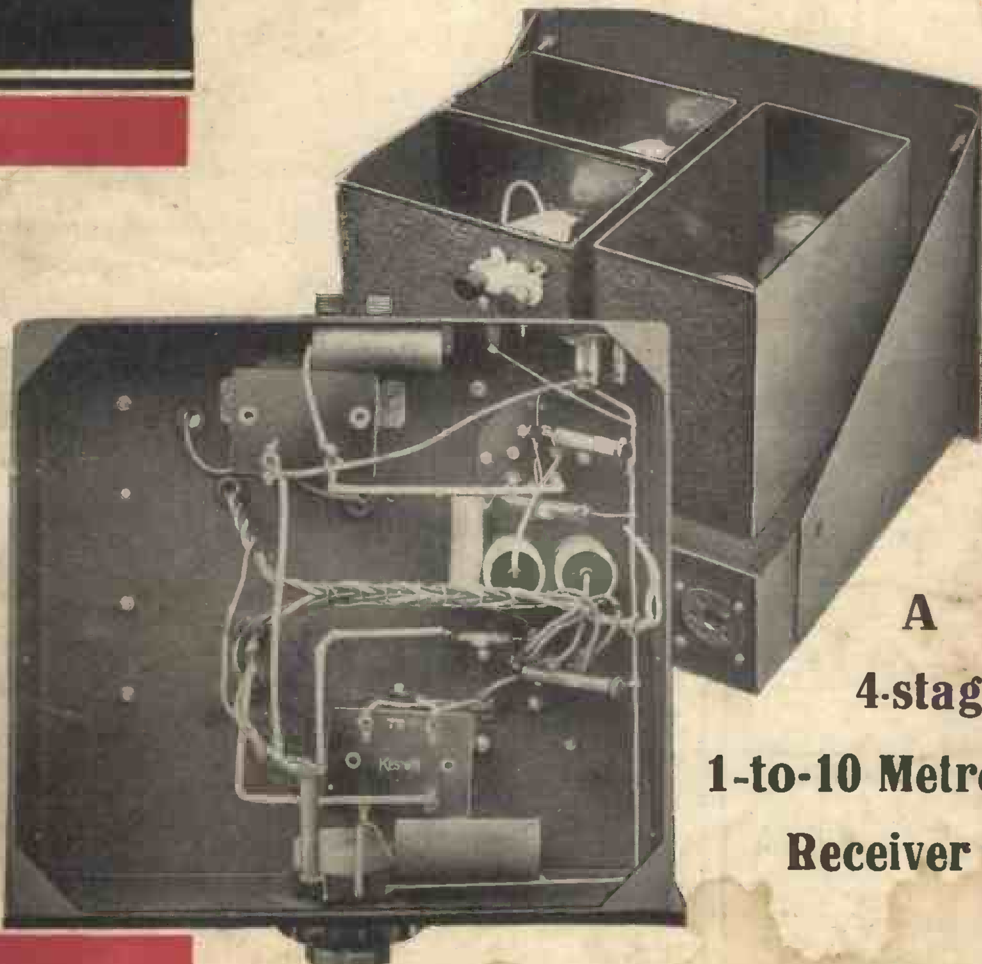
LARGE PICTURE PROJECTION By **ZWORYKIN**

Television and SHORT-WAVE WORLD

JANUARY, 1938.
No. 119. Vol. xi.
1/- MONTHLY



A 4-stage 1-to-10 Metre Receiver

ADJUSTING OPERATING and TESTING TELEVISION RECEIVERS

NEW EMITRON CAMERA

SCOPHONY DEMONSTRATION

Britain's 1-10 Unique

BERNARD JONES PUBLICATIONS LTD.
CHANSITOR HOUSE, CHANCERY LANE
LONDON W.C.2.

THE FIRST TELEVISION JOURNAL IN THE WORLD

ORIGINAL PRODUCTS

VOLUME CONTROLS

A wide selection of efficient Volume Controls is available in the Bulgin range. Values from 10Ω to .1MΩ in wire-wound types, 3 and 5 watts rating; from .05 to 5MΩ in chemical element 1 watt types. All are noiseless with squashplate reliable action. With and without mains switches.

Prices from 2/9 to 7/6 each.

SHORT-WAVE CHOKES

There is a Bulgin H.F. Choke for every waveband. Low-loss design and compactness make them the choice of discriminating designers and constructors. List No. H.F.24—5-75 metres (shown on right) 1/- each. Other S.W. types from 1/3 to 2/9 each.

List No. H.F.15, screened all-wave type, 5/- each.

WRITE FOR THE 120 PAGE CATALOGUE

BULGIN

To Messrs A. F. Bulgin & Co., Ltd., Abbey Road, Barking, Essex. Please send post free a copy of your new 120 page fully illustrated Catalogue, for which I enclose 3d. stamps.

NAME ....

ADDRESS ....

....

MI (BLOCK LETTERS, PLEASE)

SEND THIS COUPON *NOW!*

'AVO'

Accurate Testing Instruments

BRITISH MADE

Only precision instruments enable you to test accurately and trace radio faults efficiently. "AVO" instruments are outstanding for precision. They are the outcome of a constant effort to provide amateur enthusiasts and radio engineers with instruments of high accuracy and maximum utility at a moderate cost.

THE D.C. AVOMINOR

This accurate moving-coil instrument is 13 meters in one. It has 13 ranges: voltage ranges for measuring H.T., L.T., Grid Bias, Mains and Eliminator Voltages; Milliamp ranges for testing receiving valves and apparatus; Resistance ranges for all resistance measuring. In case, complete with testing prods, crocodile clips, leads and instruction booklet. **45/-**

THE AVODAPTER

Simplifies valve testing. Enables all valves to be tested under actual working conditions without need for cutting connections and groping about inside the set. Instantly adaptable for 4-pin, 5-pin and 7-pin valves. Price **27/-**

9-PIN AVO-COUPLER

Attachment (not illustrated) renders AvoDapter suitable for 9-pin valves. **12/6**

UNIVERSAL AVOMINOR

This compact precision moving-coil instrument provides facilities for all A.C. and D.C. testing. It has 22 ranges covering A.C. voltage, D.C. voltage, current, and resistance. All readings are direct. Total resistance of meter, 200,000 ohms, ensuring accurate readings. Complete with testing prods, crocodile clips and instruction booklet. **£5.10s.**
Leather Case, 10/-.

Deferred Terms if desired.

Write for illustrated literature giving full details of all "Avo" Testing Instruments

New Edition !

RADIO SERVICING SIMPLIFIED

A new and considerably enlarged edition of this popular text book. It has been entirely re-written to conform with modern requirements and in the light of present-day standards of knowledge. It takes the reader by easy stages through the whole routine of testing modern radio receivers, and describes in a clear and interesting manner every test, and much other useful information of value to the radio enthusiast. 150 pages, 8½ in. × 5½ in. Numerous illustrations, diagrams and graphs.

2/6 *Post Free* 2/10

AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.
Winder House, Douglas St., London, S.W.1. *Telephone: Victoria 3404/7.*

SOUND SALES LTD.

MAKERS OF SOUND EQUIPMENT

Invite applications for their New 56-page Catalogue which includes many new products of special interest to readers of this Journal.

You will be very interested in the details of the "S.S. Fourband Super Six," the "D.X. Plus" Feeder Unit and the "Sound Fourband Tuner."

When writing for your copy, please enclose 6d. P.O. or Stamps.

SOUND SALES LIMITED
Marlborough Road, Upper Holloway, London, N.19 Phone: Archway 1661-2-3

No. 119 VOL. XI JANUARY, 1938

TELEVISION and SHORT-WAVE WORLD

Special Features

	PAGE
The Low-cost Televisor	5
A New Emitron Camera ...	11
Projection Tubes	13
Scophony Demonstration on B.B.C. Television	23
How Cossor Television Receivers are Tested	24
A B C of Magnetic Scanning ...	26
4-Stage 1-10 Metre Receiver	37
Aligning the RME69	40
5-Band Mains-operated Monitor ...	41
A U.H.F. Emergency Transmitter ...	45
Automatic Gain Control	49
Considerations in Transmitter Design	50
Building the Precision Oscilloscope ...	58

TELEVISION
AND
SHORT-WAVE WORLD

Proprietors:
BERNARD JONES PUBLICATIONS, LTD.

Editor-in-Chief:
BERNARD E. JONES.

Editor:
H. CORBISHLEY, F.T.S.

Editorial, Advertising and Publishing Offices:
Chansitor House, 38, Chancery Lane, London, W.C.2.
Telephones: Holborn 6158, 6159.
Telegrams: Beejapee, Holb., London.

Subscription Rates: Post paid to any part of the world—3 months, 3/6; 6 months, 6/9; 12 months, 13/6.

Published Monthly—1/- net.
(On the first day of the month).

Contributions are invited and will be promptly considered. Correspondence should be addressed according to its nature, to the Editor, the Advertisement Manager, or the Publisher, "Television and Short-wave World," Chansitor House, Chancery Lane, London, W.C.2.

IMPORTANT

"Television and Short-wave World" is registered at the General Post Office, London, for transmission to Canada and Newfoundland by Magazine Post. Entered as Second-class mail matter, Boston, Mass.

COMMENT OF THE MONTH

Television for Cinemas.

THE recent demonstrations by the Baird and Scophony companies of large-screen television of a quality sufficiently good to be used commercially in halls and cinemas create a problem which will have to receive serious and considerate attention on the part of the Postmaster-General, The Television Advisory Committee and the B.B.C.

These demonstrations clearly indicate that sooner or later televised items must of necessity form part of practically every cinema programme if the full advantages of the possibilities of television development are to be secured. It is also clear that the type of entertainment that the B.B.C. is providing for the home is quite useless for public purposes, and again there is the further matter of copyright. In regard to the latter, the present position is that the B.B.C. are waiving their rights in public demonstrations in order to enable the public to gain some idea of the possibilities of television, but it is certain that this attitude will not prevail if the B.B.C. transmissions were used for general public entertainment.

However strong an argument there may be for a B.B.C. monopoly of television broadcasting, it does not seem to meet the problem which is now arising and it seems impossible that the B.B.C. will be able to supply the need which will come into existence. We understand that there is a move on the part of cinema interests to ask the Postmaster-General for powers to start a second television service entirely for the benefit of cinemagoers and in our opinion they will be able to make out a strong case, but it is very doubtful whether the Government will allow private interests to occupy space in the ether for entertainment purposes. It would appear that if such entertainment is to be provided it must either be by cable or some arrangement be made with the B.B.C. for public exhibition of events of national importance.

On the Ultra-shorts

CONSIDERABLY more light has been shed on to the possibilities of ultra-short wave transmission and reception since the introduction of television receivers. This may be a coincidence, but it so happens that less than 12 months ago very few amateurs had any experience of reception or transmission much below 8 metres. At the present time commercial and Government bodies are keenly interested in the working of receivers on wavelengths of around 1-5 metres, and are finding that these ultra-high frequencies are not quite so valueless as was at first supposed.

A commission has been sitting to determine the most suitable wavelength for general emergency use, and it is fairly safe to anticipate that the committee will recommend a wavelength of between 1 and 2 metres. It is claimed that these wavelengths will be reasonably free from motor-car ignition, and other interference problems, having at the same time a most reliable, although comparatively short range.

This fact, coupled with the growing interest and demand amongst our normal experimental readers, and from our trade readers, has led us to introduce in this issue a unique ultra-high frequency receiver plus the first section of an ultra-short wave transmitter for emergency use. We believe that the receiver is the first of its kind.

Scophony, Limited

Sir Maurice Bonham Carter and Mr. Solomon Sagall on Prospects of Television from speeches made at the Scophony Annual General Meeting on November 30, 1937

Substantial Technical Progress :: Co-operation with B.B.C. :: Cinema Television Developments

FROM Sir Maurice Bonham Carter's speech.

The first year of the television service supplied by the B.B.C. from Alexandra Palace has now been completed. A great deal of credit is undoubtedly due to the corporation and to its technical and production staff for their achievement.

The provision of programmes of adequate entertainment value lies within the province of the B.B.C., and must depend largely on the financial resources which are made available for the service. It is certain that a small expenditure will produce small results. We must hope, therefore, that the B.B.C. and the Treasury will adopt a generous policy in order to enable this young service to maintain its growth. Outdoor transmissions will probably supply a very attractive source of entertainment.

Larger Pictures

Other essential requirements of a successful service must be supplied by the manufacturers. For home receiving sets a screen in size comparable to that of the home cinema is necessary. This requirement Scophony have achieved by the development of a home receiver giving a picture 24 in. by 22 in., and approximating the home cinema in its quality. The larger receiver which we have developed for public viewing purposes measures approximately 6 ft. by 5 ft., and we are at work on the development of a considerably larger screen.

Picture Quality

Picture quality is dependent on two factors—the adequacy of the transmission and the adequacy of the reception. Scophony is satisfied with the capacity of its receivers adequately to convert into a visual image the electrical waves transmitted to it. To a large extent improvement in picture quality is a matter of improvement of detail, and this is a continuous process. I can from my own experience testify to the remarkable success of our technical staff in bringing about a continuous improvement in this respect.

Synchronisation Troubles

Scophony ascertained at the beginning of this year that there was a considerable amount of irregular timing and phase shifting in the synchronisation signals radiated from Alexandra Palace, which made such signals unsuitable for reception by receivers using scanning systems possessing inertia, as the Scophony system does. Representations were made in February last to the B.B.C. and later to the Television Advisory Committee, whilst at the same time we were in a position to demonstrate by means of a new mechanical pulse generator constructed by the Scophony engineers that a perfectly satisfactory signal for all types of television receivers could be produced. I am happy to state that both bodies have acknowledged the fairness and justice of the Scophony case and undertook to take steps to remedy the trouble as soon as possible.

In August of this year the B.B.C. installed a completely new pulse generating equipment for the generation of stable synchronising signals.

On test the new B.B.C. pulse generator it was found that some further improvements were still required, and it is really only during the last few weeks that the B.B.C. generator has reached a stage to enable Scophony to have satisfactory reception.

The B.B.C. are also engaged now on experiments with a new pulse generator in their outdoor broadcast vans.

Marketing Receivers

Scophony, Limited, are now making arrangements for marketing receivers in the very near future. Such receivers would in the first instance be manufactured and marketed by Messrs. E. K. Cole, makers of the well-known Ekco wireless sets.

Public Demonstrations

The company took part in the Television Exhibition at the Science Museum, South Kensington, which we understand was visited by a quarter of a million people. At the time, owing to the absence of suitable synchronisation signals, the pictures shown by Scophony could only be on the 240-line standard transmitted by a low-power radio transmitter from the Company's Campden Hill laboratories. Though this standard has necessarily been superseded by the higher Alexandra Palace standard, the pictures shown by Scophony were the first large pictures of that definition ever to be shown in this country or anywhere else in the world.

I will now ask the managing director to deal with certain other aspects of the television situation and the company's activities.

From Mr. S. Sagall's Speech

Mr. S. Sagall (managing director):—We are now entering upon the second year of the world's first television service.

Many are the difficulties still to be overcome in the way of making the present B.B.C. television service a success. Some very complicated and knotty problems have still to be solved. These problems are manifold. They cover a variety of political, financial, technical, and entertainment aspects. I would like to use this occasion in order to repeat a suggestion made by me last year to the Television Committee for introducing the machinery of effective and constant consultation with the various television companies and interests in this country in connection with all the problems affecting the further development of the television service.

The Television Committee, as constituted to-day, represents only the Post Office, the B.B.C., and the Department of Industrial Research, all of which are Government or semi-official bodies, and a closer co-operation between the Television Committee and those interests and concerns, without whom there would have been no television to-day, appears to be highly desirable.

Large Screens

You will recollect that at one time or other there were many people who doubted the possibility of achieving high-definition pictures with any but the cathode-ray tube method. However, we have actually achieved in the course of the last two years, by means of the specific Scophony methods, pictures so far unequalled in publicly available results. We are fully aware of attempts to achieve projected large screen pictures by means of the cathode-ray tube, but we can confidently claim that as things stand to-day no other method has succeeded in giving pictures with the same brightness as the Scophony methods.

I would like to say—without prematurely divulging research secrets—that the above achievements do not in any way represent the limit of Scophony possibilities.

In this connection I feel it also necessary to state that though the present B.B.C. standard is 405 lines—and, by the way, some further improvements in the transmission apparatus and transmission technique are required to make full use of such a standard up to its 100 per cent. efficiency—Scophony, Ltd., is in a position to design and construct apparatus for higher standards and higher numbers of lines, should such higher standards be adopted at a later stage.

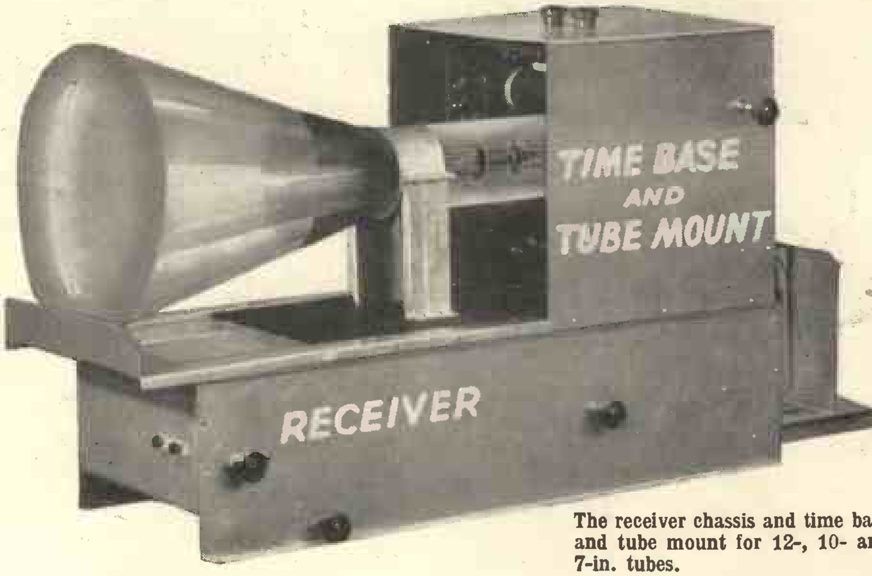
Cinema Television

By virtue of our large screen attainments, we are already actively engaged in investigating the conditions for an early establishment of a television service for cinemas.

One may immediately disperse a very ridiculous conception, fortunately not to be found in serious cinema circles, that television would kill the cinema. Just the reverse: the cinema is going to benefit materially from the introduction of television.

THE LOW-COST TELEVISOR

THE COMPLETE UNITS FOR 12-in., 10-in. AND 7-in. CATHODE-RAY TUBES



The receiver chassis and time base and tube mount for 12-, 10- and 7-in. tubes.

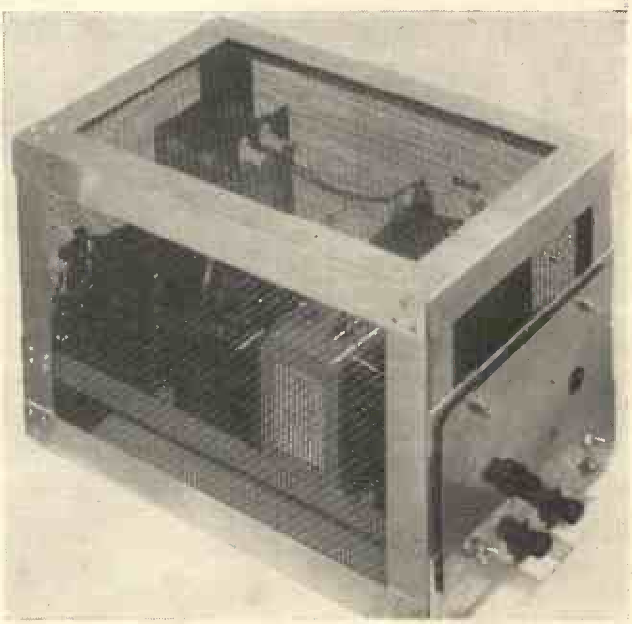
The photographs on this page show the complete units required for building the low-cost Televisor which has been described in the three preceding issues (October, November and December, 1937). The complete equipment comprises four units—the vision receiver, the time base and tube mount, the power pack for the vision receiver and the power unit for supplying high and low tension for the cathode-ray tube and time base. All these units embody ordinary wireless constructional practice and are well within the ability of any amateur to build.

The vision receiver is a super-het, so designed that either one, two or three R.F. stages can be incorporated at will, thus making the receiver suitable for long, medium or local range. This receiver using three R.F. stages has provided excellent pictures at a distance of approximately seventy miles.

The time base and tube mount are incorporated in one unit and the arrangement is such that either a twelve, ten or seven-inch tube can be used as desired. The smaller size, of course, permits of economy in tube cost, otherwise the conditions applicable to the different sizes are the same.

Two power packs are used, one for supplying high and low tension to the vision receiver, and the other for the time base and cathode-ray tube. The latter, as will be seen from the photograph, is contained in a metal gauze case and is so constructed that it cannot be opened without first disconnecting the power supply. The unit, therefore, is quite safe in use under all conditions.

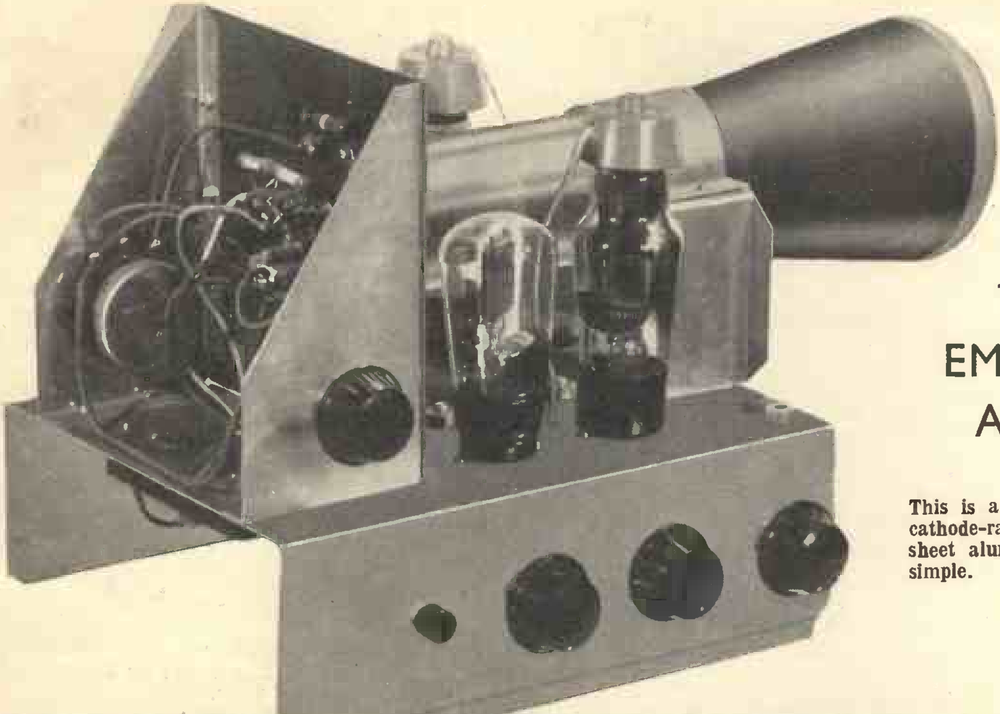
Notes on the adjustment and operation of these units are given in the following pages.



These two photographs show the vision receiver power pack and the cathode-ray tube and time base power pack respectively. Adequate precautions have been taken to render the latter safe in operation.

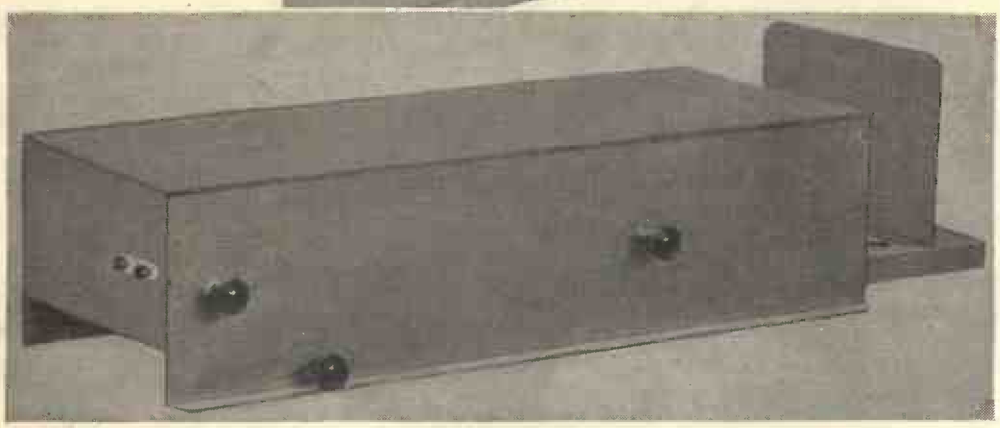
HALVING THE COST

THE UNITS EMPLOYED FOR A 4-IN. TUBE



This is a photograph of the time base and cathode-ray tube mount. The chassis is of sheet aluminium and the construction very simple.

FULL CONSTRUCTIONAL DETAILS OF THESE UNITS WERE GIVEN LAST MONTH



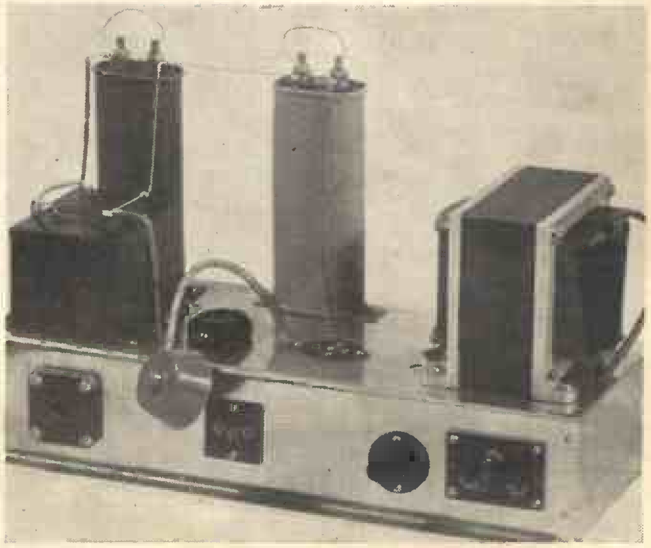
The same receiver is employed as for the larger tubes. This receiver is particularly sensitive and will give excellent results at any distance up to seventy miles from the transmitter.

Excellent pictures are obtainable on a four-inch tube and the definition is so good that they will allow of magnification. The advantage of using a small tube are that considerable economies can be effected in several ways, for, apart from the cost of the tube, lower operating voltages are possible with a consequent saving in cost of components.

The same vision receiver is employed as for the larger tubes. As with the larger tubes three ranges are available according to the number of R.F. stages incorporated. In addition to the units shown the vision receiver power pack on the preceding page is required so that the complete equipment consists as before of the vision receiver, the vision receiver power pack, the time base and tube mount and the cathode-ray tube and time base power pack, two of which are of simplified construction.

A maximum of 1,200 volts are used with this receiver and this enables a considerable saving to be made in the construction of the power pack which is shown by the photograph on the right. With the comparatively low voltage employed no special precautions are required and the entire assembly is quite simple.

Important features of these units are that they have been specifically designed for easy home construction, entailing no more difficulty than would an average wireless set.



The power unit employed for the 4-in. tube is of particularly simple construction with a maximum output of 1,200 volts.

ADJUSTING AND OPERATING

Last month the final constructional article of this series appeared, which gave instructions for building the Time Base and C.R. Tube Power Supply Unit. This article completes the series. It gives full operating and connecting instructions. It also includes a few notes on some refinements that may be added when the very best picture quality is desired.

By S. WEST

THE adjustments required to a vision receiver are similar to those for a normal broadcast receiver. Similar principles apply. The main difference is that the required frequency response of the vision receiver is necessarily broad.

For the complete outfit there is, in addition, the time base to adjust and the tube operating conditions will require to be correct.

It is preferable to undertake these adjustments in the same order as written, that is, the vision receiver unit is first correctly tuned, then the time bases and the tube's electrodes voltages are adjusted. Of course, the final exact adjustments to the vision receiver are best made while observing the received picture.

In accordance with the above remarks, we shall first deal with the initial adjustments required to the vision unit.

Headphones, or a fairly sensitive speaker may be used for these adjustments. They are connected in the first instance to the M and E terminals on the terminal strip. A 0.1-mfd. or similar value condenser is included in series to exclude the V.F. valve's D.C. voltage.

The plug is inserted into the power supply unit. This unit can be connected direct to the mains for this preliminary test and not to its normal junction on the time base power pack. It is assumed that a vertical half-wave aerial will be used, and the feeder of this is connected to the two aerial terminals.

When the Alexandra Palace transmitter is radiating the preliminary adjustments can be undertaken in this order. It may be pointed out that the transmitter usually commences radiating about 30 minutes before the programme is scheduled to commence. The required adjustments can conveniently be carried out during this period.

There is a definite advantage derived by making the adjustments at this time as, for about half this period, the carrier is modulated for a cruciform pattern. This modulation has a very distinctive sound and a close adjustment to the required one is obtained by tuning for a signal that has a characteristic as here described.

The first tuning is accomplished with the oscillator condenser C19. The signal when tuned will have a confused sound, and the frame synchronising pulses will predominate as a rapid heavy beat. As the adjustments become more correct the signal will be fuller and the line sync. pulses component will become audible as a shrill whistle. The adjustment is approximately correct when this point is reached. The signal will now have a clear cut ring that is similar to that obtained with a mains receiver that has an open circuited aerial coil.

No excuse is made for describing this signal noise in simple language. By observation the writer has found that a novice can complete the required preliminary adjustments more simply by listening to this signal than by observation of the C.R. tube's screen. The final exact adjustment, as has been earlier remarked, is made while observing the received picture.

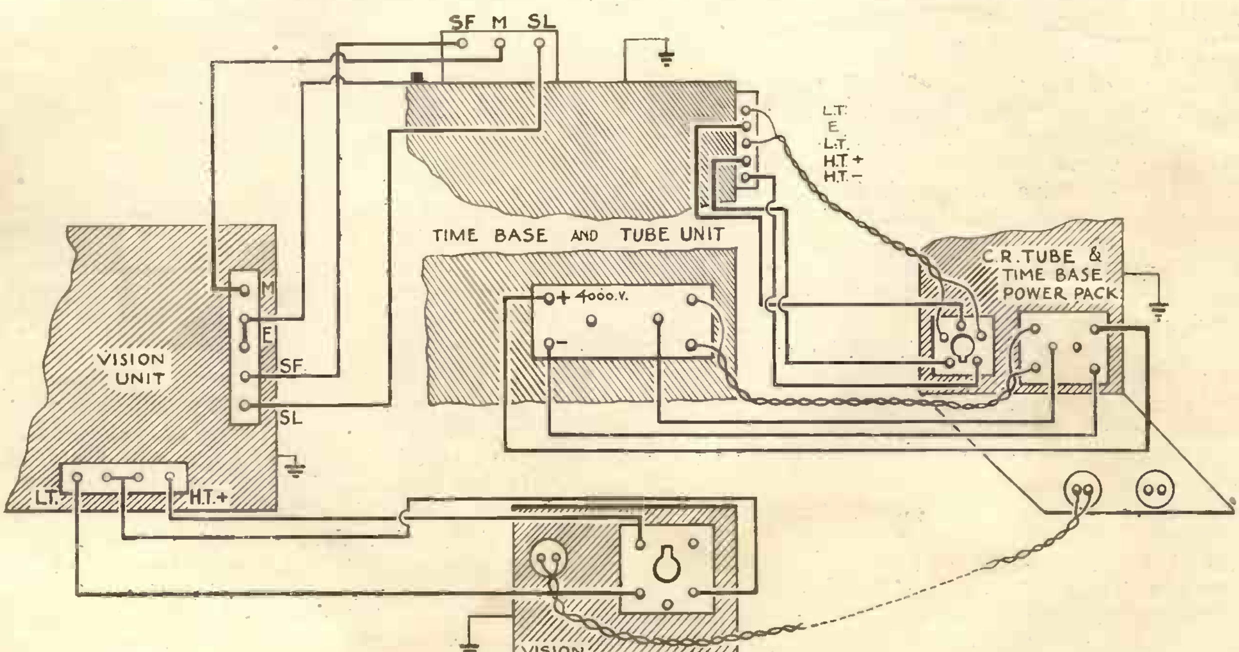


Diagram showing the method of connecting the various units together.

TRIMMING THE VISION RECEIVER

Actually, as has been pointed out in the original article of this series, due to the coil's specifications, the tuning is very simple.

C1 is the aerial tuning condenser and is uncritical. C19 is the oscillator tuning condenser and is critical, furthermore there is a very definite optimum point for the best picture definition and freedom from I.F. harmonics feed back. This feed back is revealed as a watered silk effect on the screen or, as it is explanatorily termed, I.F. spots.

This is an inherent quality of all super-heterodyne vision receivers and is unavoidable without extremely elaborate screening. However, no difficulty is experienced in finding the correct setting, for the adjustment is quite definite.

Of the trimmers C4, C8, and C12 are the R.F. trimmers. They are adjusted for the best picture. As a guide, in the original, C4 and C8 are screwed in about halfway. C12 about two-thirds. C16, C24, and C29 are the I.F. trimmers. They are, in the first instance, adjusted to resonance. They may be more finely set while observing the picture. Due to the heavy circuit damping, they will be found quite uncritical.

It may be pointed out that the I.F. trimmers have a comparatively high capacity, consequently their setting will vary the I.F. frequency over fairly wide limits. The optimum I.F. frequency will thus require to be found by trial. This is, however, quite a simple task.

Having completed these adjustments there remains the correct setting for R38 to be found. (This is the synchronising control near to the MSP4 valve. Remove the phones or speaker lead from the terminal M and attach to the terminal S.F. R38 is now rotated slowly until the noise due to the picture is lost, leaving that due to the sync. pulses only. This completes the adjustments to the vision unit.

Adjusting the Time Base

Adjustment of the time bases may now be undertaken. The potentiometers R4, R8, R21 and R23 are set about halfway round their full travel. R1 is turned full anti-clockwise.

The Belling-Lee five-pin plug is inserted in its appropriate socket on the time base and C.R. tube power unit, as is also the six-way high-voltage plug. The DLS1 delay switch may be removed and the various heater voltages can be checked. Alternatively if all the various valves' heaters, including the C.R. tube's heater are seen to be glowing, it can be assumed that all is probably in order.

The remaining connections should now be made. Short leads are taken from the junctions on the vision unit's terminal strip to the appropriate points on the time base unit. (These terminals are respectively M (this connects to the centre terminal of the small network panel), E (this connects to the earth terminal of the time base) and the S.F. and S.L. terminals. (These are connected to the left- and right-hand terminals of the small network board in this order.)

Before re-inserting the DLS1 delay switch, the potentiometer R41 is turned full anti-clockwise.

The DLS1 switch is now inserted. After a short interval its contacts will close and the time base adjustments are commenced.

The potentiometer R41 is slowly rotated clockwise. The raster will then become visible on the screen. If this raster is small it may be enlarged with an alteration to the time base controls.

It is desirable also at this stage to centre the raster on the screen. This operation is performed with the potentiometers R26 and R30. (These two controls are situated on top of the time base.

The focus potentiometer R37 is now adjusted. Rotation of this control affects the quality of the screen illumination.

A setting is found where the raster edges are clear and distinct. It will also be possible to see the frame flybacks. When this is so the focus is approximately correct. Set the potentiometer R8 for the least raster width, i.e., full anti-clockwise. With R4 adjust the width to approximately half of that required for the picture. Rotate R8 until the picture is the correct width.

With R33 reduce the raster to its minimum height, then with R21 adjust the height to equal approximately half the screen diameter measurement. With R23 increase the height so that the two extremes are within about 1 in. of the screen edge. This completes the preliminary rough adjustments to the time base.

The vision unit power pack plug may now be connected to its socket on the time base power unit. When the various valves' heaters have acquired operating temperature, black and white patterns, due to the picture modulation, will appear on the C.R. tube screen. Also the raster will have locked into synchronism for the frame dimension.

Rotate R4 slowly until a single picture is formed, then lock this into position with a slight adjustment of R1.

The correct picture dimensions may be restored with adjustment of R8 and R21.

There only remains the correct picture contrast to be found with adjustment of R41 and adjustment to R37 to secure correct light spot focus. This latter control is rotated slowly until each individual line composing the picture is plainly visible.

The final adjustment of the vision unit trimmers can now be carried out to obtain the best picture definition.

These time-base adjustments, although described in fair detail, are simple. No difficulties are encountered if the correct order of operation is observed.

When some operating experience is acquired, there are one or two refinements that can be added with a view to improvement of picture quality. These notes are included as it is felt that a number of constructors will like to incorporate some or all of these refinements.

If the theoretical circuit of the vision unit is referred to it is seen that the gain is controlled with the variable resistance R3. (This resistance is in the cathode lead of the R.F. valve V1. While such an arrangement is perfectly satisfactory for most conditions, there is the possibility, as the Mazda AC/SP3 valve has not var-mu. characteristics, of modulation distortion occurring when a strong signal appears across the coil.

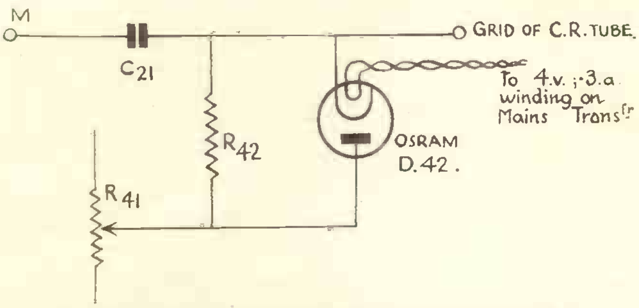
An alternative arrangement is to control two or all three of the R.F. valves.

ADDING REFINEMENTS

Quite a simple alteration will arrange this. The cathode resistances R7 and R11 are returned to the slider of R3 and not direct to chassis.

Alternatively, the screen volts may be varied. This is simply arranged by returning the resistances R1, R6, R10 to a potentiometer across the vision H.T. supply. This potentiometer may consist of the original potentiometer R3 in series with a fixed resistance of suitable value.

Reference to the theoretical circuit will reveal that



Circuit diagram showing the method of restoring the D.C. component.

the I.F. coils are damped with the resistances R21, R24 and R29. When fewer R.F. stages are used or if it is desired to increase the receiver's sensitivity, this damping may be considerably reduced without affecting picture quality. Greater care will, however, be necessary with the "lining up" of the I.F. stages. As a guide the damping may be reduced to that of a 5,000-ohm resistance.

The anode load resistance R35, of the V.F. valve V9 is given as 7,000 ohms in the original specification. Picture quality is improved by reducing this resistance value.

Reducing Attenuation

A further improvement is effected by inclusion of a small inductance in series with the load resistance. This inductance has no effect at low frequencies, but at high frequencies its effect is sufficient to reduce attenuation and phase shift.

