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Television and SHORT-WAVE WORLD

1/- MONTHLY

MARCH, 1937

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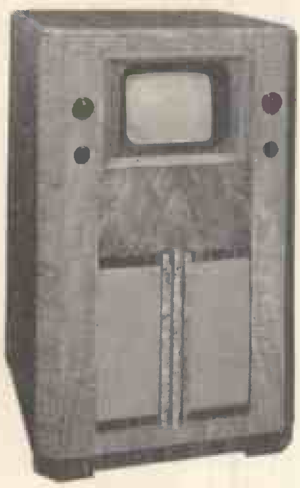
SET PRICES FALL



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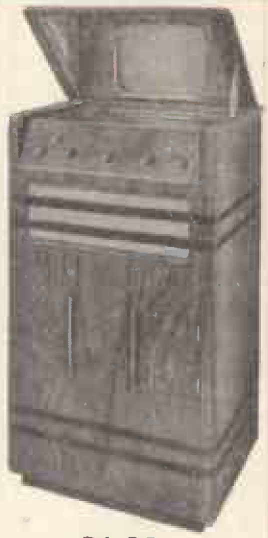

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TELEVISION DIRECTOR ON THE PROGRAMMES

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No. 109 VOL. X MARCH, 1937.

TELEVISION and SHORT-WAVE WORLD

Special Features

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COMMENT OF THE MONTH

One Standard of Transmission

AS we forecast in last month's issue, the decision of the Television Advisory Committee to employ one standard of transmission has now been announced. The test period is over and for at least two years there will be no substantial alteration—no alteration, that is, that will in any way affect receivers which have been produced in the past or will be developed during this further period.

The decision which has been made to use the higher standard of definition appeared inevitable for, as experience has shown that this is entirely practicable, it would have seemed a retrograde step to employ the lower, particularly as the trend in other countries is to go still higher. There is, we know, a very general feeling of regret that the system which bears the name of the television pioneer has, for the time, had to be placed on one side. Each system had its particular advantages and a decision to employ both, but with a common standard, would have been welcomed.

The original decision of the Committee to employ two standards has been criticised from the outset, the chief objection being that two standards would unduly complicate receiver design and construction. Experience, however, has proved that in the case of the cathode-ray receiver this fear was unfounded for the extra complication necessary to accommodate the two systems is quite trivial and only had a slight bearing on receiver cost. The real disadvantage was the duplication of transmission, which entailed duplicate studios and transmission gear and a different technique for each. These conditions placed a very great strain on the resources of the Alexandra Palace and would have retarded development of the programme side of television so long as they obtained; it was chiefly thtese factors which induced the Committee to make its recent decision.

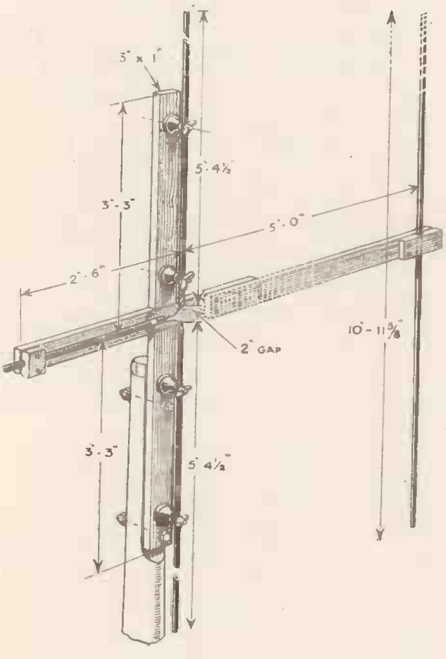
Cheaper Television

THE price reductions of television receivers which have now been announced have exceeded the most sanguine expectations. It has been generally known that it was the price factor which hitherto had retarded sales. The television receiver was regarded as the rich man's toy. At 55 and 60 guineas, and coupled with the fact that it can be purchased on easy terms, the new entertainment becomes a possibility of thousands of homes. Of but little less importance to the buying public are the guarantee of standardised transmissions for a definite period, the promise of programme enlargement and the knowledge that experience has proved that the television receiver is just as reliable and simple to operate as the ordinary broadcast set.

HOW TO MAKE A TELEVISION AERIAL

Precise instructions for building an efficient half-wave dipole

A TELEVISION aerial of recognised efficient design is very easy to construct, particularly as certain parts which it is desirable



This diagram gives all the important dimensions. The reflector can be used or not as desired.

to use are ordinary commercial articles which can readily be obtained.

The aerial about to be described was built to conform with generally accepted practice and which experience has shown to be the most suitable for television reception. It is of the half-wavelength type, commonly called the dipole, though it appears that this

A simple type of stand-off insulator—actually a lighting ceiling rose.

word is really a misnomer. The basis of the aerial is a wooden framework of the form shown by the drawing. It will be seen that this frame consists of four arms of the dimensions shown. The purpose of the short arm is to enable a reflector to be added should it be found that this is desirable; and incidentally this extension enables a stronger joint to be made.

Ordinary deal or pine can be used for the frame, though a hard wood such as oak will be better. If a common wood be used it should be given a couple of coats of good paint before erection. The section of the wood is 3 in. by 1 in. and the centre joint is made with half lap, the two pieces then being screwed together.

Construction

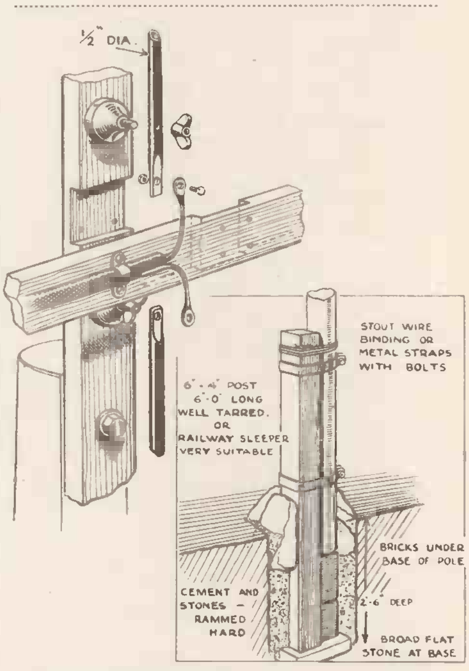
The aerial proper consists of two lengths of ½ in. copper tube each 5 ft. 4½ ins. long mounted on stand-off insulators. Excellent insulators for this purpose can be improvised out of conical porcelain ceiling roses which are used for electric light pendants. These have a flat base provided with screw holes and a hole at the top; they are obtainable from practically any electrical dealer. In the hole at the apex of each insulator a 3/16-in. metal screw is fitted and then holes are drilled in the copper tubes of the aerial through which these screws are passed. Nuts placed on the screws will then firmly secure the insulators to the copper tubes. It is advisable to allow a fairly large clearance for the clamping screws in order that any inaccuracy in drilling the holes will not impose a strain on the insulators when these are screwed down.

