubles

Difficulties were experienced in the first instance in tuning this transmitter for there were two resonant points. This ultimately turned out to be a combination of bad construction and a faulty choke. It was noticed that the mid-point was not accuruate and when this was corrected, the two tuning points showed quite a difference in R.F. output.




**On the left is the complete transmitter with its two-stage modulator, while on the right is the separate power unit which gives 500 volts and the necessary filament windings.**

It was not, however, until the choke was changed to one of a different inductance proper tuning was obtained. It is important that the choke be of the Eddystone type 1011.

Alternatively, should constructors wish to build their own R.F. chokes, this can be made up of 28 turns of 18 gauge enamel-covered wire wound on a potential and spaced to cover 1½ in.

## Coil Data

For 5-metre operation, the tuning coil should consist of four turns of 10

# Coil Data :: The Modulator

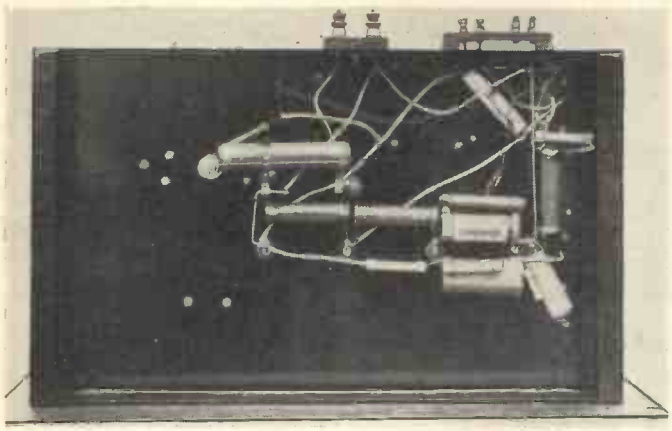
gauge copper wire wound approximately to 2 in. in diameter and spaced to cover a winding space of 3½ in.

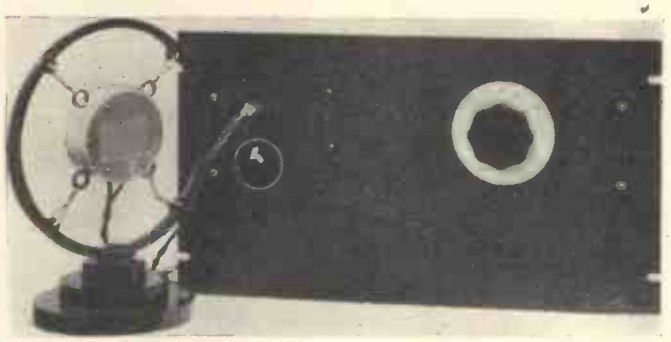
From the illustration all these constructional details can be followed but there is one more point to remember; the TZ08-20 has a 7.5-volt heater which is not centre tapped so a two-way terminal strip should be mounted on the rear lip of the chasis so an external filament transformer can be used.

A high value of bias resistor is also very necessary and R9 for this reason should not be less than 2,000 ohms otherwise there is possibility of voltage drop causing poor quality and a decrease in gain. The coupling condenser between stages, shown as C5, has a capacity of .01 mfd. and is of the mica type. The resistance network across the power unit, made up of R6, 7 and 8 is extremely important. This network

The values have been carefully worked out and must not be changed. R6 is 15,000 ohms, R7 20,000, and R8 5,000 ohms. All these resistors are of a special type having an 8-watt rating and are available from Premier Supply Stores.

It is also important to by-pass the screen of the 6L6G directly from the screened contact on the valve holder. This by-pass condenser, C3, has a mini-





**Above is a front view of the transmitter with the Premier microphone used. There is only a single control in the R.F. section. The left-hand view shows the components that are mounted underneath the chassis. These are all inter-connected in the wiring.**

## *Modulation*

Next comes the modulator. We realised that if this were to be complicated it would counteract the simplicity of the R.F. portion, so for this reason it has been kept down to two valves. It would have been possible by using a high-gain poor-quality microphone to have connected this directly into the grid of the GL6G, but the amount of gain would have been so slight as to make a reasonable percentage of modulation impossible.

For this reason, the microphone is fed into a 6C5G via a microphone transformer having a ratio of 35/1. It will be noticed at this point that the energising voltage for the microphone is obtained automatically from the power supply and provided the condenser C6 is included, hum level is negligible. This system can be employed in practically any amplifier and does, once and for all, do away with the microphone energising battery.