Choice of a suitable inductance is important for a circuit resonant to a certain frequency is formed. Also to ensure that the calculated constants are not upset by stray capacitances it is preferable to screen the inductance from the remainder of the circuit.

In the design space is left for the coil between the two valves V8 and V9. A Bulgin "coil can" encloses the inductance.

The value of this inductance is chosen so that with the capacitances of the valve, etc., a resonant circuit is formed whose natural frequency is higher than the working range of the magnifier stage.

The reactance of this inductance at the highest working frequency is made approximately equal to half the value of the load resistance when this load is equal to the reactance of the valve at this frequency.

Although having an inductance somewhat higher than is required, a Bulgin H.F. choke, type H.F.24, serves quite well. A few turns may be removed to arrive at the best value.

This choke is connected at the top end of the load resistance which is reduced in value to about 3,500 ohms. A 2-watt type will suffice.

For obvious reasons a re-adjustment to the potentiometer R38 is entailed due to the alteration in value of the load resistance.

The smoothing of the C.R. tube exciter volts is, in the interests of economy minimal.

If any hum remains, this is revealed as dark horizontal bands on the screen, an additional condenser may be included between the 3rd and 1st anodes. A 0.1-mfd. will be suitable and it must be capable of withstanding the full 3rd anode voltage of the tube.

Similarly, it may be found that the smoothing of the time base high-tension is insufficient, although this is extremely improbable. Hum on the time bases is revealed as a wavy vertical screen edge or as unequal spacing of the lines. The remedy is to increase the smoothing capacity.

The D.C. component is not retained with this receiver. Absence of the D.C. component causes uneven illumination of large uniform picture areas. Furthermore, the picture has a set illumination value level and is not instantaneously controlled by the transmitter. This has a deleterious effect on certain classes of transmission. Particularly news reels and any items having sudden transitions in lighting value.

Restoring D.C. Component

The D.C. component is simply restored with a diode valve. A winding is included on the heater supply transformer of the power pack to permit this. The

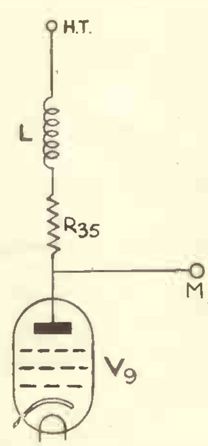


Diagram showing inclusion of an inductance L to reduce attenuation and phase shift at high frequencies. R35 is reduced in value to 3,500 ohms.

method of connection is shown in an article by the writer in the December number, entitled "High Voltage Power Supply Units for Television," page 726.

If it is not possible correctly to centre the picture, the connections of each set of plates to the shift potentiometers may be reversed, i.e., DX2 is returned to R30 and DY1 to R26. This permits an additive move-

CENTERING THE PICTURE

ment in opposition to the stray field causing unbalance.

No alteration to any of the connections is entailed if it is desired to use a 12 in. tube. The picture with this large tube is extremely good and can plainly be seen by fair-sized audiences.

In the article on the time base it was mentioned that the resistances R12 and R14 might be replaced with a potentiometer. A finer control is imparted to the frame relay with a variable feed.

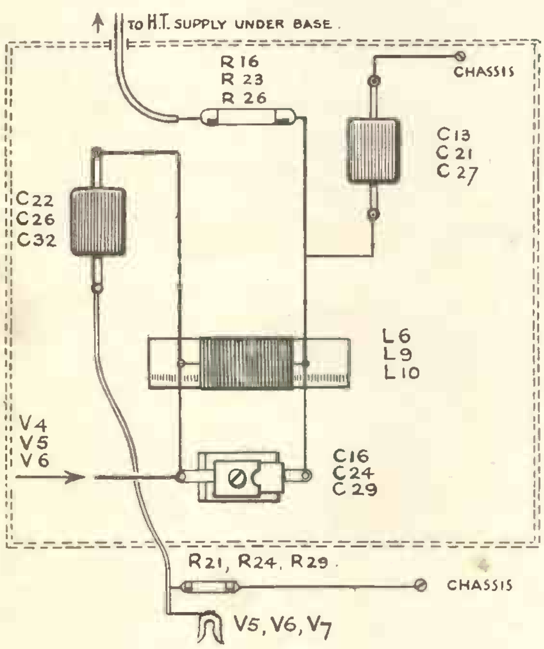
A suitable value for this potentiometer is 50,000 ohms. The adjustment is made so that correct interlace is achieved. Close examination of the picture will reveal when this is so. No rolling of the lines exists and each is equally spaced from its neighbour.

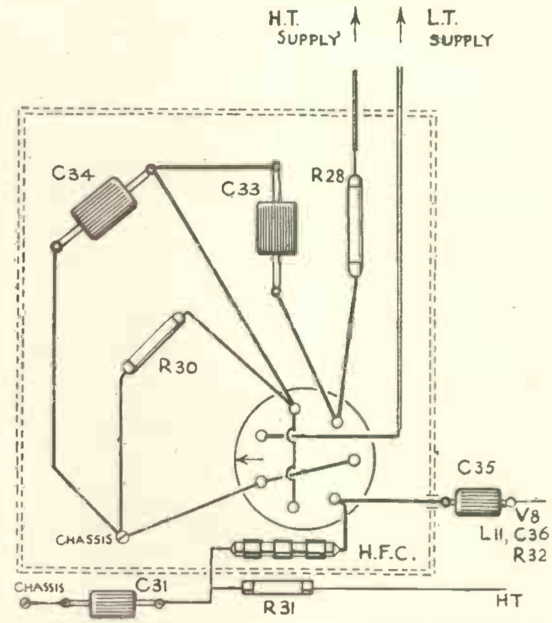
Three incorrect adjustments are possible. The first is termed " pairing " of the lines. When this happens the lines comprising the picture are grouped in adjacent pairs.

The second when no interlace exists. The picture then has a coarse appearance, the lines being visible even at large distances. Lastly poor frame lock. This is revealed as an apparent weaving in and out of the lines.

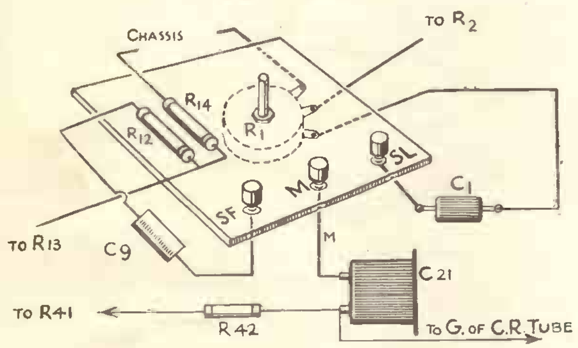
Due to the design of the various units comprising the complete receiver, a variety of layouts is permissible. This is a pleasing feature when an existing cabinet is to be utilised.

In the original the vision unit was mounted reversed, i.e., with the output terminal strip uppermost. The time base and tube were placed on top of this and the two power units underneath. An extremely compact arrangement results when this scheme is adopted. Constructors can decide their own layout, however. The only point to be observed is that the M., S.L. and S.F. leads are preferably kept as short as possible.





As some readers have experienced a little difficulty in following the diagrams showing the vision receiver construction and the synchronising application network and modulation feed, additional diagrams are given here. The top left diagram shows the wiring for sections N, O and U and that on the right (above) section S. To the left is the synchronisation application network.



Baird Cinema Television

THE Baird Company, last month, staged a surprise by showing the B.B.C. television programme on a full-size cinema screen at the Palais Theatre, Bromley, Kent. The approximate size of the picture was 8 ft. by 6 ft. and the definition and illumination were so good as to enable those present clearly to see the picture from any part of the theatre.

The picture was produced by projection from a cathode-ray tube of special design and about two inches in diameter and it is understood that 25,000 volts were employed.

Mr. J. L. Baird was present, and he said that he had been working on the idea since 1930 and now felt confident of putting the results before the public.

He said it was his intention very soon to equip large groups of London cinemas with the necessary apparatus for showing television programmes as adjuncts to the ordinary news reels. He hoped to transmit his own programmes from the Crystal Palace.

A NEW EMITRON CAMERA

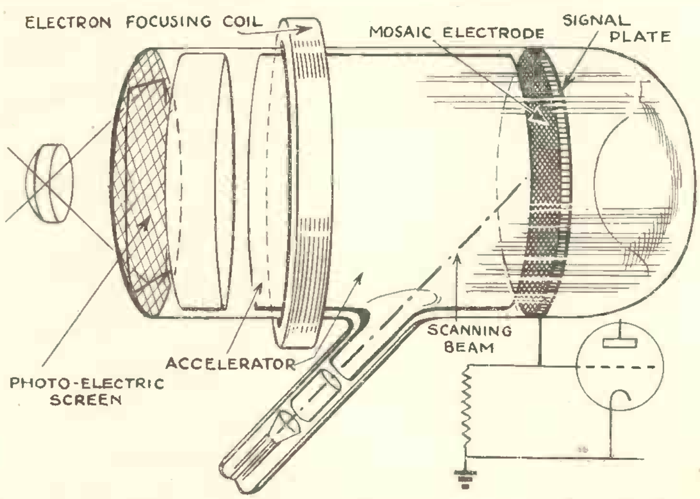
WITH GREATLY INCREASED SENSITIVITY

Here are details of a new pick-up camera with approximately ten times the sensitivity of the type formerly in use. This increased sensitivity will enlarge the possible scope of television to a very considerable extent.

FOR the first time, for the televising of the Lord Mayor's Show and again for the Cenotaph ceremony transmission, a new type of Emitron camera was used which has an efficiency of almost tenfold that of the type that has been in normal use for the past twelve months.

Secondary Emission

The new camera, which has been developed by engineers of the Marconi-E.M.I. Company, depends for its increased sensitivity upon secondary emission. It will be remembered that in the case of the original camera the actual picture was



Schematic drawing of the new Emitron camera employing secondary emission.

The efficiency of a camera depends upon the amount of light with which it can be operated, and photographers are aware that in the case of an ordinary camera under poor lighting conditions it is necessary to use a large lens aperture with the attendant loss of focusing range. This difficulty has also been experienced with the Emitron camera with the result that it has been necessary to follow very closely any movements of the object nearer to, or further away from, the camera; also it has been the experience that whilst an object close to the camera may be in focus, others quite a small distance further away would be out and appear blurred.

Obviously one solution of the difficulty would be to have a more sensitive surface upon which the lens projects the picture so as to enable a lens with a smaller aperture to be employed which would provide greater depth of focus, or enable it to be operated under adverse lighting conditions with somewhat increased aperture.

focused upon a mosaic composed of a number of photo-cells and that the charges due to the liberation of photo-electrons were discharged by the scanning beam. In the new camera there is also a mosaic, but the light image does not fall on this and neither does this mosaic require to be photo-electric. Instead the light image falls upon a photo-electric screen at the front end of the camera and it is the photo-electric image which falls on the mosaic screen, the latter being scanned by the cathode beam. This has the advantage that secondary emission takes place with greatly increased efficiency.

The drawing shows the general arrangement of the camera and it will be seen that it consists of a glass vessel with a cathode gun, capable of producing a fine beam of electrons, placed so that the mosaic screen can be scanned in the usual manner, means, of course, being provided for deflecting the beam. The mosaic electrode consists of a multiplicity of elements which are insulated from each other and from a backing plate which is made of metal and is called the signal plate. This assembly of elements may take several forms and, for instance, the elements may be of silver disposed upon a sheet of mica which may in turn be backed with a sheet of aluminium.

At the other end of the glass tube or vessel and parallel to the mosaic electrode there is a photo-electrically active screen of non-mosaic character which may, for example, consist of glass having a coating of silver oxide on which is deposited a layer of caesium. It is necessary that this coating be so thin as to be semi-transparent.

Surrounding a part of the space between the photo-electric screen and the mosaic is a coil which when suitably energised constitutes an electronic lens of large aperture, the object of this being to form an electron image of the screen upon the mosaic. Between the coil and the mosaic electrode there is a metal cylinder placed coaxially with the tube, the purpose of which is to accelerate the photo-electrons from the photo-electric screen and to collect the secondary electrons which are liberated from the elements of the mosaic when the tube is in operation. This electrode is given a suitable positive potential with respect to the photo-electric screen.

As will be seen, an ordinary optical lens system is provided outside the tube for the purpose of focusing the image on to the photo-electric screen.

How the Camera Functions

The operation of the tube is as follows: When a light image falls upon the photo-electric screen, electrons are emitted from various parts of this to an extent proportional to the light falling upon any particular part. These electrons are accelerated towards the mosaic electrode by means of the accelerator and the electron lens produces a magnetic field which has the effect of focusing electrons from any point of the photo-electric

(Continued at foot of next page.)

BRITISH TELEVISION
—AS AMERICA SEES IT

"ENGLAND is far ahead of the United States in television, and should anyone doubt this statement, let him take a trip and see for himself," said Mr. William Grimditch, Chief Engineer of Philco Radio & Television Corporation, upon his return from an extended stay abroad during which he studied the television situation closely.

"The British Broadcasting Corporation rightly assumed the responsibility of programme and transmission experiments, thus permitting the television receiver manufacturers to work out their side of the problem. I am convinced that in America the problems of programmes and transmission, in television, must be divorced from the manufacturing of receiver sets. After seeing the results obtained in England by the B.B.C. method, I am firmly convinced that, in America, no manufacturer of receivers in television should ever be granted anything but an experimental transmission licence. Few, if any, manufacturers in America could afford to assume the financial burden and responsibility of doing the pioneer research in programmes and transmission

When asked what, in his opinion, was the comparison between the present status of television in America and England, in view of his recent observations, Mr. Grimditch said, "England has behind it a few years of intensive research which we, in America, have still before us, before we can have television such as I saw in London. We can learn much from the experiences and experiments in England, but then again we have peculiar problems of our own which we must work out here in America for ourselves.

Mr. Grimditch was profoundly impressed by the television which he saw in England, and said that American engineers might well with profit look into such things as positive modulation, the types of waves used in England, and the types of synchronising impulses. He was also impressed by the fact that many satisfactory television receivers were made by comparatively small manufacturers who could not have spent great sums on experimenting. This, in his mind, was a great compliment to the B.B.C.'s transmissions.

"I would like to put at rest, if possible, a false notion held by many people in America. These people feel that television in this country is being held back by radio set manufacturers who fear that, should television come out, their sales of sound radios would be hurt. It is my honest opinion that most radio receiver manufacturers would far rather make and sell the higher priced television receiver than the great number of small radio receivers now made, in which field competition is exceedingly keen.

"In America we have many problems to solve before we can have the television which London enjoys to-day. In the first place there are the engineering problems, problems that must be worked out in the field, problems which the B.B.C. has gone a long way towards solving, and which we must yet do. England is well through this, we are facing it.

"Then there are the difficult problems of patents, licences, and such. These are indeed involved. But above all else we must have stations concerned chiefly in transmission and programmes. Transmission and programmes, I am now more convinced than ever, are not the problem of the receiver set manufacturer, nor should they be.

"We cannot disregard the fact," said Mr. Grimditch, in conclusion, "that in London to-day a man can buy a television receiver, have it installed in his home, and view scheduled programmes. That speaks for itself when the question arises as to the status of television in England as compared to that in America."

"A NEW EMITRON CAMERA"

(*Continued from preceding page*)

screen on to a corresponding position on the mosaic.

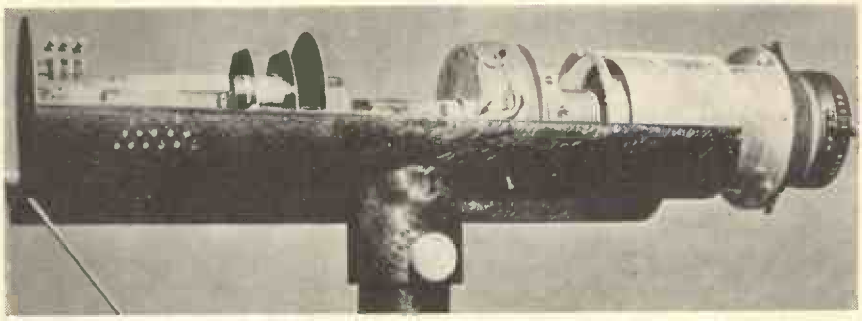
The bombardment of the mosaic results in the production of secondary electrons, the number of secondary electrons greatly exceeding the number of primary. Each element of the mosaic forms a small condenser with the common signal plate and in between successive scans each of these small condensers is charged to an extent dependent upon the photo-current striking the element. The velocity of the scanning beam is so adjusted in relation to the nature of the mosaic surface that the potential of each element when scanned is changed to an equilibrium value. If the effect of the photo-electron is to raise the potential of an element, the velocity of the beam is so adjusted that it reduces the potential. The condenser formed between an element and the signal plate is thus discharged and the value of the discharge current depends upon the charge which the condenser has acquired since the last scan. This charge is, of course, dependent upon the intensity of the photo-current striking the element, which in turn is dependent upon the amount of light falling upon a corresponding point of the photo-electric screen.

As the scanning beam, therefore, sweeps over the multiplicity of elements of the mosaic there are developed across the resistance in the lead to the signal plate voltages which depend for their value on the light intensity of corresponding points in the object and these "picture" voltages are amplified in the usual way.

Alternative constructions of this type of camera are possible. For example, instead of the photo-electric screen consisting of a continuous surface it may take the form of a wire mesh with a photo-electric coating. With suitable arrangements, transparency of the photo-screen is not essential for the light image can be thrown upon it on the side facing the mosaic.

In addition to increased efficiency which will permit of transmissions under adverse lighting conditions, as, for instance, in theatres, etc., the disposition of the elements which comprise the camera makes it possible to obtain a better optical layout than was formerly the case, and this will permit of better use being made of telephoto and wide-angle lenses which will enable the camera to be operated under many conditions which hitherto have presented insuperable problems. For studio work small aperture working will be possible enabling that momentary loss of focus after a change of distance which has been apparent in the past to be avoided.

PROJECTION TUBES



The Latest R.C.A. projection tube with which pictures four feet wide have been obtained.

AN ACCOUNT OF EXPERIMENTAL DEVELOPMENT

By V. K. Zworykin and W. A. Painter, R.C.A. Manufacturing Company Inc.

IN order to increase the size of image on a directly viewed tube it is necessary merely to increase the physical dimensions of the tube. Within reasonable limits this can be done without serious sacrifice of brilliance. However, if we wish to make the picture size 18 in. by 24 in., the physical bulk of the tube becomes enormous, and the glass face would have to withstand a pressure of over five tons.

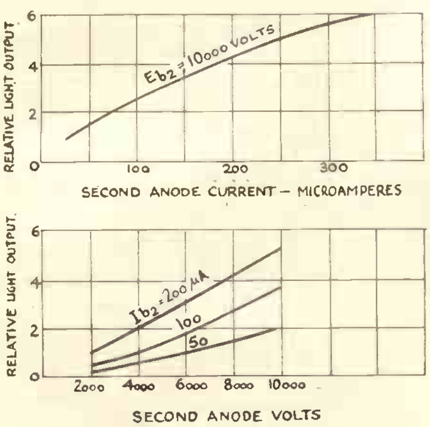


Fig. 1. Top curve shows variation of light output of fluorescent material with beam current. Bottom curve shows light output V.S. second anode potential. Both curves are for RCA phosphor No. 1.

An alternative method of obtaining an enlarged picture is by the use of a projection tube. The projection tube is similar to the directly viewed tube in principle, but produces a small, very bright image. By the use of a suitable lens the picture may be projected to any desired size on a screen. The principal problem involved in this method is that of obtaining sufficient illumination on the screen.

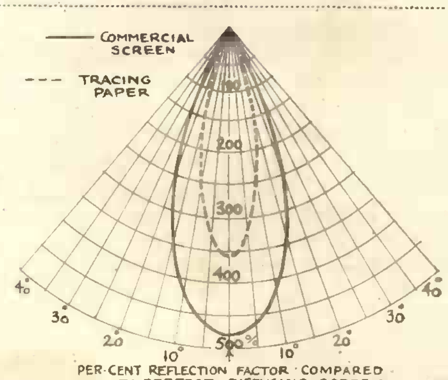
Let us consider for a moment the ordinary 12 in. tube. The tube operates at an overall potential of 4,000 to 6,000 volts with a beam current of 250 microamperes for the high lights. Thus, about 1.5 watts of electrical energy are available for conversion into light in the high lights. This energy is supplied to a tiny spot about 0.5 millimetre in diameter which is made to scan the fluorescent screen. The luminous output of the fluorescent material is a function of both current and voltage, as can be seen from Fig. 1. Under the conditions specified the fluorescent material has a luminous output of about two candles per watt. The brightness of the screen, therefore, will be

$$\frac{1.5 \times 2}{75 \times \frac{1}{144}} = 5.8$$

candles per sq. ft., or 18.2 foot-lamberts.

Motion picture engineers have devoted considerable attention to the subject of brightness in relation to moving picture projection, but the subject is full of controversy. Experience has shown that the high lights of a 35-millimetre moving picture should have a brightness of about 11 foot-lamberts if eye fatigue is to be completely avoided and it is estimated that the actual level attained probably ranges from 1 to 9 foot-lamberts. As a temporary measure it has been recommended that 3.7 foot-lamberts be adopted as a standard, with limits of from 2.7 to 5.2 foot-lamberts. This recommendation was actually made in terms of light from a projector running with no film in the gate, but we have converted them to terms of highlight brilliance for convenience in this discussion. The suggestion has also been made that a high-light brilliance of 2.7 foot-lamberts be considered standard for 16-millimetre projection. In this case the recommendation was couched in terms of intensity of light falling on the

Fig. 2. Brilliance distribution of two types of transmission screens.



Reprinted from the Proceedings of the Institute of Radio Engineers, August, 1937.

OPTICAL CONSIDERATIONS

screen; in converting, we assumed a diffuse screen with a reflection factor of 75 per cent.

For the sake of direct comparison, the brightness of these and other familiar objects is shown in the following table:—

Lighted page (minimum recommended brightness for reading fine print), 10 foot-lamberts.

High-light brilliance on screen of moving picture theatre, 2.7 to 5.2 foot-lamberts.

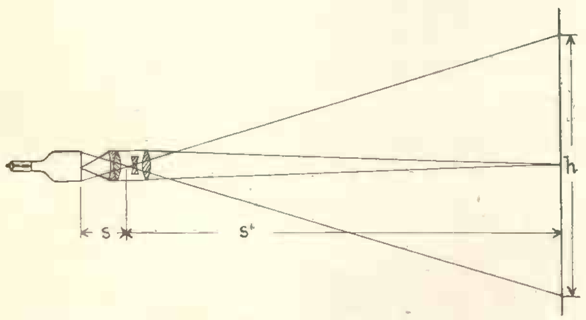


Fig. 3. Schematic diagram of optical system for projection tube.

High-light brilliance in 16-millimetre movie, 2.7 foot-lamberts.

Outdoor scene—bright day, 300 to 600 foot-lamberts.

High-light brilliance of picture on 12-in. television receiver, 18.2 foot-lamberts.

These figures, particularly those referring to the 16-millimetre movie and the 12-in. tube, should be kept in mind as we investigate the elements constituting a means of projecting television images.

The most efficient viewing screen to use for our purpose is a highly directional transmission screen. The transmission characteristics of two such screens are shown in Fig. 2. The solid line represents a commercial type of screen made from a rubberised material, while the dotted curve was obtained from a piece of ordinary tracing paper. Screens of this type will transmit in a direction normal to their surface several times as much light as would a perfect diffusing screen. For the commercial screen the ratio is 480 per cent. while for the tracing paper it is 360 per cent. In the former case the picture can be viewed without too serious loss of light within an angle of twenty degrees on either side of the normal, while the tracing paper allows an angle of about fifteen degrees. In both cases, the light is distributed with sufficient uniformity to avoid the bright area due to direct transparency of the screen known as "hot spot."

For the purpose of computation, let us consider the projection arrangement shown in Fig. 3. Before we can arrive at any conclusions as to the light output required from the tube it is necessary to make certain restrictions on the lens that is to be used. The lens must be one that can be manufactured in quantities and must be relatively inexpensive. The correction of the lens does not have to be as perfect as in the case of a photographic objective. From our present understanding of costs, it seems that the lens diameter should not be much greater than three inches nor the f value much smaller than f 1.5. A lens of this type in use at present has an angle of field of approximately 35 degrees, and the focal length is 120 millimetres.

From these lens specifications, and using our 18 in. by 24 in. standard, it can be shown that the distance from lens to viewing screen is about 4.6 feet. The image on the projection tube screen would measure 1.66 by 2.22 in.

The brightness of the projection tube screen can be calculated from the brightness of the image on the viewing screen, the lens aperture, the magnification and the losses in the system. Assuming fifty per cent. transmission through the lens and applying the distribution of our transmitting screen to the result, we find that the image on the projection tube must be 480 times as bright as that on the viewing screen. To attain a brilliance equal to that on our 12-in. tube we must have a brightness of about 2,800 candles per square foot.

At first glance this brightness seems very large indeed, but when it is remembered that we are using a small area and that we are referring only to the picture highlights it will be seen that the light output is not excessive. The equivalent light output will be

$$\frac{2{,}800 \times 1.66 \times 2.22}{144} = 71.4 \text{ candle power.}$$

There are, unfortunately, practically no data available on the efficiency of fluorescent materials at high input levels. However, if we assume that it may some day be possible to produce a fluorescent material having an efficiency of 1.5 candles per watt at such levels, then we find that the peak input required to produce this light in the high lights would be 47.6 watts. At 10,000 volts this would require a peak beam current of 4.76 milliamperes; if the voltages were raised to 20,000

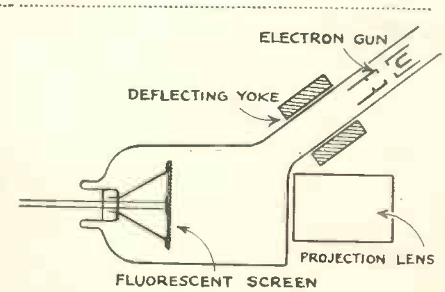


Fig. 4. "Flat-surface" type of projection tube. Use is made of the greater amount of light emanating from the side of the screen which is scanned.

volts, the required peak current would be only 2.4 milliamperes. It should be remembered that the required brilliance has been figured on the basis of equalling the brilliance of present directly viewed tubes. If, however, we are satisfied with the brilliance attained with a reasonably priced home movie projector, the brightness of the high lights need be only 427 candles per square foot, or the light output only 11 candle power. At 10,000 volts the current needed to produce this light, even with present screen materials, is only 0.73 milliampere. Thus, while the type of tube described will not yet compete with the directly viewed tube in brilliance, it does not fall so very far below the minimum requirements.

Active development of the projection tube was undertaken at the R.C.A. laboratories. The original pro-

(*Continued on page* 17.)

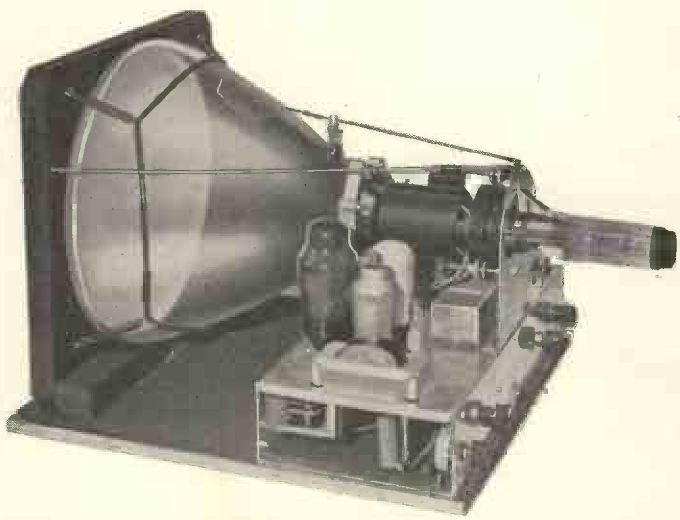
WORLD PIONEERS & MANUFACTURERS OF ALL TYPES OF TELEVISION EQUIPMENT

FIRST IN 1926 FINEST IN 1937

One of the factors contributing to the outstanding success of all Baird television receivers has been the consistently good quality of the " Cathovisor " Cathode Ray Tube. Baird Television Ltd. as pioneers, have developed this Cathode Ray Tube to a design which fulfils all the conditions for excellent picture resolution.

For modern television, the requirements of the Cathode Ray Tube are that a bright, well-defined picture be formed on the screen by the electron beam, that the picture be in sharp focus all over the screen, that the focus remain always equally sharp with the variations of gradations from light to dark, and that these variations be a faithful reproduction of the original gradations of the scene being televised.

The developments in Cathode Ray Tube technique undertaken by Baird Television Ltd. have ensured that these factors are complied with by their latest type " Cathovisor " Cathode Ray Tubes, which are the most satisfactory on the market. Not only is the electrode system extremely simple and robust but, due to the type of cathode employed and the magnetic focusing, a high intensity cathode ray beam is produced which results in a very brilliant picture on the screen. Screen grain does not impose a limit on spot size due to the special grading of the material used, and picture definition is outstandingly good.



"Cathovisor" Cathode Ray Tube Type 12MW1, as arranged in one unit for the Baird T11 Receiver.

Every tube receives stringent tests for total cathode emission, modulation range and illumination characteristics, filament rating and screen quality, and following normal picture reconstitution under service conditions, the completed Cathode Ray Tube is subjected to a further high external air pressure test.

A special feature is that each tube is completely electromagnetic in operation. Full details supplied on request together with information concerning scanning and focusing equipment.

TECHNICAL DATA

	TYPE 15MW2.	TYPE 12MW1.
Heater volts	2.2 volts approx.	2.2 volts approx.
Heater amps.	2.5 amps.	2.5 amps.
Peak to peak volts, between black and highlights	16.5 volts.	14 volts.
Maximum electro-magnetic sensitivity	2mm/AT.	2mm/AT.
Modulator/earth capacity	2 $\mu\mu$F (approx.)	$4\frac{1}{2}$ $\mu\mu$F (approx.).
Modulation sensitivity (slope)	17 μA/V (approx.)	17 μA/V (approx.).
Anode volts	6,500 volts (working)	4,900 volts (working)
Maximum input power to the screen	3.5 milliwatts/sq. cm.	4 milliwatts/sq. cm.
Screen colour	Black and white	Black and white.
PRICE	**15 gns.**	**12 gns.**

BAIRD TELEVISION LTD.

Head Office :

Greener House, 66, Haymarket, LONDON, S.W.1

'Phone: Whitehall 5454

Laboratories :

Crystal Palace, Anerley Road, LONDON, S.E. 19.

'Phone : Sydenham 6030

OF TECHNICAL INTEREST

PROJECTION TUBE CONSTRUCTION

(*Continued from page* 14.)

jection tube involved simply a scaling down of dimensions of a standard 9 in. tube. The electron gun and screen were assembled in a common Ehrlenmeyer chemical flask. The usual vacuum technique did not permit of very high voltage operation, yet a picture of reasonable detail, though lacking in brilliance, was obtained. The tendency of the soft glass to crack under the heat generated by the beam spelled the doom of a majority of these tubes.

One of the first major steps forward was the realisation that the projection tube deserved recognition as a separate problem. A realisation of the need for far higher beam currents concentrated in much smaller areas than had hitherto been considered feasible guided further experiments on the electron gun.

Gun Development

While the principle of electron optics had not yet been widely espoused at that time, the gun development proceeded along quite logical lines. Attention first centred on the focusing field between first and second anodes until the optimum conditions, within the restrictions of the bulb, were determined. It was soon realised that a major source of trouble was the field adjacent to the cathode and effort was concentrated on improvements there. The necessity of decreasing the area of the beam near the crossover was recognised; a wide range of means for accomplishing this was tried, including a study of preconcentrating cylinders attached to the grid and the shaping of fields by the introduction of various sizes and shapes of electrodes.

Two circuit considerations served to handicap the work. The first was the need of maintaining a fairly restricted modulating range, since a high signal voltage covering the necessary range of frequencies was impractical. The other was the need of maintaining a small constriction in the tube neck, in order that magnetic poles might be placed close enough together to allow full deflection of the beam. This in turn set such a limit upon the size of electrodes which could be used that considerable aberration was always present. The first of these difficulties is being overcome by refinements in tube design; the latter has been greatly modified by improvements in deflecting circuits.

The advent of electron optics allowed a theoretical analysis of the remaining faults to be made and pointed the way to refinements which are so necessary.

While the major effort was spent on tubes of the type described, several investigations of interest were made along somewhat different lines. One of these particularly worthy of mention is the so-called "front surface" type of projection tube. It has been determined that the light on the surface of the screen adjacent to the scanning beam may be double that appearing on the outer surface. To utilise this fact seemed an easy way of improving the brilliance of the image.

Attempts to accomplish this were made by depositing the fluorescent material upon a metal plate within the tube. To enable the lens to be placed directly in front of the screen, it was necessary to seal the neck containing the electron gun on to the bulb at an angle, as shown in Fig. 4. This imposes several difficulties upon the problem of focusing, first of all, because of interference with the optical lens there is little clearance of the magnetic deflecting yoke. The electron gun must, therefore, be placed well back in the neck and the distance between gun and screen is greater than in the direct type. This, of course, limits the focus obtainable. Since the beam strikes the screen at an angle the fluorescent spot is no longer round but is elliptical. To make the long axis of the ellipse equal to the diameter of the corresponding round spot requires better focusing than in the direct viewing type of tube if the same resolution is to be maintained. The keystone shape of the scanned pattern can be corrected by suitable changes in the scanning circuits. While some fairly good pictures with low definition have been obtained, this design has not yet worked successfully in a high-definition system.

In a model of one of the projection tubes developed in our laboratories the picture size was 2.25 × 3 in., the high-light brightness under operating conditions about 280 candles per square foot. Since the image is larger than in our example the lens suitable for use with it must have a slightly longer focal length (assuming the field is limited to 35 degrees). If this lens has the same diameter as the one considered in the previous example, the brightness of the picture on a viewing screen 1.5 × 2 ft. in size is about 0.6 candle per square foot, or about 1.9 foot-lamberts. This illumination is not quite great enough to allow comfortable viewing for any length of time.

Electron-optical Arrangements

The electron gun used in this tube is shown in Fig. 5. It operates at an overall voltage of 15,000 volts and delivers beam current of about 400 microamperes, thus generating six watts in the high lights at the fluorescent screen. The spot size for this condition is about 0.005 in. In principle this gun is similar to the gun used in the directly viewed tube. It consists in essence of a cathode, a control grid, and a two-lens electron optical system. The first lens in this system causes the electrons from the cathode to converge into a narrow bundle known as the crossover. This crossover has a diameter much smaller than that of the emitting area of the cathode. As well as forming the crossover, the first lens produces a virtual image of the crossover lying slightly behind the cathode itself. This virtual image serves as a virtual object for the second lens and is imaged on the fluorescent screen in the form of a small electron "spot." Fig. 6 shows the electron trajectory through the gun.

The control grid, as shown, consists of an apertured disc near the cathode, whose potential is controlled by the television signal. The potential of this element controls the size of the area on the cathode over which there is a positive field allowing the escape of electrons. Fig. 7 shows the control characteristics of this type of grid and the variation of spot size with bias.

The cathode is of the indirectly heated oxide-coated type. The emissive coating consists of a mixture of barium and strontium oxides and covers an area of about 6 × 10^{-3} square inches. This material is operated at a brightness temperature of 1,050 degrees Kel-

OPERATING VOLTAGES AND TUBE DESIGN

vin. Although the entire coated surface is capable of emission, only an area slightly smaller than the grid aperture is utilised. From this portion a current of 1.0 to 1.5 milliamperes is drawn, about 0.4 milliampere being delivered to the beam and the remainder being collected in the first anode.

The fluorescent materials commonly used in the projection tube are zinc or zinc-beryllium orthosilicates. These give a green or greenish-yellow fluorescence. Another class of fluorescent materials are the zinc sulphides, some of which produce a nearly white light. In general, the sulphides have higher initial efficiencies

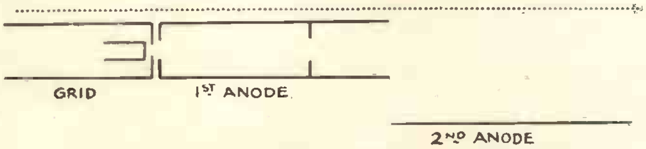


Fig. 5. Sectional diagram of electron gun used in projection tube. The second anode is formed by a conductive coating on the bulb wall.

than the silicate materials; however, they are characterised by instability, and their use to date has therefore been restricted.

It is interesting to note, however, that use of a material giving white light under normal conditions does not seem as important in the case of the projection tube as it does with larger tubes. When viewing the image projected from tubes having green fluorescent screens, several observers have commented on the apparent black and white appearance of the picture. This might possibly be due to a broadening of the spectral characteristic of the fluorescent material at high intensities, although further study is necessary before reliable conclusions can be drawn.

Turning now to the question of bringing the performance of this tube up to the standard set by our earlier considerations, the most important requirement is found to be that of increasing the brightness. In addition, it would be desirable to increase the contrast of the picture and to improve the resolution.

Increasing Brightness

An increase in brightness of the projected picture involves (1) increasing the power output from the gun while maintaining the present spot size, or, if possible, reducing its dimensions; (2) improving the fluorescent material and screen design; and (3) designing a more efficient optical system. These points will be taken up in the order mentioned.

The improvement of the electron gun can take place along one or more of the following lines: (1) Construction of the gun so that it can be operated at a higher potential; (2) improvement in the electron optical system so that less current is lost to the first anode; (3) increase of specific emissivity of the cathode; and (4) increase of the usable area of the cathode by altering the electron optical system.

The problem of constructing a tube which will withstand voltages of 20,000 volts does not seem particularly difficult. The problem is concerned chiefly with the elimination of sharp points or edges where exceptionally high gradients might build up and with proper shielding to insure that the electrons are confined within their designated path. One outstanding difficulty is the problem of applying a black conductive coating to the inside of the bulb. This coating is used to reduce reflection from the walls of the bulb. Conventional coatings consist chiefly of carbon. We have experienced some difficulty in preventing minute particles from shaking off and causing arcs. In high-voltage oscillograph tubes we substituted a coating of platinum which adheres tightly to the glass.

Improving Electron-Optical System

The matter of improving the performance of the electron optical system is much more difficult. In order to approach the question in a systematic manner, it will be necessary to examine in greater detail the way in which this system works. As was described above, the system consists of two focusing fields or lenses. The first of these lenses produces a small virtual object which is imaged by the second lens on the fluorescent screen. This second lens, like the lens which is used in ordinary optics, produces an image which is subject to the same aberrations which are met in the Seidel theory. Assuming good alignment of the gun parts, we are concerned only with axial aberration; that is to say, chromatic and spherical aberration. As far as this lens is concerned, chromatic aberration, that is, the aberration produced by the fact that the electrons do not all have the same velocity, may be assumed to be negligible. This is because the electrons entering this lens have attained a velocity, due to the accelerating field of the first lens, which is a different order of magnitude from the initial velocity of the electrons.