The feeder connections to the tubes can be made by slightly flattening the inner ends of the latter and drilling them to take ordinary brass terminals. The feeder is then taken along the horizontal arm and secured at the end by means of a wooden clamp made by drilling a block of wood with a hole of the same diameter as the feeder, which it is proposed to use, and then splitting this and finally securing the two halves to the end of the arm by screws.

Important Dimensions

If the greatest efficiency is to be secured the dimensions of the aerial members and their spacing is important and it may be repeated that each copper tube should be 5 ft. 4½ ins. long. The spacing of the tubes should be 2 ins. and the diameter of these should not exceed ½ in. If a reflector is to be used, as will be described later, then this should measure 10 ft. 11⅝ ins. and it should be spaced from the aerial proper a distance which is a trifle under a quarter wavelength—a distance of 5 ft. will be suitable for this.

The construction of the reflector will be clear from the drawing. An extension piece of wood is secured to



These sketches give the constructional details and method of erecting the supporting mast.

the projecting part of the aerial frame and the reflector is fastened to the end of this by clamping under a grooved wooden block screwed to the frame extension.

The type of feeder used from the aerial to the receiver is important and

(*Continued on page* 139).

CHEAPER TELEVISION

VISION AND SOUND IN YOUR HOME FOR £1 PER WEEK

BIG REDUCTIONS IN PRICE OF RECEIVERS

Sweeping price reductions of television receivers are announced by Baird, Cossor, G.E.C., H.M.V. and Marconiphone. These reductions amount in some cases to nearly 40 per cent. and they bring television appreciably nearer to general home use. In addition to price reductions, receivers have been made available on hire purchase terms of a small deposit and £1 per week with free aerial equipment, free maintenance and one year's guarantee.

Two classes of receiver have been produced in the past by Cossor, Ferranti, G.E.C., H.M.V., Marconiphone and Pye—one incorporating vision and the accompanying sound and in addition either all-wave or normal broadcast, and the other television and the accompanying sound only. The Baird Company concentrated on the latter type only.

The original price of the combined instruments was 120 guineas and this figure has now been brought down to 80 guineas. A corresponding reduction has been made in the case of the one-purpose instruments which sold formerly at 95 guineas, or in the case of the Baird instrument, 85 guineas. The prices now are 60 guineas and 55 guineas respectively. As will be realised these reductions mean a saving of 40 guineas and 30 guineas according to the type purchased. Prices of the Pye receivers will be announced later. We give below photographs of some of these receivers with brief specifications. Very complete details were given in our December, 1936, issue.

THE Baird receiver is a one-purpose instrument designed for reception of the Alexandra Palace sight and sound transmissions. It provides an exceptionally large picture, actually 12 ins. by 9 ins. It is a vertical console 23 ins. wide; 43 ins. high; 19 ins. deep, with the picture produced on a mirror inclined at an angle of 45 degrees. The cathode-ray tube is mounted vertically beneath the safety-glass window. The price is 55 guineas and represents extraordinary value.

The Cossor, model 137T

Two Cossor receivers are available. The model 137T is suitable for reception of the television transmissions and normal broadcasting. Picture size is 10 ins. by $7\frac{3}{4}$ ins., viewed directly on the end of the cathode-ray tube, which is horizontal. The picture is pure black and white. The price of this is 70 guineas. The model 237T includes an additional section with automatic record changer and gramophone pick-up. The price is 90 guineas. On both models 7-metre reception is possible without vision.

Two models are also available from the General Electric Co.; model BT3702 is a very high-class de-luxe receiver in which provision has been made for reception of short, medium and long wavelengths, in addition to television sound and vision transmissions. The picture is viewed directly on the end of a 12-in. cathode-ray tube which is mounted nearly horizontally. This is a massive instrument with a total height of 53 ins. and width of $30\frac{1}{2}$ ins. The price is 80 guineas. The G.E.C. model BT3701 is similar to the former but intended for reception of sound and television only. The cabinet is $39\frac{1}{2}$ ins. high, and 24 ins. wide. The price of this is 60 guineas.

The G.E.C. model BT3702

The H.M.V. model 900, another de-luxe instrument, is designed for reception of television and the accompanying sound, and in addition is suitable for reception of short, medium and long-wave stations. The picture size is 10 ins. by 8 ins., viewed from a mirror mounted at an angle of 45 degrees from a vertically mounted tube. The price is 80 guineas. The other H.M.V. model—model 901—is intended for television and sound only. The picture size is 10 ins. by 8 ins., which is also viewed in a mirror.

Still another combined de-luxe instrument is the Marconiphone which, in addition to receiving television sight and sound, is also capable of all-wave reception. The picture size is 10 ins. by 8 ins., viewed via a large lens from a mirror mounted inside the cabinet at an angle of 45 degrees to the end of the tube, which is mounted vertically. The height of the cabinet is $46\frac{1}{4}$ ins. and the width $37\frac{1}{2}$ ins. Price is 80 guineas.

Marconiphone also make a receiver intended for television and sound only. The picture size of this is $9\frac{1}{2}$ ins. by 8 ins. viewed in a 45-degree mirror in the cabinet lid. The height of the cabinet is $37\frac{3}{4}$ ins. and the width $24\frac{1}{4}$ ins. The price is 60 guineas.

As we go to press we learn that Messrs. Ferranti have also reduced the price of their receivers to 60 and 80 guineas.

The H.M.V. Model 900

WE WATCH A TRANSMISSION

A PERSONAL ACCOUNT, BY THE EDITOR, OF STUDIO ROUTINE AT THE PALACE

An hour spent in the studio during a transmission served to show the difficulties under which the staff at Alexandra Palace are at present working. On the screens of our receivers all appears orderliness, but how different in the actual studio; only that part on which the artists appear is clear, the remainder is a maze of wires, floodlights and cameras, and by no means least an operative staff of close on twenty, all crowded into a comparatively small space.