As the output from the Premier microphone is quite high, a volume control is essential in view of the high gain from the two-stage amplifier, so this control is included in the grid of the 6C5G and consists of a potentiometer having a value of 500,000 ohms.

In order that the gain is maintained, the circuit constants must be strictly adhered to. Resistance, R10, the anode impedance for V3, is 60,000 ohms and the decoupling resistor 50,000 ohms. The associated by-pass condenser, C8, has a capacity of 4 mfd. and is of the electrolytic type.

fulfils three functions. It stabilises the power supply and prevents high voltage peaks before the valves heat; the screen voltage is obtained from a tapped point and remains reasonably constant, and finally a small percentage of the available H.T. voltage is tapped off to energise the microphone.


**This is the valve designed for amateur use which has proved so satisfactory. It is priced at 17s. 6d.**

mum value of .1 mfd.

With the values shown for the 6L6G modulator, an output of approximately 7 watts can be obtained and this is rather too much unless the carrier is at least 15 watts. It is not advisable to modulate more fully than to 60 to 70 per cent. otherwise there is considerable frequency shift. This point must be borne in mind and the input reduced should the modulation be too heavy.

The 6L6G has its grid tied down to earth by means of R3, a 500,000-ohm resistor, and has a full 500 volts applied to its anode. Across the primary of the modulation transformer is a resistance-capacity network of 15,000 ohms and a .01-mfd. condenser in order to attenuate top note response. The secondary of the modulation transformer is connected directly into the H.T. supply lead in series with H.T. positive and the R.F. choke in the TX section.

## *Power Supply*

A separate power unit is used and this is made up of a Premier transformer giving 500 volts at 120 mA. and three filament windings. There are six terminals on the back of the transmitter chassis and these are used to interconnect the transmitter with the power unit. The six terminals are for the 7.5-volt heater, 6.3-volt heater and H.T. positive and negative.

It will be noticed that there is a switch in series with the centre point of the high-voltage winding. This is

(*Continued in third column of page* 768)

# Active American U.H.F. Stations

This list indicates some of the American U.H.F. stations which are now active. Many of these should be heard in Europe if a good receiver and aerial system are used. The stations are of three types, general broadcast, general police and relay.

## *Broadcast*

| *Call.* | *Location.* | *Frequency.* |
|---|---|---|
| W2XSN | P. F. Godley, Montclair, N.J. | 41.8mc. |

## *Relay Broadcast*

| | | |
|---|---|---|
| W4XGO | Isle of Dreams, Miami, Fla. | Gen. Re. |
| W5XHU | WDSU, Inc., Ardmore, Okla. | Gen. Re. |
| W8XO | Carter Pub., Ft. Worth, Tex. | Gen. Re. |
| W8XRZ | WJR, Inc., Detroit, Mich. | Gen. Re. |
| W9XMK | Peoria Brdcstg., Peoria, Ill. | Gen. Re. |
| W10XIO & W10XIQ | Yankee Network, Boston, Mass. | Gen. Re. |

## *Forestry Service*

| | | |
|---|---|---|
| W1XOA to W1XQF | Mass, Dept. of Conservation | Gen. Br. |
| W3XMP | Maryland Dept., Brandywine | Gen. Br. |
| W3XMQ | Maryland Dept. | Gen. Br. |