Spherical aberration, however, is by no means negligible. In order to reduce this aberration, it is necessary (1) to shape the electrodes in such a way that the fields they produce give a minimum of aberration, or (2) to limit by means of apertures the portion of the lens used, or conversely (3) to increase the diameter of the electron lens, which involves necessary improvements in the deflecting system.

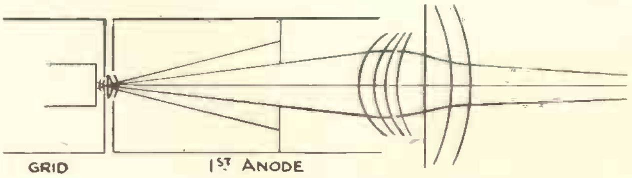


Fig. 6. Diagram of electron trajectories through the electron gun of Fig. 5. The Electron lenses are represented by lines of equal potential.

The spherical aberration of such a lens has been the subject of considerable investigation. It is possible to show mathematically that spherical aberration cannot

TUBE LIFE

be entirely eliminated in any electron lens. However, the aberration can be reduced and guns which are used to-day are superior in this respect to earlier guns. As our knowledge of the properties of specific lens fields increases, it will undoubtedly be possible to make better electron lenses.

With the type of lens available at present about fifteen per cent. of the lens aperture (i.e., fifteen per cent.

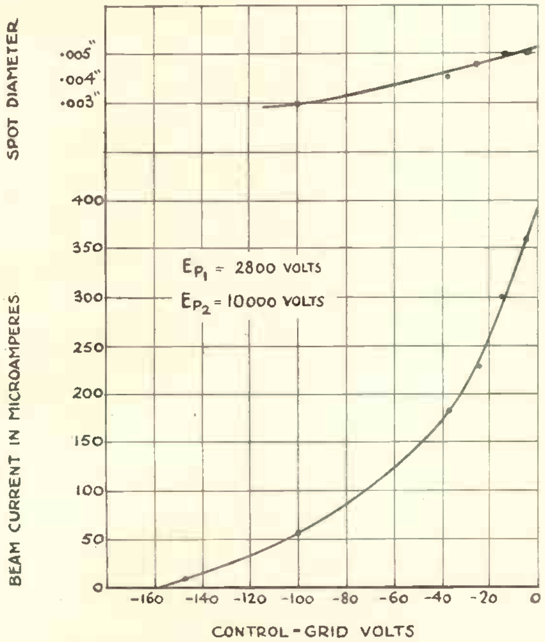


Fig. 7. Control characteristic of a projection tube. The upper curve represents the variation of focused spot size with control grid bias.

of the diameter of the first anode) can be used. The course of electron rays coming from the crossover, it extended to the second lens, would occupy slightly more than twenty-five per cent. of its diameter. The aperture, therefore, limits the beam current to about thirty per cent. of the current from the crossover. This not only reduces the beam current, but also represents considerable power loss and causes undesirable heating at the first anode. As the spherical aberration inherent in the lens is reduced by better lens design, it will permit the use of larger stopping apertures and, therefore, a greater beam current.

The configuration of the first lens and the cathode diameter determine the current in the crossover and also the angle subtended by the electron rays as they enter the second lens system. From a theoretical standpoint the first focusing lens is very complicated. The current density is very high in this region and cannot be neglected. Furthermore, the electrons enter the lens system at a low velocity so that the initial velocities produce considerable chromatic aberration. Finally, the analysis is further complicated by the varying action of the control grid as modulation is applied. In spite of its complicated nature, considerable progress has been made in analysing this region. As this study has progressed, it has been possible to decrease the angle of the beam leaving the crossover and to increase the ratio of the area of cathode used to the area of the crossover.

Analysis of the electron optical properties of the cathode-ray has now made it possible to design a gun in which there is very little change in spot size with control-grid voltage, which utilises an area of the cathode several times greater than that of the crossover, and in which thirty to fifty per cent. of the current leaving the cathode is delivered into the beam.

The cathode materials used at present give fairly satisfactory performance but it is quite possible that a material may be developed which will give even higher emission and have greater stability. One of the more serious problems is the destruction of the emitting surface due to bombardment by positive ions originating in the residual gas always present even in a high vacuum. The cathode, of course, lies directly at one end of the beam path and, except for the control grid, is the most negative element in the tube. The ions generated by the passage of the beam through the residual gas strike the surface with tremendous impact. Numerous cathodes have been examined from which the emitting material opposite the grid aperture has been knocked off completely. The solution of this difficulty is not yet at hand; still, it is believed that a rigorous processing will yield good enough vacuum to at least minimise the effect. This hope is borne out by life tests in which tubes have run at an anode potential of 10,000 volts for well over 500 hours with little trace of the bombardment effect.

Also connected with the general problem of cathodes is the characteristic dark spot which appears on the fluorescent screen directly opposite the apertures of the electron gun. The exact nature and cause of this discoloration is still the subject of considerable study, but many indications point to the fact that it may be due to bombardment of the screen by negative ions originating at the cathode upon bombardment by the positive ions mentioned above.

The type of gun just described, though quite practical, is not the only one possible. Work is being done on different types which make use of a higher ratio of working area of cathode to crossover in order to increase the beam current.

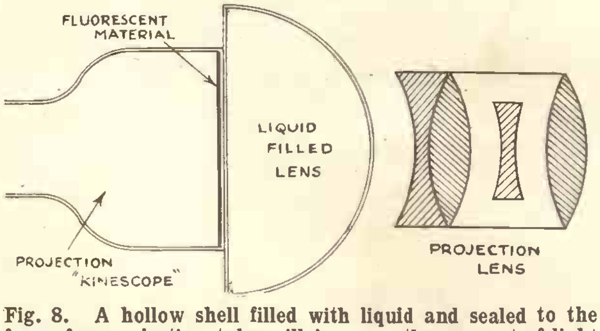


Fig. 8. A hollow shell filled with liquid and sealed to the face of a projection tube will increase the amount of light entering the projection lens. Aberration is a serious defect in the system.

While most of our attention has been devoted to questions concerning the electron gun, the problems

(Continued at foot of next page.)

Scannings and Reflections

TELEVISION IN COLOURS

FURTHER progress has been achieved by Mr. J. L. Baird in the development of colour television. The pictures are produced by optical-mechanical methods and three light sources are employed—blue, green and red.

"I have been experimenting for years, and succeeded a few months ago," Mr. Baird said in speaking of this development.

"Experiments were carried out in my private laboratory under conditions of strict secrecy.

"This is the first time that wireless television in colours has been achieved, although I demonstrated the principles of it in 1928 before the British Association.

"The invention has nothing to do with films. A Union Jack can, for example, be held in front of the television camera and be reproduced in natural colours."

It is hoped to give a public demonstration at the Dominion Theatre, Tottenham Court Road, shortly.

INCREASED SALES

It is calculated that within the past four months nearly three thousand television receivers have been sold within the Greater London area. This upward rise in sales is generally attributed to the Lord Mayor's Show and Cenotaph broadcasts with an original impetus given by the Coronation transmission. The promise of longer hours of transmission and the likelihood of Sunday broadcasts no doubt have also influenced purchasers.

TELEVISION IN CLACTON

A television demonstration was a special feature of the Christmas Trade Fair and Exhibition at Clacton. Some doubt was felt at first whether it would be possible to pick up the Alexandra Palace programmes in Clacton for the distance is close on sixty miles, and therefore well outside the normally accepted range. Day-time programmes were at first spoiled by some unknown interference but excellent pictures were received in the evening, and the demonstrations attracted large numbers of people.

Experiments have also been carried out at Norwich, which is more than ninety miles from London, and a picture received. A great deal of interference was experienced, but the tests showed that reasonably good reception at this distance was possible, particularly in view of the fact that the aerial height was only 40 ft. In all cases of long-distance reception it appears that the evening transmissions are received better than those in the afternoons and mornings.

TELEVISION "DIARY FOR 1937"

Television will look back to the early days of Radiolympia, 1936, and recall all that has happened since then in "Diary for 1937," an hour's programme to be presented on the last night of the Old Year. This transmission will be a combination of film records and "live" studio presentation which will tell the story of the world's first high-definition television service. Guest artists, films taken side by side with the television camera at events such as the Coronation Procession, sporting contests, shooting in the film studios, and memories of the high spots in "Picture Page"—all these will be combined in a high speed programme which will open in the Announcers' Room at the Alexandra Palace, where

(*Continued on next page*)

"PROJECTION TUBES"

(*Continued from preceding page*)

involved in the fluorescent material can in no wise be neglected. At the current densities and voltages used in the directly viewed tube, present fluorescent materials yield fairly satisfactory light output and have demonstrated their ability to withstand bombardment for extended periods of time without undue deterioration. However, as the beam current and operating voltages are increased, a saturation effect becomes evident. The exact point at which the effect becomes objectionable varies with different materials, and not very much information concerning the behaviour of fluorescent materials at high input levels is yet available for discussion.

Extension of the point where voltage saturation sets in seems to depend upon a better understanding of the secondary emissive properties of the screen material, which place a limit upon the effective bombarding voltage as distinguished from the final accelerating potential.

The question of the useful life of the material immediately comes to mind when voltages and currents of the order contemplated are mentioned. The picture is more encouraging than might be imagined; life tests run with a steady beam current of 200 microamperes at a potential of 10,000 volts have shown an efficiency drop of only twenty-seven per cent. in 1,200 hours.

There is some possibility of improving the performance of the projection system by improving the optical system. An obvious way of doing this is by increasing the diameter of the projection lens; however, there we are restricted by the increasing cost of such lenses. There is, however, the possibility of increasing the light-gathering power of the system by a factor of two or three times by the use of a liquid lens in contact with the face of the projection tube. Such a lens is shown in Fig. 8. The arrangement consists of a hollow shell sealed to the front of the projection tube. This shell is filled with a liquid whose index of refraction is about equal to that of the glass of the projection tube. Aberration is a serious problem, but proper design of the shell can minimise this defect. Such an arrangement increases the effective aperture by a factor equal approximately to the square of the index of refraction of the liquid in the shell. With water as the liquid, output is increased by a factor of about seventy per cent., while if a liquid such as paraffin oil or cedar oil is used the gain in light is in the neighbourhood of two-and-one-fourth times.

MORE SCANNINGS . . . . . .

Jasmine Bligh, Elizabeth Cowell and Leslie Mitchell will ask each other, "Do you remember . . .?"

Viewers, as they watch the procession of events, will, it is believed, be struck by the steady development in presentation since that first Radiolympia programme. "Diary for 1937" will be repeated in the afternoon programme on January 4.

SOME FUTURE O.B.'s

The "Rugger" International at Twickenham, the Boat Race, Croydon Airport and the Derby are prospective objectives for future outside broadcasts. Tests of the possibility of transmitting from Epsom Downs have already been made, and it is understood that they have proved satisfactory. There is little doubt, therefore, but that the Derby will be televised and the dream of television pioneers become an actual fact. It is not expected that there will be any difficulty at either Hammersmith, Croydon or Twickenham for the other transmissions, but careful tests are to be made with regard to the possibility of interference which ruined the broadcasts from Hatfield and King George V Dock a few months ago.

It is noteworthy that of all the programmes that have been transmitted during the past twelve months only those for which the B.B.C. were not responsible have created any considerable amount of interest. These were all outside broadcasts.

TWO-WAY TELEVISION

The televised two-way conversation between Mr. Gerald Cock, the Television Director, at Alexandra Palace, and Mr. Walter Mycroft at Elstree, was an interesting experiment in the future possibilities of television. It was made possible by the arrangements that had been made for the transmissions from the Elstree studios.

LORD HIRST TO BE R.M.A. PRESIDENT

The Rt. Hon. Lord Hirst of Witton has succeeded Lord Gainford as President of the Radio Manufacturers' Association. The announcement was made at the eleventh annual banquet of the Association held on November 22. In the course of a speech at this banquet, Mr. M. M. Macqueen, chairman of the R.M.A., said "The industry believed more than ever in the future of television. So far, this country had led the world in television development.

"We in the industry believe that the efforts of the Government will be valueless unless it takes a bold policy to increase television broadcasting hours and to raise the general level of the entertainment provided." He suggested that a children's hour feature should be introduced in the television programmes at once.

TELEVISION IN ITALY

Plans are being made for the erection of a television transmitter on the summit of Mount Mario, which is north of Rome. Few details are as yet available, but it is understood that a wavelength of 7 metres will be used and that the system will be very similar to that employed in this country. It is expected that the station will be ready in the early part of 1938.

SUNDAY TRANSMISSIONS

It is practically certain that Sunday television programmes will be introduced early in the New Year irrespective of an increased Government grant for the television service. The provision of a Sunday service is one of the first matters which is to have consideration in the development of the service.

THE TELEVISION SOCIETY'S TENTH ANNIVERSARY

The Television Society has now attained its tenth anniversary and to celebrate the event a dinner was held at the Grafton Hotel, Tottenham Court Road, on Wednesday, November 24. For this event collaboration with the B.B.C. was arranged and the chairman of the Society, Dr. Tierny, after the dinner concluded, went to the Alexandra Palace and gave a talk on the history and objects of the Society. Dr. Tierny was seen and heard by those present at the dinner, who adjourned to the Marconiphone premises a short distance away. Five receivers were in use and the reception was excellent and entirely free from interference.

"MUSIC HALL PARTY"

Veterans of the Music Hall will hold a New Year party in the television studio on the afternoon of December 31. Gathered round a table loaded with cakes and Christmas crackers will be seen Sam Mayo, who will entertain the company with "I've Only Come up for the Day"; May More Duprez, who will sing her famous number "By the Side of the Zuyder Zee"; Charlie Lee, the seventy-two-year-old high kicker; Tom Leamore, the original "Percy from Pimlico"; George Mozart, who is still famous on "the boards"; and that music-hall favourite, Daisy Dormer. The Chairman will be a "youngster," George Benson, who is well known to viewers for his appearances in musical comedy and in the "Television Follies." There will be an audience in the studio, which will be televised at intervals while the party is in progress.

MR. LESLIE MITCHELL RESIGNS

Mr. Leslie Mitchell, the first male television announcer, has resigned from the B.B.C. in order to accept an appointment with a news reel company. His resignation will take effect towards the end of February, until when he will continue to appear regularly in the television programmes. Mr. Mitchell joined the B.B.C. as an announcer in 1934.

AN R.M.A. ASSURANCE

In order to allay any doubt that might exist in the public mind that television receivers as manufactured to-day will become obsolete in a short time, or that there will be any considerable reduction in price, the Radio Manufacturers' Association make the following announcement:

The success which has attended the reception of the Alexandra Palace transmissions over the metropolitan and a large part of the home counties areas, and particularly those of special events of national importance and interest, has shown that television has now reached a stage such as to warrant its installation in a large number of homes.

With this in view, the Radio Manufacturers' Association, after conference with the authorities concerned, takes this opportunity of advising the public that the television receivers available are of a type that will continue to receive the transmissions from Alexandra Palace for a long time to come.

It has been stated in authoritative circles that the present system of transmission will continue for a definite period of a length which will

. . . AND MORE REFLECTIONS.

avoid any question of obsolescence in present-day equipment.

The prices of present-day receivers are such that there is practically no likelihood of better value for money being offered for some considerable time.

EXTENSION OF HOURS LIKELY

The Radio Manufacturers's Association has reason to believe that extensions of the present hours of transmission may be expected shortly.

The parties concerned with the production, distribution and reception of television are all agreed that the development of this new branch of the radio art has reached a definite and stable position where the utility value of the service is now fully available to the public as a home entertainment of great merit.

AMATEUR BOXING—TELEVISION BAN

The Amateur Boxing Association has circularised club secretaries informing them that no television will be allowed at any competitive boxing " until conditions are improved."

MORE AUSTRALIAN BROADCASTS

There is to be a very considerable increase in the number of broadcasts on short-waves from Australia. Starting on January 26 and finishing up the beginning of May, 1938, Australia is celebrating its 150th anniversary. The short-wave stations are to be brought into more general use, and a considerable number of the events scheduled are to be relayed via short-waves. The first transmission is to take place on Tuesday, January 18, with a commemoration of Capt. Phillips' arrival at Botany Bay, which has been organised by Capt. Cook's Landing Place Trust.

TRANSMISSIONS FROM LABRADOR

An amateur short-wave station isolated in the north of Labrador, and unable to receive any mail for nearly four months, will shortly be heard in all parts of the world. This station, call-sign, VO6D, or the Voice of Six Ducks, as he is familiarly known, is going to broadcast a programme of his own which will include some native trappers who will face the microphone for the first time. It is also hoped that some of the local inhabitants will come along and say a few words, and so make this programme of general interest.

A 5-METRE TEST

The International 5-metre tests organised by the Radio Society of Great Britain, will have considerable interest to designers of television receivers. As amateurs in all countries are taking part in the tests, the ranges covered by their simple apparatus will be a guide to the possible range of television signals. It is expected that consistent transmission and reception will be possible over quite long distances, but this is merely a matter of conjecture.

BRITISH AMATEUR CALL-SIGNS

There has been a startling increase in the number of licences issued to amateurs wishing to use transmitting apparatus. This is accounted for in official quarters by the large number of all-wave receivers sold that cover the amateur waveband. Ordinary listeners merely interested in short-waves have been hearing the tests carried out by amateur transmitters and a percentage of them have taken up this fascinating hobby for themselves. Owing to the number of licences issued the G2, G5, G6 and G8 numbers have all been exhausted, so that G3's are now being used. Also the British Isles have been split into sections with English stations having the prefix G, Welsh stations GW, Scottish stations GM, and those in Northern Ireland GI.

GERALD COCK, Television Director, sending an exclusive message to "Television and Short Wave World," says:

"Television has already shown what it can do, and is in a sufficiently advanced stage of development to provide an intimate and altogether delightful home entertainment, for which alone it is devised and produced: but I am sure that what has been accomplished in the last eighteen months will prove to be as nothing when compared with the future. I believe we are at the beginning of a new era in entertainment in the widest sense of that much abused word, though it is bound to be a bit of an uphill fight against inertia and non-co-operation. If the public could be made to realise what this amazing medium is capable of giving them, their encouragement would be invaluable in these still early days of disappointments and difficulties. To the staff at Alexandra Palace their jobs are an exciting adventure in a world without precedents.

"The field that can be covered by television has proved wider than most people thought possible even a year ago. To have a set in one's own home is a unique pleasure."

BRITISH COMMUNICATION RECEIVERS

America has for the past few years scooped the amateur market for communication receivers. The majority of experimenters in this country are using receivers of American design, particularly with ultra-high frequencies. It seems now as if British manufacturers have realised that there is a good amateur market in this country. In the next few months there will be quite a number of British built communication receivers of an entirely new type.

The British makers are capable of producing high-grade communication sets, which has made it all the more annoying that they should have ignored this market for so long. The standard British domestic receiver has a degree of efficiency higher than that of the American receivers with a similar number of valves, and many amateurs have hoped that before long they could obtain British communication sets embodying a similar degree of efficiency. This wish is now about to be realised.

CIRCUS TELEVISION

Bertram Mills' Circus will be televised daily from Olympia from January 4 to January 8 next. This will be the first occasion on which the mobile television unit has transmitted pictures direct from a place of entertainment in London.

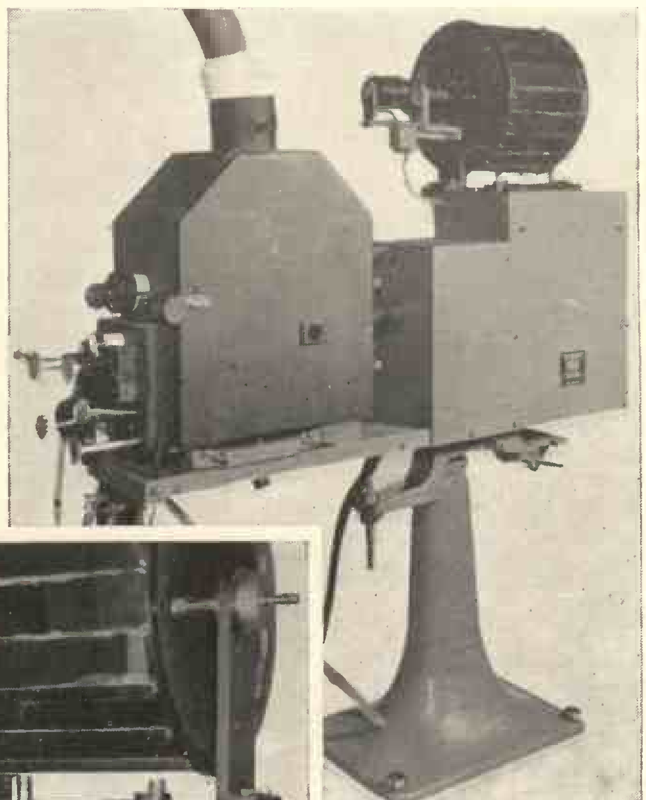
The items which it is hoped to televise will include Albert Schumann with his twenty horses and ponies; Harry and Merkey, the crazy contortionists; the Five Vikings—Sweden's Silly Sailors; Crocker's Teddy Bears, in climbing and balancing feats; the Three Codonas in their flying trapeze act; Koringa, the only female fakir in the world; the Chinese Lucky Girls; Gindl and his Elephants; the Arthur Family of acrobatic and comedy cyclists; the Karpi troupe of acrobats; the Four Maniacs in Comedy Ladder acts; and Mr. Bertram Mills' world-famous team of horses.

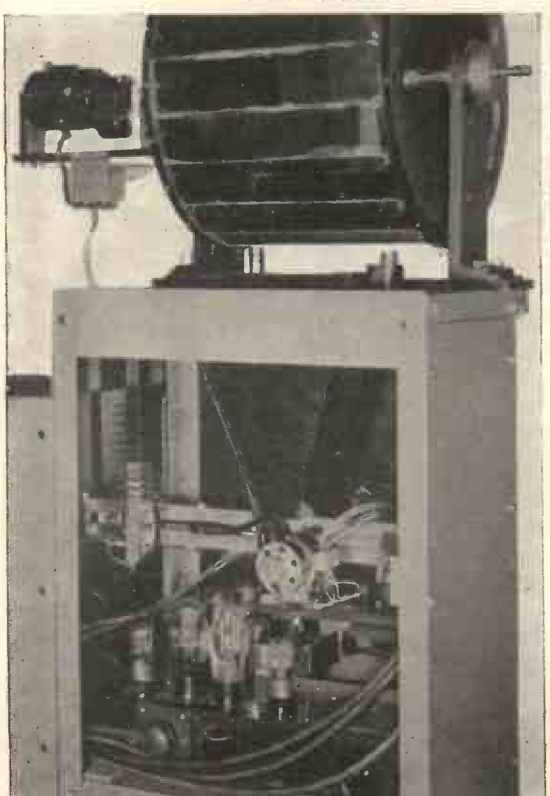
The television cameras will work at varying distances from the ring to give close-ups of the clowns and comedy turns, as well as full views of the arena and audience. Telephoto lenses will be used. Viewers will be " visiting " the Circus in the company of Frederick Grisewood, who will comment on the items.

SCOPHONY DEMONSTRATION ON B.B.C. TELEVISION

SYNCHRONISING DIFFICULTIES OVERCOME

LAST month Scophony demonstrated their receivers for the first time on transmissions from Alexandra Palace. Accounts of the performance of these receivers on *Scophony* transmissions have been given previously in this journal and it has been explained that owing to irregular timing and phase shifting in the Alexandra Palace transmissions, previously it has not been possible to synchronise mechanical receivers. This fault has now been remedied and the recent demonstration





Right: Scophony television projector for public halls producing a 5 ft. by 4 ft. picture.
Below: Interior view of the projector showing amplifier which drives the light control. Above the amplifier is the high-speed synchronous motor.

showed that synchronism by the Scophony system is just as good as when a cathode-ray tube is used.

Two receivers were demonstrated—the home type with a screen 22 in. by 24 in. and the cinema type with a screen 5 ft. by 4 ft. Both receivers employ " split focus " and " supersonic " light control which are fundamental to the Scophony system.

" Split focus," is an optical arrangement of cylindrical lenses with their axes crossed, so that a beam of light is focused in two separate planes. An advantage of the split focus is that where scanners are employed (as is essential in optical mechanical television systems) they can be of a considerably smaller size than would be necessary with ordinary spherical lens systems.

Synchronising Difficulties Overcome

The Scophony supersonic 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, 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, an image of the light control itself is, by means of suitable lenses, formed on the screen. If the modulated carrier frequency is now 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 a speed that follows exactly the speed of the waves in the liquid.

The modulation then becomes visible on the screen as an image. In the liquid, the waves produced by the element frequency on the quartz crystal, are equivalent to one scanning spot on the screen. A large number of scanning spots are therefore used simultaneously. In the apparatus demonstrated 150 picture elements were shown simultaneously on the screen, increasing the apparent brightness of the picture 150 times.

A further advantage of the Scophony light control is that comparatively low power (5 to 10 watts) is required to operate it.

In the Home Receiver the light source used is a high-pressure mercury lamp which operates from a D.C. source. Internally, the appara-

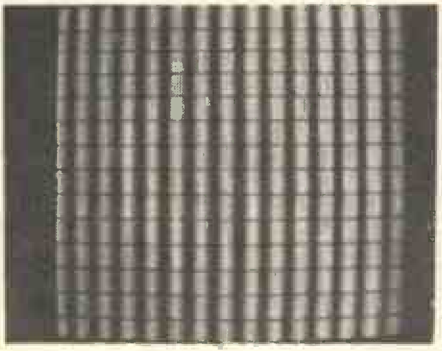
(*Continued on page* 25.)

HOW COSSOR TELEVISION RECEIVERS ARE TESTED

A special technique is necessary in the testing of a television receiver. The method employed is described in this article.

BEFORE a television receiver is completely ready to install in the home of the viewer it has, of course, to undergo a series of tests. It will be interesting to describe some of these tests as carried out by Cossors, since they are quite peculiar to television as distinct from radio.

A television receiver can be conveniently considered as three distinct sections. Firstly, there is the radio set, which amplifies the signals from the dipole aerial and delivers the vision information, consisting of the picture and synchronising signals, to the scanning chassis, and the accompanying sound to the loud-speaker. Then there is the scanning chassis, which has the task of reconstituting the picture from the vision signal, separating the picture modulation from the synchronising pulses, and supplying the scanning motions to the light spot on the cathode-ray tube in exact time with the scanning at the transmitter. Thirdly, there is the power unit which delivers the various voltages to drive the radio receiver, the scanning chassis and the cathode-ray tube.



This pattern is a photograph of a complete test raster.

Trimming the Vision Receiver

The radio receiver is trimmed up on a special signal generator designed for the ultra-short wavelengths. The Cossor vision receiver is of the superheterodyne type, and great care has to be taken when trimming the intermediate frequency amplifiers to see that both sound and vision signals are tuned in simultaneously. There must also be no hint of cross-talk between the two outputs; sound modulation appearing super-imposed on the picture is one fault which is carefully watched for on test.

The power unit has, among other things, to deliver a voltage of 4,500 to the cathode-ray tube. In order to handle this voltage safely, particular care has to be given to insulation. The transformer is tested for breakdown at 10,000 volts and the smoothing condensers are tested at double their working voltage. When checking these high potentials, the meter used must not add an appreciable load, or a false reading will be given, so electrostatic meters are used.

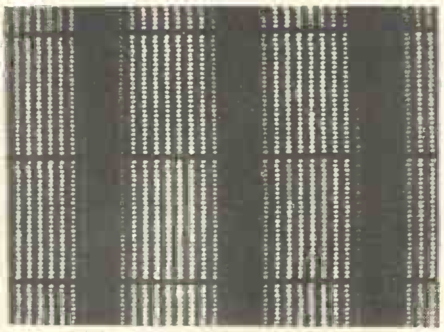
Scanning Tests

It is, however, in connection with the scanning chassis that the most interesting tests are made. This part of the apparatus has no parallel in normal broadcast receivers, and even the valves have work to do which would have broken the hearts of valve designers a few years ago. The four triodes that are used to give the vertical and horizontal scanning deflections have to work under conditions that allow the anodes to run to many hundreds of volts. Of these, the two time-base valves which generate a saw-tooth waveform, have to simulate an infinite resistance one instant and as nearly as possible, a short-circuit the next. This means valves which can pass a heavy current for a short time, with a sharp cut-off when the grid is a few volts negative.

The other two scanning valves are amplifiers, and it is imperative that they should have characteristics that follow very closely to a particular curve. If their characteristics fall outside the very close limits set, then the scanning spot will not travel uniformly, but will speed up in certain parts of the picture and so make people appear to get fatter as they walk across the screen, or give them a small head and very long legs; in other words, the scanning would be non-linear. Slight variations in curvature of characteristic in valves intended for broadcast receivers are of no importance at all, but in a television receiver the effects of such variation can be such as to completely ruin the picture. The same thing applies to the valve that sorts out the synchronising impulses from the composite vision signal; a valve slightly off specification could destroy the picture in a different way, by causing lines to be scanned too short when there is a black area near the right-hand edge of the raster. The valve could not differentiate between a " black " and synchronising signal.

Valve Checks

To examine every valve by plotting the complete characteristic curve on a valve-testing board would be an impossibility. It would be much too slow and much too expensive. So a piece of apparatus was devised consisting of a time-base valve which caused a horizontal trace on a cathode-ray oscillograph. Part of this sweep voltage was taken and applied to the grid of the valve under test. A resistance was put into the anode circuit of this valve and the voltage developed across this resistance was applied to the vertical deflector plate of the same oscillograph. So the horizontal position of the spot gave a measure of the grid volts on the valve and the vertical position gave an indication of the anode current corresponding to that grid voltage. Thus with the time-base valve working at about fifty cycles per second, a continuous line was drawn giving the dynamic characteristic of the valve tested.



A portion of the test raster shown above enlarged to show the 2-megacycle dots.

Selected valves representing the upper and lower limits were then plugged into the apparatus and their curves copied on to the screen of the oscillograph. Thus, by making each valve draw its own curve, it is a simple matter to go through a batch of valves and select quickly and accurately those that lie within the limits.

An Artificial Signal

When testing the scanning chassis in conjunction with its cathode-ray tube previous to putting the complete set into its cabinet, one finds that a suitable testing signal presents a problem. The B.B.C. transmits a film for one hour each morning and, of course, there is the usual hour in the afternoon, but two hours out of eight does not provide sufficient time to do justice to a day's production of sets. A transmitter at the factory is therefore available, providing a signal on tap at several points in the works. It has been found, however, as the result of experience, that testing and adjusting a receiver on actual pictures does not always give satisfactory results. One needs something analogous to the signal in broadcast receiver testing, or the beat frequency oscillator in checking amplifiers.

A special form of signal which contains the essential information required to make all the necessary adjustments has been developed, therefore, and this is always available in the testing department. Photographs taken off the end of a cathode-ray tube when this signal was being used are shown.

The signal is generated by a combination of sinusoid and saw-tooth oscillators, and the whole is locked to the synchronising signals so that a stationary pattern is obtained on the receiver under test. The screen is covered by minute dots of light which are produced by a two-megacycle beat, and at regular intervals in the horizontal or line direction, bands of maximum and minimum amplitude of oscillation occur. Also at regular intervals in the vertical or frame direction appears a dark line. The fine two-megacycle pattern is a good signal to check up the performance of the cathode-ray tube, since any woolly focusing of the scanning spot immediately makes the points of light run into one another.

A different kind of bad focusing, known as astigmatism, which causes the focus to be good in a given direction and poor at right-angles to it, also shows up quickly, and the pre-set controls which are provided on the set to eliminate this error can be quickly adjusted to their correct setting. The fact that the pattern is stationary makes it easy to see that interlacing of the raster is good, this being difficult on a moving picture, since the eye tends to follow any movement and the resulting stroboscopic effect apparently throws the interlacing out.

The vertical bars and the horizontal lines give accurate time markings and show up immediately any non-linearity in either direction, which would cause the intervals to be spaced out at unequal distances. Non-linear scanning is an error that is not always immediately obvious on a picture, but can be very annoying when there is much motion from side to side or up and down.

Any departure from the parallel or from straightness of the time-marking bars shows as a non-rectangular raster or poor synchronising. While still on this signal, the raster is centered on the screen of the tube by means of the shift controls, and the horizontal and vertical sweeps are set so that the picture is correct as regards size and shape, and so will comfortably fill up the mask in the cabinet.

When everything is satisfactory, the set is then put into its cabinet, the chassis are bolted down and the various connecting leads are plugged in and anchored down.

The set is finally given a long run on the B.B.C. programmes as a final test under normal working conditions, attention being given to constancy of performance of the picture and quality of the accompanying sound.

"SCOPHONY DEMONSTRATION"

(*Continued from page 23*)

tus is arranged so that the light source is first 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 through a projection lens on to the two-foot screen.

The large receiver is very similar to the Home Receiver except that the light source is a standard cinema arc consuming 100 amperes and that the low speed scanner is of a larger diameter. The picture is rear projected on to a sand-blasted glass screen.

The high speed polygons of both receivers are rotated by special synchronous motors and synchronised by the line frequency transmitted by the B.B.C.

Excellent Reproduction

At the recent demonstration the two receivers were shown to at least a hundred people, all of whom were able to see quite clearly even on the smaller model.

The definition on the small model was, as far as could be compared from memory, equal in every way to the best type of cathode-ray receiver, while the synchronisation was perfect in every way. There was a slight lateral movement of the entire picture twice during the transmission but this was apparently due to faults at the transmitter end.

On this domestic receiver light values were very good although there appeared to be rather more light in the centre of the picture with a slight drop towards the sides. However, the instrument gave a very well defined picture.

A stage was fitted up on the lines of a cinema complete with stage and a large screen 6 ft. by 5 ft. The commercial type receiver provided a picture that completely filled this screen.

The definition was not so good as with the smaller receiver, but it was as good as the present standard of definition will allow. Compared with the normal cinema screen the definition was poor, but at this stage definition is not the most important feature,

The demonstration clearly indicated that the Scophony big screen system has considerable scope with a promise of coping with higher standards. At the present time the transmissions are not good enough for big screen television both as regards the number of lines and studio arrangements. Lighting is poor, there being far too many shadows, while the poor scenery shows up very badly. This defect is not noticeable on the smaller television receivers.

The noise which might be expected from mechanical units was quite unnoticeable—a most important feature.

A delivery date for the smaller receiver was not fixed although it is expected that the price will be £70 and £80. Orders for the big screen receiver can be taken with delivery within three months.

FOR THE BEGINNER

A B C OF MAGNETIC SCANNING

In view of the increasing use of magnetic scanning, this article, by G. Parr, explaining the elements of the system, is of particular interest

THE use of magnetic fields for controlling the beam in the cathode-ray tube is by no means a new development, and is in fact a

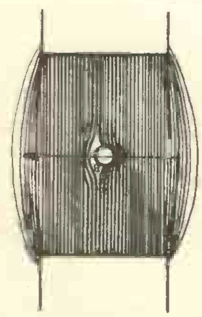


Fig. 1. How the beam is deflected by a magnetic field.

reversion to the original means by which the beam was deflected and focused. (The use of a coil for focusing the beam was described in 1905, and in illustrations of that period the tube is seen with two coils strapped round the neck to provide the deflecting force on the beam.

There is, however, a wide difference between the simple deflection of the beam by a magnetic field and the use of this field to produce a regular

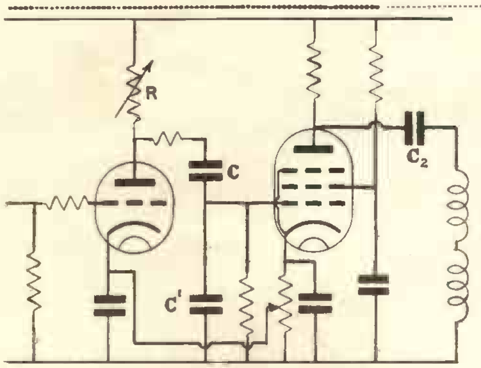


Fig. 2. Circuit suitable for use when iron-cored coils are employed.

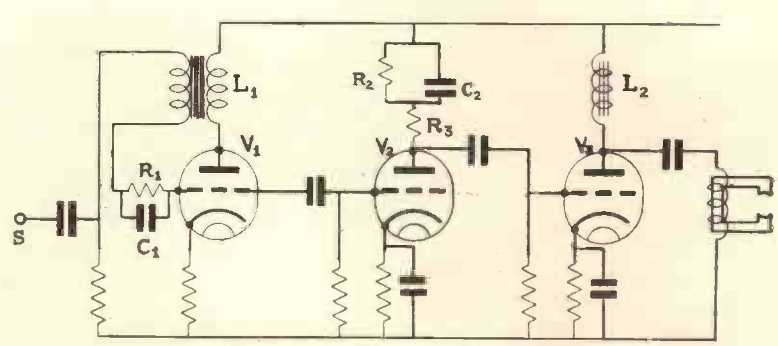


Fig. 3. Ticking-Grid oscillator scanning circuit.

series of scanning lines when the speed of scan is one line in 1/10,000th sec. At very high frequencies the design of both the coil and the circuit have to be carefully investigated, and it is no longer a matter of winding a number of turns of wire and fixing them to the neck of the tube.

To appreciate some of the difficulties involved it is convenient to revise briefly the principles of magnetic deflection of the beam. The beam can be considered as an exceedingly flexible conductor carrying a current. If this conductor passes through a magnetic field it will experience a force due to the interaction of the magnetic field surrounding the conductor and the field through which it passes.

Fig. 1 shows a cross-section of the beam as it passes up the tube and the deflecting field is represented by the lines passing transversely across its path. The interaction of the circular field surrounding the conductor (i.e., the beam) and this field are shown by the merging of the lines on one side of the conductor and the bulge produced in the transverse lines of the field. If we consider these as in the nature of elastic threads their action will be to force the conductor out of the field in the direction shown by the arrow. The direction of movement of the conductor depends on the direction of flow of the current and the polarity of the magnetic field. In the case of the cathode-ray tube the direction of flow of the current is non-reversible and alteration of movement of the beam is done by reversing the magnetic field in polarity.

Note from the diagram that the movement of the beam is at right angles to the direction of the field. This means that if we mount two coils so that the axis of each is horizontal the beam will be deflected at right angles to this axis, i.e., vertically.

The amount of movement of the beam can be calculated from the strength of the field and the accelerating voltage applied to the beam, but the theoretical deflection is seldom realised in practice owing to the difficulty of finding the exact extent of the field. A certain number of lines of force spread out in a curved path at each end of the magnet poles, as shown in Fig. 1, and this "fringing" field also influences the beam, although its effect can only be estimated approximately in any calculation.

Whether the beam is deflected by an electrostatic or by an electromagnetic field the same requirements hold—a deflecting force which increases uniformly with time and then ceases momentarily to allow the beam to return to its original position. In electrostatic deflection we have the familiar saw-tooth wave of potential which is applied to the deflector plates. In magnetic deflection the saw-tooth represents change of current through the deflecting coil, which must increase at the same rate to produce the same scanning movement.