The studio arrangements are roughly as shown in the sketch, which by the way is the Marconi-E.M.I. studio. There are four cameras on the floor, a centrally placed one on a truck, one on the left which is chiefly used by the announcers and soloists, a duplicate of this on the right and a fourth on the right which is used for pictorial announcements and the clock. The announcements and clock mounting measure about two feet square and consist of a board pivoted in a framework, the clock being on one side and the announcement on the other. By swinging the board round, either the clock or the announcement can be made to face the camera. Running right across this studio there is a bridge on which there is another camera for obtaining bird's-eye views of the set.

Control

All the cameras are controlled from a small room at the extreme top of the studio and facing the stage. Here sit the producer, who can fade from one camera to another, and the control engineers, one for vision and one for sound. In this room there is a monitor receiver.

At each camera there is an operator who is responsible for correct focusing and direction and these operators have assistants who move the bogies or stands upon which the cameras are mounted, into suitable positions.

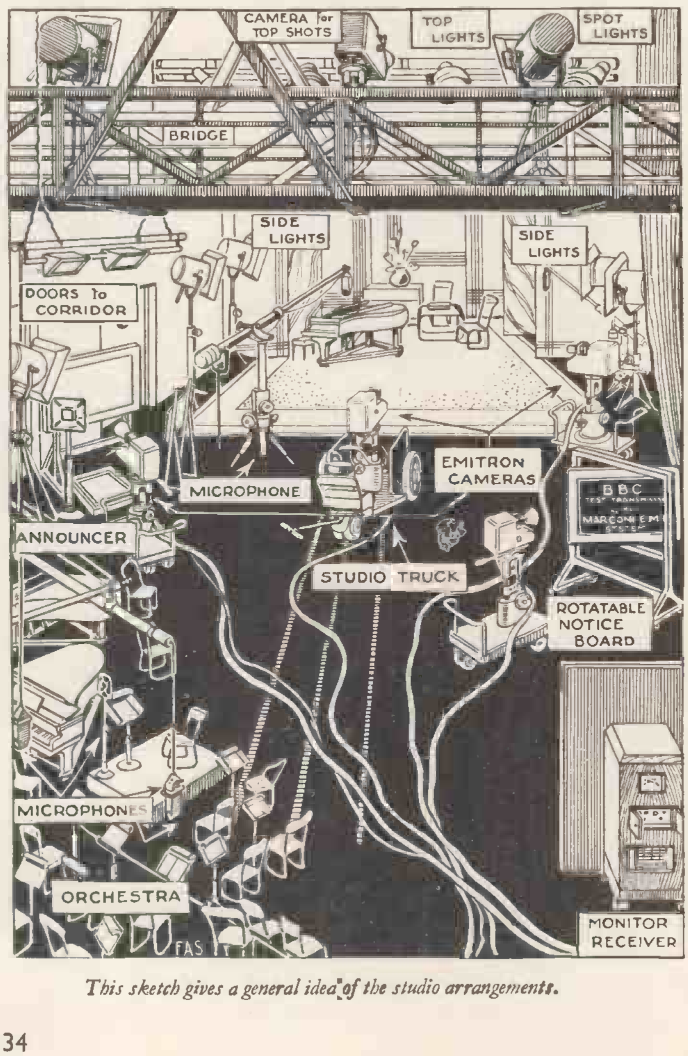
The orchestra is situated at the end of the studio farthest from the set and its position indicates why it is so rarely seen on the screens of our receivers; its transport with all the impedimenta would take quite a time. Ordinarily the orchestra does not appear in its smart uniforms.

Down one side of the studio are a series of doors which open out into a corridor in which are the dressing rooms. Each door is provided with two peepholes and outside there is a red light indicating that a transmission is on. It is through these doors that the artists make their entry to the studio and the arrangement seems most inconvenient, for during a transmission the doors are blocked to some extent by the floodlights, which are situated just behind them.

How a Transmission is Started

Fifteen minutes before a transmission is due to take place the television tuning signal is put out to enable viewers to check the ratio of the picture. If this is correct the white border should occupy the full area of the screen and be of a 5 to 4 ratio. At one minute before the hour a senior engineer announces " One minute to go," and then the tuning caption is faded out and the clock face or a visual announcement of the programme is faded in. At the same time the stage manager blows a whistle and the studio entrance lights are flashed on and off as signals for all operators to take up their positions. The producer and control engineers are now in their cubicle, the camera and floodlight operators have donned headphones and finally the announcer is in readiness before the microphone. Then comes the announcement " Vision on. Sound on," which is the signal for total silence. The clock commences to chime and as the sound of the last stroke is dying away the announcer commences to talk, and the producer fades in the camera which she is facing.

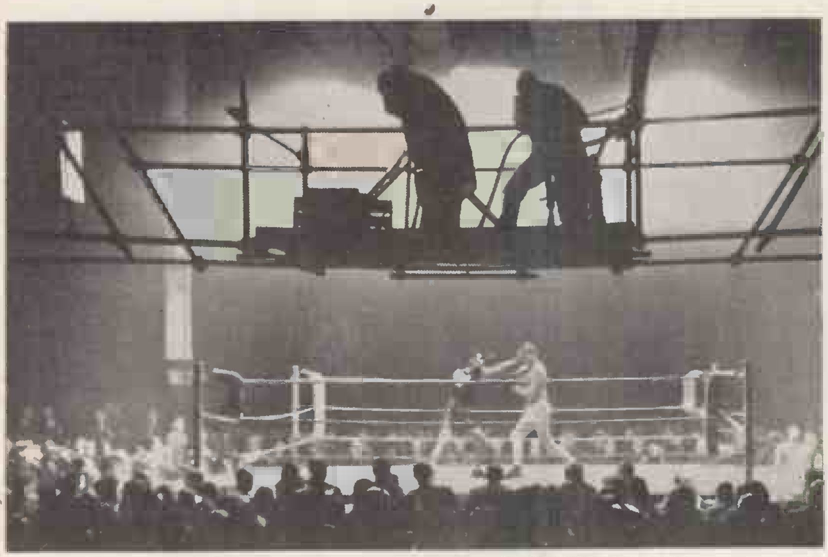
This, roughly, is an outline of the procedure though variation is sometimes necessary on account of special



This sketch gives a general idea of the studio arrangements.