## *Police Broadcast*

| | | |
|---|---|---|
| W1XLI | Boston, Mass. | Gen. Po. |
| W2XSI & W2XSJ | New York City Police Dept. | 33.1mc. |
| W2XSK | Rockland County, N.Y. | Gen. Po. |
| W2XOZ | Lakewood, N.J. | Gen. Po. |
| W2XPS | Lakewood, N.J. | Gen. Po. |
| W2XOG | Hempstead, N.Y. | 40.1mc. |
| W2XQH, I, J, K. L, M | Hempstead, N.Y. | 40.1mc. |
| W2XRX | Hempstead, N.Y. | Gen. Po. |
| W2XSL | New York City Police Dept. | Gen. Po. |
| W2XSM | Englewood, N.J. | Gen. Po. |
| W2XSO | White Plains, N.Y. | Gen. Po. |
| W2XSP to W2XSX | White Plains, N.Y. | Gen. Po. |
| W2XSY | Elwood, N.J. | Gen. Po. |
| W3XLJ to W3XLN | Wilmington, Del. | Gen. Po. |
| W3XMC | Bound Brook, N.J. | 33.1, 37.1mc. |
| W3XMD | Bound Brook, N.J. | 33.1, 37.1mc. |
| W3XML | Staunton, Va. | Gen. Po. |
| W3XMM to W3XMO | Camden, N.J. | Gen. Po. |
| W4XGD | Sanford, Fla. | Gen. Po. |
| W4XGG & W4XGH | Wilmington, N.C. | 33.1mc. |
| W4XGP to W4XGT | Tampa, Fla. | 30.1mc. |
| W4XGU & W4XGV | Miami, Fla. | 30.1, 33.1mc. |
| W5XEL, M, N, O, P | Wichita Falls, Tex. | Gen. Po. |
| W5XFA to W5XFT | Austin, Texas | Gen. Po. |
| W6XUA | Las Vegas, Nev. | 30.1mc. |
| W6XUP | National City, Cal. | Gen. Po. |
| W6XUQ & W6XUR | Alameda County, Cal. | 37.1mc. |
| W6XUX & W6XUY | Long Beach, Cal. | Gen. Po. |
| W6XXA to W6XXL | Los Angeles, Cal. County | Gen. Po. |
| W6XXZ | Watsonville, Cal. | Gen. Po. |
| W6XYF & W6XYG | Los Angeles, Cal. Red Cross | |
| W7XDU & W7ZDX | Portland, Ore | Gen. Po. |
| W7XDW & W7XDX | Multnomah County, Ore. | 30.1mc. |
| W7XDY | Pierce County, Ore. | 33.1, 37.1mc. |
| W7XEG to W7XEJ | Butte, Mont. | 40.1mc. |
| W8XPS | Wayne Count., Mich. | 33.1mc. |
| W8XQX | Royal Oak, Mich. | 30.1mc. |
| W8XRC | Oneonta, N.Y. | 30.1mc. |
| W8XRE | Ottawa Hills, Ohio | Gen. Po. |
| W8XRF | Ottawa Hills, Ohio | Gen. Po. |
| W8XRR | Midland, Mich. | Gen. Po. |
| W8XRS | Wierton, West Va. | 33.1mc. |
| W8XRT to W8XRW | Wierton, West Va. | 33.1mc. |
| W8XRX & W8XRY | Fremont, Ohio | 30.1mc. |
| W8XSD | Indian Hill, Ohio | 33.1, 37.1mc. |
| W8XSE & W8XSF | Indian Hill, Ohio | 33.1, 37.1mc. |

## "An Experimental 5 metre Transmitter"

(*Continued from page* 766)

merely for stand-by operation. It enables the H.T. voltage to be switched off with the valves still supplied with L.T. voltage.

By using the Eddystone rack recommended, this little transmitter can be used in a standard relay rack. There is also sufficient space on the chassis to take a small unit so experimenters who wish to use this transmitter fairly permanently could mount everything on the one chassis. It is not intended for long-distance communication for it is not suitable for reception with anything but flatly tuned receivers of the super-regenerative type, but it is quite suitable for local working and field days should a small convertor be obtainable.

### Components for AN EXPERIMENTAL TRANSMITTER

**CHASSIS AND PANEL.**
1—Chassis type 1109 (Eddystone).
2—Brackets type 1110 (Eddystone).
1—Panel type 1112 NO4 (Eddystone).

**CONDENSERS, FIXED.**
1—.002-mfd. type 620 (C1) (Dubilier).
1—.50-mfd. 50 v. type 3004 (C2) (Dubilier).
1—.1-mfd. type 4603/S (C3) (Dubilier).
1—.01-mfd. type 691W (C4) (Dubilier).
1—.01-mfd. type 691W (C5) (Dubilier).
1—10-mfd. 50 v. type 3016 (C6) (Dubilier).
1—10-mfd. 50 v. type 3016 (C7) (Dubilier).
1—4-mfd. 500 v. type 0281 (C8) (Dubilier).