It is this change of current which gives rise to some of the difficulties in the design of magnetic scanning circuits as, owing to the inductance of the coil, the rapid change of cur-

ADVANTAGES OF MAGNETIC SCANNING

rent produces undesired effects. For example, in a highly inductive circuit the abrupt cessation of the current at the completion of the scanning movement will give rise to a high voltage induced in the coil, which may be sufficient to break down the insulation. The inductance of the coil will also tend to retard the fall of current to zero at the end of the line and it may even be necessary to introduce a potential of opposite polarity to assist in the reduction of the current.

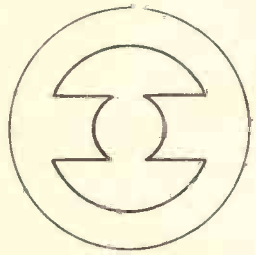


Fig. 4. Typical yoke for iron-cored deflecting coils.

The problem is a little simplified in the case of the scanning circuit for picture frequency as the rate of change of the current is slower and coils with iron cores can be used. The presence of the iron core serves to increase the density of the field and localises it over a more sharply defined area. This enables a lower value of current to be used and the scanning circuit can be made up on the lines of Fig. 2. The saw-tooth wave is generated by the thyratron and condenser shown. R is the variable speed control and the charging condenser is divided into two parts C and C' to reduce the potential applied to the grid of the pentode amplifier. In the output of the pentode the deflecting coils DD are connected. The coupling condenser C_2 needs to be of large capacity at the low frequency of the scan—about 8-10 mfds. A similar circuit could be used for the line scanning frequency although the coils would not be iron-cored owing to the increased impedance which would be produced at 10,000 cycles.

A more complicated scanning circuit was described in an issue of the I.R.E. Journal* some years ago in which a negative pulse of potential was applied to the scanning amplifier during the flyback of the beam. This materially improved the efficiency of the scanning circuit as the following brief explanation will show:

The scanning voltage is produced by a "ticking grid" oscillator, the anode and grid circuits of the left-hand triode being coupled and the rate of oscillation being controlled by the time constant of the leak and condenser R_1 and C_1. The valve V_2 is normally biased so that no anode current is flowing, but each pulse of the oscillator applies a positive pulse to the grid, causing the anode current to flow and charge the condenser C_2. This produces a negative potential across the grid of V_3, which is followed by a positive one as the anode current in V_2 ceases and the condenser discharges through R_2. With this arrangement a sharp negative pulse is followed by a positive saw-tooth wave of voltage.

When this pulse is applied to the grid of V_3 the negative portion cuts off the anode current by increasing the bias. Each saw tooth is, therefore, followed by a short period during which the impedance of the valve V_3 is high and this ensures a rapid decay of current through the scanning coils. The anode load of the output valve is the choke L_2 which is large in value compared with the inductance of the scanning coils.

Scanning Coil Design

As said before, it is not possible to design scanning coils accurately for a given tube as so much of the theoretical values are modified in practice. The values of ampere-turns and dimensions of coils are largely the result of experience and are determined empirically, the principal difference between the line and picture coils being in the inductance. For low scanning frequencies it is permissible to use a relatively high inductance coil with a low value of deflecting current and for the line frequency the coil is of few turns with a high value of current.

This is one of the advantages of the magnetic deflecting system over the electrostatic system. In the latter the scanning voltage must be high in order to produce sufficient movement of the beam in a large tube and the value of voltage is not affected by the frequency of scan. In the magnetic system the operating voltage can be kept low provided that it is sufficient to enable the valves to be operated on the straight portion of their characteristic and a considerable saving in components is the result.

From the point of view of distortion the all-magnetic system has several advantages over the electrostatic focusing and deflecting system. The various distortions which are present in the electrostatic tube have already been described in this journal and it is understood that troubles which arise from the presence of high-voltage deflecting fields do not exist in the magnetic system. At the same time the presence of the deflecting coils may introduce a certain amount of distortion, particularly if the magnetic field is spread over a wide area by leakage.

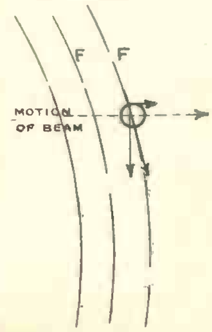


Fig. 5. Showing how a beam passing through a curved field is influenced by two forces.

In some cases a form of "cross-modulation" is produced by the interaction of the fields due to the two pairs of deflecting coils and the position of the coils has to be carefully chosen to avoid this. In some cases this effect is produced by want of symmetry in the deflecting system, the coils either being displaced relative to the axis of the tube or the magnetic circuit (in the case of iron-cored coils) being of unequal cross-section.

A typical magnetic circuit is shown in Fig. 4, which is specially designed to keep the field uniform and to minimise leakage.

When the deflecting field is curved, such as occurs at the edges of the main field (see Fig. 1), a certain amount of distortion of the spot may occur, which is due to the fact that the beam has a definite area, although small. In Fig. 5 the beam is shown as a circle passing across a curved

(*Continued at foot of page 29*)

* Holmes, Carson and Tolson, Proc. I.R.E. Nov 1934.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

Specially Compiled for this Journal

Patentees:- Marconi's Wireless Telegraph Co., Ltd., and L. M. Myers :: Marconi's Wireless Telegraph Co., Ltd. :: Baird Television Ltd., C. Szegho and D. M. Johnstone :: Telefunken Ges. fur Drahtlose Telegraphie M.b. h. :: E. Michaelis :: Baird Television Ltd. and G. Dovaston :: Baird Television Ltd. and T. M. C. Lance

Light-sensitive Amplifiers

(Patent No. 470,102.)

LIGHT is focused on to a sensitised cathode, and the electrons so liberated are controlled first by an open-mesh grid and then by a series of close-meshed electrodes, coated with sensitive materials of low work-function. Secondary emission occurs at each electrode stage, successive electrodes being biased in an ascending order of positive voltages from a common potentiometer. The amplified current is drawn off from an outer circular anode.

Suppressor grids may be arranged in front of the secondary emission electrodes in order to reduce back-coupling. No electron focusing devices are necessary.—*Marconi's Wireless Telegraph Co., Ltd.*, and *L. M. Myers.*

Making Fluorescent Screens

(Patent No. 471,190.)

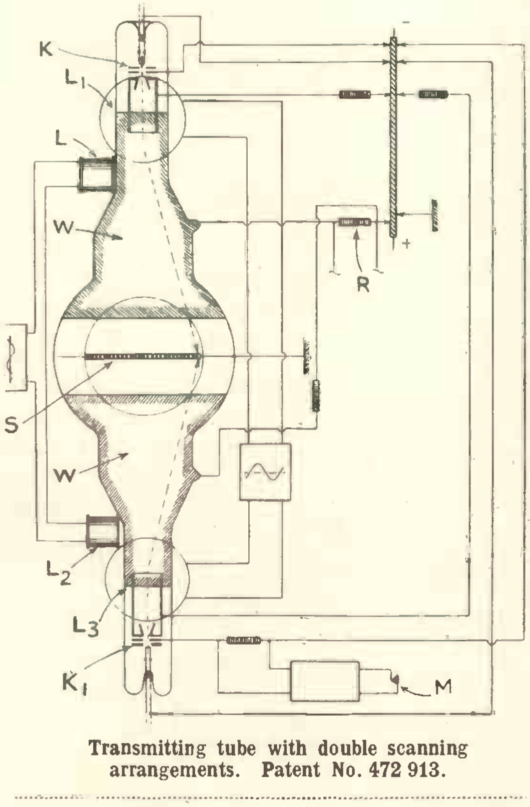
When making a fluorescent screen from willemite (which contains zinc, silicon and manganese) the mineral is usually ground down into a very fine powder, preparatory to laying it on the glass face of the cathode-ray tube. It has now been discovered that the grinding process injures the crystalline surface of each of the small particles, and so causes the fluorescent light given off by them to be less intense than it should be.

In order to remedy this defect, the willemite, after it has been powdered, is immersed for some hours in an alkaline solution. This appears to have the property of restoring the original crystalline formation, either by dissolving the injured face and exposing a fresh one, or else by dissolving a part of the powder and redepositing it as a new crystalline facet on each particle. The result is a screen which emits more light and is less liable to be burnt out.—*Marconi's Wireless Telegraph Co., Ltd.*

Cathode-ray Receivers

(Patent No. 471,539.)

A certain amount of "flicker" may be traced to the fact that the fluorescent light from the screen has no perceptible after-glow. In order to remedy this, the picture is projected in two stages. It is first thrown on to a fluorescent screen made of materials selected to give an appreciable "after glow." The light from this first screen is then passed through a transparent sheet on to a thin layer of photo-sensitive material.



Transmitting tube with double scanning arrangements. Patent No. 472 913.

Here it liberates a stream of electrons, which are focused by an external winding on to a second fluorescent screen, which is mounted on the bulb end of the C.R. tube, in the ordinary way. The second screen is made of material selected to produce a white or bluish-white light of high brilliance.—*Baird Television, Ltd.*, and *C. Szegho*, and D. M. *Johnstone.*

Cathode-ray Tubes

(Patent No. 471,913.)

A sensitised electrode S is fitted in the centre of a cathode-ray tube where it is scanned on both sides by separate electron streams from the two ends of the tube. The sensitised electrode may consist of a "mosaic" of small photo-electric cells, or it may consist of insulated "squares" of metal which liberate secondary electrons under the impact of the scanning streams.

The secondary electrons are collected on the metal wall coatings W, W1, and pass through a resistance R to produce signalling currents. The arrangement can be used for interlaced scanning by applying different control voltages to the deflecting coils L, L1 and L2, L3, respectively.

Or the tube may be used for transmitting secret telephony. In this case speech currents from a microphone M are applied to the two control electrodes K, K1 to vary the amount of secondary emission from the electrode S. By causing the scanning stream to move in opposite directions over the two faces of the electrode S, the speech is "distorted" or made secret to any listener not provided with a corresponding form of receiver.—*Telefunken Ges. für draghtlose Telegraphie m.b.h.*

Low-voltage Tubes

(Patent No. 472,073.)

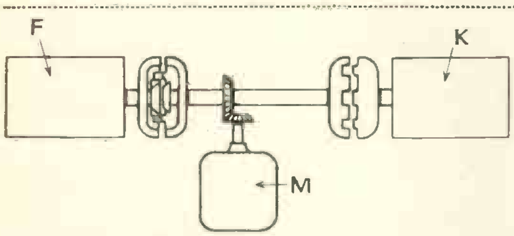
A cathode-ray tube is designed to be run on low operating voltages and to produce, in the first place, only a faint picture on a small-sized fluorescent screen. The dim picture is then focused by a lens on to a photo-sensitive surface, from which electrons are emitted. These are passed through an electrostatic focusing system, which intensifies the stream and projects it on to a second fluorescent screen where it produces a bright picture of normal size.

The use of low operating voltages results in a considerable saving in the cost of the component parts of the set.—*E. Michaelis.*

Driving Motors

(Patent No. 472,274.)

The drawing shows an arrangement used for coupling the driving motor M to a film to be televised. It is found that if the motor is first run up to the proper speed before being clutched to the film, the sudden application of the load tends to make the motor drop out of synchronisation. On the other hand, if it is " revved " up to synchronous speed



Driving motor for film which remains in synchronism on application of load. Patent No. 472,474.

whilst coupled to the film, the first few pictures of the film are not properly radiated.

The motor is accordingly provided with an artificial " load " K to which it is clutched whilst it is being speeded up. Once it has reached the synchronous speed, it is switched over to the film apparatus F. Whenever it is necessary to disconnect the film F, the artificial load K automatically comes into play, so that the motor can be left running at the proper speed, ready to drive the film when required.—*Baird Television, Ltd.*, and *G. Dovaston.*

Electron Multipliers

(Patent No. 472,485.)

The electrons liberated by light from a photo-electric cathode are amplified by making them strike against metal electrodes which liberate several secondary electrons for each primary impact.

It is found that the number of secondary electrons can be increased if the primary stream is made to strike the metal surfaces at an angle of about 30°.

As shown in the drawing, the electrons produced by light focused on a sensitive cathode C are directed against a series of strips S which are set at an angle to each other, something like the slats in a venetian blind. In each case the primary electrons strike against the strips at the most favourable angle to produce secondary emission, and the overall amplification is correspondingly increased.—*Baird Television, Ltd.*, and *T. M. C. Lance.*

Summary of other Television Patents

(Patent No. 471,185.)

Time-base circuit for generating saw-toothed oscillations with a very rapid " fly-back " period.—*Standard Telephones and Cables, Ltd.*, and *R. M. Barnard.*

(Patent No. 471,250.)

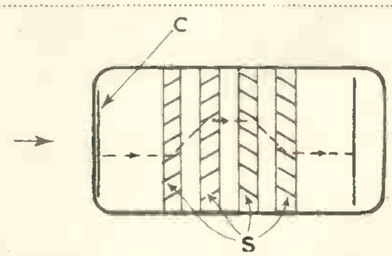
Cathode-ray tube adapted to produce continuous oscillations by automatic deflection of the electron stream.—*Farnsworth Television Inc.*

(Patent No. 471,365.)

Method of amplifying light by back-coupling a photo-electric cathode to a fluorescent screen contained in the same tube.—*Telefunken Ges. für drahtlose Telegraphie m.b.h.*

(Patent No. 471,696.)

Preventing mutual reaction between the scanning voltages applied to the deflecting plates of a cathode-ray tube.—*The Plessy Co., Ltd.*, and *C. E. G. Bailey.*



Electron multiplier. Patent No, 472,485.

(Patent No. 471,747.)

Arrangement for polarising light, suitable for use in television.—*Radio-Akt. D. S. Loewe.*

(Patent No. 471,825.)

Rotating-disc system of interlaced scanning.—*Cie pour la fabrication des Compteurs et materiel d'Usines à Gaz.*

(Patent No. 472,064.)

Photo-electric cathode for use in a light-sensitive cell.—*The British Thomson-Houston Co., Ltd.*

(Patent No. 472,162.)

Cathode-ray television receiver or transmitter fitted with a screen capable of giving " abnormal " secondary emission.—*H. G. Lubszynski.*

(Patent No. 472,284.)

Improvements in the construction and support of the deflecting plates in a cathode-ray tube.—*F. H. Nicoll.*

" ABC OF MAGNETIC SCANNING "

(Continued from page 27.)

magnetic field represented by the lines FF. At the edge of the beam the field line may be considered as having two components of deflecting force, one in the direction of deflection and the other at right angles to it as shown in the figure. The effect of the component in the direction of movement of the beam will be to deflect it at right angles, and as a result the circular section of the beam will be stretched into an ellipse. This mainly occurs at the extremities of travel of the spot, with the result that the screen at the edges of the picture may be slightly blurred. In most cases this effect is minimised by careful adjustment of the focus of the spot when the line screen is actually formed on the screen.

On the whole the magnetic scanning system suffers from less major defects than the electrostatic system and with careful design is capable of giving results in some respects superior to those of the electrostatic tube. With the added advantages of lower operating voltage it is probable that the next few years may see the displacement of the electrostatic tube by the magnetic in commercial television receivers. For the amateur constructor the former still possesses certain advantages which commend it in home-built receivers and the purchaser of an electrostatic tube need not be deterred by the thought that it will become obsolete in a short time.

Philips' Cathode-ray Tubes

With regard to the particulars of Philips' cathode-ray tubes given on page 730 of last month's issue, it should be noted that these tubes are only supplied for the continental market and are not available in this country.

STUDIO & SCREEN

A MONTHLY CAUSERIE on Television Personalities and Topics

by K. P. HUNT
Editor of "Radio Pictorial"

NO one would be rash enough to predict what new developments in television we are likely to see in 1938, but if the remarkable rate of progress witnessed in 1937 is maintained, we can certainly expect a great deal.

After all, the first regular television service in the world started providing daily programmes as recently as November, 1936. The television fare of to-day already seems a long step from those first programmes which ushered in the new service. Those early programmes, produced at the Alexandra Palace mostly in a hectic rush and often with much improvisation, were considered wonderful enough at the time. Yet compare them with what is seen on the home screen to-day, and they become crude experiments in a medium hardly understood by those handling it.

The great television developments of the past year have been not so much in the quality of material or artists, but in the methods and studio technique used to present material and artists. The early programmes were all based on the first simple principle of television—placing objects and people right before the camera and transmitting. Settings were scarcely thought of. The announcers came to view between each item, destroying any continuity of programme or any attempt at providing a continued effect with the programme as a whole.

How this has altered in the space of a year!

To-day it is difficult to enumerate the many settings and methods of presentation used in a week's programmes. The use of two—or even three and four—cameras to obtain superimposition effects, movement and a sense of spaciousness, has come to the fore in a startling manner, and offers inestimable possibilities for the year ahead.

An art has sprung up, which might be termed the art of getting the best out of faces. Producers have learnt from which angles to shoot artists and speakers to their best advantage, not merely to flatter their beauty or handsomeness, but to get over their personality. 1937 saw the birth of "television personality" making.

In the matter of settings, the Alexandra Palace property room is as busy and packed with scenic devices to-day as that of a Hollywood film studio which has been turning out "mammoth spectacles" for years. As many as eight different sets a week are frequently used, turned out by a staff which in the year has grown from a man and a boy to fourteen skilled craftsmen and artistic designers.

Among sets which have been landmarks were undoubtedly those for "The Mizzen Cross Trees" (old world sea-port settings); "The Eve of St. Agnes" (a monastery); "Journey's End" (with its dug-out realistically collapsing in the final explosion); and "Once in a Lifetime."

"Once in a Lifetime" epitomised the great strides made all round. It was the first full-length play attempted. Youngest producer in the service, 23-year-old Eric Crozier, proved with this production that television enters 1938 as a home entertainment of high standard. There were five different sets, ranging from a railway coach to a Hollywood studio. The whole thing was a miracle—if one remembered to compare it with what was being put on the screen but a year ago.

There is little doubt that settings will be still further developed during 1938.

* * *

A plan is afoot, I hear, to convert a disused theatre at the Alexandra Palace into a multi-set studio. It would have perhaps a dozen different sets around its walls, the cameras in the centre of them all. Thus it would be possible to televise a production with as many as twelve quick-change scenes. Something of the slickness and range of setting of the best cinema films would thus be obtained—and will be obtained, the experts have no doubt.

I must not give the impression, however, that the glory of television's first year has been entirely in presentation and technique. Good methods sometimes can make a good show out of poor material, but there has been none of that about the programmes. In fact, one of the biggest surprises has been the ease with which varied programmes containing hundreds of stars and celebrities have been arranged.

* * *

All the early talk about entertainment interests threatening to do their worst to strangle television by restrictive clauses in artists' contracts was soon drowned in the shouts of joy with which most of the entertainment moguls welcomed the sight of their artists on the screen.

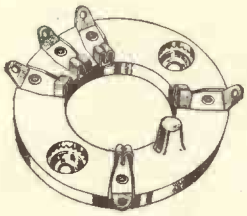
A typical example was the great willingness of the film companies to allow the B.B.C. to televise work in their studios. Only one West End music-hall manager remains to-day who forbids his stars to televise. Only a glance is needed at the list of famous names in the A.P.'s visitor's book to convince you that the entertainment profession has completely accepted television. Gracie Fields and George Robey have starred in variety; Laurence Olivier and Diana Wynyard have come from the legitimate stage; G. B. Shaw and J. B. Priestley have represented the world of letters; and the celebrities from the sporting, scientific and medical spheres who have demonstrated their work before the camera already are innumerable.

* * *

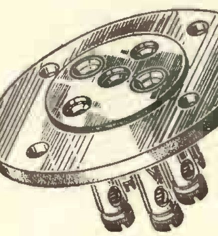
Television of events outside the studio came late in the first months of the service owing to the wait for the O.B. vans. But when this flying squad of eighteen men once got out and about, the prophecy that television would revolutionise the communication of news was soon found to be no exaggeration. The televising of the Coronation procession, the Cenotaph Service, Wimbledon tennis, motor racing at Crystal Palace and the like all demonstrated the unique value of a medium which shows people what is going on as it is going on.

When it's valve-HOLDERS it's CLIX

and we don't mean valve-holders that make hard work when inserting or withdrawing valves. All Clix valve-holders—with the exception of the "Acorn" type—are fitted with the Clix patented helically slotted sockets, which allow for perfect fitting of valve pins and which give full surface contact. The "Acorn" type has Silver Nickel clip sockets which make knife-edge bidding contacts.



"ACORN" TYPE



STANDARD TYPE

Clix wish all readers of this journal a Happy New Year.

CLIX SPECIFIED

IN THIS ISSUE FOR THE :—

1—10 METRE RECEIVER

2. "Acorn" type ... ... 2/- ea.
1. 5-pin type, V.1. ... ... 6d.
1. 7-pin type V.2. ... ... 9d.

(without terminals)

5-BAND MONITOR

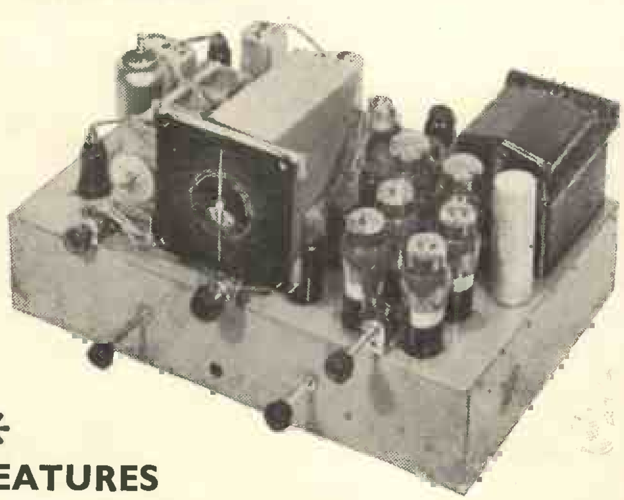
6. Insulated sockets, type 12 2d. ea.
6. Coil pins, type 36... ... 2d. ea.

1938 FOLDER "T.S." FREE.

CLIX

BRITISH MECHANICAL PRODUCTIONS LTD.,
79a Rochester Row,
London, S.W.1.

The "WARD" 18 VALVE CHASSIS



FEATURES

* 28 watts undistorted output
* 6 wave bands $4\frac{1}{2}$ to 2,000 metre
* Squelch Control
* Sensitivity Control
* Delayed A.V.C.
* All L.F. Stages—resistance capacity coupled

A remarkably fine chassis which is well worth your sending a postcard request for full particulars.

CHARLES F. WARD
46, FARRINGDON STREET, LONDON, E.C.4
Telephone: HOLBORN 9703

"The finest book published on Radio Engineering"!

Practical radio engineers, professors of radio engineering, students—everyone who requiries a sound, comprehensive book covering all phases of radio communication are unanimous in their praise of

TERMAN'S RADIO ENGINEERING

New Edition

813 pages, 9 × 6, 475 illustrations.

30/-
NET

Read this list of Chapter Headings and see how this book can help you

1. The Elements of a System of Radio Communication
2. Circuit Constants
3. Properties of Resonant Circuits
4. Fundamental Properties of Vacuum Tubes.
5. Vacuum-tube Amplifiers
6. Vacuum-tube Amplifiers (Cont.)
7. Power Amplifiers
8. Vacuum-tube Oscillators
9. Modulation
10. Vacuum-tube Detectors
11. Sources of Power for Operating Vacuum Tubes
12. Radio Transmitters
13. Radio Receivers
14. Propagation of Waves
15. Antennas
16. Radio Aids to Navigation
17. Television
18. Sound and Sound Equipment

Appendix. Formulas for Calculating Inductance, Mutual Inductance, and Capacity

Index

McGraw-Hill Publishing Co., Ltd.
Aldwych House London, W.C.2

Outside televising has been the most significant development, simply because what it has accomplished leaves no doubt of the great things it will do in 1938.

Tests already have been made, I hear, for the televising of the Boat Race, the Derby, the Olympia Circus, cricket at the Oval, and the arrival of celebrities at the great London stations. It is perhaps most surprising that of these tests, those taken between Epsom and the Alexandra Palace have given the best O.B. pictures. From these successful investigations it will be recognised at once that there can be no telling where the mobile television camera will get to in 1938. The possibility of televising a "Music Hall" from St. George's Hall, though at the moment dropped, opens up the other great avenue of progress anticipated this year, that of television from theatres and halls away from the station. A start will be made, in fact, with the televising of the Olympia Circus, beginning January 4.

* * *

The inauguration of a "floating hour" supplementary to the present two which will be used for O.B.'s will be the first expansion of the year. Sunday programmes will also be introduced, and will consist largely of plays. Although the production staff at the Palace has grown from six producers to a round dozen, still more recruits are expected within the next few months. The full television service staff now numbers 250, and by the middle of the year, when summer weather provides an expected spate of outside events, the staff list is likely to reach the 300 mark.

Extension is also expected of the film unit, which has been much in demand going out at short notice to shoot backgrounds and incidental material for variety and features. A greater use, in the sense of more effective not necessarily a greater amount, of film in pure television programmes, written for television, is expected.

* * *

When I visited Alexandra Palace the other day I was rather impressed by the way in which everything seems to have settled down to a definite routine. In the early days at the Palace there was not the same atmosphere as there is now. Alexandra Palace has become very "B.B.C."

The additional space now available as a result of the one system of transmission is a great help to the producers. For instance, they used the old Baird studio (now known as No. 2 studio) for a complete variety programme not long ago, and it is a wonderful standby. At present this studio is used mostly for announcements and talks, and it has enabled the producers to bring about a new development in talks, which in their presentation are distinct from mere announcements. The fact that a separate studio can be devoted to an announcement makes it possible to provide a setting for the announcer. For example, we have recently seen Elizabeth Cowell opening a door or sitting at a table prior to making announcements which are now regarded almost as miniature programmes in themselves.

Then, in producing big programmes such as the Vic Wells ballet, by the use of the two studios one programme can be set up before transmission and not disturbed, which, of course, is a great advantage.

* * *

Referring to the Vic Wells ballet reminds me that the production of "Le Lac des Cygnes" was one of the most beautiful that televiewers have seen. Balletomanes will recall that the ballet begins with a sight of the swan moving slowly across the stage, and this is again seen at the end of the ballet. In the television version an improvement was effected because a shot was made of an actual flight of swans on the lake of Alexandra Palace.

I think that Mr. D. H. Munro, productions manager at Alexandra Palace, deserves a special word of commendation for the capable and artistic way in which he is developing television ballet, for which I understand he is mainly responsible. I have not yet had the pleasure of attending in the studio for one of the ballet programmes or rehearsals, but I hope to do so when opportunity offers. I believe that Munro does the thing with meticulous care, all the rehearsals being timed with a stop watch and great attention paid to grouping and the general artistic effect. In fact, ballet looks like becoming a main line in television, and in the early New Year we are to see the Vic Wells company again on January 3 in "Nocturne" (Delius), while on the following day the Polish ballet, which has just come to Covent Garden, is to make a television appearance. The art director is Nijinska.

Leslie Mitchell, the television announcer, is not leaving until February, when he takes up his new position with British Movietone News. I gather that the cause of his leaving is merely that he wants more scope, and it is ridiculous to suggest, as some newspapers have done, that as a consequence he will be lost to televiewers. On the contrary, he will be frequently seen in the television programmes in 1938, as I am told he will come back on a contract basis and the B.B.C. is quite anxious to retain and utilise as far as possible his experience.

Exactly who is to be Mr. Mitchell's successor is, at the moment of writing these notes, a mystery, but I heard the other day that several candidates already have been observed at Alexandra Palace.

* * *

Although it is rather late in the day, I must not forget to mention Joan Miller's recent party at the Langham Hotel, which was a sort of birthday celebration in honour of "Picture Page," which passed its 100th performance. About seventy people were present, including most of the important folk in television. Mrs. Westhead, of Brighton, who is said to be the B.B.C.'s most distant regular television viewer, also was there.

Baird Cathovisor Tubes.

In our December issue, pages 736-737, we have given details of the Baird Cathovisor tube, type 12MWI, having a screen diameter of 12 in. This data was incomplete insomuch as we omitted to state that the 12 in. tube has a cut-off voltage of minus 18 and operates with an anode voltage of 4,900. This tube, which also has a heater voltage of 2.2 and takes a current of 2.5 amperes is priced at 12 guineas.

German Amateur Radio.

In the November issue we mentioned that German amateur stations were now virtually off the air. We are glad to say that now, however, the situation has rather improved and that contacts can now be made with German amateur short-wave stations. The present position is that although no new licences are being issued for the time being, the originally licensed stations are still operating.

Our Readers' Views

Correspondence is invited. The Editor does not necessarily agree with views expressed by readers which are published on this page.

The Eiffel Tower Transmissions

SIR,

I was interested to read your suggestion in a recent issue of TELEVISION AND SHORT-WAVE WORLD that listeners on the South Coast should attempt to receive the Eiffel Tower television transmissions.

During the latter part of August and September, the sound channel on 42 mc. and the vision channel on 46 mc. were audible here daily, the signal strength approaching that of the London tranmissions.

While the transmissions were received at fair loudspeaker strength, except when fading, ignition interference from traffic on a main road 100 yards away rendered them of little programme value. A plain inverted "L" aerial was employed, but the use of a simple "V" or diamond system, correctly matched to the receiver input would probably have brought the French signals to quite strong loudspeaker volume, above the interference. For the British signals, the directive system would merely increase the interference level as well as the required signals, as the road lies to the north of the aerial.

Transmissions were made at intervals from 16.00 to 18.00 B.S.T. (on Sundays till 1.00 B.S.T.), but I do not know the present schedule.

It would be interesting to hear how these French signals are received in other parts of the country, as though received daily, they were the only ones audible on many occasions about 25 mc.

B. W. F. MAINPRISE
(Hythe, Kent).

SIR,

You may remember my writing to you *re* reception of Eiffel Tower television a few months ago. I have again heard their transmitter at R7 on a recent Sunday. The items heard consisted of songs by a lady and gentleman, accordion solo, piano solo, Spanish music, and a dancer with castanets, a lady announcer giving out the items broadcast. A strange thing occurred when a train passed; it completely cut out signals from this station. Does this suggest that 7 m. wireless waves travel over the face of the earth. My set is in an upper room with the lead in wire at the top of aerial, which is 17 feet long, the lower end being below the level of the railway coaches.

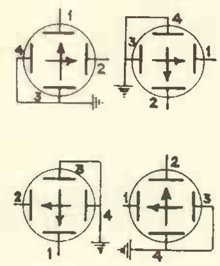
J. TAYLOR
(Lake, Isle of Wight).

Miniature Television—A Note

SIR,

In the description of the miniature television receiver on p. 668 of the November issue it is remarked that the connections of the tube are such as to give a reversed line scan and it is questioned whether the plate connections can be re-arranged to give the correct scan in both directions.

Mr. L. C. Jesty has pointed out to the writer that it is possible to "wangle" the connections to the plates to obtain any direction of scan if the plates themselves are crossed over from picture to line frequency.



The diagram above explains this, giving four positions of the tube when rotated in the clockwise direction.

If we assume that the direction of the scan is always towards the "free" plates 1 and 2, then on turning the tube and at the same time altering the picture and line scanning connections it is possible to obtain any combination of spot movements, as shown by the arrows.

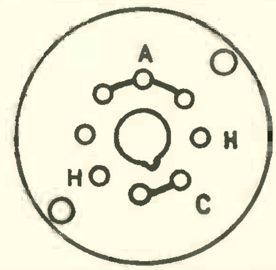
Unfortunately, in the receiver in question, this will mean drilling fresh holes for the tube socket, and under the circumstances it may not be worth while. I might add that I have obtained excellent pictures from the 1 in. tube using a straight receiver and the definition is surprisingly good considering the limitations of the tube and circuit.

G. PARR (London, N.21).

Correction.

We regret that the diagram of the valve socket given in Fig. 3 on p. 669 of the November issue was incorrectly drawn.

One or two readers have pointed out that the heater was shown joined to the anode. The correct connections are given below.



Avometers

AVO apparatus, made by the Automatic Coil Winder and Electrical Equipment Company, Limited, is becoming increasingly popular, as shown by the fact that no less than ten instruments were stolen from a representative's car in Islington on November 2. The company has the serial numbers of these instruments, which we hope someone can identify, in which case information should be sent to the above company at Winder House, Douglas Street, London, S.W.1. The instruments are:—

Universal "Avometer," No. 66-5454.
D.C. "Avometer," No. 6594.
Universal "Avominor," No. U.-23257-46.
D.C. "Avominor," No. 41931-46.
"Avo" Oscillator, No. 3150.
"Avodapter."
"Avocoupler."
"Avo" Exposure Meter No. 14015-107.
Smethurst High-light Meter, No. H.1012-67.
"Avo" Light Meter, No. H.1020-37.
1—"P" type Zeva Iron, No. H.16.
1—"P.O." type Zeva Iron, No. G.109.

All Avometers are numbered and a record is kept of any instruments that are lost or stolen. In the event of any such instrument being returned for repair the original owners are advised and in many instances lost instruments have been traced in this way. This is a very good service and yet another point that should be borne in mind when readers are buying test equipment.

THE TELEVISION ENGINEER

THE FREQUENCY SPECTRUM OF SAW-TOOTH WAVES

By Manfred von Ardenne

The following article is published from notes kindly supplied by the author. The original appeared in a monograph, "Television Reception," Dec. 12th, 1936.

IN the calculation and design of transformers for saw-tooth oscillators it is often required to know the frequency components which form the wave and a knowledge of these enables ordinary A.C. waveform theory to be applied to the design.

Assuming a standard saw-tooth waveform in which the return stroke time is zero, the Fourier analysis of the wave can be written:

$$f(t) = \frac{A_k}{T} \cdot T \ldots\ldots (-T/2 < t < T/2)$$

which gives rise to the expression:

$$f(t) = \sum_{n=1}^{\infty} A_n \sin. n\omega t.$$

$$A_n = (-1)^{n-1}. \ A_k/n\pi$$

A_k is the amplitude of the saw-tooth wave.

The amplitudes A_n of the partials decrease with $1/n$, and for a final return stroke time $T_r = p$ % of T, the value of A_n becomes:

$$\frac{(-1)^{n-1}. \ A_k}{n^2\pi^2} . \ 100/p \ . \sin \frac{(n.p.\pi)}{(100)}$$

The amplitudes of the partial waves decrease more rapidly than $1/n$ and periodically become zero, the first zero position lying at the value of n, which equals 100/p. Fig. 1 shows the frequency spectrum of a saw-tooth wave with various return stroke times.

While the degree of distortion of saw-tooth wave with a return stroke time of zero will reach a very high value when all the harmonics are cut off above a certain value (e.g., n = 10), a saw-tooth wave with a reasonable return time will be free from distortion when all the harmonics above the value of the first zero point are suppressed. The only difference will be a slight rounding off of the corners of the wave.

In practice the above considerations give two alternatives for the transformation of a saw-tooth impulse:

(a) By suitable measurement of the return stroke time, saw-tooth waves are produced with a relatively rapid decrease in harmonic and in the subsequent circuit the partial oscillations are suppressed after the first zero point.

(b) Initial saw-tooth oscillations with a short return stroke time (slight decrease of harmonic) are applied to the circuit and the response of the following circuit is so adjusted that the harmonic amplitude decrease is proportional to the law of decrease for the final return stroke time.

In the case of change of phase of the fundamental oscillation as compared with the higher harmonic, the phase displacement for a degree of distortion < 1.1 and T_r 5 per cent. must not exceed 1.4°. The effect of the change in amplitude may be neglected.

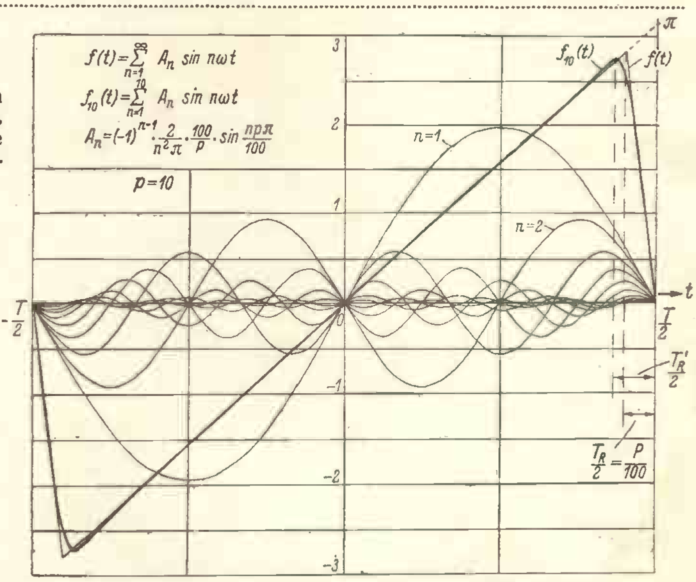


Fig. 1. The addition of harmonics to a fundamental wave produces the saw-tooth shown.

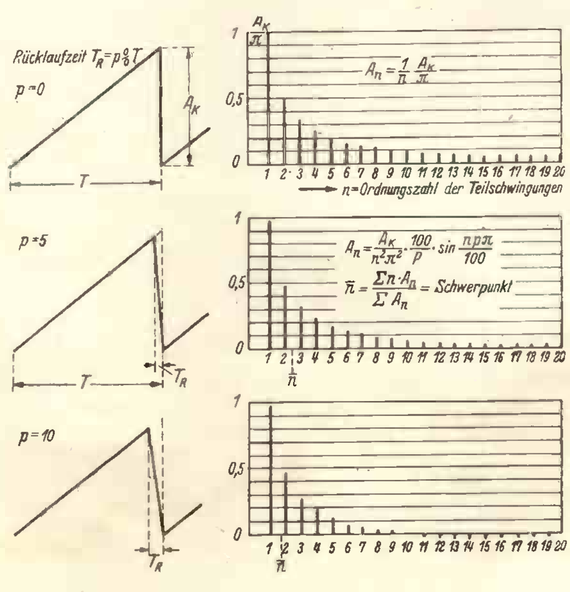


Fig. 2. The frequency spectrum of a saw-tooth wave with various return stroke times.

(Continued at foot of next page)

Telegossip

By LUMEN

Mirrors

I CAME across an amusing question in a book on optics the other day which sounds almost paradoxical. Here it is: Prove that if a man walks towards a mirror his image moves at the same rate, but that if the mirror moves towards the man the image will move at twice the rate. It might bear explaining on paper, but how does one prove it? Anyhow, you can amuse yourself with a bit of paper and pencil sketching little men in front of mirrors.

For reflecting television images it is generally agreed that surface silvered mirrors are essential. If plate glass is used with the back silvered the double reflection from the silver and from the front surface of the glass produces a nasty ghost image to the observer. As a matter of fact if the plate is thin enough the ghost should not be too distinct, but ⅛ in. plate is difficult. On the other hand, surface silvered mirrors are very dear and there is always the risk of scratching them accidentally.