STUDIO ROUTINE AT ALEXANDRA PALACE

circumstances. Once the programme has started everything appears to go smoothly, but a study of studio routine makes it apparent that the programmes are being produced under somewhat difficult conditions, though they are conditions which no doubt in time will be rectified when more space becomes available. The human element enters very largely into presentation and although the programmes are very carefully rehearsed under transmitting conditions beforehand it is obvious that any slip is impossible of rectification.



A photograph during the actual transmission of a Boxing Match on February 4.

A steady improvement has taken place in the programmes of late and it can be reasoned that this progress will be maintained and the scope materially increased, particularly when the apparatus for outside broadcasts which is now under construction is ready, and the space which at present is occupied by the 240-line transmission gear becomes available. The decision to use one standard of transmission should make a great deal of difference to the programmes for, presumably, the present studio arrangements will be duplicated and so enable ambitious programmes to be run continuously.

THE DIRECTOR OF TELEVISION ON THE PROGRAMMES

As there has been a considerable amount of adverse criticism of the television programmes we took the opportunity when at the Palace of discussing this side of television with Mr. Gerald Cock, the B.B.C. Television Director.

"One of our greatest difficulties," said Mr. Cock, "is lack of space." (He was talking to us on the eve of the announcement that one of the transmitting systems was to be discontinued.) "This is practically a duplicate television station and all rehearsals have to be conducted in the same studio from which transmissions take place. With the adoption of one standard of transmission our work would naturally be facilitated as there would be available another studio which when properly re-equipped could be used under transmission conditions.

"Catering for *two classes of viewers* is also making programme construction difficult, for obviously a programme intended for casual viewers who may drop into viewing rooms for a few minutes will not be appreciated by home viewers who are able to watch the programme throughout in comfort. The best viewing-room programmes would probably be a succession of short cabaret and topical turns which would be appreciated in the short time available, but while we appreciate that the casual looker-in should not be neglected at this stage, we have to remember that the home viewer is our real objective. Ultimately we hope to provide a service with a balanced mixture of entertainment and general interest.

"Suitable light entertainment is not easy to secure, the difficulty being increased by the ban placed on artists by certain theatrical interests," continued Mr. Cock. "That is the reason we use a number of foreign cabaret artists. A wide selection of suitable films is not readily obtainable, but later on it is hoped to give excerpts from the current films as was done during the experimental transmissions to Radiolympia. At present their preparation takes too much time.

"The present stage should be regarded as experimental. There is no precedent anywhere in the world and it is only possible to develop the technique of presentation by experiment. We do not desire to imitate the pictures, the stage or the newspapers.

"Drama is difficult to present; but with the general title 'Theatre Parade,' there will be excerpts from current productions. A series of one-act plays, and scenes from Shakespeare and other classics, will be played by leading actors. Opera and ballet have not been too successful on the present small screen, and, as with serious music, we shall have to feel our way towards the best form of presentation.

"In the near future we hope to be able to present more original productions. This would need facilities which we do not possess at the moment but which will come. Local outside broadcasts will start again when the weather and light become more reliable. Later, when our outside broadcast equipment is ready (this is now under construction) we shall go further afield, and that will be a great day for television. We can at any rate contemplate such exciting events as film or theatre foyers at first nights, or the arrival in London of celebrities, as well as more important national events.

TELEVISION IN CZECHOSLOVAKIA

Results obtained by the B.B.C. with the television transmitter at Alexandra Palace have been carefully watched by the Czechoslovakian Post Office before they committed themselves to any definite line of action.

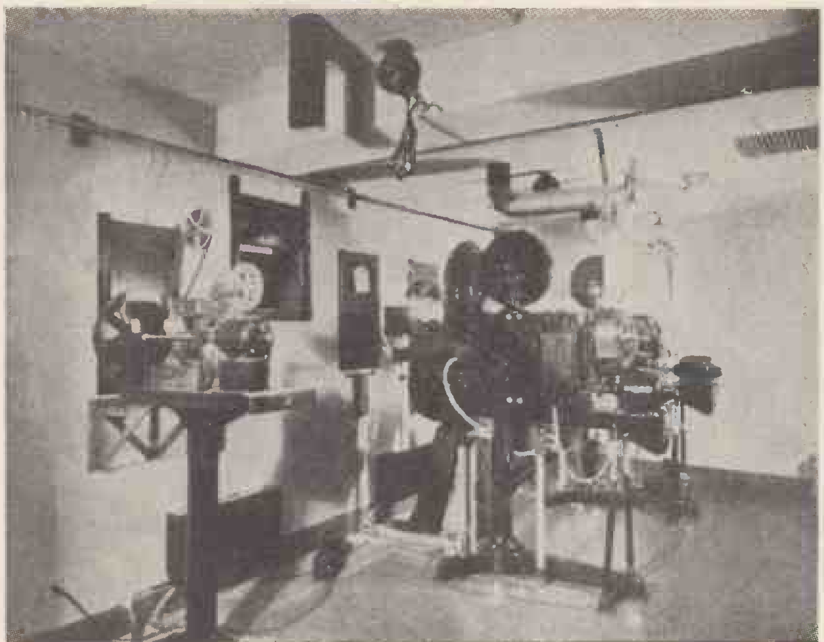
However, as one standard system has now been adopted in this country giving the impression abroad that television has come to stay, other countries are going ahead with their own plans.

The Czechoslovakian Post Office now announce that plans for a television station in Prague are well in hand and that transmissions can be expected towards the end of 1937.

THE R.C.A. TELEVISION SYSTEM

We are indebted to Electronics (New York) for this abstract of a paper read before the Radio Institution of New York describing the television system developed by the Radio Corporation of America.

The first tests of high definition television using the new standards which have been recommended by the radio industry to the Federal Communications Commission are now being conducted by engineers of the Radio Corporation of America and the National Broadcasting Company.



The film projection room containing the special projectors

Images scanned by the R.C.A. Iconoscope at the rate of 441 lines per frame have been transmitted from the N.B.C. experimental station in the Empire State Tower and successfully received by a selected number of experimental television receivers in the homes of RCA-NBC engineers.

THIS description of the R.C.A. television system was given recently by Mr. Ralph R. Beal, Research Supervisor of R.C.A., who presented before a large audience at the New York Section of the I.R.E. a paper entitled " The R.C.A. Television Field Test System." The paper made no attempt to present or to interpret the information thus far revealed by the tests, but concentrated on describing the experimental units.