**CONDENSERS, VARIABLE.**
1—.00015-mfd. type VC15X (VC1) (Raymart).

**DIALS.**
1—Type 1098 (Eddystone).
1—I.P.7. (Bulgin).

**HOLDEDS, VALVE.**
1—4-pin type SW21 (Bulgin).
2—8-pin octal type 1120 (Eddystone).

**JACK.**
1—Type closed-circuit insulated (Premier Supply Stores).

**PLUG.**
1—Type P15 (Bulgin).

**MICROPHONE'**
1—Reisz type (Premier Supply Stores).

**RESISTANCES, FIXED.**
1—10,000 ohm type 2-watt (R1) (Erie).
1—30 ohm CT (R2) (Premier Supply Stores).
1—500,000 ohm type ½-watt (R3) (Dubilier).
1—200 ohm type 4-watt (R4) (Premier Supply Stores).
1—15,000 ohm type 1-watt (R5) (Erie).
1—15,000 ohm type 8-watt (R6) (Premier Supply Stores).
1—20,000 ohm type 8-watt (R7) (Premier Supply Stores).
1—5,000 ohm type 8-watt (R8) (Premier Supply Stores).
1—2,000 ohm type 1-watt (R9) (Premier Supply Stores).
1—60,000 ohm type 1-watt (R10) (Premier Supply Stores).
1—50,000 ohm type 1-watt (R11) (Premier Supply Stores).

**RESISTANCE, VARIABLE.**
1—500,000 potentiometer type B (VR1) (Dubilier).

**TRANSFORMERS.**
1—Microphone type LF35 (T1) (Bulgin).
1—Output type 1-1 ratio (T2) (Ferranti).

**VALVES.**
1—TZ08-20 (Mullard).
1—6L6G (V2) (Tungsram).
1—6C5G (V3) (Tungsram).

**POWER UNIT SECTION**

**CHASSIS.**
1—Steel chassis 10 × 8 × 1½ ins. (Premier Supply Stores).

**CONDENSERS, FIXED.**
1—4-mfd. type LEG 600 v. (C1) (Dubilier).
1—4-mfd. type LEG 600 v. (C2) (Dubilier).

**CHOKE, L.F.**
1—200 m AH10/250 (L. F. C1) (Sound Sales).

**SWITCH.**
1—Toggle type S80T (Bulgin).

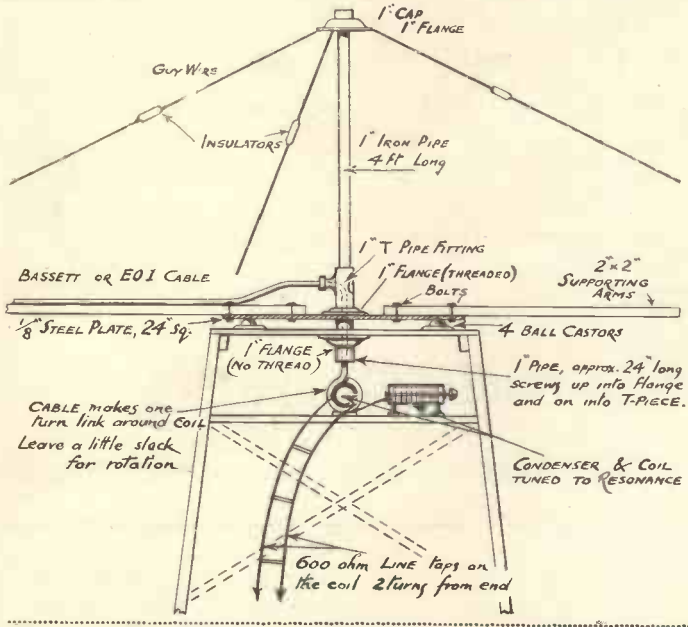
**TRANSFORMER.**
1—to give :—500-0-500 120 m A.
2.5-0-2.5 3 A.
3.75-0-3.75 2 A.
3.15-0-3.15 1.5A.
(T1) (Premier Supply Stores).

**VALVE.**
1—5Z3 (Premier Supply Stores).

# Constructional Details of a Rotary-Beam Antenna

*Amateurs who have heard the American station W1CAA will value this article on the antenna system used at that station. It was designed and described by W1CAA and W1AXA*

THE radiating and reflecting elements for this beam are made of ½ in. galvanised electrician's tubing, thin wall, which costs approximately 2d. per foot. It is the cheapest material that can be obtained and although it is a little heavier than aluminium or copper tubing the supporting construction of the tower will easily take care of this. We recently experienced in New England a hurricane with a gale blowing at 125 miles an hour and the tower withstood this gale without suffering any damage.