For a mirror measuring about 18 in. square the average figure is £1, and a slip in mounting it may touch the pocket heavily.

The majority of commercial mirrors are surface silvered, and I believe that some firms use a special aluminium surfaced mirror made by Metropolitan Vickers. All surface mirrors need to be handled carefully and it is generally fatal to use a cleaning fluid as it dissolves the protective transparent coating. The best thing is to wipe with soft cotton wool, although most manufacturers have their own special recommendations. Another tip—don't poke your head in the cabinet if your hair has brilliantine on it. A splodge of brilliantine takes a lot of wiping from the mirror!

It is a clever trick of Murphy Radio to tilt their tube slightly in the cabinet. It is inclined slightly off the vertical facing towards the back of the cabinet and the angle of the mirror in the lid is much improved so far as viewing is concerned.

I believe there is a patent by Mr. Jesty (G.E.C.) for a cabinet in which the mirror is mounted at the bottom and the tube is upside down. The idea is to enable a better view to be obtained by a large audience although it doesn't appear very much different from the standard arrangement on casual inspection.

The G.E.C. staff are usually very smart in their ideas—witness the same gentleman's patent safety switch for tubes which operates if the tube bursts—so there is no doubt something in it.

Phone Seeing

Linking television and telephone, which has been so successful in Germany is to be tried by the G.P.O. early next year. It will be for experimental and not public use, but no doubt before very long the general public will be able to have the benefit of these experiments. In Germany a phone-television service already exists between Berlin and Leipzig, and it is shortly being extended to Nuremburg and Munich. The cost per call is approximately 3 shillings for 3 minutes, which is not very high for such a novelty. A screen, about 8 ins. wide, is attached to the telephone.

Looking Back

In examining the progress made by Gerald Cock's staff at the Palace during the past year, there naturally first comes to mind the great widening of scope which resulted from the coming of the "O.B." television vans.

The Coronation Procession gave the B.B.C. a chance in a million to take the television medium out of the studio in a big and significant way. The success of the vision programme transmitted from Apsley Gate opened up wide vistas of the possible uses to which television can be put in the way of bringing national events to viewers' own homes simultaneously with their occurrence—a possibility hitherto mostly dreamed of but never realised so completely. The vans have also given the B.B.C. the means of putting sport on the home screens. Also the televising of matches on the Centre Court at Wimbledon, for instance, was another significant milestone reached with brilliant success.

Book Reviews

Automatic Frequency Control Systems—*By J. F. Rider*

(Holiday and Hemmerdinger, 74-78 Hardman Street, Deansgate, Manchester, price 5s. plus 5d. postage.)

Automatic and semi-automatic tuning systems with circuits as used in American receivers are dealt with really comprehensively in J. F. Rider's latest book on this subject.

The details and circuits given can be applied to British-built receivers when in the original stages of design without very much difficulty, and as automatic tuning has not been very extensively used in this country, engineers in design work will find this book of very great value.

Chapter II, devoted to a general review of automatic frequency control from all angles, gives a very concise idea as to the general principles involved.

The difficulties in aligning and testing A.F.C. circuits have been carefully brought to light, and suggested methods of counteracting these difficulties are fully given. The final chapter on servicing A.F.C. systems is most interesting, and also those who are at present using an automatically tuned receiver will find some interesting tips

---

"THE FREQUENCY SPECTRUM OF SAW-TOOTH WAVES"

(*Continued from preceding page*)

The effect of the circuit can be derived from the ordinary theoretical considerations of a highly damped oscillatory circuit. In Fig. 2 the amplitude and phase conditions of a highly damped series resonant circuit are shown for various values R/2L.

For the effective transmission of saw-tooth oscillations the resonant frequency of the circuit should lie at the centre of the frequency spectrum to be transmitted, so that

$$n = \frac{\Sigma n\, A_n}{\Sigma\, A_n}$$

The majority of defects in the saw-tooth generator may be attributed to over controlling or faulty synchronisation.

(a) Breakdown of lines.
(b) Visible return stroke both in line and picture.
(c) Wandering of the picture.

The regularity of the synchronising impulses for a 400-line picture with an independent saw-tooth oscillation should be within 2-5 per cent. according to the strength of impulse available, but with dependent oscillations .5 per cent. is required.

An efficient layout, with the panel controls symmetrical, as can be seen from the illustration.

Britain's 1-10 Unique

A New-style 4-valve Receiver covering 1-10 Metres

WE have great pleasure in presenting to constructors and ultra-high frequency experimenters generally a new type of receiver that has a guaranteed performance, and is, to the best of our belief, one of the first of its kind to be offered to constructors in this country.

The normal method of presentation is of how to describe the receiver in such a way that constructors would not have any difficulty in obtaining results equal to those given by the original model.

It was finally decided that it was most unlikely that the constructor could build the H.F. and detector stages in the most efficient manner. For this reason it is not suggested that the amateur try to wire. In this way there is very little possibility of any difficulties occurring.

This enabled us to utilise one or two components which are not normally available to constructors. We refer mainly to the special ceramic condensers which are only available from Dubiliers by special ordering. These components are being obtained by

This four-stage ultra-high frequency receiver, using a most efficient super-regenerative circuit with single high-frequency stage, has been designed by Kenneth Jowers in collaboration with E. van Rhee and H. R. Adams, G2NO. It is intended for communication use of the ultra-high frequencies and not primarily for programme reception.

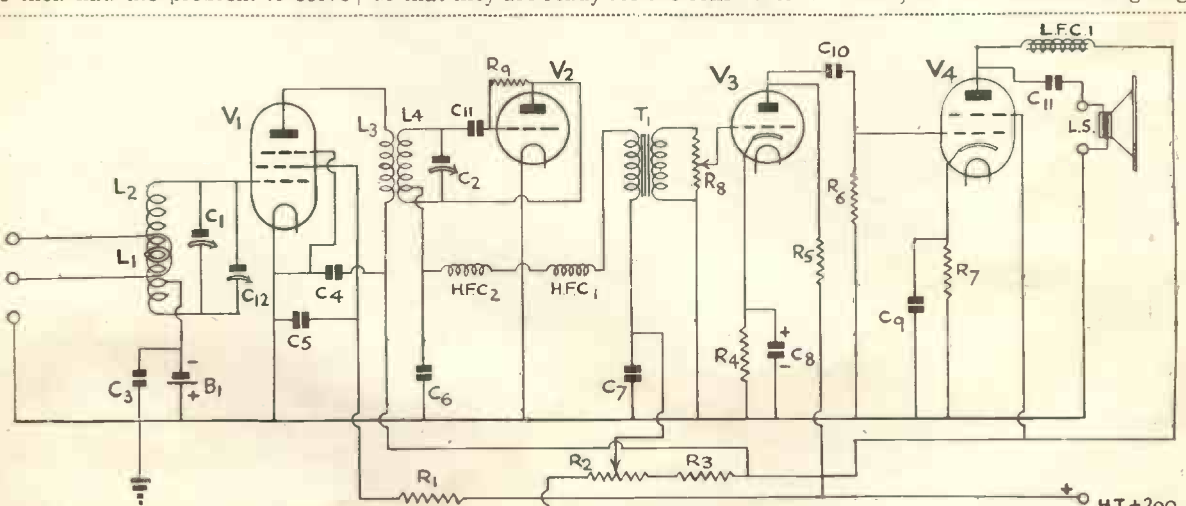
quite useless with a receiver of this kind, as we do not feel that constructors would be able to build a receiver to go down to one metre without experiencing a considerable amount of difficulty.

In the circumstances, therefore, even after the original receiver had been built and passed as perfectly satisfactory, we then had the problem to solve and build the first two stages even though he may do his best to follow the original design.

Ready-built Units

Messrs. A.P.A., Ltd., have offered to build the H.F. and detector units with the components in the correct positions, so that they are ready for the constructor Messrs. A.P.A. and will be included in the R.F. and detector units when ordered This scheme solves all our problems, for the constructor can now confidently begin the construction of a precision receiver and not experience any more difficulties than would normally occur when building a two-stage amplifier.

Also, as the receiver is going to be



This is the comparatively simple circuit of the 1-10 receiver, having an Acorn high-frequency stage and an Acorn triode as a super-regenerative self-quenching detector. The two low-frequency stages are quite conventional.

Construction :: Short Leads

purchased by commercial companies, Messrs. A.P.A. are building complete receivers ready for operation. These receivers, and also complete kits for those who want them, will be marketed by Messrs. Webb's Radio, who also have a full stock of individual components.

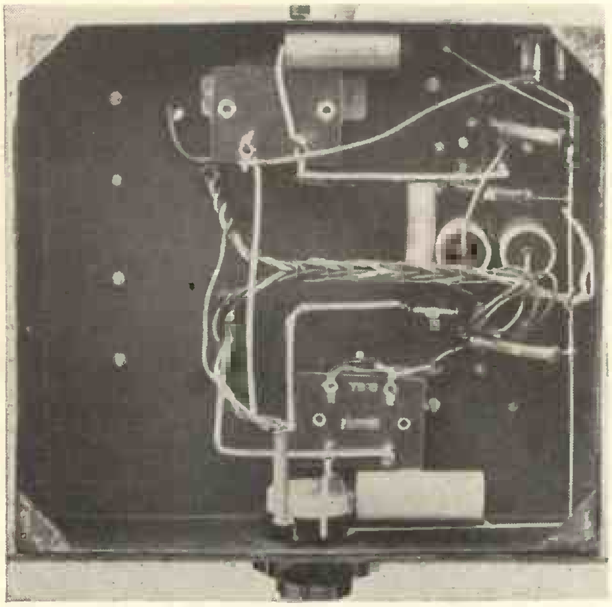
The receiver utilises four valves in a more or less conventional circuit, being made up of a pentode H.F. amplifier, using an Osram ZA1 acorn, transformer coupled to an HA1 triode detector operating as a self-quenching super-regenerator. This valve is coupled by means of a transformer to an MH4 triode, followed by a KT42 tetrode in the output stage.

The whole of the high-frequency stage up to the anode of the acorn pentode is included within the first screen box. The anode lead, however, of V1 comes through the box on to the primary of L3. In this way there is no wire at all coupling the high-frequency stage on to L3, as the anode lead to the pentode goes directly to the coil.

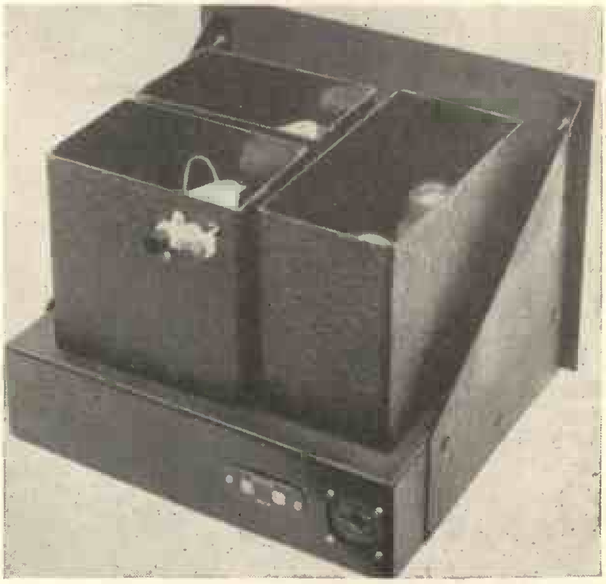
As can be seen from the constructional photographs, the coils are of a special type mounted on ceramic bases and are of the plug-in type. The bases are arranged so that the grid side of the coil in each case solders directly to the fixed plates of the appropriate tuning condenser. In the detector stage the grid contact on the acorn valve holder also solders directly on to L4 via the special ceramic grid condenser, C11. In the high-frequency stage the anode lead joins to the coil, L2, by a lead only 5/16th in. in length.

By carefully using special components and pruning down all waste space we have eliminated every possible excess wiring in both H.F. and detector circuits. This was the only way in which satisfactory reception was possible under 2½ metres.

It was, in fact, the very high frequencies that proved most difficult to get perfectly satisfactory, but a combination of several developments enabled us to obtain a high performance below 2½ metres. For example, the grid coil L2, is tapped differently for each coil so as to adjust the load imposed on the grid of the acorn pentode by the aerial.



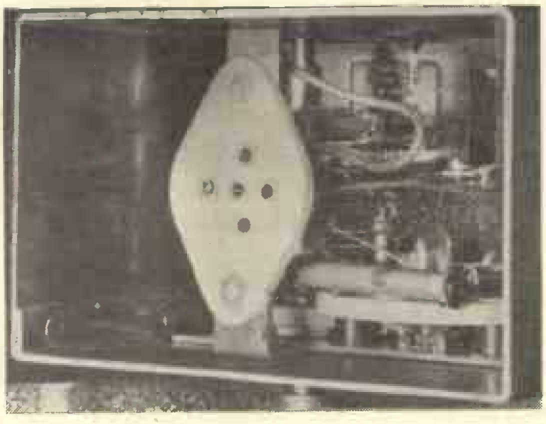
Providing the longer leads under the chassis are grouped together in the manner suggested the general construction underneath the baseplate remains clean and straightforward.



This back view gives a good idea as to the clean lines of the receiver. Power supply is connected by means of a 5-way cable with a two-contact strip for the loudspeaker.

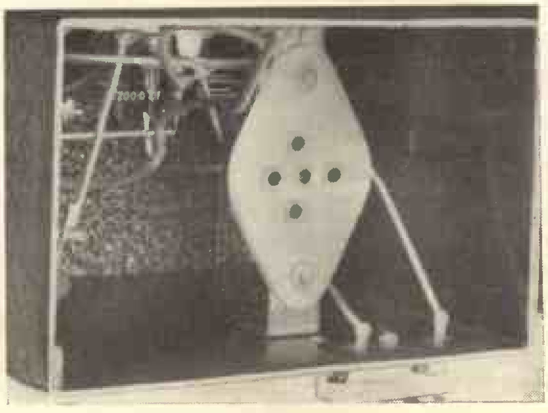
Correct H.F. Choke

Then the choke, HFC2, is only used on the higher frequency bands when the choke, HFC1, begins to fall off in efficiency. For this reason HFC2 is an integral part of the three higher frequency coils so that it is only brought into action on definite frequencies. These are but two of the features that have helped to make the receiver so satisfactory.



Left. This is the detector unit with the HA1 triode super-regenerator. The coil is mounted on a special ceramic base, almost on top of the tuning condenser.

Right. In the high-frequency stage the valve is mounted in between two screens and is so arranged that all leads are absolutely to a minimum.



Coil Ranges :: Power Supply

It must be admitted that the circuit is fundamentally quite simple, but it is the layout of the components which is one of the most important parts of this receiver. There must not be any variation in layout, and to satisfy ourselves that this cannot occur the two first stages are assembled by the manufacturers.

The low-frequency section is rather unconventional owing to the fact that the transformer stage comes before the resistance-capacity coupled stage, so reversing the usual procedure. It was discovered that with resistance-capacity coupling following the super-regenerative detector the regeneration could not be smoothly controlled. Reversing the couplings cured this defect without causing any other difficulties.

Bias is obtained automatically in the low-frequency stages, but a bias of 3-volts negative is essential in the high-frequency stage if the ZA1 pentode is to function satisfactorily. Automatic bias in this circuit was not desirable, so for that reason a small 3-volt grid cell has been included which should have a life of at least 12 months. This grid cell is by-passed by the condenser, C3, having a capacity of .002-mfd.

The three screening cans are gapped by approximately ¼ in. and it is important when mounting these cans to make quite sure that when the lids are in position they do not touch, for otherwise the efficiency is greatly impaired.

Wiring the H.F. and Detector

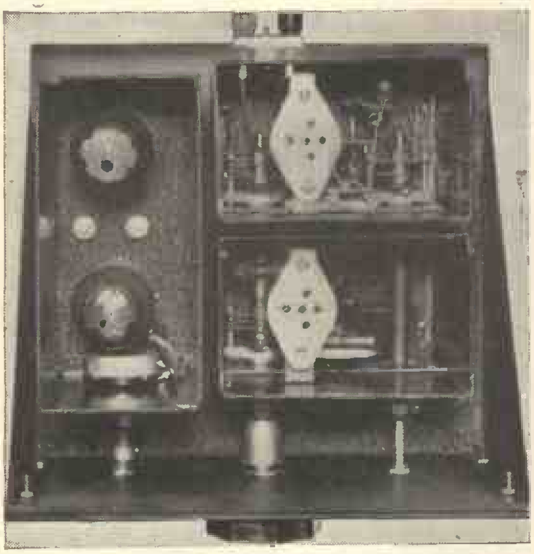
The H.F. and detector stages are wired before the actual cans are bolted to the chassis. In this way wiring is quite simply carried out and much more neatly than if the components were bolted directly to the chassis.

Another point to remember is that the slow-motion drive fixed to the two tuning condensers is at earth potential, whereas the condensers are isolated from the chassis. Therefore the drive must be insulated from the spindle of the condenser by means of an ebonite bush.

It can also be seen from the plan view that the condensers and valve holders in the first two stages are mounted on paxolin strip with strip in turn bolted to the side of the screening can.

The two coil holders for L1 and L2, and L3 and L4, are fixed to the side of the screening can by two steel brackets

(*Continued on page* 64)



The three screening cans are mounted in this way. Notice that the two L.F. amplifiers are in the left-hand screen, while the bolts that can be seen at the bottom are the negative contacts of the cathode-bias shunt condensers.

The finished receiver presents quite a professional appearance, being built on a steel chassis and housed in a steel cabinet.

Components for
A FOUR-STAGE 1-10 METRE RECEIVER

CABINET.
1—Steel, 11 in. by 8 in. by 9½ in. with lid, finished black (A.P.A.).

CHASSIS AND PANEL.
1—Chassis with brackets 9¼ in. by 10 in. by 2½ in. finished black (A.P.A.).
1—Aluminium panel ⅛ in. finished black 11 in. by 7¾ in. (A.P.A.).

COIL HOLDERS.
2—Special ceramic 5-pin (A.P.A.).

COILS.
10—To cover 1-11 metres (A.P.A.).

CONDENSERS, FIXED AND VARIABLE.
1—20-mmfd. type Apex (C1) (Webb's Radio).
1—20-mmfd. type Apex (C2) (Webb's Radio).
1—.002-mfd. type 620 (C3) (Dubilier).
1—.0003-mfd. type 620 (C4) (Dubilier).
1—.0005 mfd. type 4802 (C5) (Dubilier).
1—.003-mfd. type 620 (C6) (Dubilier).
1—.5-mfd. type 4608/S (C7) (Dubilier).
1—10-mfd. type 401, 50-volt working (C8) (Dubilier).
1—10-mfd. type 401, 50-volt working (C9) (Dubilier).
1—.1-mfd. type 4603/S (C10) (Dubilier).
1—.00005-mfd. type CDS1 (C11) (Dubilier).
1—5-mmfd. type Apex (C12) (Webb's Radio).
1—.5-mfd. type 4608/S (C13) (Dubilier).

CHOKE, HIGH-FREQUENCY.
1—Type 1011 (RFC1) (Eddystone).

CHOKE, LOW-FREQUENCY.
1—Type 20-henry to specification (LFC1) (Keston Manufacturing Co.).

DIAL, SLOW-MOTION.
1—Type 1085 (Eddystone).

HOLDERS, VALVE.
2—Type ceramic Acorn (Clix).
1—5-pin type V1, less terminals (Clix).
1—7-pin type V1, less terminals (Clix).

PLUGS, TERMINALS.
1—Ceramic terminal block, type 1046 (Eddystone).
1—5-way socket type 1260 with plug (Belling-Lee).
1—2-way terminal strip type P54 (Bulgin).

RESISTANCES, FIXED AND VARIABLE.
1—35,000-ohm type ½ watt (R1) (Erie).
1—50,000-ohm potentiometer wire wound (R2) (Reliance).
1—20,000-ohm type 1 watt (R3) (Erie).
1—700-ohm type 1 watt (R4) (Erie).
1—100,000-ohm type ½ watt (R5) (Erie).
1—.5-megohm type ½ watt (R6) (Erie).
1—420-ohm type 1 watt (R7) (Erie).
1—500,000-ohm potentiometer (R8) (Relince).
1—20-megohm type ¼ watt (R9) (Erie).

SUNDRIES.
2—Coil mounting brackets (A.P.A.).
2—Extension outfits type 1 (Eddystone).
3—Special 1-in. knobs (Eddystone).
2—Coils Quickwyre (Bulgin).
2—Dozen 4 B.A. roundhead bolts, nuts with washers (Webb's Radio).

TRANSFORMER, LOW-FREQUENCY.
1—Special type 1/4 ratio (T1) (Keston Manufacturing Co.).

VALVES.
1—ZA1 Acorn R.F. Pentode (V1) (Osram).
1—HA1 Acorn triode (V2) (Osram).
1—MH4 (V3) (Osram).
1—KT42 (V4) (Osram).

A Complete Kit of Components and Completely Assembled Receivers obtainable from :

WEBB'S RADIO, 14, SOHO STREET, W.1.

Assembled Radio-Frequency and Detector Units and wired receivers obtainable from :

MESSRS. A.P.A., LTD., 171C, BATTERSEA PARK ROAD, S.W.8.

Aligning the R.M.E. 69

Those who operate the R.M.E. 69 receiver will find this article of help when checking up the I.F. stages for maximum gain.

ONE of the most popular receivers in the country at the present time is the RME69, but despite its multiplicity of stages in order to obtain maximum performance the intermediate frequency stages must be very carefully lined up.

The manufacturers of this receiver do not place very much reliance on the average commercial oscillator which is supposed to have a frequency of 465 kc., and they advise users of the RME69 not to use a commercial oscillator but to rely upon a system which they have evolved specially for this receiver.

If any reader should find that the gain on their RME69 is not quite what it might be, try checking the I.F. transformers in the following way. These remarks will also be applicable to other types of communication receivers employing a crystal filter.

It is for the purpose of re-alignment of the intermediate frequency transformers that the following procedure is outlined. It is essential that the 465 kc. intermediate signal which is used for re-alignment of the intermediate frequency amplifier is not set according to any arbitrary calibration on the test oscillator itself, since it has been found that many oscillators vary to such an extent that they will not permit of proper alignment in a receiver using a crystal filter.

No Test Oscillator

In the circumstances it is better that no test oscillator be used since a broadcast station of constant signal strength will furnish an adequate test signal for checking up the I.F. amplifier using the quartz filter for stabilising the proper I.F. frequency in the following way.

The meter on the RME69 receiver affords an excellent method of indicating the peak alignment of each of the transformers, which are designed for a frequency of 465 kc. Since the receiver is always supplied with a quartz crystal filter it is essential that the intermediate frequency transformers be accurately tuned to that frequency. Crystals are supplied in frequencies slightly at variance from 465, but never more than plus or minus one kilocycle. It is, therefore, advisable to align the I.F. amplifier to a set frequency governed by the crystal rather than the 465 kc. In this way the I.F. amplifiers are always perfectly in tune at crystal frequency.

The first step in the alignment procedure is to tune in a broadcast station, preferably towards the low-frequency end of the broadcast band. The signal should be one of medium strength, so that the R meter indicates the level of R9 or slightly less. If no station of this amplitude is available, but a stronger station can be received, a reduction of the efficiency of the aerial can be made by using only a very short length of wire sufficient to give a signal of the required level.

When the station has been chosen, assuming for the purpose of example that the frequency is 700 kc., the next step is to slightly de-tune the main tuning control, so that the frequency reads approximately 715 or 720 kc. This, of course, will tune the station out. It does not necessarily have to be the frequency mentioned, or the exact frequency of de-tune, but the general procedure is to tune the main control slightly higher than the chosen station so that it may be brought back to resonance by decreasing the scale reading of the band-spread control. This is done merely to provide vernier tuning.

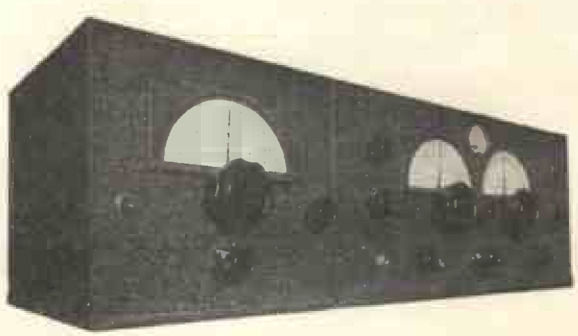
With the station chosen and resonated on the band-spread scale, the crystal filter is switched to the series position, which is the middle position of the three available. The band-spread scale is then adjusted with respect to the signal so that a maximum meter reading is obtained. The procedure is one that requires patience and accuracy in adjustment, since the receiver is ultra-sharp with the crystal filter in circuit, but there will be one definitely sharp peak indicating crystal resonance. The receiver should be tuned to this peak and left on it during all adjustments that have to be made to the I.F. amplifier.

When the peak has been tuned in and the meter is showing maximum reading, a small standard I.F. trimmer tool of the insulated screw-driver type should be used. Then the control, E, should be set so that the condenser is adjusted to be 50 per cent. in mesh. Then without particular attention to a course of procedure, any I.F. transformer can be adjusted to resonance by merely noting a rise or fall in the R meter. It is, however, advisable to start with No. 1 transformer, following with No. 2 and No. 3.

From time to time it is advisable to make sure that the signal is still adjusted to peak resonance of the crystal by slightly varying the adjustment of the band-spread control. When this procedure has been completed and all transformers adjusted and left at maximum meter reading, the intermediate-frequency amplifier of the receiver is in peak adjustment and the crystal aligned with it for maximum effectiveness in filter action.

With an RME69, including a type LS1 noise-silencer, one or two points should be noted. The general procedure is the same as for the standard RME69, but preliminary adjustments, as previously mentioned, should be made with the silencer threshold control set at maximum clockwise position. When the intermediate-frequency transformers have been aligned, the silencer transformer may be peaked by turning the band switch to No. 6 band on the receiver and tuning in and resonating the frequency band around 10 metres so that the receiver is sensitive at this point. Then, under conditions of motor-car ignition interference, the silencer control should be set to maximum counter clock-wise position and a small screw accessible to the hole in the noise rectifier transformer adjusted for minimum response of the interfering noise.

This ensures accurate alignment of the noise amplifying system with that of the interfediate frequency, a condition which must necessarily exist for efficient silencer action.



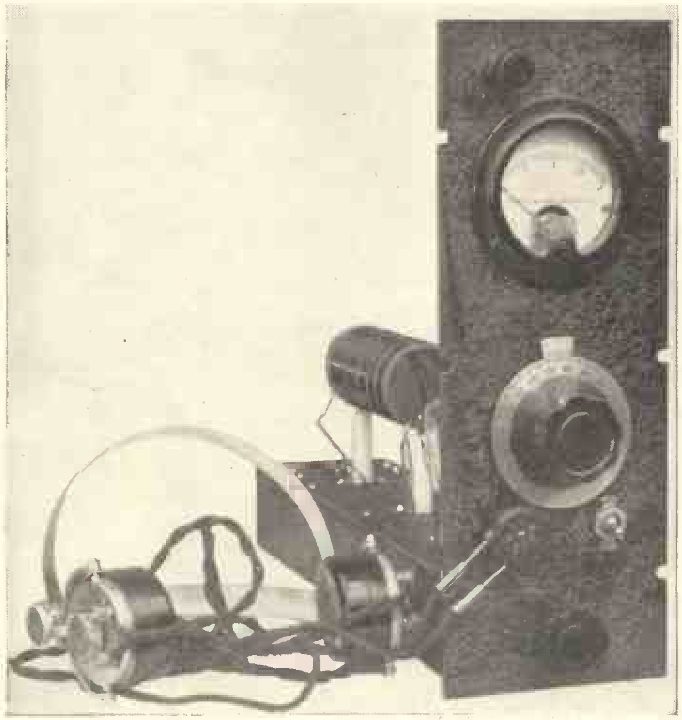
This is the R.M.E. 69 receiver with DB20 pre-selector. This combination is about the best possible for both amateur use and general broadcast reception.

A 5-band Mains-operated Monitor

By Kenneth Jowers

Transmissions on any of 5 wavebands can be checked with this double-diode monitor. Details are also given for including the 5-metre band if required.

WITH the increasing use of phone transmitters in this country readers are more frequently asking for designs of monitors suitable for checking speech quality, and also at the same time, without waste of apparatus, being able to have some sort of radiation check. At the moment we are producing a special receiver for general amateur use which includes as an integral part a radiation meter-cum-phone monitor, also a multi-voltage signal strength meter.



The bottom knob is for the wave-change switch with the headphone plug and jack to the left and the cut-out switch to the right. Although a vernier is fitted to the Crowe dial this is only used as an indicator.

In view, however, of the number of amateurs who have asked specifically for a monitor, we are publishing this unit rather before we had anticipated, and as a unit on its own rather than as a part of a communication receiver.

This accounts for the unusual shape of the chassis and panel, which is 12 in. by 4 in., and made from $\frac{1}{8}$ in. thick aluminium. The panel is supplied cut ready to take the flush mounting meter, special tuning dial, rotary switch and other panel accessories.

The layout of the components, which are very few, can be seen from the ilustration in these pages, but for those who would prefer a different type of chassis there is no reason why components should not be differently arranged to suit individual requirements. It should be remembered that there are no H.F. or L.F. amplifiers in a monitor of this kind, so that the possibility of oscillation or instability does not arise.

As regards component values, these should be strictly adhered to, otherwise the tuning range of each band may differ so that instead of covering the 10- and 20-metre bands, constructors may find that the tuning range falls short of their requirements. All components are of a standard type with the exception of the 5-way coil, which must be home-constructed, and this should be the first job when building the monitor.

Making the Coil

Obtain a 2-in. diameter coil form 6 in. long from Webb's Radio and mount this on two small stand-off insulators, so that the bottom of the coil form is at least $1\frac{1}{2}$ in. away from the metal chassis. Drill two holes in the end of the coil form for use as fixing holes for the wire, and wound on three turns of 20-gauge enamel-covered wire to cover a space of $\frac{1}{4}$ in. Then drill two more holes to terminate this coil and take the end down to one contact on the rotary switch.

Such a coil will cover approximately the 10-metre amateur band. A similar coil must then be wound for 20 metres, again having the same spacing and terminated in the same manner. This coil is joined in series with the 10-metre coil, so that there are six turns in use on 20 metres.

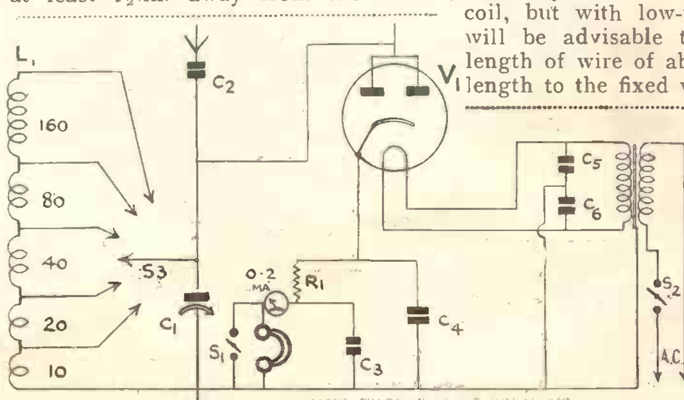
The 40-metre band requires 14 turns of 20-gauge wire wound in solenoid fashion without any gap between turns. This is in turn connected in series with the 20- and 10-metre coils, so that the 40-metre coil actually consists of 20 turns.

On 80 metres the coil is wound exactly as on 40 metres except that 16 turns are required of 26-gauge enamel-covered wire, so giving a total of 36 turns to cover the 80-metre band.

The Largest Coil

The hardest job of all is winding the 160-metre coil, for 32-gauge wire should be used with a total of 56 turns. As the surface of the former is very slippery the wire should be held in a vice and kept perfectly taut when winding, while it is advisable to fix a soldering tag rather than to depend on the two holes, for when fixing in this way the wires are inclined to become slack. How this coil is used can clearly be seen from the theoretical circuit. The coils are switched in series to increase inductance so that on the 160-metre band there is a total of 92 turns. On the other hand, when tuned to 10 metres the only coil in circuit is the three-turn one which, with the large condenser specified, more than covers the 10-metre band.

With high power there is no need to have any aerial at all connected to the coil, but with low-wattage stations it will be advisable to connect a short length of wire of about 2 or 3 ft. total length to the fixed vanes of the tuning

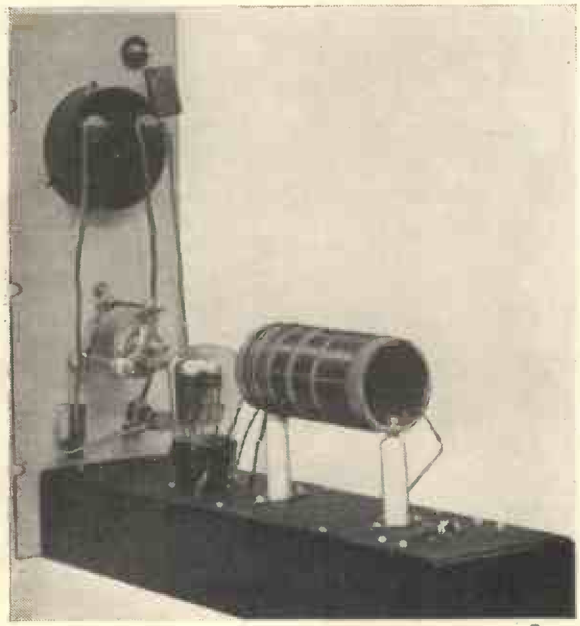


Very few components are required in this circuit while the coil must be home wound.

Operating :: Field strength Meter

condenser. A .0001 mfd. fixed condenser should advisedly be connected in series wth the aerial lead in order to prevent damping on the higher-frequency bands. Refer a moment to the theoretical circuit. It will be seen that a V914 double-diode is used as a conventional rectifier with both anodes strapped together. In this way a rectified current of at least 5 mA. can be obtained, should only a high scale reading meter be available, but as a matter of interest, .5 to .75 of a mA. current reading coincides with ample headphone strength.

In order to obtain maximum sensitivity there should be connected in series with the cathode of the V914 a resistor of 2,000 ohms shunted by a .001-mfd. condenser. Also in series with the cathode is the 0-1 milliammeter, which is in turn shunted to earth by another .001-mfd. condenser. The headphones in the same circuit have in parallel with them a two-point toggle switch, so that the phones can be cut out of circuit as required. This is most important otherwise with a strong signal feed-back is caused between the headphones and the microphone circuit.



The filament transformer is mounted beneath the coil and terminated at two soldering lugs. Five holes are required to take the five leads from the coil to the switch.

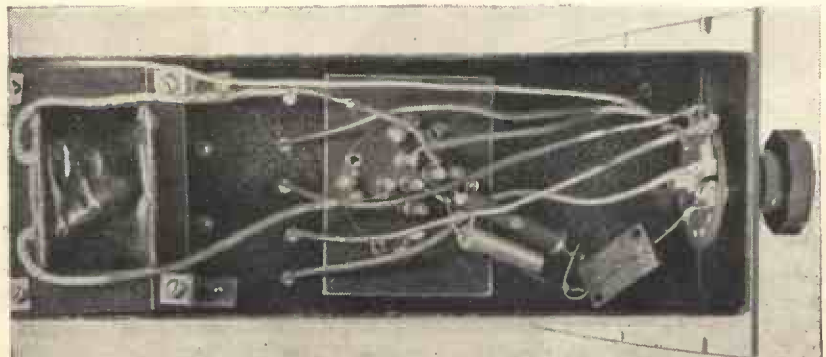
Another point to remember is that a monitor of this kind can give a very distorted idea as to the percentage of hum level on the carrier unless there are shunt condensers across the filament winding which are connected to earth in the manner shown. In a circuit similar to the one of this monitor, which was described in February, 1937, these two condensers were not included and it took two months before we realised that the rather high hum level experienced was due to this omission.

The mains transformer, T1, is mounted underneath the chassis, so that it is screened from the coil, and has its primary terminated in two double-ended soldering tags which are fitted to a strip of bakelite mounted on the top of the chassis.

If the unit is completely screened, as it will be in the finally designed receiver to be published very shortly, then there is absolutely no pick-up on the monitor coil when the unit is being used as a field strength meter. When used as a monitor, however, the headphone leads provide sufficient indirect pick-up when there is any sort of radiation directly from the tank coil. However, at the present time with a correctly designed P.A. stage running with an input of 50 watts link coupled to the aerial there is insufficient pick-up on the monitor unless an aerial is connected.

This point is mentioned because constructors might be in doubt as to the amount of pick-up they should expect. It should, however, be remembered that excessive current in the monitor indicates that the P.A. stage is not putting all the power it might actually in the aerial. To quote an example, with a transmitter correctly tuned, providing a current of .5 mA. in the monitor, this current rose to over 5 mA. when an untuned line was used for a feeder which was not correctly terminated at the antenna end. A point to watch when using this monitor as a radiation meter is that maximum current in the monitor does not mean maximum radiation unless the meter is actually within the field of the antenna. If it should be

(*Continued on page 60*)



This is how the components are arranged beneath the chassis. The valve holder is mounted on a paxolin strip.

Components for A 5-BAND MAINS OPERATED MONITOR

CHASSIS AND PANEL.
1—Steel panel finished black to specification (A.P.A. Ltd.).
1—Steel chassis finished dull black to specification (A.P.A. Ltd.).
COIL FORMER.
1—2 in. by 6 in. bakelite former (Webb's Radio).
CONDENSERS, FIXED.
2—.001-mfd. type 690W (Dubilier).
2—.01-mfd. type 691 (Dubilier).
1—.0001-mfd. type 690W (Dubilier).
CONDENSER, VARIABLE.
1—Type 942/180 (Eddystone).
DIAL.
1—Type Crowe (A.C.S. Ltd.)
HOLDER, VALVE.
1—5-pin type V1 less terminals (Clix).
METER.
1—0-2 M/a flush mounting (Ferranti).
PLUGS TERMINALS, ETC.
6—Insulated sockets type 12 (Clix).
6—Coil pins type 36 (Clix).
1—Terminal type B marked Aerial (Belling-Lee).
RESISTANCE, FIXED.
1—2,000-ohms, 1-watt (Erie).
SUNDRIES.
¼—lb. 26 gauge enamelled covered wire (Webb's Radio).
24—6BA roundhead bolts, nuts and washers (Webb's Radio).
1—J2 jack (Bulgin).
1—P15 plug (Bulgin).
SWITCHES.
2—S80T (Bulgin).
1—S119 (Bulgin).
TRANSFORMER, FILAMENT.
1—4 volt .3 amp with wire ends (Premier Supply Stores).
ACCESSORIES
VALVE.
1—V914 double-diode (Mazda).
HEADPHONES.
1—Pair type F (S. G. Brown, Ltd.).