The various equipment units in the system may best be described by following a typical programme through from studio or film projector to the viewing screen at one of the receivers. Briefly, the video units involved in the R.C.A. building are: A completely equipped television studio for live talent, a projection room for transmitting film, monitoring facilities, a central synchronising generator for generating synchronising impulses, and video line amplifier and terminal equipment. This terminal equipment feeds either of two connecting links between the R.C.A. building and the Empire State transmitter. One link is an experimental coaxial cable; the other is a u-h-f transmitter operating on 177 mc. which sends a more or less directional beam toward the 85th floor of the Empire State building.

At the Empire State building are input equipment (including a receiver for the radio link and terminal amplifiers for the coaxial cable), further monitoring equipment, the transmitter itself, and finally the transmitting antenna. Paralleling all this video equipment is audio equipment of more or less conventional design, including a high-fidelity telephone circuit between the studios and the transmitter.

Thus it will be seen that the experimental system is a complete broadcasting plant, and it has been installed substantially as it would be employed in a radio broadcasting service. The equipment as shown in the illustrations has a highly professional appearance and has been constructed with a degree of care not often found in an experimental system.

Standards of Transmission

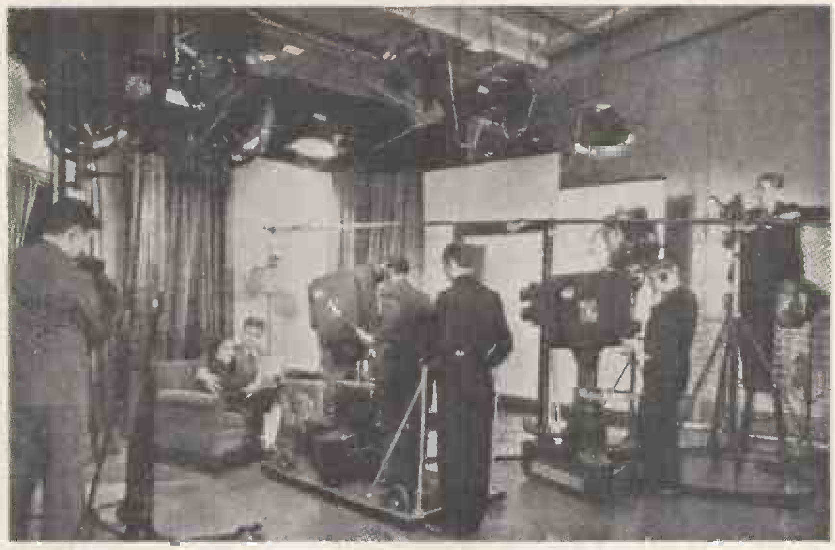
Of basic importance in the tests are the standards used for scanning and for picture repetitions. At the time the tests to which this paper relates were made the pictures were scanned in 343 lines per frame, and 30 times per second. Odd-line interlacing was used, in a 2-to-1 ratio, giving 60 field scannings per second. The aspect ratio (width-to-height) was 4-to-3. The maximum video frequency in the R.C.A. system has been set at 1.5 mc., which is 64 per cent. of the value (2.35 mc.) dictated by the conventional formula for the maximum frequency = $\frac{1}{2}$ (aspect ratio) (frame frequency) (number of lines)^2.

With 1.5 mc. as the maximum frequency in the sight signal, all of the video equipment from Iconoscope pick-ups through to the modulator of the transmitter must be capable of passing frequencies from about 20 cps. to 1,500 kc. The 177 mc. radio relay link passes two side-bands of this width. The carrier frequencies of the main transmitter are 49.75 mc. for the picture signals and 52 mc. for the sound. Both of these carriers are radiated from the same antenna, whose frequency response is wide enough to pass the audio side-bands (10 kc. wide) and the upper side-band of the video signal (1.5 mc. wide). The lower side-band frequencies (49.75 mc. to 48.25 mc.) are partially attenuated by the antenna system. Feeding both audio and video transmitter outputs to the same transmission line requires the use of concentric

tric line filters to prevent interaction between the two transmitters.

The standards of the system have now been changed to agree with those recommended by the R.M.A. Television Committee, which call for a 441-line picture and a maximum video frequency of 2.5 mc., but which are otherwise in substantial agreement with the present set-up.

The studio is provided with three Iconoscope pick-up cameras, each with its associated amplifier. The cameras are supplied with synchronising pulses from the main generator. The cameras are fitted with optical equipment as follows: Telescopic lens, 18 in. focal length; "straight" lens 7.5-in. focal length. The latter lens, which operated at f. 4.5, gives an effective depth of focus of about 3 feet at a distance of 10 feet.



The R.C.A. studio. Five men operate cameras, lights, and microphone boom in the experimental studio.

The lighting system of the studio is of considerable interest. Normally, incident light of 800 to 1,000 foot-candle intensity is used. The light sources are conventional incandescent lamps, fitted with heat filters which are necessary to protect the artists. An augmented air-conditioning system is installed in the studio and is capable of removing heat-energy at a rate of 50 kilowatt-hours per hour. The audio pick-up is handled with the conventional microphone boom now used in motion picture productions. At least five men are required on the studio floor to handle cameras, lights, and microphone.

A feature of considerable interest is the monitoring and control booth associated with the studio. The monitoring console has three positions arranged on a single desk, for audio monitoring, video monitoring, and for production control, the latter being the centre position. The audio position is conventional.

The video position contains detail, brightness, contrast, and scanning-voltage controls for each of two channels, which are each individually monitored by means of a Kinescope and a conventional oscilloscope. The former gives the image in reproduced form while the oscilloscope shows the waveform of the scanned lines in relation to the "pedestal" (d-c signal level) on which the synchronising impulses are superimposed, thus making possible maximum use of the modulation depth available for the video signal.