**This is the rotating assembly which consists of a radiator and reflector made of galvanised tubing**

## Closed Spaced Array

There has been considerable discussion about the close spaced array using a radiator and director. No doubt many amateurs have found this type of array satisfactory but they do offer a number of difficulties in tuning up matching and adjusting. They have a better front to back ratio but we feel that the *effective* forward gain does not compare with the beam described in this article. The fact that a beam has a tremendous front to back ratio does not necessarily mean that it will have an exceptional forward gain. We suggest that amateurs in Europe check up on the signals they hear from America and make notes as to the signal strength with the different types of beam antennæ.

## A Cheap Rotary

However, our objective in this article is to offer the constructor details of a home made rotary beam that is very inexpensive and yet is unusually satisfactory for both receiving and transmitting. It should show a front to back ratio of 2½ R points and will show an even greater dip off the ends.

For those who do not wish to go to the expense of using a motor for rotation, we suggest that a pair of ropes tied to the extending arm be used and turned by hand. It may be even possible to arrange the rotary section in such a way that rotation may be made from the window of the radio room.

There must be enough slack in the feed cable from the radiator to allow the beam to rotate one complete revolution. This slack should be where the cable is attached by link to the tuned tank at the centre top of the platform as shown in the diagram.

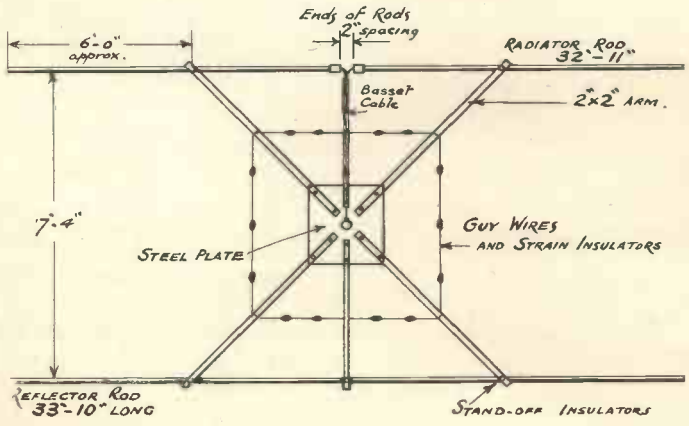
It will be noticed that there will be little or no plate anode current change in the final amplifier anode circuit when the beam of this type is rotated. This point is mentioned as many American amateurs experience severe changes in anode current with the close spaced arrays when rotated, causing serious plate load conditions.

From these remarks one might be led to believe that we are not in favour of the newer type close spaced beams. On the contrary, we have all the faith in the world that these new beams will undoubtedly replace the beam we are describing, both in performance for receiving and transmitting when they have been worked out a little better in the way of matching for efficient performance.

## W5BDB Beam

The system used by one of our amateur radio companies, W5DBD, is without question the most efficient and sim-

(*Continued on page 773*)




**Very little space is needed to erect this most effective beam array.**

# Surplus Equipment For Experimenters

IN the latest list issued by Galpin Electrical Stores, of 75 Lee High Road, Lewisham, S.E.13, are a large number of components and some electrical equipment which should appeal to the average amateur constructor and experimenter.

Galpins are offering a large number of power transformers all fully guaranteed and made by such well-known manufacturers as Fosters, etc. These transformers vary in price from 25s. upwards and are suitable for all purposes.

Auto-transformers for 100/120 volts to 200/240 volts or *vice versa* are priced at 10s. for 100 watts, 12s 6d. for 150 watts, and so on to 2,000 watts at 52s. 6d. Double output generators which provide 1,200 volts at 100 mA. and 10 volts at 4 A. cost 15s., while hand-operated generators giving 800 volts at 30 mA. and 6 volts at 2½ A. are priced at 30s. for new instruments and 25s. for guaranteed second-hand instruments.

Amateurs who need reliable grid resistors can obtain from Galpins a 4,000-ohm resistor capable of carrying 200 mA. for 1s. 6d. These resistors are wound on mica and are space wound. Ex-G.P.O. automatic telephone dials, which can be used in transmitter construction for frequency changing, etc., or for station selection, are available complete with selector mechanism for 1s. 6d. Hand combination phones with finger switch are 4s. 6d., and Western Electric microphones 2s. 6d.