The Short-wave Radio World

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

IN view of the extra interest in the W8JK flat top beam it is interesting to note that VK2NO, the well-known Australian authority on 5 metres, has been using a type of aerial of this kind for DX transmission and reception. The arrangement used is shown in Fig. 1 where the main support is a length of $1\frac{1}{2}$ in. bamboo pole 17 ft. overall carrying three cross-pieces for the radiator

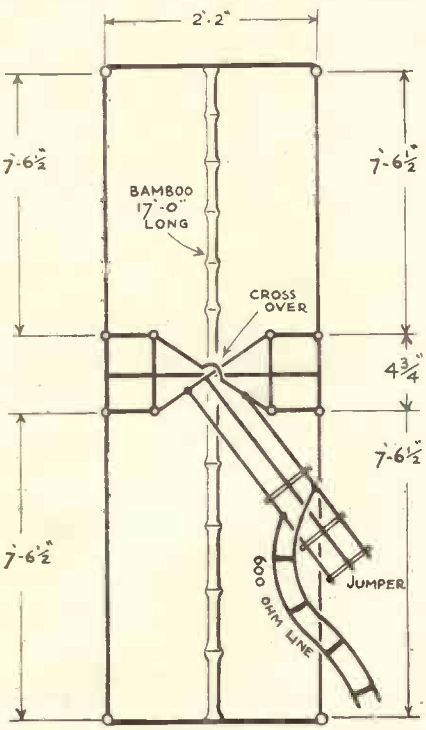


Fig. 1. Two British amateurs have heard 5-metre signals transmitted by VK2NO from Australia when the transmitting aerial has been this beam array.

spacing, and also a right-angled support at the centre for the sub-line. As vertical polarisation appears to be of most use—although tests may prove otherwise—while it is a very simple matter vertically to erect an array such as this.

Being only 2 ft. 2 in. in width the system offers very little wind resistance even when erected on top of a high mast. As it is not always possible to obtain a 17 ft. bamboo centre piece, two long poles can be used with the thin ends cut off. These can then be fitted into a base and pegged and finally secured with stout twine covered with clear lacquer.

This system is directionally end-fire. It consists of four half-waves, two per side, spaced $\frac{1}{8}$ wave and fed out of phase. The dimensions given in Fig. 1 are correct for approximately the centre of the 5-metre amateur band. At the centre of the array the inner ends of the radiators are crossed over as shown, and at the centre a $\frac{1}{4}$ wave stub is fitted. In reckoning the length of this stub, the included length of ·1 ft. 1 in. to the crossover from each aerial length must be considered, so that the actual projecting stub is only 3 ft. 3 in. in length from the crossover.

Spacing of the stub and crossover leads is $4\frac{3}{4}$ in. for No. 14 gauge wire, of which gauge the aerials are also made. Incidentally the length of each aerial is 7 ft. $6\frac{1}{2}$ in.

The method of resonating is quite simple. The transmitter is switched on with reduced power and a 600-ohm line is connected somewhere about 1 ft. from the crossover on the stub. A radio-frequency meter is used as the jumper for determining resonance, or if a meter is not available, a low-wattage lamp can be used equally well. This is adjusted along the stub until maximum light or current is shown. When this is reached the array is resonant at the frequency of the transmitter, so a shorting bar is then soldered in position at this setting.

Then increase the power and check the feeder line for standing waves by using an indicator device such as an absorption wave-meter plus lamp. This indicator is moved uniformly along the line from the aerial to the transmitting position.

If large variations in R.F. current are noticed at intervals of about 4 ft. the line has standing waves on it. These are reduced by moving the feeders along on the stub-line until the R.F. shown is more or less uniform along the whole length of the line. It is unlikely that standing waves will be completely eliminated, but they can always be materially reduced.

If it is desired to use a twisted pair line in preference to an open wire feeder, the feeding of the array is greatly simplified. A twisted pair line such as the Belling-Lee 80-ohm is attached at the end of the stub and no shorting bar is used. This method of feed may not be so efficient as the space line, but it is very effective.

Alternately the array can be fed by a conventional tuned Zepp feeder connected directly at the crossover without, of course, any stub section.

Hauling the array to the top of the pole is quite simple. A length of wood carrying two hinge bolt sockets is fixed to the rope halyard. Two hinge bolts are fitted to the bamboo at the correct distance apart and near the centre. The two arrangements are fastened together, and the whole is pulled to the top of the pole. As the halyard is fastened straight up and down the array is kept vertical. It is arranged for rotation simply by attaching a rope to the extreme end of the projecting wooden centre piece holding the stub line. By pulling on this rope the array can be swung from the ground through 180 degrees.

In practice the aerial gives exceptionally good results with low-angle radiation, and so far tests have compared very favourably with the more complicated Bruce aerial. We hope that many more experimenters interested in ultra-high frequency working will consider the use of an aerial such as this, for as long as the conventional half-wave di-poles are so consistently used we cannot see any possibility of more DX records being broken on the ultra-high frequencies.

This beam aerial can be used equally well for reception and can be modified for use on other wavelengths, including television. The fact that it includes a reflector and can be used in any direction through 180 degrees makes it particularly useful for long-distance reception of ultra-high frequency signals.

Regenerative Doubler

In the December issue of Q.S.T. was described a very simple regenerative frequency doubler using a very popular valve, the 46. W8CSE is using this circuit and claims that the output from the regenerative doubler can be materially increased over the normal circuit which is an ideal arrangement when a little more drive is required on the higher frequencies. The circuit arrangement is shown in Fig. 2 and it will be seen that the modification over the normal doubler is very slight.

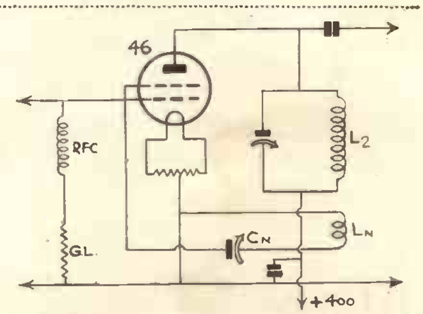


Fig. 2. To make a doubler stage regenerative only requires these simple modifications.

All that is required is a small trimming condenser and a few turns of 26 gauge double cotton covered wire. By using a separate neutralising coil in the manner shown, the neutralising condenser CN need not be of the high voltage type, since there is only a low D.C. potential across it.

It is claimed that this circuit will give an increase of 100 per cent. in the grid current of a type 10 when used as a

Signal Generator :: Frequency Meter

doubler. At the same time the anode current of the preceding 46 was lowered by approximately one-third.

The addition of the neutralising coil does not mean any changes in the existing connections. The coil Ln has the same number of turns as L2 and is wound ⅛ in. away from the low potential end of L2. No. 26 gauge wire is quite large enough, while the circuit is neutralised in the normal way. The circuit is in Fig. 2.

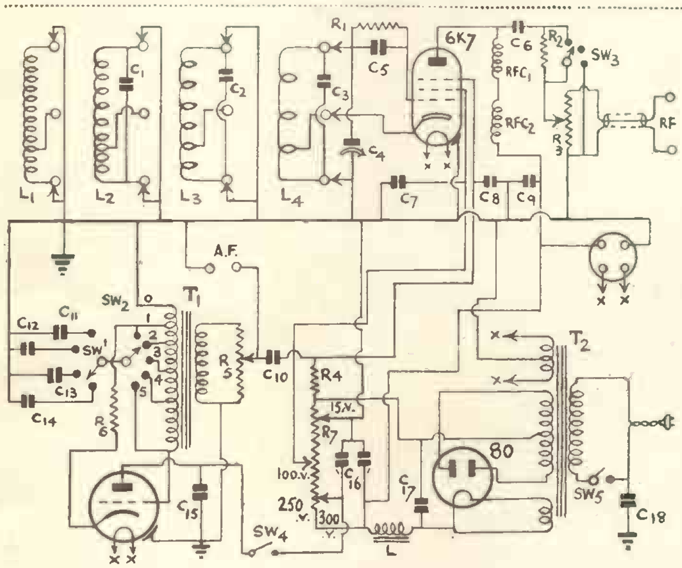


Fig. 3. An all-wave signal generator of this type is most useful for general test work. Its many advantages are explained in the text.

An All-wave Signal Generator

We were very interested in the design of an all-wave signal generator which was described in detail in the new A.R.R.L. Handbook. When lining up multi-stage receivers some type of signal generator is a necessity. The generator must also have a wide frequency range, give stable output and, at the same time, be mains operated. The circuit for an oscillator having these requirements is shown in Fig. 3, where it will be seen that three valves are used in a more or less conventional circuit. It has a continuous frequency range of from 450 Kc. to 60 Mc. A type 6K7 pentode is used as an electron-coupled oscillator with a 6C5 as a variable audio frequency generator and normal type 80 rectifier.

Although the original coil switching arrangements called for a special turret made by Communications Products, Inc., suitable switching gear can be obtained from Messrs. A. F. Bulgin. All unused coils are shorted to earth so as to prevent any dead-end or absorption losses, while the high capacity in the tuned circuits gives increased stability. The attenuator consists of a potentiometer connected so as to present a constant impedance to the receiver input terminals. A three-position switch gives high and low output plus a short circuited position when working into the aerial circuit of a sensitive receiver.

A sheet of aluminium is mounted directly behind the dial so as to eliminate possible radiation directly from the tuned circuit, but it is also recommended that when checking high gain receivers at maximum sensitivity, the entire unit should be well screened.

A separate L.F. oscillator employing a triode with cathode feed-back and bias provides 20 different L.F. frequencies between 100 and 10,000 cycles. The frequency is controlled by means of taps on the oscillator inductances and also four tuned capacities selected by means of two rotary switches. The four-position capacity switch brings into circuit the major ranges, while the inductance switch provides intermediate steps.

The output of this generator is used to suppressor grid modulate the oscillator with transformer coupling and an output volume regulator. In the original model designed by A.R.R.L. a modulation percentage of 100 was obtained with this control approximately half-on. It is suggested that the modulation level be restricted between 30 and 50 per cent., so to this end the volume control must be retarded to provide the required 8-15 volts output.

Terminals on the panel enable experimenters to use this output from the audio-frequency generator for external purposes, such as checking modulation in transmitters.

Although the harmonic content has been reduced to a very low level, the waveform is not absolutely perfect owing to the use of iron-core inductances, so this point must be remembered in checking amplifier distortion.

If trouble is experienced in making the audio frequency oscillator oscillate, increase the value of R5 or decrease R6.

When used with single signal supers having a crystal filter it is a good plan to use the crystal itself to control the test oscillator when lining up the I.F. transformers.

With this end in mind it is advisable to provide a holder for a crystal filter, so it can be installed in the oscillator in place of the grid coil when making checks on single signal receivers. It is most unlikely that the average test oscillator will provide a sufficiently stable signal to test a receiver using a crystal filter, so that by using the actual filter from the crystal itself perfect alignment is possible.

A Combined Frequency Meter, Monitor and Keying Oscillator

The Canadian amateur, VE2EE, has designed a complete frequency meter, monitor and audio oscillator using two receiving type valves. This unit should be almost indispensable to a well-operated amateur station despite the almost general use of crystal control. It must be remembered that the best of crystals are inclined to peak and that a transmitter does not always function satisfactorily whenever it is switched on. VE2EE has used a 56 triode as a detector and by re-arranging the gird circuit to function as an audio oscillator for listening to C.W.

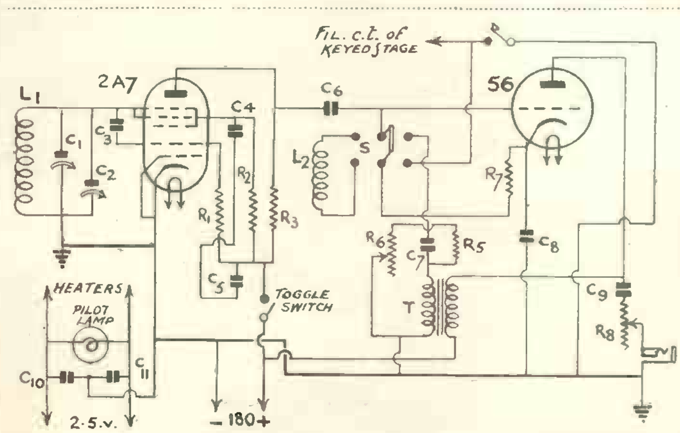


Fig. 4. This is the circuit for a combined frequency meter, monitor and oscillator designed by the Canadian amateur VE2EE.

A D.P.D.T. switch is connected in

(*Continued on page 63*)

A U.H.F. Emergency Transmitter

Building the Modulator

This modulator is the first half of a complete emergency ultra short-wave telephony transmitter. The entire equipment runs from a 12-volt accumulator.

TRANSMITTERS for ultra-high frequency use are most suited for emergency and portable work. It is anticipated that before very long Government bodies and local borough and municipal councils will be instructed to have installed some type of transmitter suitable for maintaining short-range contact should there be any failure of the normal telephone service.

The finished amplifier with crystal microphone and built-in converter. The output is between 5 and 7 watts depending on the percentage of distortion allowed.

No Mains Used

Such transmitters, in fact, the entire emergency equipment would have to be independent of public supply mains, while dry batteries could not be used in view of the comparatively short storage life. This limits the power supply to something run from a chargeable low-tension accumulator, which means either a rotary converter or vibrator unit.

In anticipation of the general requirements of an emergency transmitter this equipment has been produced, but it must not be taken for granted that it can only be used for emergency use. During the coming year there will be a considerable number of amateur field days on ultra-high frequencies where phone transmitters powered by an accumulator will be in great demand.

Obtaining a sufficiently high input without overloading the accumulator was rather a problem, but two suitable power units were obtained which give more than sufficient output for the modulator and transmitter with quite a reasonable low-tension drain.

The Modulator

First of all is the modulator section. The requirements are an amplifier of great simplicity that does not require any dry batteries, but at the same time will give an output sufficiently high fully to modulate a 10-watt carrier. After considerable experimental work a suitable circuit was designed, as shown in this page. It consists of an A.C./D.C. pentode valve, resistance-capacity coupled to a pair of high-slope pentodes in parallel. This arrangement gives a comfortable 5-6 watts of audio from a low-level input. A special microphone was also designed for use with this amplifier and is of the hand set type, but with a crystal unit.

A Crystal Microphone

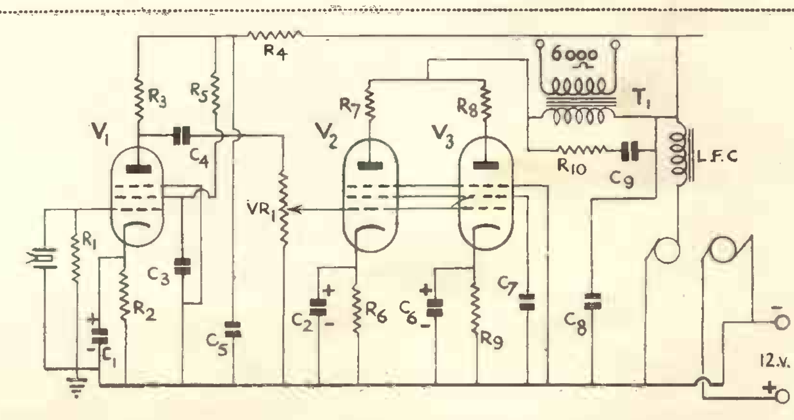
This crystal microphone is suitable for feeding into a 500,000-ohm load and has a sufficient output to enable a considerable gain to be obtained in the first L.F. stage by means of the SP13C pentode. However, unless the first pentode valve is correctly used with the optimum anode impedance the gain drops quite rapidly. For this reason it is essential that the anode resistance in the first valve be 100,000 ohms followed by a decoupling resistor of 50,000 ohms. The screen voltage is quite easily obtained by means of a series resistor tapped into the junction of the anode impedance resistance and decoupling resistance.

A resistance of 250,000 ohms is required to drop the main H.T. supply to the correct voltage to the screen owing to the fact that the screen current is extremely low when the SP13C is used as a straight L.F. amplifier.

The 4-mfd. decoupling condenser in the first L.F. stage is part of a double unit and the second condenser in this unit is for smoothing and follows the X32B smoothing choke.

With the SP13C used in the manner suggested sufficient output is developed fully to load the 7D8's in parallel. A satisfactory value for the coupling condenser between stages is .01-mfd. followed by a grid resistor having a maximum value of 500,000 ohms. This grid resistor is actually a variable potentiometer performing the dual function of grid impedance and volume control.

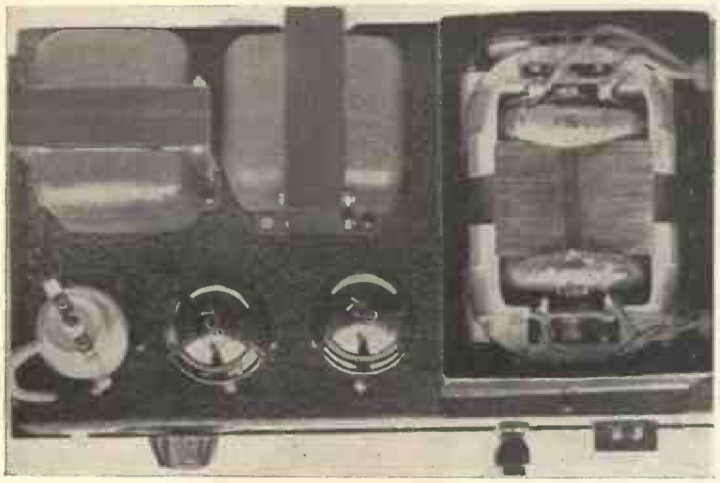
Owing to the high slope of the 7D8's the auto-bias resistor has the low value of 100 ohms, but this is fairly critical



The circuit is very simple consisting of a pentode amplifier followed by two pentodesin parallel.

Building :: Connecting Up

for a lower value causes the total anode current to rise to a point where it is in excess of the output given by the power supply.



This plain view clearly shows the lay-out of the components and the construction of the converter.

In order to prevent L.F. instability and oscillation a 5,000-ohm resistor should be connected in series with the arm of the volume control potentiometer, while in addition there should be a resistance of 100 ohms in the anode of each 7D8. A point to remember is that the 100-ohm resistors should be soldered directly to the anode pin on the pentode valve holders.

A special output transformer has been designed so that the 7D8's are accurately matched to the working impedance of the transmitter. Actually, although the transmitter is to be fully described in our February issue, it is in order to state at this point that it has been designed to have an operating impedance of 6,000 ohms. For this reason the output transformer was specially designed to have a secondary of this impedance.

Tone Corrector

Across the primary of the output transformer is a resistance and condenser network in order to attenuate the top notes which are rather accentuated with these pentode valves. In the original amplifier a resistance of 20,000 ohms in series with a condenser of .01-mfd. gave a sufficient top note attenuation for average use. This network may at first glance seem to be a little drastic but it must be remembered that a crystal microphone unit is to be used which is rather prone to boost the upper frequencies.

All valve heaters are wired across a 12-volt accumulator, which in turn is connected to a rotary converter which provides an output of 250 volts at 80 mA. from the low D.C. 12-volt input. As can be seen from the illustrations, this converter is housed in a metal container, complete with lid, and bolted to the chassis on the extreme end so that with the exception of the 12-volt accumulator the amplifier is entirely self-contained and self-powered.

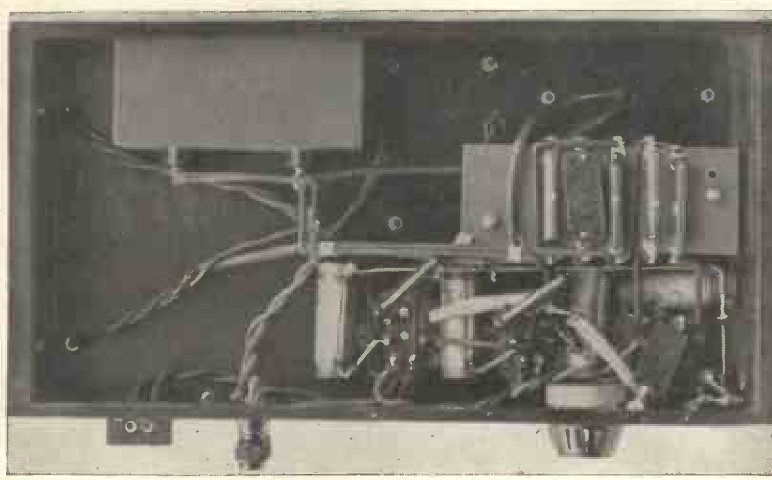
Construction

Just how the components are laid out can be seen from the plan view. The three valves are, on the left, SP13C pentode, followed by the two 7D8's. The composition of the converter is quite easily understandable after reference to the photograph of it, but care should be taken in the way it is mounted.

Two large holes on the side of the converter box are bushed with rubber bushes through which come the L.T. and H.T. leads. These two leads go down to the chassis on the extreme edge through bushed holes in order to prevent any possibility of breakdown on the metal chassis.

As regards the two iron-core components which will be noticed are mounted

(*Continued on page 62*)



Keep as many components as possible anchored to the 5-way strip in the manner illustrated.

Components for A U.H.F. EMERGENCY TRANSMITTER

MODULATOR SECTION

CHASSIS.
1—Special steel finished black 13½ by 7½ by 3 ins. (Bryan Savage).

CHOKE, LOW-FREQUENCY.
1—Shrouded type X32B (Bryan Savage).

CONDENSERS, FIXED.
3—25-mfd. type 3016, 25-volt working (Dubilier).
1—.5-mfd. type 4608/S (Dubilier).
2—.01-mfd. type 4601/S (Dubilier).
1—4 plus 4 mfd. 500-volt working type BE355 (Dubilier).

HOLDERS, VALVE.
3—7-pin less terminals type V2 (Clix).

PLUGS, TERMINALS, ETC.
2—Terminals type B marked Output (Belling Lee)
1—Shrouded top cap connector type 1224 (Belling-Lee).
1—Two-way connecting block marked plus minus (Andrew Bryce).
1—Microphone socket (Bryan Savage).

RESISTANCES, FIXED.
1—500,000 ohms type 1 watt (Erie).
1—1,000-ohms 1 watt (Erie).
1—100,000-ohms 1 watt (Erie).
1—25,000-ohms 1 watt (Erie).
1—50,000-ohms 1 watt (Erie).
4—100-ohms 1 watt (Erie).
1—20,000-ohms 1 watt (Erie).

RESISTANCE, VARIABLE
1—500,000-ohms potentiometer type L.A.B.(Erie).

SUNDRIES.
2—Coils Quickwyre (Bulgin).
1—5-way group board (Bulgin).
1—IP7 dial (Bulgin).
2—Dozen 4BA roundhead bolts, nuts and washers (Webb's Radio).

TRANSFORMER OUTPUT.
1—Type 4250/6000 (Bryan Savage).

ACCESSORIES

MICROPHONE.
1—Special crystal unit (Bryan Savage).

TRANSFORMER, ROTARY.
1—Type 12 volt input 250-volt 80 M/a output (Electro Dynamic Construction Co.)

VALVES.
1—SP13C (Mullard).
2—7D8 (Brimar).

If any amateur wishes to make the most of his aerial system a globe of this kind is essential.

With the Amateurs

By G5ZJ

This feature is intended for the transmitting amateur, and deals with current topics of general interest. Some details regarding the W8JK beam are given in these notes.

IF reception conditions remain as they have been for the past few weeks, listeners will be in for a special treat on New Year's Eve in view of the new schedules for the General Electric International broadcasters, W2XAD and W2XAF, located in Schenectady. These stations will be on the air continuously and simultaneously for 40 hours from 2 p.m. Friday, December 31, until 6 a.m. Sunday, January 2. Dance bands from coast to coast will be in almost continuous use, particularly around midnight on December 31.

W2XAD operates on 19.56 metres, or 15.3 megacycles, while W2XAF uses 31.48 metres, or 9.5 megacycles. The lower wavelength station is suitable for reception up until 9 p.m. or so, after which W2XAF will probably maintain a stronger signal.

I have just received some good news from VK2NO in Australia. It must be remembered that he is the first Australian amateur to transmit a signal into England on 5 metres. He has now, however, been heard in Wellington, New Zealand, by Mr. P. A. Morrison, who gave him a QSA4, R5 report.

At the time of this transmission VK2NO was using an 8JK beam north-west/south-east, and was on automatic C.W. This is the first time that Australian signals have been heard in New Zealand, and it is hoped that before long there will be a two-way QSO between these two countries.

F3CX has written a long letter to me about his W8JK beam. It seems to be gaining in popularity in France, for just recently several of the stations I have worked have been loud in its praises. W8JK, incidentally, has written me a special article on the beam antennæ specially for the benefit of European amateurs, and this includes a number of new type end-fed beams of original design. All the data is being published in the February issue.

To get back to F3CX, since using the beam he had had more QSO's with America in a month than he had previously in two years when using a 133 ft. Zepp or a 66 ft. Windom. The beam in use is the one described in the November, 1937, issue, and although his power is only 55 watts, the average reports are about R8.

The same aerial is being used by F3CX on 10 metres without any alterations whatsoever, and, as on 20 metres, results are highly satisfactory. A single unit flat-top beam is also in use for ZL, VK, PY and LU contacts. This aerial works well, for in one month 15 ZK's were contacted as compared with five in the previous year.

G2HK is doing extremely well considering the maximum input averages 8 watts, for during the two years he has been licensed he has worked all continents half-a-dozen times on phone, and has just worked his 60th country on phone. This is a very good answer to those who say consistent DX is impossible with low power.

The transmitter consists of a 47 crystal oscillator, a 210 doubler and a 210 P.A. For a modulator system G2HK uses a single stage pre-amplifier followed by an ML4 driving a pair of PX25A's in Class A push-pull. In this way more than sufficient audio is obtained without spoiling quality, and this probably accounts for the consistent DX worked.

This station is mainly used for experimenting with aerial arrays and during the past two years or so, more than a dozen different aerials have been erected. At the moment a horizontal Johnson "Q" is performing very satisfactorily.

A photograph of the station is in this page, and from left to right can be seen on the top shelf a 12-watt modulator, 5-metre transmitter and a 5-metre receiver. On the bottom shelf, a head amplifier, transverse current microphone, 6-valve communication receiver, pre-selector and monitor. The transmitter is link coupled to the aerial coil which can be seen on the wall, for this completely eliminates B.C.L. interference and has proved most effective.

Dorothy Hall, whose station W2IXY, was described in our December issue, has sent me some further information regarding her activities. In a period of 12 months operating on 20-metre phone she has worked 61 countries with an input of 250 watts. Amongst her contacts has been Australia 156, Africa 48, Europe 751, South America 232, North America 466, Asia 31, making a total of 686, of which 1,390 were outside the United States.

She tells me that VO6D, located at North West River, Labrador, operates on a frequency of 14,276 kc., and has a regular schedule with W2IXY every Monday at 21.45 G.M.T. and Thursday at 02.30 G.M.T. If any G station would like to contact VO6D please contact W2IXY, who will be glad to arrange it.

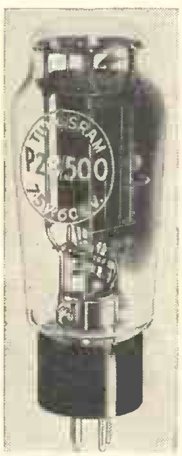
VE2JK is the operator at VO6D, while the power is 500 watts. A petrol driven engine supplies the necessary A.C., and so far this station has done extremely well despite its limitations.

This is G2HK who operates mainly on 20-metre phone with an input of 8-10 watts. In this illustration can be seen the communication receiver and 5-and 20-metre transmitters.

10 Metres :: Australian Schedules

Incidentally, if any listening station has sent a QSL card to VO6D they need not expect confirmation for approximately six months, for at the present time VO6D is isolated from the rest of the world except for radio.

Here is another note for listening stations. VK2ME, Sydney, operating on 31.28 metres, is on the air from 06.00 to 08.00 G.M.T. and 10.00-14.00 hours each Sunday. VK3ME, Melbourne, are radiating every weekday on 31.5 metres from 09.00 to 12.00 G.M.T., while VK6ME, located at Perth on



For those who still prefer the type 10 triode valve, this P28/500 Tungsram triode is interchangeable with the American 10, and gives amazingly high R.F. output.

31.28 metres, radiates from 09.00 to 11.00 G.M.T. every week-day.

Although conditions on the 10-metre band have been rather poor during the past few weeks, I hear from W6 that British stations are being received quite well in California around 10 p.m. although so far it has not been consistently possible to maintain two-way contacts. W6 amateurs are querying whether British receivers are at fault or whether it really is conditions. They also tell me that the Hungarian station, HA4A, is being consistently heard out in America, so I have got in touch with this station and obtained a whole load of data on the transmitter and aerial systems used. I intend to publish these details in the February issue, but meanwhile, for those who know this station, here are one or two brief notes.

The transmitter consists of a APP4C crystal oscillator, an APP4C sub-amplifier, two 0-15/400's in push-pull driving a pair of OQ71/1,000's as final amplifiers with an input of 250 watts. The modulating system consists of a crystal microphone fed into an HP212, followed by an HR210 with two APP4C's in push-pull driving a pair of 0-75/1.000's in Class AB.

Short-wave Clubs

The Edgware Short Wave Society have applied for a full transmitting licence, and to enable their members to become actual operators, are holding morse lessons each week. Full details of this Society can be obtained from the Hon. Sec., Mr. G. Yale, 40 Raeburn Road, Edgware.

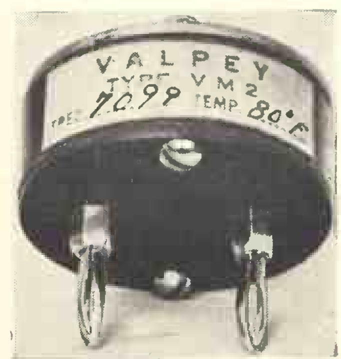
A new television society has been formed at *Cambridge*, and the first meeting had an attendance of over 40. Full details can be obtained from the Hon. Secretary, W. Jones, 115 Milton Road, Cambridge.

Michael Hedgeland, the Hon. Secretary of the *Maidstone* Amateur Radio Society, tells me that the society has a membership of 22, including G8UC and five A.A. licence holders. They have a large clubroom, which can be opened on request almost every evening, also Wednesday, Saturday and Sunday afternoons. I strongly advise any reader within a reasonable distance of Maidstone to get in touch with the Hon. Secretary of this enterprising Society at 8 Hayle Road, Maidstone.

The *Sheffield* Short-wave Club, which is now in its fifth year, has moved to much larger premises. Quite a considerable amount of equipment has been installed so that members can obtain good working knowledge of radio equipment and test gear, when perhaps otherwise cost would prevent them from owning such equipment. The subscription is ten shillings a year, but full details can be obtained from the Hon. Secretary, D. H. Tomlin, 32 Moorsyde Avenue, Sheffield, 10.

A receiving contest is being organised by the Secretary of the *Wirral* Amateur Transmitting and Short-wave Club, the President of which is G2OA. This contest is, of course, mainly intended for club members, but all the rules and regulations can be obtained from the Secretary, J. R. Williamson, 49 Neville Road, Bromborough, Birkenhead.

I notice that several new valves have been introduced just recently, in particular an RCA—809. This is similar to the popular T20, being rated for 25 watts anode dissipation and is fitted with ceramic base and top cap anode connection. It differs, however, in the fact that it requires a 6.3-volt heater supply with a current of 2.5 amps. As a Class C amplifier it requires 750 volts on the anode, minus 200 on the grid, takes a maximum plate anode current of 100 mA., and is designed for an anode input of 75 watts with a dissipation of 25 watts.



These new Valpey crystals should make it possible for every amateur to have a crystal controlled transmitter for they cost only 15/6d. in a dust-proof holder, or 10/6d unmounted.

The B.E.R.U. Contests take place next month, and here are some of the trophies to be presented to the winners later on in the year.

Automatic Gain Control

By
F. E. Henderson

We consider these notes on automatic volume control as applied to low-frequency amplifiers to be of the utmost interest to those undertaking public address work and amateur transmission.

CASES often arise in microphone work in which considerable variation in the microphone sound input, such as occasioned by a speaker's voice, may introduce considerable difficulties in intelligibility of reproduction.

In the normal way the gain of the microphone amplifier is proportional to the intensity of sound picked up by the microphone up to the limit of volume which the amplifier will handle. With moving coil, or condenser microphones, as distinct from the carbon type, in all probability the amplifier will "blast," that is overloading will occur before distortion is set up in the microphone itself, such microphones being capable of handling a wide range of input without distress. A sudden loud noise, or sudden increase in intensity of the speaker's voice, may, therefore, give rise to serious "blasting," and in the opposite sense the dropping of a speaker's voice, or turning away of the head from the microphone, may cause remarks at that moment to be lost.

Microphone Feed-back

There is another serious difficulty which often occurs in microphone work. That is the tendency for howl-back when operating the microphone and loudspeaker within the same enclosed space, this usually necessitating a reduction of amplification to such an extent as to prevent howl-back should the speaker suddenly raise his voice or some extraneous loud noise be impinged upon the microphone.

A means of compensating for both the above disabilities is therefore often of considerable use, and this can be effected by means of an Automatic Gain Control circuit.

The simplest method of automatic gain control is by utilising the same principles as are now commonly employed in radio frequency circuits for wireless reception and known as A.V.C.

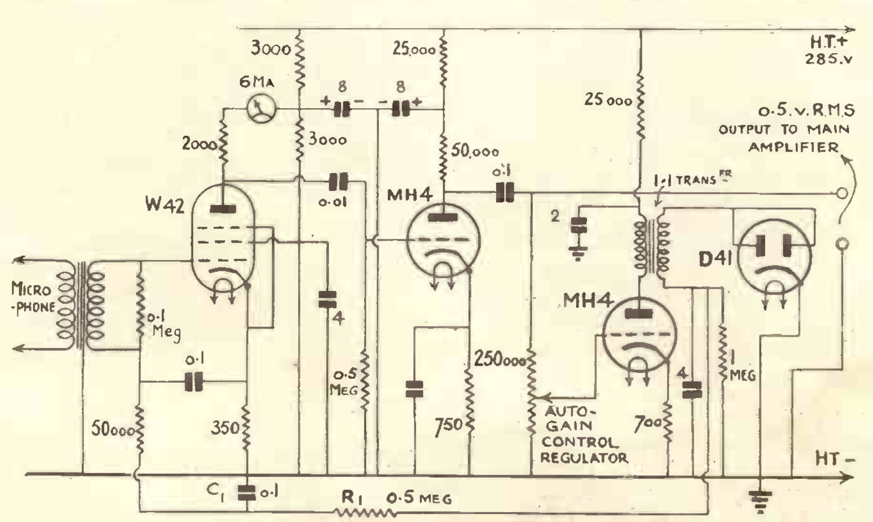
An adaptation of such a circuit is quite satisfactory for low frequency amplification in conjunction with a microphone providing the input to the controlled valve is of a very small order, which it normally is with a condenser or moving coil microphone.

The A.V.C. Circuit

A typical circuit is shown which uses a variable-mu H.F. pentode as the controlled valve, coupled by two stages of amplification to a diode. The rectified voltage from the diode serves to bias back the control grid of the variable-mu pentode, the increased bias being dependent upon the strength of the signal. As increased bias naturally introduces some non-linearity into the amplification, the method must only be used with a small input to the valve, but it is found that for ordinary microphone work the very slight distortion introduced is not noticeable in practice, the advantages of the Automatic Gain Control completely offsetting this slight theoretical distortion.

The amount of gain control introduced can be varied by means of a potentiometer input to the second stage of amplification.

The output from the complete unit is applied to the main power amplifier, and the volume control should be applied between the unit and the power amplifier.



This is the circuit of the A.V.C. low-frequency amplifier. The fact that it is mains operated is another feature to be considered.

It will normally be found that by increasing the gain control slight adjustment requires to be made to the main volume control at the same time. Once set, however, at any level the gain control and volume control should not be altered for any given set of conditions.

It will be found that a small time lag is experienced, depending upon the time constant of the resistance and capacity of R_1 C_1. This lag can be adjusted to suit individual circumstances and the values given are those satisfactory for all normal conditions.

When using the unit with the components and valves shown, it will be found that the gain control potentiometer can be so set as to maintain the output from the amplifier sensibly constant and that, if the microphone is employed close to the speaker, the overall gain can be at a higher level without howl-back when using the microphone amplifier and loudspeaker in the same room than would be possible without the gain control.

Such a unit can easily be constructed from simple components, and will be found very useful for many applications of public address.

A New A.R.R.L. Handbook

WE have just received a copy of the new 1938 A.R.R.L. Handbook, which is handled in this country by F. L. Postlethwaite, G5KA, of 41 Kinfauns Road, Goodmayes, and also available from Webb's Radio, of 14 Soho Street, W.1. This interesting publication is not primarily intended for beginners but is a complete reference book for any matter in connection with short-wave transmission or reception.

Circuits covering almost every type of transmitter are shown in detail with full constructional matter, including suitable modulating systems. Several chapters are devoted to aerials of all kinds, both reception and transmission, and short-wave and ultra-short wave types. The chapters devoted to receiving and transmitting valves are the most complete guide we have ever seen for American valves, and give every possible detail likely to be required by the constructing amateur.

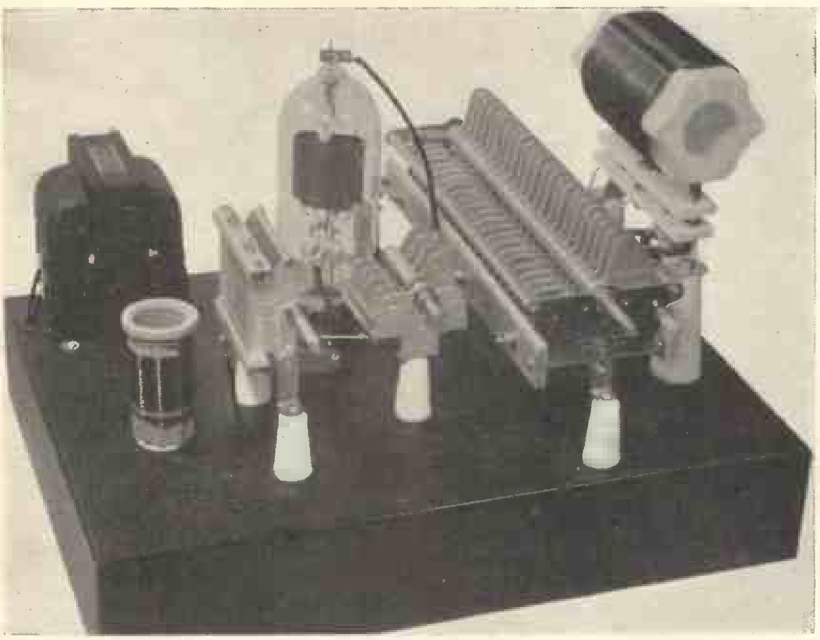
The ultra-high frequency section, dealing both with transmitters and receivers, is absolutely up-to-date, including designs of the very latest type. We were also pleased to notice that many of the designs were inexpensive for the constructor to build and did not include specialised components that were not obtainable in this country.

Stocks are available and the price is 5s. 6d.

Considerations in Transmitter Design

In this article supplied by the well-known American amateur, W9LIP, is a wealth of valuable information suitable for both the novice and the experienced amateur.