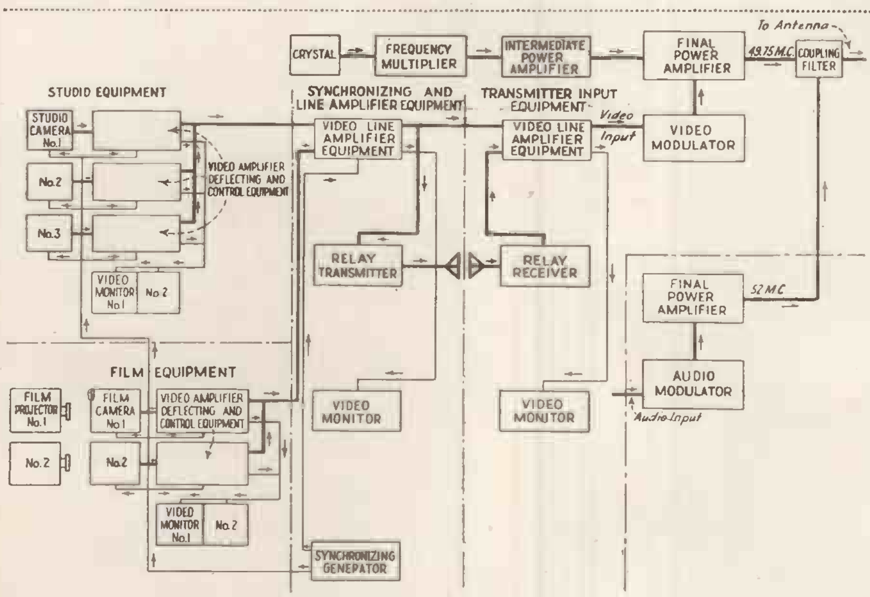
Two channels are provided so that one may be set up and made ready for use while the other is delivering the programme. Also in the control booth are the video and audio amplifiers which feed the signals to the terminal equipment in the main equipment room.

Motion-picture Projector Equipment

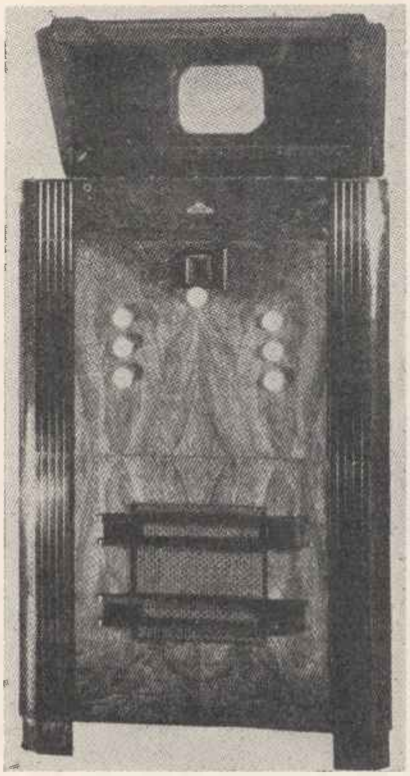
A separate room in the Radio City studios is set aside for film projection. Two projectors of special design are available. The special design is made necessary by the fact that standard sound motion picture film runs at 24 frames per second, whereas the television image is scanned at the rate of 30 times per second.

The film runs through the projector at an average speed of 24 frames per second, so that the sound track is reproduced at proper pitch and tempo, but each individual frame does not remain in place for the same length of time. Instead the frames are projected alternately at a rate of 20 and 30 frames per second, by means of a special intermittent mechanism, which gives an average rate of 24 per second. Two successive frames are available, 1/20 second scanned three times and 1/30 second scanned twice, averaging 1/24 of a second each.

The projector is fitted with a shutter which admits light from the film to the Iconoscope during only a very small part of the time during which each frame is stationary, actually only during the time when the scanning beam in the Iconoscope is returning from bottom to top of each set of interlaced lines. The light impulse



Schematic arrangement of the R.C.A. television system.



An R.C.A. receiver which was used for checking the transmissions.

creates a charge-picture on the mosaic of the Iconoscope which remains until scanned.

The film-projection room is fitted with monitoring apparatus for two video and audio channels, one for each projector, so that continuous film programmes can be handled.

Studio to Transmitter Connecting Links

The 177 mc. "interbuilding radio-relay" circuit consists of a transmitter situated on the 10th floor of the R.C.A. building and a receiver on the 85th floor of the Empire State building. The relay transmitter is fed from the studio or film projection room through a coaxial cable, and the video signals are monitored at the transmitter input. A directive antenna in the 14th floor level consisting of a dipole in front of a plane metal reflector directs a beam toward the Empire State building. Here a receiver (with monitor) converts the 177 mc. signal back to the video frequencies (from 20 cps. to 1.5 mc.) which in turn are fed to the modulator of the main transmitter. The radio relay circuit has been found to be highly satisfactory, and gives a picture quality equal, in detail and in freedom from noise, to the signal transmitted over the coaxial cable. The latter is terminated in the main equipment room of the N.B.C. and extends to the Empire State building, finally terminating at the modulator input of the main transmitter.

Main Transmitter

The transmitter in the Empire State building consists of two units, the video and the audio, which operate at carrier powers of 8 kW each. Both units use special valves in the final amplifier which are designed for generation of wide bands at the high carrier frequency required. The valves dissipate about 30 kW at the plate, and deliver an electron emission of 18 amperes per valve, a value which permits 8 kW output when the final tank circuit is loaded to pass the 1.5 mc. side bands which are produced. No attempt is made to reduce either of the side-bands, at the transmitter, although as pointed out above, the antenna does attenuate the lower side-band frequencies somewhat. In the audio transmitter, conventional plate modulation is used, but in the video unit, it is next to impossible to produce efficiently the high voltages required for plate modulation over the extremely wide frequency band. So grid circuit modulation, impedance-coupled to the grids of the final amplifier, is used.

The transmitter is provided with a control board which gives visual monitoring of the video signal at the input to the modulator. This monitor can be connected either to the coaxial cable or to the radio relay receiver. All video signals throughout the system are sent over coaxial cable, except, of course, in the case of r-f transmission from the radio relay and main transmitter radiators. Even the line-cord jacks used in the video circuits are of special coaxial design.

The outputs of the two transmitters are coupled through selective filters to a common transmission line of the concentric type which in turn connects with the main radiator mounted on the top of the Empire State building at a height of 1,250 ft. The horizon at sea level viewed from this antenna is approximately 45 miles away.

The radiator is of unusual design; it consists of nine horizontal dipoles arranged as the sides of three equilateral triangles, one above the other and supported by a pipe framework. The emitted wave is horizontally polarised, and the radiation pattern around the antenna is approximately circular. The vertical spacing between each triangular set of dipoles is so chosen that the high angle radiation from the structure is reduced to a very low figure. Great concentration of radiated energy in the horizontal plane has been achieved. The signal is, in fact, about 3.2 db. stronger in the horizontal plane than it would be if radiated directly from a vertical dipole.