An amplifier suitable for modulating a 20-watt transmitter giving 10 watts of audio is available with valves for 30s. Rotary convertors which with 12-volt input provide 500 volts are priced at 20s., or similar convertors giving 750 volts are priced at 25s. A range of Zenith wire-wound resistors are available and include 2,500 ohms at 250 mA. for 1s. 6d. down to 250 ohms 500 mA. at a similar price.

# Making the Tower

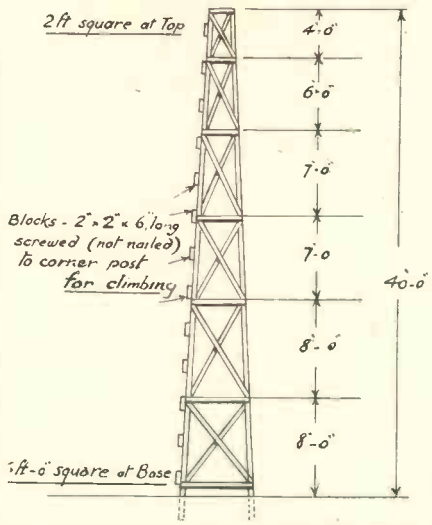
## "Rotary Beam Antenna"

(*Continued from page* 770)

ple in construction that has been offered to the amateur to date. In this aerial, the "Mims Signal Squirter," the feed system is inductively coupled by two copper rings mounted horizontally at the top of the rotated assembly allowing the beam to be continuously rotated without the fear of feed lines becoming entangled. There is also used a short tuned matching stub. The director is also made in such a way that it may be tuned from maximum front to back ratio or forward gain. However, as we have already mentioned our idea is to offer plans for an inexpensive home-made beam aerial of the highest possible performance bearing cost in mind.

It has been suggested that it may be more feasible to use a pair of slip-rings on the end of the pipe and drop down through the top of the tower and a pair of wiping contacts make contacts with the rings allowing the rotating assembly to be continuously variable without the possibility of the feed line becoming twisted and causing damage to the cable.

Some amateurs may ask, "How about three-element beams?" To our knowledge there are only one or two in America that appear to be worth while. These are all fairly expensive but directly any new ideas are advanced, we will endeavour to modify them for amateur constructors.




**The designers claim that the total cost is under £5 if made in the manner described.**

*Tower Foundation.*—Four foundations are needed, one for each leg of the tower. A hole three feet deep and 15 in. wide is required which is filled with rocks and cement. An iron anchor has to be fitted as shown in the illustration. This anchor is hooked over in order to offer strong resistance from a pull in an upward direction.

*Tower Data.*—We have made the towers 40 ft. high, 6 ft. square at the base, tapering to 2 ft. square at the top. This tower is made entirely of soft pine. The corner posts are 2 in. square while the cross work material, also of soft pine, is 1 in. by 2 in. Five pounds of sixpenny galvanised nails are used for nailing the tower into shape. In starting the tower lay out the 2 by 2's on the ground for one side, spacing the legs 6 ft. at the base and 2 ft. at the top. Then fix the horizontal pieces as shown in the sketch and add the cross pieces. When this side is completed, make the next size in a similar manner, after which it can be used as a pattern. With the two sides completely finished, stand them up on their sides and as before separate them 6 ft. at the base and 2 ft. at the top. Put on the horizontal pieces and the cross bracing, after which this side is completed. Turn over the entire assembly and finish the remaining two sides in a similar manner.

# LONG SKIP

*This is the second in a series of articles on amateur activities written by the well-known amateur G5KA.*

ORCHIDS to all those who have been so kind as to send along letters of appreciation and good wishes upon the inauguration of these columns. Thanks a lot, fellows. These notes are being prepared only a few days after publication of the November issue of this magazine containing our first efforts, consequently we have not, as yet, received much information from the DX hounds. Remember OM's we want to know *your DX*. While we of this department spend hours huntin' for the rarer ones, we cannot possibly work every palpitater on the band, so it is up to you sharp eared DX merchants to send along your spicy bits. This will be to the mutual benefit of all of us smitten with that dread disease, DX-itis! Now for the notes and news:

Pitcairn are now back on the air again after having been QRT for some time owing to power supply troubles. They are pushing through a super signal on 14,368 kc. and at the moment are audible until about 07.30. You might be lucky to work them once they have cleared with W2IXY! For those who have had the courage to leave their warm beds, there has been juicy DX for them early mornings. Some of the best on phone (L.F. end) have been CX2CO, TG9AA, HH2B,LU4OJ and K6OQE (the latter, of course, being in the American phone band).