A TRANSMITTER which presents a neat and workmanlike appearance is a great source of satisfaction when visitors drop in. Not only is neat appearance desired, but stability, in the sense of reliability, dependability and consistency, is a very important requisite.



A good example of efficient P.A. design using the T-125 triode amplifier. Notice the short leads and the lay-out chosen.

Transmitters which fail to function properly when mains voltage drops and whose adjustments change as the stages warm up, are provoking. The maximum amount of operating pleasure can only be obtained from a transmitter that works perfectly every time the switch is thrown.

A dependable and stable transmitter is not difficult to construct; the use of good components and good design are the major requirements. Each stage must function properly with no interaction between it and other stages and should be free of spurious or parasitic oscillations or regeneration except in the case of a frequency doubler where regeneration is important and almost indispensable. The transmitter must have a sufficient number of stages so that more excitation is present at the grid of each valve than is actually required. This point is of particular importance yet there should not be more stages than are necessary to accomplish a reasonable surplus of excitation. It is almost mandatory that trick circuits be avoided since they usually involve critical adjustments.

In general, for transmitter use, triodes combine low cost, efficient operation, ease of adjustment. There is one exception :—For crystal oscillator stages, pentodes or valves with pentode characteristics have advantages which dictate their being used for this purpose in preference to triodes.

Circuits

Basically, the requirements for a triode amplifier are, an input circuit capable of being tuned to the desired operating frequency, an output circuit capable of being tuned to the same frequency, a source of R.F. voltage of opposite phase for neutralisation, and suitable sources of filament, anode, grid and excitation voltages.

Starting with the grid circuit, the anode circuit of the preceding stage may also act as the grid coil for the amplifier under consideration. See Fig. 1. This is an instance when capacity coupling is used. The advantages of this system are its low cost and simplicity. If the impedance of the grid circuit is approximately the same as that of the driver anode circuit this coupling system is equally as efficient as any other, at least on the three lowest frequency bands.

On 20 metres and higher frequencies the combined input and output capacities plus the capacities of associated equipment to ground may be high enough to prohibit the use of enough inductance in the circuit and the anode efficiency of the driver stage may become poor. If the grid impedance of the driven stage is lower than the anode impedance of the driver stage maximum efficiency may be obtained by tapping down on the anode tank at a point which gives maximum grid drive at minimum anode current to the driver stage. Such an arrangement will provide maximum power efficiency, but it is not commonly used since it generally creates new circuits which invite oscillation at parasitic frequencies.

When the grid impedance of the driver stage is sufficiently different from the anode impedance of the driven stage to prohibit using the same tuned circuit for both or where the capacities resulting from this connection would be too great it is common practice to use a separate tuned circuit for the anode of the driver stage and the grid of the driven stage. The coil may be placed in the field of the driver anode coil or it may be placed out of the direct field of the anode coil and coupled through a low impedance line. This latter method is usually called link coupling. See Fig. 2.

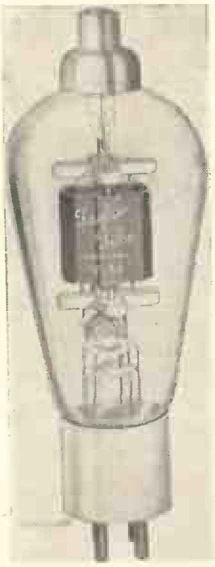
Inductive Coupling

Inductive coupling in one of its forms is usually of greatest advantage at the higher frequencies and when working from a single ended stage to a push-pull stage and from a push-pull stage to a single ended one and when the driven grid impedance is widely different from the driver anode impedance. A further advantage is the elimination of or minimisation of the importance of R.F. chokes. The disadvantages are higher cost because of more parts, greater space requirements, and more tuning adjustments and coils to change when shifting bands.

Choice of an input circuit will depend upon all of the considerations previously mentioned and when not duplicating a complete unit already designed the various factors should be weighed carefully that an intelligent selection may be made. The present trend toward link coupling is probably due to the fact that with it best results may be obtained under most any conditions even though the cost is higher and the complexities greater.

Neutralising :: Bias Troubles

Anode circuit considerations can be well determined in advance. The important considerations are the L/C ratio to provide maximum unloaded tank impedance consistent with minimum harmonic content and if phone is used to have sufficient capacity in the circuit to provide for linear action under modulation.



One of the best low-capacity triodes available. It is the Taylor T-55 with a 55-watt anode dissipation.

Neutralisation also ties in with grid circuit and anode circuit design, except in the case of push-pull. With push-pull the fundamental circuit arrangement is identical whether the stage is a tuned grid, tuned anode oscillator, or a neutralised amplifier. The only practical method of neutralising a push-pull stage is the so-called cross neutralising method employing two neutralising condensers, each connected from one grid to the anode of the other valve. See Fig. 3.

However, in a single ended stage either of two methods may be used. With grid neutralisation the centre of the grid coil is at ground R.F. potential. See Fig. 4. One end of the coil goes to the grid of the driver valve and the other end to one side of the neutralising condenser. Grid neutralisation will usually operate satisfactorily and may be of advantage in an unbalanced output stage.

However, the grid of the valve puts a resistive load across half of the input coil resulting in the opposite end of the coil being other than 180° out of phase if the coupling in the grid coil is less than unity. Unity coupling is never realised in practice at radio frequencies but satisfactory neutralisation may usually be realised if the turns of the grid coil are wound as close together as possible. If difficulty is experienced it will usually be at the higher frequencies.

Anode neutralisation of a single ended amplifier necessitates operating the centre of the anode coil at ground R.F. potential. One side of the neutralising condenser is connected to the opposite end of the anode coil to which the plate of the tube is connected and the other side of the neutralising condenser goes to grid. See Fig. 5.

For maximum power gain with reasonable efficiency the bias should be approximately cut-off and the grid current the normal recommended value. An amplifier of this type is suited for use as an intermediate or buffer stage or as the final stage in a C.W. transmitter.

Class C operation requires somewhat greater than twice cut-off bias with normal recommended grid current. This stage would be characterised by slightly better anode efficiency than the one previously described and would be suitable for intermediate or buffer stage, final stage C.W. or anode modulated phone.

Another type of Class C operation would require bias of several times cut-off with normal grid current flowing. With the anode circuit tuned to the same frequency as the grid circuit and with a high impedance anode tank, higher voltages may be applied and higher anode efficiencies, over 75 per cent. obtained. However, the harmonic content will be high and unusual precautions to prevent harmonics being radiated by the antenna must be taken. This grid bias and excitation condition is also ideal for the operation of a doubler stage with the anode circuit tuned to twice the frequency of the grid circuit. Reasonable efficiency may be obtained from a doubler if the bias and excitation are high.

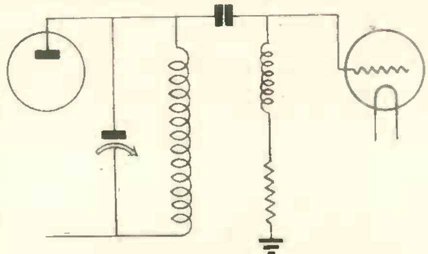


Fig. 1—The basic anode and following grid circuit.

Class B Linear

The Class-B linear of grid modulated amplifier requires approximately cut-off bias and little or no grid current. The unmodulated efficiency will be low, varying between approximately 25 per cent. and 35 per cent. This type of operation necessitates the use of fixed voltage bias sources. The voltage must remain consistent regardless of current variations. Batteries are probably the most satisfactory source because the smaller types may be used and the life will be long.

For all other types of operation it makes little or no difference how the necessary bias is obtained. The simplest and cheapest method is the use of a resistor in the grid return circuit. This arrangement is entirely satisfactory in every respect except that no protection is afforded the valves in the event the excitation fails or is removed while the anode voltage is on. Batteries are frequently used and they make an excellent bias source from every standpoint except that of cost, life, and in some cases, size. The same amount of power which would be dissipated in a resistor in the same circuit is dissipated in the batteries. This heat dries out the batteries so rapidly where any great amount of grid current is present that the use of batteries can become very expensive.

Bias Packs

Bias supplies of one type or another are becoming more common. A discussion of the units would be too involved and lengthy for the space available. Let it suffice to say that even the simplest types should prove entirely satisfactory for R.F. stage bias since regulation, except in the case of efficiency modulated amplifiers, is not a factor.

Cathode bias also is used. It consists of a resistor between filament centre tap and ground. It must be capable of carrying the total grid and anode current and as the anode current is increased the bias also increases. If the stage is modulated the resistor must by by-passed with a large condenser in addition to the R.F. by-pass which is required anyway. The principal use for this type of bias is to protect the valves in case of excitation failure. Without excitation cut-off bias can never be reached. The drop across the resistor must be subtracted from the supply voltage to give the actual anode voltage.

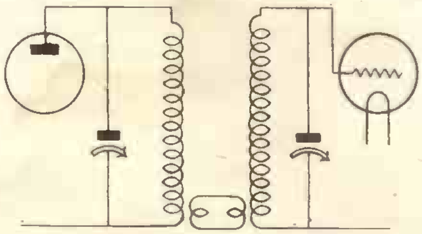


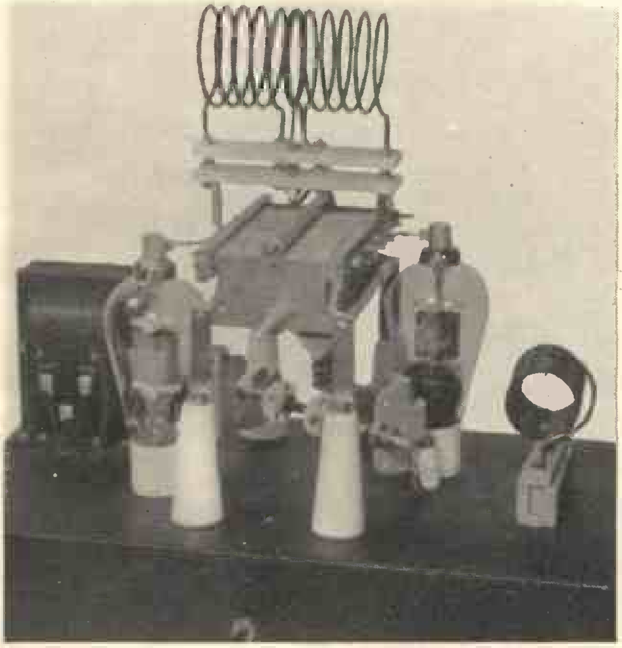
Fig. 2—A link coupled circuit.

The most common arrangement which takes advantage of the best features of each type of bias supply is usually enough pack or battery bias to provide

Crystal Oscillators :: Buffers

cut-off with no excitation and the balance by resistors. It is particularly important in a C.W. transmitter to have all stages following the keyed stage biased to cut-off. In the phone transmitter where the anode voltage is off during standby periods enough cathode bias to limit the anode current to a reasonable value plus resistor bias for the balance makes an excellent arrangement.

Grid current should never be permitted to exceed the maximum rated value. If high drive is required or desired the bias should be increased to the maximum which will allow normal recommended grid current to flow. In this manner you may increase grid excitation without greatly affecting valve life.



This is about the most efficient manner in which to build a low-loss output stage. It is suitable for low and high power use with any of the modern low capacity valves.

If any type or combination of types of bias are used they may be measured by connecting a voltmeter from the filament centre tap to the grid side of the last source of bias in the circuit. The measurement should, of course, be made with anode voltage applied to the stage and everything operating under normal conditions. If the rectified grid current and the value of the resistance in the circuit are known the bias will be the product of the two. If any cathode bias is used due allowance should be made for the anode current through the amount of cathode resistance used.

Crystal Oscillator

No triode can provide the versatile crystal oscillator operation obtainable with tetrodes and pentodes. In selecting a crystal oscillator circuit there are five requirements to be remembered.

1. High output on fundamental and second harmonic frequencies.
2. Minimum number of coils to wind and change.
3. Minimum number of tuning controls.
4. Lowest current through crystal for best frequency stability and crystal safety.
5. Lowest cost consistent with maximum performance.

The 6L6G is a very popular tetrode for a C.O. It fulfils the first, third and fifth requirements perfectly and to a greater degree than any other circuit. It has only one tuning adjustment and one coil to change. The tritet, its nearest competitor, has two coils to change and two tuning adjustments. The only bad feature, which is the fault of the 6L6 and not of the circuit, is that when working straight through on the fundamental frequency with a 20- or 40-metre crystal the R.F. current through the crystal is too high. When doubling in the oscillator the crystal R.F. current is extremely low—about 10 to 20 mA. A type 6F6G in the same circuit provides satisfactory fundamental operation with safe R.F. crystal current with all crystals including 20- and 40-metre ones, but when doubling the output is only a small fraction of that obtained with a 6L6G. As a result we use a 6L6G with an 8-prong ceramic base when doubling in the oscillator and replace it with a 6F6G when working straight through. Both valves fit the same socket and no circuit changes are necessary. Merely place the 6L6G in the socket when the output of the oscillator stage is twice the crystal frequency and the 6F6G when the oscillator stage output frequency is the same as the crystal. With a 40, 80, or 160-metre crystal working straight through the oscillator output will be about 15 watts. With a 20-metre crystal it will be about 10 to 12 watts. The 40-metre output from an 80-metre crystal will be about 12 watts and the 20-metre output from a 40-metre crystal will be 6 to 9 watts.

While even badly cracked crystals will operate on their fundamental in this circuit a good crystal is required for harmonic output. It must not only be active but must have only one frequency. 20-metre crystals will be very satisfactory in this circuit for straight through operation, but do not provide satisfactory 10-metre output. Most 20-metre crystals are 60-metre crystals operating on their 3rd harmonic. In this circuit the 10-metre output is apparently the 6th harmonic of 60 rather than the second harmonic of 20.

When not oscillating the 6L6 will draw about 140 mA. With the crystal oscillating and the anode circuit off resonance the current will be about 100 mA. When the anode circuit is brought into resonance on the fundamental or harmonic frequency a very pronounced dip in anode current will be noticed. With the 6F6G, the non-oscillating anode current will be about 80 mA. and will dip in the conventional manner near resonance.

The fact that this crystal circuit is to be preferred does not mean that it must be used. There is probably more difference of opinion concerning which is the "best" crystal oscillator arrangement than there is concerning any other unit in the transmitter.

The circuit as shown delivers 20 to 25 mA. of grid current to the following stage even on 20 from a 40-metre crystal and the circuit used should do equally as well if equivalent results are expected.

Buffer Doublers

A triode such as the T20 or T55 makes a fine buffer. At the maximum ratings of 750 volts and 75 mA. input, a T20

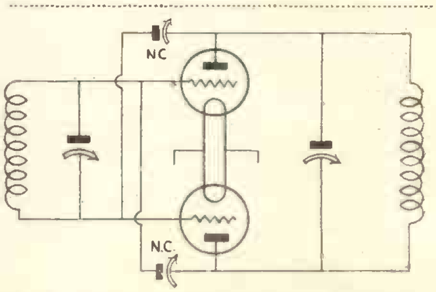


Fig. 3—How to neutralise a push-pull stage

will deliver about 40 watts of output. At frequencies lower than 15 mc. where circuit losses may be kept at a reasonable value and practically the whole 40 watts delivered to the final stage, a T20 will furnish sufficient grid drive for an anode modulated final stage with an input of approximately 500 watts or

NOW READY

Premier 1938 New enlarged Illustrated Catalogue, Handbook and Valve Manual! Send 6d. in stamps for 90 pages of Valve Data, Technical Articles, Circuits and Premier 1938 Radio.

POST ORDERS

Jubilee Works, 167, Lower Clapton Rd., London, E.5. Amherst 4723

CALLERS

5C, High Street, Clapham, S.W.4 Macaulay 2381

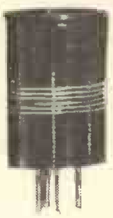
165 & 165a Fleet Street, E.C.4. Central 2833.

PREMIER

SUPPLY STORES

Manufacturers of

TRANSMITTERS, RECEIVERS, MODULATORS, AMPLIFIERS, COMPONENTS



SHORT WAVE COILS

Low-loss interchangeable coils, 4- or 6-pin standard and other fittings.

12-26 metres	1/9	41- 94 metres
22-47 metres	each	78-170 metres

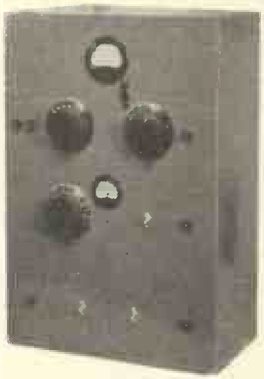
Other wavebands up to 2,000 metres from 2/-.

S.W. Coil Formers as used in above coils, 2¼ in. long, 1½ in. diameter, 4-, 6- or 7-pin fitting. Plain or threaded, 1/- each.

3 NEW PREMIER TRANSMITTERS

10-watt 'Phone Transmitter (as illustrated) 6L6G exciter. Regenerative Crystal Oscillator Doubler. 802 Pentode Amplifier with Suppressor Grid Modulation. Price complete with 4 Tubes and Crystal, **£15.**

25-watt 'Phone Transmitter. 6L6G exciter Regenerative Crystal Oscillator Doubler. 801 Triode Amplifier. Grid neutralised grid and anode meters. Price complete with 6 Tubes and Crystal, **£21.**

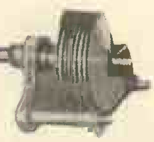


10 watt A.C./D.C. C.W. Transmitter. Pentode Crystal Oscillator. Low crystal current. Minimum frequency drift. Price, complete with Valves, Crystal and Key, **£4 4s.**

Premier Battery Chargers. Westinghouse Rectification.

Complete ready for use. **To charge 2 volts at ½ amp., 10/-; 6 volts at ½ amp., 16/6; 6 volts at 1 amp., 19/6; 12 volts at 1 amp., 21/-; 6 volts at 2 amps., 32/6.**

TWO NEW MODELS completely enclosed. To charge 6 volts at 4 amps., £3/19/6 To charge 6 or 12 volts at 2 amps., £3/19/6.



SHORT WAVE CONDENSERS

TROLITUL insulation. Certified superior to ceramic. All-brass construction. Easily ganged.

15 m.mfd.	1/6	Double-Spaced Transmitting Types.	
25 m.mfd.	1/9		
40 m.mfd.	1/9		
100 m.mfd.	2/-	15 m.mfd.	2/9
160 m.mfd.	2/3	40 m.mfd.	3/6
250 m.mfd.	2/6	160 m.mfd.	4/6

All-brass slowing-motion Condensers, 150 m.mfd., Tuning, 4/3; Reaction, 3/9.

AMERICAN VALVES

We hold the largest stocks of U.S.A. tubes in this country and are sole British Distributors for **TRIAD** High-Grade American Valves. All Conceivable types in stock. Standard types, **5/6** each. All the new Metal-Glass Octal Base tubes at **6/6** each, 210 and 250, **8/6** each. 4-, 5-, 6- and 7-pin U.S.A. chassis mounting valveholders, **6d.** each Octal Bases **9d.** each.

EUROPA MAINS VALVES

Famous Europa **4 v.** A.C. types, H.L., L., S.G., Var.-Mu-S.G., H.F.-Pens., Var.-Mu-H.F. Pens. 1 and 4-watt A.C. directly-heated-output Pentodes. Full-wave rectifiers, 250 v. 60 m.a. A.C./D.C. types. 20-volt .18 amp. S.G., Var.-Mu-S.G., Power, and Pentode. All **4/6** each.

Following Types. Full-wave rectifiers, 350 v. 120 m.a. and 500 v. 120 m.a. 2½ watt indirectly heated Pentodes. Frequency Changers (Octode), Double Diode Triodes, all **5/6** each.

2½ watt Directly Heated Triodes, **6/6** each.

BATTERY VALVES. 2 volts, H.F., L.F., **2/3.** Power, Super-Power, 2/9. S.G. Var.-Mu-S.G., 4- or 5-pin Pentodes, H.F. Pens., Var.-Mu-H.F. Pens., **5/-.** Class B, **5/-.**

R.C.A. TUBES. 800, **65/-.** 801, **29/-.** 802 (=RK25), **25/6**

POWER PACKS

Completely assembled on steel chassis. Finest components.

Outputs:

120 volts	20 m/A.	25/-	Westinghouse Rectification.
150 volts	30 m/A.	27/6	,, ,,
250 volts	60 m/A.	33/-	,, ,,
300 volts	60 m/A.	37/6	,,
150 volts	30 m/A.	17/6	Valve Rectification.
350 volts	120 m/A.	40/-	,, ,,
500 volts	200 m/A.	65/-	,, ,,
1,000 volts	250 m/A.	£5	,, ,,
1,500 volts	200 m/A.	£6 10s.	,, ,,
2,000 volts	150 m/A.	£7	,, ,,

MODULATION TRANSFORMERS

Primary and secondary impedance to your requirements.

10 watts	...	14/-
25 watts	...	18/6
50 watts	...	26/-

TAYLOR TRANSMITTING TUBES

T.20	... 17/6	203A.	... 72/-
T.55	... 45/-	203B	... 72/-
825	... 27/6	866	... 11/6
841A.	... 40/-	866B.	... 17/6
		866JR.	... 7/6

OVER 20,000 PREMIER SHORT-WAVE KITS have now been sold! BECAUSE they are simple, efficient and amazing value. Each Kit is complete to the last screw.

NEW 1938 1-VALVE SHORT-WAVE RECEIVER OR ADAPTOR KIT, 13 to 86 metres without coil changing. Complete Kit and Circuit, **12/6. VALVE GIVEN FREE!**

DE LUXE MODEL, 14 to 150 metres, complete Kit with Chassis, 4 Coils and all parts, **17/6.**

1937 SUPERHET CONVERTER KIT, 13/6.
DE LUXE MODEL, 18/6.

S.W. SUPERHET CONVERTER, for A.C. Mains Receivers, **20/-.** A.C. Valve given **FREE!**

NEW 1938 2-VALVE S.W. KIT, 13 to 86 metres without coil changing. Complete Kit and Circuit, **19/6. VALVES GIVEN FREE.**

DE LUXE MODEL, 14 to 150 metres, complete Kit and Chassis, 4 Coils and all parts, **25/-. VALVES GIVEN FREE. 3-VALVE S.W. KIT,** S.G., Det. and Pen., **42/-. VALVES GIVEN FREE! Metal Cabinet 10/6 extra.**

PREMIER HIGH-FIDELITY AMPLIFIERS AND MODULATORS

Premier, 1938, Super 3-Watt Amplifier for A C. or A.C./D C. mains. 2-stage, high-gain circuit. Complete Kit, with metal chassis, all parts and 3 matched Valves, **40/-.** Wired and tested, **£2 15s.**

Premier 1938 8-Watt Amplifier for A.C./D.C. mains. 3-stage, high-gain, with Push-Pull output. Complete Kit, with metal chassis, all parts and 5 matched Valves, **£4 4s.** Wired and tested, **£5 5s.**

Premier 1938 12-Watt P.A. Amplifier or modulator for A.C. mains. 2-Beam Power tubes in Push-Pull output, phase inversion high-gain, distortionless output. Complete chassis-built Kit, with 5 matched Valves, **£5 5s.** Wired and tested, **£7 7s.**

Premier 1938 30-Watt P.A. Amplifier and Modulator System for A.C. mains. Push-Pull R.C. coupled to 2-Beam Power tubes in Push-Pull output, high impedance input. Completely wired and tested **with matched Valves, £12 12s.**

Premier Mains Transformers.—Screened primaries 200-250 volts. Guaranteed 1 year. Wire end types.

HT8 + 9 or HT10 with 4 volts 4 amp., C.T. and 4 v. 1 a., C.T., **10/-. 250-250 v. 60 m/A.** or 300-300 **v. 60 m/A.**, with 4 v. 1-2 a., 4 v. 2-3 a., 4 v. 3-4 a., all **C.T., 10/-. 350-350 v. 150 m/A.**, 4 v. 1 a., 4 v. 2 a., 4 v. 4 a., all C.T., **11/6. 350-350 v. 150 m/A., 5 v. 2 a., 6.3 v.** 2 a., **6.3 v. 2 a.**, all **C.T., 13/6.** Fitted with Panel and Terminals, 1/6 extra.
500-500 volts 150 m/A., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 5 a., all C.T., **21/-. 500-500 v. 200 m/A.**, 5 v. 3 a., 6.3 v. 3 a., 2.5 v. 5 a. or 7.5 v. 3 a., all C.T., **25/-. 500-500 v. 150 m/A., 15/-. 1,000-1,000 v. 250 m/A., 21/-.** 1,500-1,500 **v. 200 m/A., 50/-. 2,000-2,000 v. 150 m/A., 57/6.** Fitted with Panel and Terminals, 2/- extra.

Premier Filament Transformers. Primary 200-250 volts, 1,000 insulation test. 2.5 volt. 8 a. C.T., **8/6**; 4 v. 5 a. C.T., **9/6**; 5 v. 3 a. C.T., **8/6**; 6 v. 3 a. C.T., **8/6**; 6.3 v. 3 a. C.T., **8/6**; 7.5 v. 3 a. C.T., **8/6**; 10 v. 3-4 a. C.T., **11/6.**

PREMIER METERS.—Moving Coil 0-1 m/A. full scale, resistance 100 ohms, **3½ in. diameter,** flush mounting, **22/6. Multipliers, 1/-** each. Tapped shunts: —10, —50, —100, —200 m/A., **4/-** each. **Moving Iron Meters, 2½ in.** diameter, flush fitting. Read A.C. or D.C. All readings from **0-10 m/A.** to **0-10** amps., **5/9** each. 0-6 volts, 0-16 volts, **5/9** each. 0-250 volts, **8/6. Telsen Multimeters.** Read A.C. or D.C., 0-6 volts, 0-16 volts, 0-250 volts; 0-30 m/A., 0-300 m/A., **8/6** each.

Doublers :: L/C Ratios

less. For C.W. only the T20 will probably drive a 700-watt stage. No definite statement on this subject can be made because the amount of grid drive required can vary over wide limits in different transmitters.

A T20 as a straight buffer on 10 metres may be expected to adequately drive a 250 to 300-watt final stage.

As a doubler to 10 from 20 the efficiency will vary greatly with the excitation, the bias and the L/C ratio, but 15 watts of output should be obtained under average conditions without any colour showing on the anode. This excitation would permit an input of about 150 watts to the final stage.

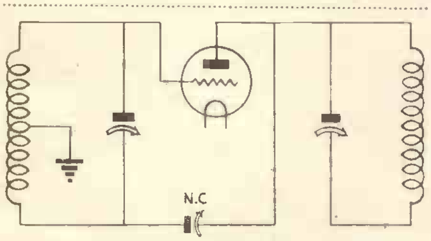


Fig. 4—The grid neutralising system.

For those applications where the T20 does not have sufficient output a T55 may be substituted. The grid drive from the oscillator shown is sufficient for full rated input to the T55. 150 to 170 watts of output may be obtained which will be far more excitation than is required for 1-kW final stage. No changes need be made in the circuit when replacing the T20 with a T55 except to use components with adequate voltage ratings so that breakdowns will not be experienced if higher voltages are applied to the T55 than to the T20.

The first two stages, a 6L6 and T20 or T55, will make an excellent 2-stage all-band transmitter, and would be ideal for portable operation. The excitation on all bands from 40 to 160 is sufficient for anode modulation with full input. On 20 the excitation is adequate for anode modulation with 100 to 150 watts of input. If operating 20-metre phone with two stages a 40-metre crystal should be used. The 6L6 operates as an oscillator and doubler and apparently the isolation on 20 is adequate to keep frequency modulation to a negligible amount.

Doublers

A doubler is used to obtain an output frequency of twice the input frequency, and one or more of these stages are usually necessary when working on the higher frequency bands. Because the anode circuit is not tuned to the same frequency as the grid circuit, neutralisation is not necessary to prevent oscillation. However, the efficiency of a doubler may be improved greatly if regeneration is added. The circuit for a regenerative doubler is exactly the same as for a neutralised amplifier so the same stage may be used for either purpose by merely changing the anode coil. The neutralising circuit provides regeneration when doubling.

As a doubler the anode efficiency of a stage will be much less than when working as a straight amplifier. Consequently for a given anode dissipation the output must be much less. More grid drive is required also so the power gain will be less. The grid bias should be several times that for straight through operation. The L/C ratio should be as high as possible.

If a stage is used for both straight through and doubler operation it may be neutralised and the neutralising condenser setting left the same for doubler operation. If it is used for doubler operation only, the neutralising condenser adjustment should be for maximum efficiency without oscillation.

Insulation

When operating on the lower frequencies only insulation is no great problem. Below about 8-mc. bakelite or most any of the various commonly used types of insulation are sufficiently good. About the only important consideration is that it be able to stand the voltages involved without breaking down.

Above 8-mc. the situation is much different and at 8- and 56-mc. only the very best insulation is good enough. (At these higher frequencies the amount of grid drive required by a valve does not increase greatly but circuit losses increase tremendously making valves appear to require more grid drive.) If sufficient grid drive is to be had at the higher frequencies and if reasonable efficiency is to be experienced insulation should be used only where necessary and it should be the best available.

Sockets and condenser insulation should be of ceramic or Mycalex. Wherever possible the inductances should be self-supporting with no foreign objects in their field.

Antenna Coupling

The method of coupling the transmitter to the antenna will depend upon the type of feeder system used and the characteristics of the antenna coil will depend upon the impedance of the feeders at the transmitter. Because there are so many variables I cannot provide any quantitive data. In the case of untuned transmission lines the correct number of turns in the pick-up coil will be the number which will load the final to the desired input. With tuned feeders the characteristics of the antenna coil will depend upon the amount of inductance necessary to tune the antenna system to resonance. With single-wire fed or end-fed antenna systems, a separately tuned circuit coupled to the final tank is probably advisable because of the lack of harmonic discrimination with these antennas. If the L/C ratio in the final stage is low enough for reasonable harmonic suppression the L/C ratio of the separately tuned coil may be very high.

Any pick-up coil coupled to a tank circuit should be placed at the point of minimum R.F. voltage to minimise capacity coupling. In the case of a balanced output tank as with push-pull or an anode neutralised single ended stage the coupling coil should be at the centre of the output tank. With a grid neutralised single ended final stage the coupling coil should be at the cold end of the tank coil.

A Faraday screen between tank and pick-up coil is usually very helpful in preventing even harmonic radiation, but sometimes presents mechanical difficulties if the coils are changed for multiband operation. Grounding the centre of the pick-up coil to the final stage filament or ground circuit is usually equally effective and far more simple mechanically.

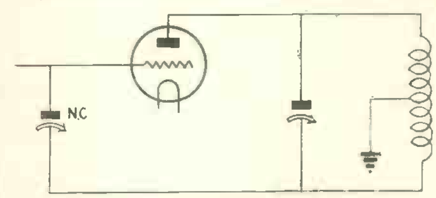


Fig. 5—The usual anode neutralising method.

With transmission lines it is legal to tap the feeders, single or double wire, directly on to the final tank, but this is likely to result in high mutual impedance between anode circuit and radiating system at the harmonic frequency. It is almost impossible for this condition to exist with a two-wire line and a pick-up coil whose centre is grounded so it would be wise to avoid direct coupling and to use a two-wire line to keep harmonic radiation at a minimum.

L/C Ratios

The tank circuits are worth careful consideration for they greatly influence the operation of the transmitter. As far as valves are concerned the inductance and capacity in the circuit when tuned to resonance are a resistance, as shown in Fig. 6. With no load coupled to the tank, the impedance (A.C. resistance) should be high and its value will be proportional to $\frac{L}{CR}$ where L is the amount of inductance, C the amount of capacity, and R the resistance. When

Efficient Valve Working

a load is coupled to the tank the situation, as shown in Fig. 7, is obtained. R_{p1} is the unloaded impedance of the tank circuit. R_{p2} is the load impedance reflected across R_{p1}, and the power developed across R_{p2} will be delivered to the load or antenna. It is useful output. However, the power developed across R_{p1} is power wasted in the tank circuit and shows up in the form of heat. It may easily be seen that as the ratio of R_{p1} to R_{p2} is raised less power will be wasted and more will be delivered to the load. Because R_{p1} is the unloaded tank impedance it can be seen why, as the impedance of the tank circuit is raised, less power will be wasted in the tank and more delivered to the load. As shown from the formula L/CR the impedance may be increased

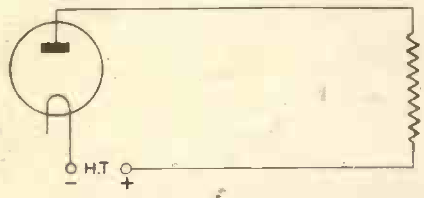


Fig. 6—The anode inductance and capacity can be considered as a pure resistance in this form.

by increasing the amount of L and reducing the amount of C.

If efficient coils and condensers are used it probably would not be practical to attempt to reduce R, but if C were reduced to half its former value, L would have to be doubled to hit resonance at the same frequency so the impedance would have increased to four times its former value. Actually, it would not be four times because R would increase slightly with an increase in L, but the gain in impedance would approach four.

From the foregoing it would seem advisable to use as much inductance and as little condenser as possible. From an anode efficiency standpoint only this is more or less true, however, after a certain value of tank impedance is reached the efficiency increases only very slightly, yet the driver power required continues to increase and from an over-all efficiency standpoint there might be no improvement.

However, increasing the L/C ratio leads to one disadvantage for C.W operation and an additional disadvantage for phone operation.

As the L/C ratio is increased the harmonic content is also increased. If these harmonics reach the antenna, and it is sometimes difficult to prevent them from doing so, they will be radiated and may cause interference to other services. Consequently it is necessary to select an L/C ratio which must necessarily be a compromise between anode efficiency and harmonic content. Fortunately, a ratio may be selected which does not result in appreciably lower efficiency yet the harmonic content is kept at a reasonably low value. In fact measurements seem to indicate that excessively high L/C ratios do not result in increased fundamental or useful output. The increase seems to be composed entirely of harmonics which are not useful and are to be avoided.

For phone operation a certain amount of capacity is necessary if the amplifier is to be linear. Less than this minimum of capacity will result in distortion and carrier shift. This amount of capacity is usually somewhat greater than the amount required to reduce harmonics to a satisfactory value and for this reason different L/C ratios have sometimes been specified for C.W. and phone operation.

However, the permissible L/C ratio for phone is high enough that increasing it to permissible C.W. value for that type of operation results in so small an increase in efficiency that it seems desirable to specify L/C ratios for all forms of operation which are capable of linear phone operation to permit modulation if desired and to obtain greater harmonic suppression. On the other hand, if only C.W. operation is contemplated the L/C ratio may be quadrupled by using about half as much capacity and twice as much inductance as would be required for phone. Twice as much indurtance may be obtained with about 41 per cent. more turns.

Correct L/C ratios become the greatest problems on the highest and lowest frequencies when all-band operation is desired. For example, any condenser with enough capacity to provide a reasonable ratio on 160 metres would undoubtedly have a minimum capacity so high that efficient operation would be impossible on metres, whereas a condenser with suitable capacities for 10 metres would have so low a maximum capacity that poor linearity and high harmonic content must necessarily be present on 160 metres even though the efficiency would be good on both bands. Probably the most satisfactory answer to this problem would be to build the circuit for the highest frequency to be used and connect another condenser in parallel with the H.F. tuning condenser for low frequency operation.

If the L/C ratios are correct it is possible to obtain maximum fundamental frequency output with minimum harmonic content and minimum distortion if modulated. If the L/C ratios are not correct one or more of these desirable characteristics will be lost.

In general, if the L/C ratios are right the minimum anode current with no load coupled to the output circuit will be about 10 to 20 per cent. of the loaded value. Minimum anode currents in excess of 25 per cent. of the loaded value are usually an indication that circuit losses are higher than they should be. However, tank circuit losses drop rapidly as the loading is increased so minimum anode currents, unless greatly excessive, need not be taken too seriously.

Optimum L/C ratios are not directly a function of the type of valve or valves used. The factors used in the calculations are anode voltage, anode current, frequency, and the type of operation.

Valve Installation

To obtain efficient performance from any radio circuits where valves are used great care should be exercised in the installation of valves in these circuits. The heart of a vacuum valve is its filament. Improper operation of the filament will shorten its life.

Although small variations in filament voltage are compensated for in valve design, most satisfactory results are obtained when filaments are operated at their rated voltage. Lower voltage limits the electron emission of the filament and generally results in the overheating of the valve, while higher voltage will rapidly dissipate the supply of thorium in the filament.

Use sockets with large sweeping contacts. Poor contact between socket springs and valve prongs will cause a drop in filament voltage. Heavy, well-soldered leads are very essential. Light valve at rated filament voltage for ten minutes before applying anode voltage for the first time. Preheating of filament after first installation is not necessary.

The ground return should be connected to centre tap of the filament. Where the ground is returned to one side of the filament, connections should be reversed at intervals of 100 hours. Using one side of the filament for

Fig. 7—A loaded anode circuit should be considered in this way.

ground return causes the opposite side of the filament to function harder. Where D.C. is used on filaments, connect grid and anode returns to negative side of the filament.

All connections in the anode tank circuit should be heavy enough to stand the circulating R.F. current. At frequencies higher than 14,000 kc. bolted connections are recommended as the heat at these frequencies will melt ordinary solder.

A Precision Oscilloscope for Experimenters

NO matter how carefully the wiring has been carried out, no attempt should be made to connect up the cathode-ray tube to the chassis until careful tests have shown that everything is in order. No transmitting amateur would think of switching on until he was certain that all connections were properly made and the same caution applies to any high voltage test equipment although the actual power employed is small.

Constructional Checks

Before fitting the tube in place, therefore, the chassis should be turned upside down and the whole of the wiring carefully inspected to make sure that there are no loose bits of solder or wire snippings left under the group boards. Each wire, whether well protected by systoflex or not, should stand clear of its neighbour and of the chassis. Where the wires pass through the chassis they should be insulated with a double thickness of sleeving and even if the voltage is low it is best to be on the safe side. An inspection of the wiring diagram of Fig. 1 will show the high voltage points and particular attention should be paid to these. For example: R11, where the lead passes through the chassis; R16, ditto; the lead from L2 through the chassis to the group boards.

These precautions may seem elementary to the experienced amateur, but it is surprising how even the old hand may overlook an obvious fault, especially if his attention has been distracted during wiring up!

This month's article contains instructions for the preliminary tests to be applied to the oscilloscope before it is finally finished off. It is regretted that space does not allow the completion of the instrument to be described this month, but readers who have any difficulty are invited to write to us.

For final checking an electrostatic voltmeter is almost essential. If this is not available a high resistance voltmeter can be used with sufficient series resistance to enable it to read 1,500 volts. The H.T. supply to the tube may be taken on trust if no electrostatic voltmeter is available, as the load of even a high resistance voltmeter will alter the voltage across the tappings.

To commence the detailed tests, remove all the valves from their sockets, remove all connections to the tube temporarily, and switch on the transformers by themselves. If there is any fault in the wiring to the rectifiers, or an accidental short-circuit, a loud hum will be heard which should be the signal for immediate switching off and a careful search for the trouble.