The range of the transmitter has only partially been investigated. The reliable service area seems to be about 25 miles. However, good reception in a favourably-situated suburb 45 miles away is consistently reported.

Test Receivers

The reception of the television signals is confined to a small number of receivers, not over 100 in all, which are distributed in New York City and the surrounding suburban area.

The receivers are superheterodynes, tune from 42 to 84 mc. and accept both the audio and video signals at once. A common video-audio r-f amplifier (using an acorn tube) feeds the two carriers to a common first detector, at the output of which two different i-f frequencies (audio and video) appear. The video i-f is amplified, applied to a second detector and thence to the control electrode of the Kinescope. Included in the receiver are circuits for selecting the synchronising signals from the incoming wave (amplitude and wave-shape selection are used); these signals control the vertical and horizontal deflection generators. Control knobs are provided for control of tuning; of sound volume, sound high-frequency tone, sound low-frequency tone; sight detail, sight brightness, sight contrast; horizontal and vertical scanning and synchronisation.

The Kinescope image-tube is mounted vertically, screen uppermost and protected by a shatterproof glass plate. The image is viewed in a front-surfaced mirror on the underside of the cabinet lid. Including the Kinescope, 33 valves are used in the receiver; two power supplies, one for the high accelerating voltages in the Kinescope and the other for all other requirements, are used. The receiver draws approximately 350 watts from the power line. The audio system in the receiver is high fidelity (to 10,000 cps.) throughout.

The receiver so far as the video

channel is concerned is a quasi-single-sideband type. The i-f circuits in the video channel pass only the high-frequency side-band without attenuation, whereas the low-frequency side-band is considerably attenuated. This practice is adopted solely in the interest of economy, since the narrowed band involved permits much higher amplifications per stage with the valves at present available.

Each observer in the area has been provided with forms to be filled in during each observation. The information reported on concerns the settings of the controls, and the necessity of resetting them, whether or not trouble was encountered with the vertical and horizontal framing or synchronisation, with the type of noise interference encountered, and similar items.

The two most troublesome sources of noise interference with the video signal were those resulting from automobile and aeroplane ignition systems and from electronic diathermy machines. In the absence of such interference a signal of one millivolt is generally considered satisfactory to drive the receiver. However, when those noises are present, a much stronger signal is necessary to overcome their effects. Ignition noise usually affects a part of one or more lines in the picture, causing that part to remain either completely bright or completely dark. Interference from diathermy machines, especially when the machine is operated with unrectified plate supply, takes the form of a blanketing of many successive lines, sometimes as much as one-fourth of all the lines in the picture.

SCREENS FOR DAYLIGHT PROJECTION

A NEW type of screen which enables projected pictures to be viewed in daylight, was demonstrated in London recently. This screen, which has been developed primarily for cinema purposes, would appear to be very suitable for television systems employing mechanical scanning. The advantages are that there is no flare, as the nature of the material, which is a specially treated fabric, diffuses the light evenly over the whole of the surface; in addition it is evident that full use is made of the available light and the picture is therefore considerably brighter than is the case when projected on to ordinary surfaces.

Two main types of screen were shown—front projection and rear projection—and the difference in brightness between the two was not apparent, though obviously in the latter case there must have been a slight loss of light.

Contrary to the usual practice of having complete darkness between the projector and screen for rear-projection, there was almost as much light *behind* the screen as in front.

With rear-projection there is no eye-strain, so the pictures can be viewed close-up as well as from a distance. There is no distortion or shadows produced by side-viewing.

Another novelty shown was a black screen, and with this again there are two types for both front and rear projection. With these there was a noticeable loss of light, but not sufficient to make daylight projection impracticable. The chief value of the black screen is an æsthetic one, the idea being that when no projection is taking place the actual screen is invisible to the audience. The patentees of these screens are Universal Opalescent Projections, of Parsonage Chambers, Manchester.

Lenses Moulded from Plastics

AN entirely new method has been invented for the production of optical systems—lenses and the like—from plastic materials.

The invention, which consists of a moulding process, delivers from specially designed machines lenses already polished and ready for mounting into cameras, binoculars, opera glasses, telescopes, spectacles, range-finders, stereoscopes, scientific instruments, television apparatus, etc. The lenses are made by special treatment for their particular purposes from various plastic and transparent materials. They are for all practical purposes unbreakable as well as being half the weight of glass and have certain optical properties which are stated to be superior to glass. One of the plastics used in the process is known as "Perspex," a material recently developed by Imperial Chemical Industries, Ltd.

All the long and expensive grinding and polishing processes by highly skilled labour, which are at present necessary for the manufacture of optical systems, are not needed, for the lenses come from the moulding machines in the finished state. They are, however, only suitable for quantity production owing to the initial cost of preparing the moulds. The refractive index of the material can be varied in its preparation to suit particular requirements and it is stated to be unaffected by ordinary variations of temperature. The Combined Optical Industries, Ltd., of 21 Denmark Street, W.C.2, are placing these lenses on the market.

"How to Make a Television Aerial"

(*Continued from page* 132)

if the greatest efficiency is to be secured one of the special types designed for the purpose should be employed. Twisted feeders consisting of ordinary or rubber-covered flex are not recommended as their use recults in a considerable loss. The concentric type is very efficient, but rather costly. There is an excellent alternative in the Belling Lee high-frequency low-impedance transmission line that has been specially designed for television purposes. This consists of two enamelled copper conductors embedded the correct distance apart, in an oval Teleconax sheath. This feeder can be brought away from the aerial in any direction, but if the concentric type is used then it is desirable to carry it horizontally for a distance of at least three feet, and it is for this purpose that the horizontal extension arm is provided.

Bright metal-to-metal joints should be made where the feeder is connected to the aerial and these should be covered with insulating tape, and finally with some insulating compound to prevent oxydisation taking place.

The aerial should be erected in as high a position as possible and free from the screening effects of near-by buildings. If a reflector is used, aerial and reflector must be on a line in the direction of the transmitter, the reflector, of course, being the further away. The direction can easily be arrived at by means af a map and compass.