Surprising C.W. has been coming through on 14 mc. from the West Indies around mid-morning, among which HH3L, K4FCV, VP7NE and K4RJ take the honours. HH3L is putting over a very consistent signal from Haiti and he is to be found hiding around 14,300 kc. Late evening seems to be the time . . . . Alaska is not such an easy one to hook and you are advised to listen up the H.F. end for K7FST and K7UA, who have been heard working Europeans around 07.30.

### *Phone Signals*

Phone specialists have probably been having lots of fun in the evenings working VK's and ZL's which have been coming through in fine style, holding hands with many and varied South Americans. Rarer ones heard have been XZ2DY, FB8AX, VS7RA, VQ2HC and OQ5AG, all on the L.F. end. Mr. Dennis Tyler, of Ilford, Essex, sends along a fine list of DX heard, of which the most outstanding is ZK1AA (Cook Island) up the H.F. end. He was heard at 22.00 at a good R8. A couple of other gems from Dennis are VS5AC (Sarawak) on approximately 14,050 kc. and AC4YN in Tibet. The latter one was in the American phone band and heard at 07.30.

C.W. men after elusive ones for their B.E.R.T.A. certificate should look for ZS4AA around 14,270. ZS4L on about 14,320, and ZS3F on 14,035 kc. All these are fairly regular performers. The latter station has probably ECO, so he may pop up anywhere. This ECO business is making it very difficult to ascribe definite frequencies to anyone, so if we list good DX and give no frequencies it is because we are treading lightly . . . . and treading treading lightly, but this time over the band, we again ran across K6PMP in Guam, on whom you might remember we turned the spotlight in last month's notes.

G3BS landed his 73rd country, Gibraltar, thanks to OXVC, a Danish ship moored in Gibraltar harbour. This station comes on at odd times. You should listen for his C.W. up the H.F. end. When worked by 3BS he was on approximately 14,350 kc. running a Hartley TX with an input of 4 watts. His card is plainly marked "Gibraltar" and he QSL's 100 per cent.

G5ZG's phone certainly goes places. His latest on 14 mc. is HI3N (approximately 14,100 kc.) and HK3CG (H.F. end American phone band). Roger sends along a nice list of DX worked on 28 mc. including lots of W6's and TI3FG (L.F. end). He also tells us that that very tricky State, Wyoming, is yours for the asking if you can grab W7BJS (H.F. end 28 mc.), who keeps a good look out for G's wanting a leg-up for their W.A.S. diploma.

G6ID reports a very interesting test heard between G5DT and SU1MW. G5DT was using a single element W8JK rotatable beam and was proving to SU1MW the beam effect of the antenna when rotated through an angle of 90°. At 120° he was beamed directly on SU1MW and was being received by that station at R9 plus. At 130° he was reported as R8; 140° R7; 150° R6; 160° R6; 170° R5; 180° R4; 190° R4; 200° R4, and 210° R3. This should convince some of you that beam antennas really work!

By the way, can anyone supply us with a formulæ for extracting QSL's from the U.S.S.R.? If you have worked all districts in "U," this means, according to the A.R.R.L. "List of countries" that you have worked seven countries. We know many a ham who has worked all seven "countries," but has only received anything up to one card to show for his labours. We also need sympathy . . . .

**This imposing station is operated by the well-known Californian amateur W6-PMB. Illustrated are his RCA transmitter which drives a pair of 808's in the main amplifier, an RME 69 plus DB 20 pre-selector, oscilloscope and frequency meter. W6PMB is being well received in this country at the present time on 10 metres.**

After his long, weary climb, G5RV is now flashing around his DX Century Club certificate. Louis is the 6th in this country to attain that meritorious award. And talking of certificates, why not a "Worked all Countries of England Club" to stimulate a revival of "G" hunting? As English stations now seem two a penny in most parts of the world, the DX'ers seem to give us the "go by" in preference to some of the lesser heard European calls. Opinions and comments on this idea welcomed.

Has anyone noticed, as we have, that when R9 signals predominate from SU, it is usually a foreteller of poor conditions? We have noticed this several times in the past and it has always happened around times of magnetic disturbances. The phenomenon was last noticed on Wednesday, September 26, but this time conditions had picked up within a day or so.