Timed Delay Switching

If the transformers are working correctly, replace the tube H.T. rectifier in its socket and switch on again. Note that the switching on the chassis is so arranged that the rectifier filaments can be run up to operating temperature before the H.T. is applied.

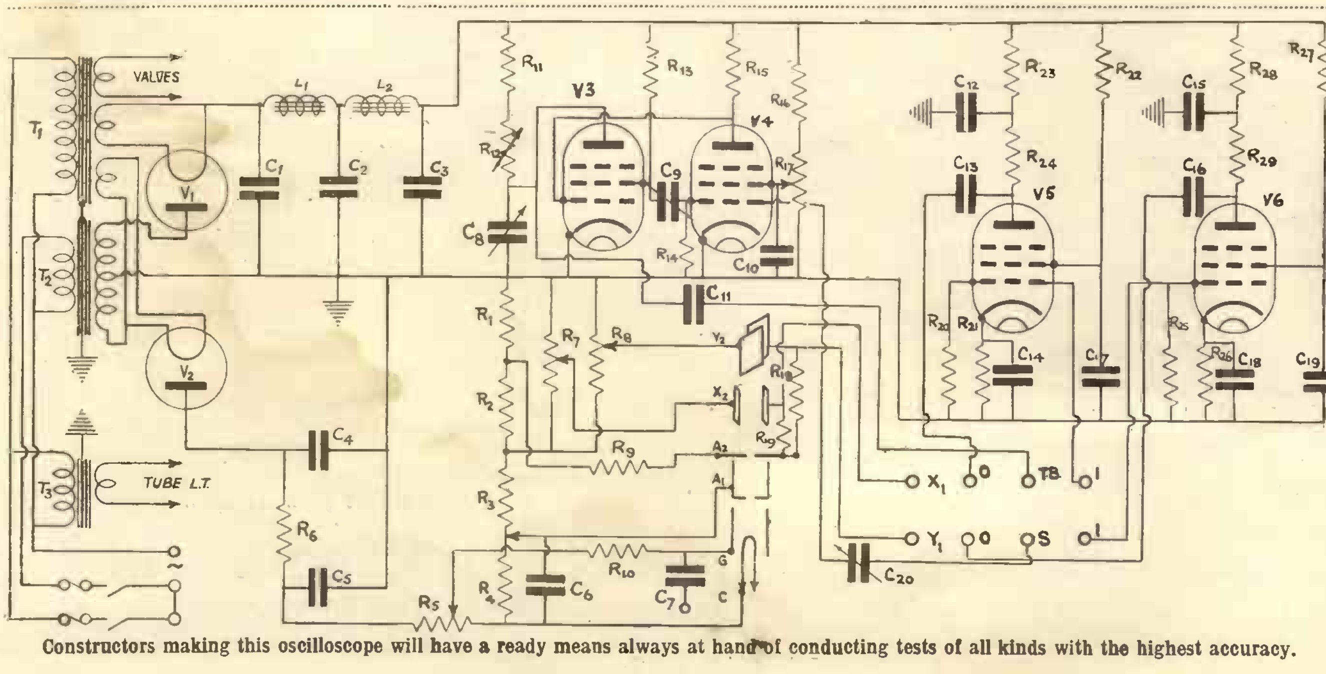
This is particularly desirable in the case of mercury vapour rectifiers feeding an appreciable current, although in the case of tube supply units it can sometimes be dispensed with.

On switching on the H.T. the rectifier should flash blue as the condenser charges and then the glow should die down to a faint haze. Excessive glow indicates abnormal current due to leaky condensers or a fault in the potentiometer chain.

For those with electrostatic voltmeters the following are the approximate readings across the potentiometer tappings: With one end of the meter connected to the cathode,

- Between A_1 and cathode: 350-400 volts in max. position.
- Between A_2 and cathode: 3,300 volts.
- Bias voltage between grid and cathode: 70 max.

The above values are, of course, approximate as they depend on the transformer voltage, but they will serve as a guide to any abnormal conditions. If no electrostatic voltmeter is available a milliammeter connected in the main H.T. lead to the chain (remember the condensers may be charged!) should read between 0.7 and 0.9 mA. If at a later date the H.T. voltage requires reducing to obtain greater sensitivity the resistance R6 in the circuit can be increased.



Constructors making this oscilloscope will have a ready means always at hand of conducting tests of all kinds with the highest accuracy.

Selected and Specified for the

"5-BAND MAINS OPERATED MONITOR"

S. G. Brown

SUPERIOR HEADPHONES

All instruments of quality must bear a price in proportion to the genius and time attending their invention, and the craftsmanship and labour involved in their manufacture.

Such instruments do not come into being by chance, neither can they be manufactured at small expense, and although the price may appear heavy at first, they are, when their efficiency and value is justly estimated, the cheapest. Instruments constructed for cheapness, and not for efficiency and excellence of workmanship, are the frequent and certain cause of inferior Radio reception.

Will YOU weigh the certainty of the highest degree of SENSITIVITY, FREQUENCY RESPONSE, QUALITY of REPRODUCTION and absolute RELIABILITY for many years, against the outlay of a few shillings more ?

Price 50/- per pair
ANY RESISTANCE

S. G. Brown Ltd., Victoria Rd., W.3. ACO 1174

Engineers' Guide

Shows how to quality in Television, Sound Recording, Radio Engineering and Servicing, Wireless Communications, etc., by studying at home with The T.I.G.B. Write to-day for this Great Guide containing world's widest choice of engineering courses and which alone gives the Regulations for A.M.I.E.E., A.M.I.R.E., A.M.I.T.E., etc.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
160 Temple Bar House, London, E.C.4
(Founded 1917. 20,000 Successes)

Free!

To Success

200 Courses

PIEZO QUARTZ CRYSTALS

1.7 mc., 3.5 m.c., and 7.0 mc., Amateur Bands.

Power Type	Standard Type
20/- post free.	15/- post free

CRYSTAL HOLDERS :—
Type A, Open Electrodes, 4s. 6d. post free.
Type B, Totally enclosed and dustproof, 8s. 6d. post free.

OUR 1938 CATALOGUE

Ready early in January. Put your name on our mailing list.

THE QUARTZ CRYSTAL CO., LTD.
63 & 71, Kingston Road, New Malden, Surrey
Telephone : MALDEN 0334.

Explains over a thousand terms

TELEVISION TECHNICAL TERMS AND DEFINITIONS

By E. J. G. LEWIS—108 pages 5/- net (by post 5/3)

"Here in one volume is easily accessible information for which one would otherwise have to search through vast numbers of books and papers."
—WIRELESS WORLD

"The definitions are concise and clear, and the book should be a very useful guide and reference."
—T. & R. BULLETIN.

"There can hardly be a single television term not included, and each item is not simply defined, it is explained. This work is no mere glossary of terms but an encyclopaedia in miniature."
—POPULAR WIRELESS.

PITMAN, Parker St., Kingsway, London, W.C.2

SPECIFIED KESTON PARTS

:—1-10 METRE RECEIVER

28 H choke	No. 410A	6/6
4/1 LF transformer	No. T77	8/-

:—4 INCH TUBE TELEVISOR

MAINS TRANSFORMER No. T4 35/-

:—TRANSCEIVERS

100:1 mic. trans. No. W44 8/- 204A choke 6/6

KESTON Mfg. Co. **GIPsy 0979**
69A PARK RD. **S.E.21**

Assuming the H.T chain to be satisfactory, switch off and discharge the condensers by shorting them with 100,000 ohms held in insulated pliers. It is bad practice to short them "dead" and it is safer to use a medium resistance rather than to rely on the H.T. resistance chain to discharge them. Actually, if this is used and the condensers are allowed to discharge naturally, the potential at the end of 5 secs is still 1,200 volts!

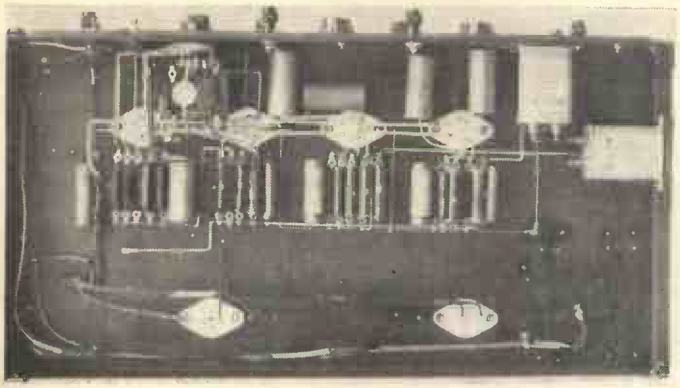
Before testing out the time base valves it is convenient to disconnect the H.T. feed to the group boards G1 and G2 (last month's diagram, p. 760). Should there be a fault present, it is easier to localise it if the amplifiers are temporarily out of service. Do not insert the time base valves, but put in the H.T. rectifier and after switching on note the current taken.

By a printer's error in the issue of November, 1937, the value of R16, the screen resistance was given as 25,000 ohms. This should have been 250,000 ohms, and if the alteration is not made excessive current will be taken by the potential chain. Normally, this should be between 5 and 8 m.A. At this stage the resistances and condensers can be checked for leakage. No current should flow through R11, R12 and C8, nor should there be any signs of sparking or "sizzling" when the full H.T. is applied to the condensers.

If all is in order, plug in the valves and note the current taken by both, which should not exceed 25 mA. The current may be altered by changing R13 and R15, but these are best left until the final running of the time base.

The amplifier valves are the last to be checked and these should consume 5 mA. max. with an anode voltage of 300 approximately. When checking these the grid leaks should be connected (R20 and R25 in the diagram) as a free grid will upset the readings.

When using the amplifier, it must be remembered that the value of the leak is the effective resistance of the input circuit and this is 2 megs. in the circuit given. Under certain circumstances this may be increased, but not if there is any tendency to grid current in the valve. A simple test for grid current is to short-circuit the leak and note if the anode current changes appreciably. The final adjustments to the time base and the calibration of the amplifier will be described next month.



This is the sub-chassis completely wired with all components in position. Carefully notice wires have been screened.

Components for A PRECISION OSCILLOSCOPE FOR EXPERIMENTERS

CHASSIS.

1—Double Steel Chassis to specification finished black (A.P.A.).

Expanded metal side shields (optional).

CONDENSERS, FIXED.

C1—2-mfd. 1,000 volt working type 950A (Dubilier).
C2—4-mfd. 1,000 volt working type 951B (Dubilier).
C3—4-mfd. 1,000 volt working type 951B (Dubilier).
C4—.1-mfd. 4,000 volt working type 951C (Dubilier).
C5—.1-mfd. 4,000 volt working type 951C (Dubilier).
C6—.5-mfd. type 4608/S (Dubilier).
C7—.1-mfd. 4,000 volt working type 951C (Dubilier).
C8—.1-mfd. B770 500 volt working, .01-mfd. .005 mfd. .001-mfd. 005-mfd. type 670 (Dubilier).
C9—.005-mfd. .001-mfd. .0002-mfd. .0001-mfd. .00005-mfd. type 670 (Dubilier).
C10—.5-mfd. type 4608/S (Dubilier).
C11—.1-mfd. 1,000 volt 950 working (Dubilier).
C12—1-mfd. type 950 1,000 volt (Dubilier).
C13—.1-mfd. 1,000 volt working type H.V.T.P. (Dubilier).
C14—50-mfd. 12 volt working type 3016 (Dubilier).
C15—1-mfd. 1,000 volt working type 950A (Dubilier).
C15—1-mfd. 1,000 volt working type 950A (Dubilier).
C16—.1-mfd. 1,000 volt working type H.V.T.P. (Dubilier).
C17—.1-mfd. 1,000 volt working type H.V.T.P. (Dubilier).
C18—50-mfd. 12 volt working type 3016 (Dubilier).
C19—.1-mfd. 1,000 volt working type H.V.T.P. (Dubilier).

CONDENSERS, PRE-SET.

C20—14.5-mmfd. type SW54 (Bulgin).

CHOKES, LOW-FREQUENCY.

2—30 h.50 M/A. (L1, L2), type 30 H (Sound Sales)

HOLDERS, FUSE.

1—Type 1054 (Bulgin).

HOLDERS, VALVE.

4—7-pin ceramic chassis type less terminals (Clix).
2—4-pin ceramic chassis type less terminals (Clix).

PLUGS AND TERMINALS

6—Top connectors type P92 (Bulgin).
2—Terminals type B marked "Mod." (Belling-Lee).
1—Terminal type B marked "Earth." (Belling-Lee).
2—Terminals type B marked "Input." (Belling-Lee).
2—Terminals type B marked "output" (Belling-Lee).
2—Terminals type B marked "X1," "Y1," (Belling-Lee).
2—Terminals type B unmarked (Belling-Lee).

RESISTANCES, FIXED AND VARIABLE.

R1—100,000-ohm 1 watt (Erie).
R2—100,000-ohm 1-watt (Erie).
R3—2-megohm and 1.2-megohm 2-watt (Erie).
R4—.5-megohm potentiometer (Reliance).
R5—.1-megohm potentiometer (Reliance).
R6—200,000-ohm type 1-watt (Erie).
R7—.5-megohm potentiometer (Dubilier).
R8—.5-megohm potentiometer (Dubilier).
R9—100-000-ohms ¼-watt (Erie).
R10—2-megohm ½-watt (Erie).
R11—.5-megohm 1-watt (Erie).
R12—2-megohm potentiometer (Reliance).
R13—50,000-ohm type 1 watt (Erie).
R14—50,000-ohm type ½-watt (Erie).
R15—200,000-ohm 2-watt (Erie).
R16—250,000-ohm 2-watt (Erie).
R17—100,000-ohm potentiometer (Reliance).
R18—2-megohm ½-watt (Erie).
R19—2-megohm ½-watt (Erie).
R20—2-megohm ½-watt (Erie).
R21—200-ohms 1-watt (Erie).
R22—.5-megohm 2-watt (Erie).
R23—50,000-ohm 2-watt (Erie).
R24—50,000-ohm 2-watt (Erie).
R25—2-megohm ½-watt (Erie).
R26—200-ohm 1-watt (Erie).
R27—.5 megohm 2-watt (Erie).
R28—50,000-ohm 2-watt (Erie).
R29—50,000-ohm 2-watt (Erie).

SUNDRIES.

5—5-way group boards type C31 (Bulgin).
Paxolin Panel to Specification (Bulgin).

SWITCHES.

1—Ganged 5-way Rotary switch 1039K (F. W. Lechner).
1—Ganged 3-way Rotary switch 1039K (F. W. Lechner.)
2—S80T switches (Bulgin).

TRANSFORMERS.

1—4 v. 4a.
—2 v. 2a to specification (T1) (Premier).
—2 v. 2a.
1—1000-0-3500 v. to specification (T2) (Premier)
1—2 v. 2a. to specification (T3) (Premier).

VALVES.

2—M.U.2. (Mazda).
2—AC/S2PEN (Mazda).
2—AC/S2P3 (Mazda).
1—Type 5H C.R. Tube with socket (Ediswan).

"A 5-band Mains-operated Monitor."

(*Continued from page 42.*)

mounted near to the transmitter maximum radiation is more often indicated by minimum current reading, showing that the R.F. is actually going into the aerial instead of being radiated from the tank circuit.

With the meter shunted and with a long aerial connected, we have been able to work a small loudspeaker from this monitor, but the suggestion is not to be recommended in view of the fact that feed-back is almost bound to occur with the average type of microphone used in amateur radio.

Operation on 5 metres is possible but not with the coil former specified. For those who are more interested in 5-metre than in some of the other amateur bands covered by this meter, should obtain a 1 in. length of ½ in. former and wind three turns on it and connect it in series with the 10-metre winding, and earth. On the other hand, this arrangement could be used to cover six bands if a 6-point multi-switch is obtainable.

Choosing the Link Between Crystal and Amplifier

The problem of connecting a crystal unit to a main amplifier is fully discussed in this article by C. K. Gravley of The Brush Development Co.

BEFORE the announcement of the first commercial crystal microphone in 1931, the radio or electronic engineer had little reason to concern himself with the transmission of electrical energy from relatively high impedance sources, aside from two possible exceptions, the condenser microphone and the photo-cell.

In any case their problems were not entirely similar, and as a great deal has been accomplished since then, it is the purpose of this article to present the existing information in its simplest form.

There has been and continues to be a certain degree of mysticism connected with the name crystal, while actually a piezo crystal is about the simplest form of device for converting electrical to mechanical energy or the reverse. For all practical purposes a crystal when used in a microphone, gramophone pick-up, vibration pickup or a similar device, can be considered as a capacitance generator having negligible internal resistance, but high internal capacitive impedance. Since the device is a capacitance and has effectively no series resistance, a capacitance connected in parallel with it will only reduce the voltage output and no frequency distortion will occur since this reduction will be the same for all frequencies.

The expression for computing the voltage loss in db. caused by a capacitance load across a crystal generator device is as follows: db. loss = 20 log $(1 + C_1/C_2)$ when C_1 represents the capacitance in microfarads of the load and C_2 the capacitance in microfarads of the crystal device. Since the impedance of a shielded cable is effectively capacitative reactance, a cable can be considered as a capacitive load on the crystal device. Thus it is a simpler matter to compute the loss that can be expected from a length of cable of known capacitance.

Another point that might be considered here is the proper input resistance to use in the amplifier. The input impedance of an amplifier is essentially resistive when connections are made directly to the grid, which is the usual case if crystal generators are being used, and since the internal impedance of crystal generators is capacitive the problem can be considered as similar to that of choosing a grid resistor for a condenser-resistance coupled amplifier. Neglecting valve capacitances, in the latter case, the low frequency cutoff of the stage is determined by the relationship between the coupling condenser and the grid resistor. The higher the value of the grid resistor, the lower the frequency which the amplifier stage will pass for a given coupling condenser. The same is true of a crystal device, the crystal capacitance represents the coupling condenser. The valve measures the voltage drop in the grid resistor and this is vectorially at right angles to the reactance drop in the crystal generator. The total impedance of the crystal generator circuit is therefor the vectorial sum of the reactance of the crystal and the grid resistance, i.e., the square root of the sum of the squares of these values. The useful voltage is therefore proportional to the resistance R divided by the impedance, and the loss in decibels for a resistance R is given by the expression:

$$\text{db. loss} = 20 \log \frac{\sqrt{R^2 + X^2}}{R}.$$

Where R = the grid resistance in ohms

X = crystal reactance = $\dfrac{159{,}000}{fC}$

C = capacitance of crystal in microfarads

f = frequency in cycles per sec.

For example, let us assume we have a grid resistor with a resistance of 500,000 ohms and a crystal device with a capacitance of 0.005 microfarads and we wish to determine the voltage loss at 60 cycles per second.

$$\text{The } X_c = \frac{159{,}000}{60 \times 0.005} = 530{,}000 \text{ ohms}$$

approximately and

$$20 \log \frac{\sqrt{500{,}000^2 + 530{,}000^2}}{500{,}000} = 20 \log 1.4572$$

= 3.26 db. loss at 60 cycles per sec.

It should be pointed out that for a combined parallel capacitive and resistive load, the capacitance to be considered when determining the size of resistor to use is the sum of the crystal capacitance and cable or load capacitance.

The New Super Skyrider.

The new Super Skyrider, built by Hallicrafters, is on demonstration at Webb's Radio, and we were surprised to find that this 11-valve receiver covers all frequencies from 545 kc., right up to 62 mc., with separate coils on each band. It is one of the most popular receivers of its kind, and is one of the few to include efficient reception between 5 and 10 metres. Other refinements on this set are carrier level meter, a crystal filter, and, of course, switchable A.V.C. and a beat note oscillator. The receiver is priced at £32, and is suitable for 110 to 250-volt input.

"The U.H.F. Emergency Transmitter."

(*Continued from page* 46.)

with the cores at right-angles, the left-hand component is the X32B smoothing choke, while on the right is the special output transformer.

The Sub-chassis

Now refer to the photograph showing the layout of components underneath the chassis. The double 4-mfd. condenser is mounted straight on to the lip of the chassis and has four terminals, two of which are joined together and are connected to the nearest earth point. On the front lip of the chassis are mounted the special holder for the crystal microphone, the volume control, output terminals and two-way block for the low-tension input.

As regards volume control, this is bushed off the panel by means of a circular disc of bakelite in order to make quite sure that there is no possibility of leakage from the moving arm to earth. This would cause a big drop in volume owing to the input to the pentode being almost short-circuited.

Similarly with the output terminals, which must be carefully bushed, but in this instance manufacturers supply bushes with the terminals. It must be remembered, however, that there will be a potential of 250 volts between these terminals and chassis so that good insulation is essential.

A special 5-way group board should be mounted in the centre of the chassis, as can be seen from the illustration. This is mounted on two lengths of 2 B.A. studding and enables some of the resistors which would otherwise be left floating to be carefully anchored down. Make the most possible use of this group board in order to have at least one end of resistors or condensers anchored.

In normal designs of this type it is quite in order for small resistors and condensers to be connected in the wiring without further fixing, but when the equipment is to be roughly handled it is advisable to firmly fix every component.

Another point in construction is the method of fixing the cathode by-pass condensers. It will be noticed that there are three such condensers; one across the cathode of the SP13C, and one across each cathode in the 7D8 circuit.

These condensers should be mounted alongside the cathode pin of the respective valve-holders. They are fixed down by means of a length of thin presspahn folded around it with the two ends bolted down underneath the nut and bolt used primarily to hold the valve-holder in position.

Another component that should be carefully watched is the .01-mfd. coupling condenser between the input and output valves. The components have been arranged so that one side of this condenser can be soldered actually to the anode leg on the valve-holder with the opposite end of the condenser soldered to the top end of the potentiometer. In this way the condenser, which would normally be left floating, is properly fixed.

Connecting Up

It is suggested that all filament leads be wired with heavy gauge twin flex in order to prevent any possibility of voltage drop. The remainder of the wiring can be satisfactorily carried out with ordinary push-back or Quickwyre, using red wire for anode connections and black wire for all negative connections. Again, it must be emphasised that the equipment will probably be used by operators not fully conversant with the apparatus, so that in case of breakdown they must be given every assistance in order to locate the source of the trouble. By differentiating between negative and positive wiring this should help very considerably.

For those who wish to use this amplifier for gramophone or speech work, a special output transformer will have to be obtained from Messrs. Bryan Savage. The secondary of this transformer will have to be designed to have an impedance equal to that of the loudspeaker it will work. Those who are without any source of mains supply and who need an amplifier giving comparatively high output will find this equipment ideal for the purpose. It will also be suitable for outdoor work, and in fact for any usage where an accumulator will be the only source of supply available.

All valves are of the 7-pin type with British bases and are designed for a 12-volt accumulator only.

It has been arranged that a complete kit of parts be obtainable from Messrs. Webb's Radio, of 14 Soho Street, W.1, while the complete amplifier, ready-wired and tested with microphone, can be obtained from Messrs. Bryan Savage.

In our next issue will be given full details of an ultra-high frequency transmitter also running from a 12-volt accumulator, while to complete the U.H.F. installation, elsewhere in this issue will be found details of a special receiver tuning from 1 to 10 metres.

"The Short-wave Radio World."

(*Continued from page 44.*)

circuit as shown in Fig. 4, which earths one side of the cathode resistor, while the grid is connected to L2. This coil consists of five turns of No. 20 gauge wire on a valve base, and without any tuning condenser it resonates at approximately 20 metres well enough to provide an R9 tone signal with the switch in the oscillator anode to the off position.

With the oscillator anode switch closed the carrier or key transmitter can be tuned in by means of C1, so functioning as a frequency meter. With the D.P.D.T. switch in the opposite position the grid of the 56 triode is connected through the grid leak and condenser, R5, C7, and also the L.F. transformer secondary to earth, while cathode is connected through one wire to the centre tap of the keyed stage in the transmitter.

The L.F. oscillator is therefore keyed simultaneously with the transmitter. R6 is a panel control for L.F. output and enables the pitch of the note to be varied between 300 and 5,000 cycles. The volume control, R8, provides a means of controlling the volume from the oscillator without affecting the frequency. This is an essential point as the level of the audio oscillator is about 15 db over the output from the frequency meter. The toggle switch in the anode circuit of the 2A7 is important as it prevents the R.F. oscillator signal from damping the audio oscillator because C6 is always in circuit.

The 2A7 functions as a negative resistance oscillator of the retarding field type with electron coupling to the output stage. In the circuit shown, grid No. 2 functions as a screen, with grids Nos. 3 and 5 coupled together as an anode. Grid No. 4 is the conventional suppressor. The screen and suppressor are at the same R.F. potential, and when the potentials of both vary together increase in screen potential will be accompanied by decreasing screen current and vice versa, so giving the negative resistance effect.

Grid No. 1 is connected to cathode but as there is no feed-back required L1 is an untapped solenoid coil.

Subscription rates for "Television and Short-wave World" post paid to any part of the world are : 3 months, 3/6 ; 6 months, 6/9 ; 12 months, 13/6.

New Components for Constructors

JUST recently we have been testing some of the new Shure crystal microphone units which are being stocked in this country by Webb's Radio, Ltd., of 14 Soho Street, W.1. We have come to the conclusion that whenever possible amateurs should use microphones of this type, for their advantages are too numerous to mention in the small amount of space available. However, the fact that they do not require any energising battery or input transformer, and at the same time are entirely free from feed-back troubles, even when used on the ultra-high frequencies, is a very big point in their favour.

High-gain amplifiers can be built to use a crystal microphone that are entirely free from hum, which would normally be picked up in the microphone transformer circuit. There are two models in particular that we recommend to amateurs, and these are the 701A and the 702A. The 701A at four guineas represents excellent value for money and is about the best type of microphone that we have so far tried.

We have previously mentioned the new Valpey crystals which Webb's are stocking, but we did not mention that there is also in this range a crystal suitable for use in the intermediate frequency stages of a super-het receiver. Crystals for this purpose are available in frequencies of 465, 500 and 525 kc.

A new crystal for 20-metre fundamental operation is also available and is capable of withstanding a grid current of 150 mA. It therefore, once and for all, overcomes the objections to crystal operation on 20 metres with a fundamental crystal owing to the possibility of crystal fracture. Actually, the LW20 Valpey 20-metre unit is a 60-metre crystal cut to oscillate at a 14 mc. frequency.

Johnson feed-through insulators have a lot more uses than merely to carry R.F. or high-voltage D.C. from one chassis to another. We have used them on which to mount variable condensers by means of a small bracket so that the rotor plates can be joined to a coil underneath the chassis without additional wiring other than the 2BA bolt through the insulator. These Johnson insulators are made in two types, costing 10d. or 8d. each, according to size, and it is absolutely impossible for there to be any breakdown to metal chassis owing to the use of a long insulating collar inside the insulator.

It is possible to obtain no less than 245 watts of audio from a pair of ZB120 Ampere Class-B triodes. These valves do not require a grid bias and can be driven by quite a small pre-amplifier. These valves cost 65s. each and are about the cheapest way of obtaining high audio output.

and it has been arranged that the grid

"Britain's 1-10 Unique."

(*Continued from page* 39.)

pins in each case come directly above the fixed plates of the tuning condenser, so that they can be soldered directly on without additional wiring.

Plug-in coils fitted with handles, which also serve as protective covers, plug in to these holders, and are so arranged that when the lid of the can is in position there is at least a $\frac{3}{4}$ in. gap between the top of the coil and the bottom of the lid.

In the L.F. section the only component above the chassis is the volume control, R8, which is mounted close to the grid of V3. The remaining L.F. components are kept as near as possible to the L.F. end of the chassis, with the output choke and condenser in the filter circuit next to the 5-pin power socket.

Resistance R9 is of a special type, having a D.C. resistance of 20 megohms and with a $\frac{1}{2}$-watt rating. This component is rather important, otherwise the lead between anode and grid of V2 will be lengthened. In practice it will be found that the distance between C11 and the anode of V2 is approximately the length of the $\frac{1}{2}$-watt resistor.

The standard by-pass condensers are of the normal mica type, but it is an advantage if these are of the special ceramic type owing to the reduction in size.

No less than five coils, however, are required to cover this range owing to the use of miniature tuning condensers. It is not thought advisable at this point to describe the construction of the coils owing to the difficulty that experimenters may have in building their own units, but coils are available ready-built and it is hoped that by the next issue we shall have found some means of describing the construction of the coils in some way that experimenters will be able to copy them exactly.

A maximum of 200 volts H.T. is required with a minimum of 180, with a total current consumption of 40 mA. Valve heaters are fed from a 4-volt accumulator, while for mobile use the entire receiver can be run from a single 4-volt cell plus a vibrator converter or rotary converter for H.T. supply. Full constructional and operating data will be given in the February issue.

The receiver is not intended for programme use owing to the fact that quality is not of the highest order with the super-regenerative detector. However, the receiver is quite suitable for long-distance reception of 7-metre television sound signals for those who care to use it for that purpose.

We have made arrangements for the original receiver to be on show at Webb's Radio for a short period, commencing January 1, 1938.

The New Cossor All-wave Console.

A NEW standard in value has been reached by the introduction of an all-wave super-het console receiver by A. C. Cossor, Ltd. This instrument, model 598, is a very satisfactory family set that will give a very good account of itself.

The wavebands covered are 16 to 52.2 metres, 196 to 556 metres, and 968 to 2,050 metres, so that all the more important channels that cover entertaining stations can be tuned in.

This model is one of the first at its price to be fitted in a console type of cabinet, and, as may be expected, in view of the extra baffling effect obtained with a large cabinet of this kind plus the use of a 10-in. energised moving-coil loudspeaker, quality is extremely good. We also noticed that with very low volume, such as would be used in a small private house, that the overal response did not fall off.

This model 598 is excellent value for money, and the average listener, wanting a reasonably priced set and with maximum value for money, will be agreeably surprised with both the appearance and the performance of this set. Full details can be obtained from the manufacturers, Messrs. A. C. Cossor, Ltd., Highbury Grove, N.5.

OPPORTUNITIES SECTION

BUSINESS :: EQUIPMENT :: EMPLOYMENT :: MISCELLANEOUS

The charge for miscellaneous advertisements on this page is 12 words or less 2/-, and 2d. for every additional word. Single-column inch rate displayed; 12/6. All advertisements must be accompanied by remittance. Cheques and Postal Orders should be made payable to Bernard Jones Publications Ltd., and crossed, and should reach this office not later than the 15th of the month previous to date of issue.

INDEX TO ADVERTISERS

A.C.S., Ltd. ... 32
A.P.A. Metalworks ... 32
Automatic Coil Winder & Electrical Equipment Co., Ltd. ... 1
Baird Television, Ltd. ... 15
Belling & Lee, Ltd. ... Cover ii
British Institute of Engineering Technology ... 62
British Mechanical Productions, Ltd. ... 31
Brown, S. G., Ltd. ... 59
Bulgin, A. F., & Co., Ltd. ... 1
Chapman & Hall ... 57
Clix ... 31
Dubilier Condenser (1925), Ltd. ... 57
Edison Swan Electric Co., Ltd. ... 2
Fluxite, Ltd. ... Cover ii
Foyles, Ltd. ... Cover iii
G5KA ... Cover iii
G5NI (Birmingham), Ltd. ... 62
Galpin's ... 63
General Electric Co., Ltd. ... 16
Keston Mfg. Co. ... 59
McGraw-Hill Publishing Co. ... 31
Mullard Wireless Service Co., Ltd. ... Cover iv
Pitman ... 59
Premier Supply Stores ... 53
Quartz Crystal Co., Ltd. ... 59
Radio Clearance ... 61
Radio Resistor Co., Ltd. ... Cover ii
Radio Society of Great Britain ... 64
362 Radio Valve Co., Ltd. ... Cover iii
Scophony, Ltd. ... 4
Technological Institute of Great Britain ... 59
Sound Sales, Ltd. ... 1
Television Society, The ... 64
Ward, Chas. F. ... 31
Webbs Radio, Ltd. ... 55
Westinghouse Brake & Signal Co., Ltd. ... 32

PATENT AND TRADE MARK AGENTS

GEE & CO., patents and trade marks throughout the world (H. T. P. Gee, Mem.R.S.G.B., A.M.I.R.E., etc.). Estab. 1905. 51-52, Chancery Lane, London, W.C.2 (2 doors from Government Patent Office). 'Phone: Holborn 4547 and 4548. Handbook free.

KINGS PATENT AGENCY LTD. (B. T. King, Patent Agent) 146a, Queen Victoria Street, London, E.C.4 ADVICE, Handbook and Consultations free. Phone City 6161.

SERVICE BOOKS

"Servicing Superheterodynes." Rider. 5/5
"Automatic Frequency Control." Rider. 5/5
"Cathode Ray Tube at Work." Rider. 11/-
"Modern Radio Servicing." Ghirardi. 18/-.
"Radio Physics Course." Ghirardi. 20/6.
"An Hour a Day with Rider" series. 3/3 each.
All prices post free.

HOLIDAY & HEMMERDINGER LTD., 74-8 Hardman St., Deansgate, Manchester 3

FOYLES

BOOKSELLERS TO THE WORLD

Stock of nearly three million new and second-hand volumes. Catalogues free on mentioning your interests.

119-125 Charing Cross Rd., London, W.C.2. *Telephone: Gerrard 5660 (14 lines)*

MISCELLANEOUS

AUSTRALIAN MUSEUM requires specimens of early television apparatus. Write particulars, Room 518, Australia House, Strand, London.

CONDENSERS. Fixed paper, in Metal Containers. 1000volt Wkg. 1mfd 2/6. 2mfd 4/9. 4mfd 7/6. 8mfd 10/6. Bakelite Tubulars. 1000volt Wkg. 1mfd 2/6. 0.5mfd 2/-. 0.25mfd 1/9. 0.1mfd. 1/3. 0.01mfd 9d. The Static Condenser Co. 11, Eden Street, Hampstead Road, London, N.W.1. "Makers of Good Condensers."

RADIO AMATEURS HANDBOOK 1938, 500 pages, 500 illustrations, Formulas, charts and Tables. 5/5d. post free. Smith, bookseller, 6, Racquet Court, London, E.C.4.

SHORT WAVE Variable Directional Aerials. 360° rotating armchair control O-V-1, O-V-2, T.R.F., Super, state receiver and enclose 1½d. stamp for full details to A. W. Mann, 62, Costa Street, Middlesbrough, Yorks.

BEAUTIFULLY built 100 watt C.W. 30 watt Phone transmitter in black crackle finished cabinet for 7, 14 and 28 Mc. with separate power pack. Commercial equivalent would retail at over £60. First £30 or nearest offer will secure. Demonstrate in London, Box No. 16.

OFFERS.—Ediswan 12H, GU1, N43, D42, KT66, Oil condensers, etc. Seen Appointment. Box No. 18.

AMERICAN A.R.R.L. Type Sectional Wood Aerial Masts, complete, insulated guy wires, strainers, pulley, 100 ft. cotton rope, all metal galvanised. 50 ft. 64/6d. Creosoting extra 2/6d. White Painting, two coats, 7/6d. "Fibromet" panels and chassis, "Works like wood," but screens like metal," 3/16", 1/- sq. ft. to size. Low Impedance feeder, 75 ohm approx., 2/9d. 50 ft. Cash with Order. Carr. Fd.—Radio & CNT. Co (G.6.Q.F.), Atherton.

THE HAMS' BOOKSHOP.

RADIO AMATEUR'S HANDBOOK (1938 edition). Completely rewritten and enlarged, with two new chapters. The only thing unaltered is the price (5/6d. post free).

HINTS AND KINKS (A.R.R.L.). The 2nd edition of this book is a bigger time and money saver than its predecessor. (Don't save the money—send 2/6d. at once.)

RADIO AMATEUR CALLBOOK. December number with thousands of new QRAs, 6/- post free. (A two year old copy isn't good enough !)

AMATEUR RADIO GLOBE OF THE WORLD. Marked with all amateur prefixes, time bases and W.A.C. divisions. 27/6d. post free. (Don't let the price stop you—it will always keep the baby quiet.)

RADIO MAP OF THE WORLD (A.R.R.L.). The only difference between this and the Globe, is that the Map can be nailed on the wall. 4/6d. post free. (Can also be used to cover up holes left by QSLs.)

G5KA. 41, Kinfauns Road, Goodmayes, Ilford, Essex. Dept. "T 1."

BINDING CASES AND INDEXES FOR 1937

Binding cases and indexes for the 1937 volume of "Television and Short-Wave World" will be available on Jan. 14th. The cases are full brown cloth with stiff boards lettered in gold. The price, including the index, is **2/9** post free. Indexes may be obtained separately and the price is **6d.** post free. Orders should be addressed—

BERNARD JONES PUBLICATIONS, LTD., CHANSITOR HOUSE, 37/38 CHANCERY LANE, LONDON, W.C.2 and should be accompanied by the remittance.

EXTRA SPECIAL

362 RB 750/150

BI-PHASE 750 VOLT

RECTIFIER 150 M/A IN STOCK!!!

16/- POST FREE

SEE ADJOINING ADVT.

SPEAK TO THE WORLD WITH AN R.F.P.30 TRANSMITTING PENTODE

CHARACTERISTICS:

Filament Volts	4v.
Filament Amps	2a.
Anode Volts	650v.
Max. Anode Input	50 watts
Max. Anode Dissipation	30 watts
Anode Load	10,000 ohms
Screen Volts	400v.
Speech Input	2 watts
Radio Input	2 volts (R.M.S.)

PRICE **45/-** POST FREE

THE 362 RADIO VALVE CO., LTD.

324-6 LIVERPOOL ROAD, LONDON, N.7

TELEPHONE: NORth 1853

Mullard introduce a new type of Cathode Ray Tube

TYPE A.41-G4

THIS NEW TYPE of Mullard Cathode Ray Tube has been specially designed to permit the pair of plates nearer the screen to be used with a non-symmetrical deflection circuit, thus considerably reducing the cost of the associated apparatus.

The design of the focusing electrodes enables an exceptionally small spot size to be obtained over the entire screen area.

Price £6 15s.

COMPLETE WITH SPECIAL SOCKET

ABRIDGED SPECIFICATION

Screen Diameter	4 ins. (approx.)
Heater	4 volts, 1.2 amperes
Maximum Final Anode Voltage	1,200 volts
Deflection	Double Electrostatic
Focusing	Electrostatic

FLUORESCENT COLOUR

A.41-G4	Green
A.41-B4	Blue
A.41-4	White

Full technical information from

THE MULLARD WIRELESS SERVICE CO. LTD.

Cathode Ray Tube Department,

225 Tottenham Court Road, London, W.1

Printed in Great Britain for the Proprietors and Publishers, BERNARD JONES PUBLICATIONS, LTD., Chansitor House, Chancery Lane, London, W.C.2, by THE PRESS AT COOMBELANDS LTD., Addlestone, Surrey. Sole Agents for South Africa: CENTRAL NEWS AGENCY, LTD. Sole Agents for Australia and New Zealand: GORDON AND GOTCH (AUSTRALASIA), LTD.