After the recent intensive hostilities in the Far East, bringing with it the fall of Canton, it seems rather likely that we are going to miss a lot of our "XU" friends. XU6X on about 14,135 kc. seems to be one of the very few stations now active in that country,

# Reliance Variable Resistors

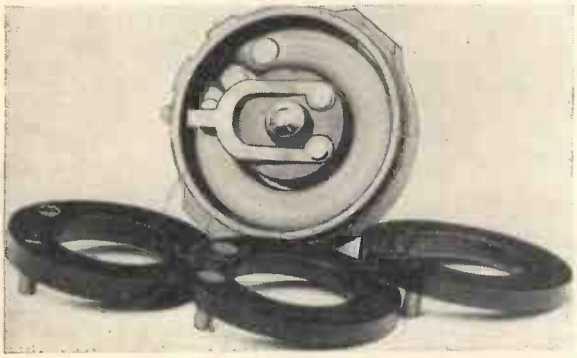
A NEW factory devoted to the manufacture of variable resistors and mouldings of all kinds has recently been opened by The Reliance Manufacturing Co. (Southwark), Ltd., of Sutherland Road, Higham Hill, Walthamstow, E.17. Our representative was able to see some of the Reliance products being manufactured and discovered just why Reliance potentiometers are so reliable even under conditions of continuous operation with a reasonably high current flow through the element. The Reliance wire-wound potentiometers have the element wound on a flat strip of compressed linen and are so arranged that the windings are absolutely smooth. In this way, there is no wear on individual turns. With poorly designed potentiometers it will often be found that individual turns are slightly raised. These turns then receive far more wear than the remainder of the winding, and ultimately break. It is practically impossible to tell by touch whether the linen former is wound or unwound with a Reliance unit owing to the extreme accuracy of winding.

This is the main reason why it is practically impossible to cause a Reliance potentiometer to break down. The manufacturers claim that even after many years' use, the rotating arm is more likely to break than the actual windings. *Wire-wound* potentiometers are available in values of ½ ohm up to ½ megohm while any unit can be supplied with a fully insulated spindle to withstand high voltages such as are encountered in television receivers. However, all potentiometers have insulated spindles as standard fitment suitable for 500-volt operation.

A range of composition type potentiometers are also manufactured and these are excellent for use as volume controls where a reasonable current is applied. Owing to the use of a patented system of manufacture, the Reliance potentiometers of this type are quite noiseless in operation and can be obtained from .05 to 5 megohms which covers the range likely to be needed in a modern radio receiver

The three formers shown indicate the method of construction. On the left is the moulded former in its first stage, to which is fitted two contact plugs. In the second stage the former is machined to provide a perfectly smooth surface and also a smooth surface to the connecting lugs. Finally, the former is coated with resistance element, after which it is dropped into the moulded case through which the lugs protrude, so making the external contacts.

Variable resistances of high wattage rating can also be supplied while Reliance claim that they can build a potentiometer for any type of work. No catalogues are issued of Reliance components but a descriptive leaflet is in the course of preparation as they prefer to build most of their resistors to customers' actual requirements.



**This is one of the Reliance composition type potentiometers which are suitable for L.F. volume or tone control circuits. It is shown in four stages of manufacture.**

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### Empire Stations. VP3AA.

British Guiana has not been a particularly easy country to work, so that details of a VP3 station which is putting a consistent telephony signal into this country will be of interest.

VP3AA is owned and operated by Mr. Louis Fonseca, at 33 Robb Street, Georgetown. The photograph shows the transmitter and receiver, the latter being a Phillips' 361A tuning down to ten metres. On the lower desk of the open type rack is the final power supply, together with H.T. blocks for final amplifier grid bias, since replaced by a bias pack. On the next deck is the speech equipment; a single button carbon microphone feeding a 2A6 coupled to a 2A5 driving two 40's in class-B. The exciter unit occupies the next deck and consists of a 6L6G as doubler, the latter being link-coupled to the final stage on the top deck—two 801's in push-pull, operated with a D.C. input of 80 watts. The antenna is a 66-ft. centre-fed Zepp. running north and south, and the bands used are 7, 14 and 28 mc. VP3AA is usually to be found on 14 mc. from about 20.000 G.M.T. daily in the region between 14.1 and 14.35 mc., a variable frequency crystal covering 14.1 to 14.32 and a fixed crystal on 14.136 mc. He is always glad to contact home stations.—G6DT.

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