REVOLVING MIRRORS—A THEOREM

By CHARLES DALTON

In this article the writer states and proves a theorem, not hitherto published to the best of his knowledge. With the aid of the theorem the study of certain distortions in the path of a reflected ray is greatly simplified

It would be rash at this stage of television development to forecast the demise of the mirror drum. It forms the basis of mechanical optical vision receivers not yet in commercial production but giving promise. Any day some inventor may devise a modification or adaptation that will help still further to restore the balance as against the purely electric systems.

In connection with the revolving mirror the writer has developed a theorem which stated formally is:—

The path traced by the image of any stationary point or line in a mirror revolving about a fixed axis is identical with the path traced by some point or line fixed in relation to a cone which revolves, apex to apex, about a similar fixed cone. The common apex is the point where the fixed axis meets the plane of the mirror. The semi-vertical angle of both cones is equal to the angle between the fixed axis and the plane of the mirror.

Here is the demonstration:

Let A be the fixed point, B its initial reflection in the mirror, O the intersection of the fixed axis OC with the plane of the mirror, OD the reflection of OC in the mirror, Q a cone touching the mirror and with OC for axis, R a cone touching the plane of the mirror and with OD for axis.

Consider the displacement of B when the mirror rotates through an angle L. This is the same as if the point A, instead of remaining fixed, first revolved with the mirror through the angle L and then revolved about OC through an angle L, the mirror remaining in its new position. The corresponding movement of the image point B is first a rotation through angle L about OC followed by a rotation through angle L about the new position of OD.

Compare this with the displacement of B, when it is regarded as being in fixed relation to the cone R. When R rolls through an angle L about Q its final position is the same as if it first rotated through the angle L about OC, maintaining the same orientation to OC, and then rotated through the angle L about its own axis OD.

The effect of these two displacements on B is first a rotation L about OC and then a rotation L about the new position of OD. The final position of B is the same whether it is regarded as the image of A in the revolving mirror or as a point fixed in relation to the cone R.

The proof also holds for any series of points such as a straight line. If a pencil of rays is directed upon a revolving mirror the reflected pencil may be visualised as a long needle stuck into the rolling cone.

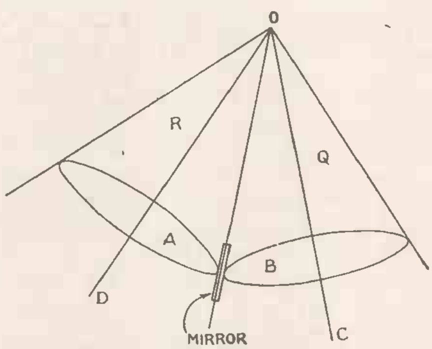


Diagram explaining the theorem.

Practical Applications

Several results follow at once upon this theorem.

The image B lies at the same distance from the apex O of the cones as the fixed point A. Therefore B always lies on a sphere with centre O and passing through A, and since the two cones meet the sphere in equal circles the path of B may be regarded as that of a point fixed in relation to a circle which is rolling on an equal circle, all the movements taking place on the spherical surface. Thus the exact position of B can be readily calculated by spherical trigonometry after the mirror has revolved through any given angle.

Usually the mirrors of a mirror drum are parallel to its axis, or very nearly so. This means that the apex of the two cones is very remote or even at infinity. In the latter case the problem becomes that of one cylinder rolling upon another.

If the pencil of light from a Kerr cell is at right angles to the axis of the drum and falls on a mirror paralled to the axis, the reflected pencil is carried by the rolling cylinder. It will trace out a straight line on any plane parallel to the drum axis and, with one or two exceptions of merely theoretical interest, this is the only instance in which a ray reflected from a mirror drum can trace a straight line on a screen.

If the light falls on one of the staggered mirrors we get a cone of very small vertical angle rolling on another cone and the reflected ray itself traces out a surface very nearly that of a flat cone. This meets the screen in a figure resembling a hyperbola. The more the mirror is staggered, the more marked the hyperbola shape of the line on the screen. This effect gives mirror drum pictures a slight "waist."

In a straightforward drum picture the effect is no particular detriment, but in systems using compound reflection the designers may find that their picture lines intersect or fall into zones. By compound reflection systems is meant those such as the Mihaly-Traub in which the light from the modulating cell, reflected by a mirror drum, traverses a series of stationary mirrors, each of which reflects the light back to the mirror drum, whence it travels to the screen.

For all such systems the equivalent arrangement of rolling and stationary cones may be worked out, and will probably help to clear the inventor's ideas, particularly if he is not one of those fortunate people who can think easily in three dimensions.

OUR POLICY
The Development of TELEVISION

WHAT THEY EXPECT OF TELEVISION

Many of Britain's most famous men and women in the entertainment world reveal in this intriguing symposium—which appears exclusively in "Television and Short-wave World"—the high hopes and dark fears which the institution of a regular television service has aroused in their minds.

Contributors, whose views have been collected by Kenneth Baily, include :

C. B. COCHRAN—*World's greatest wizard of the stage.*
DAME SYBIL THORNDYKE—*One of our most famous actresses.*
JACK HULBERT—*Britain's well-known film comedian.*
DOROTHY DICKSON—*Beautiful revue star.*
LEONARD HENRY—*Famous microphone mirth-maker.*
GORDON HARKER—*Great character comedian of stage and film.*
JACK HYLTON—*World-famous " Daddy " of all dance bands.*
GEORGE ALLISON—*The celebrated radio sports reporter.*

WHEN broadcasting began in Great Britain the show business monarchs of the West End and sports promoters throughout the country did not talk much about it, and in fact regarded it with grave suspicion. For a long time they tried to dismiss it as purely an interesting experiment with wireless, a novelty for the few technically-minded.

It is gratifying that history is not repeating itself in this respect with the beginning of television.

The aerial mast at the Alexandra Palace already points a meaningful finger to the sky, and below it London's theatre and film land is humming with speculation, guesses and prophecies as to whether that finger is beckoning—or threatening.

What are the impresarios, the actors and actresses expecting of this new medium on their horizon?

Our special investigator has been among them and put the question: "What do you expect of television?" Here are their replies:

Charles B. Cochran, Britain's premier showman, is quite definite about it, startlingly frank.

" I expect television completely to revolutionise the entertainment business," he said. " Pictures and talkies have occasioned only slight readjustments. Television will get to the very roots of all entertainment. Its way will not be anything like so smooth and easy as the path which sound broadcasting has taken, despite all the difficulties even that medium has overcome. Television will need almost superhuman control and super intelligent development. Yet I believe that all workers in the amusement industry ultimately will benefit by television."

Dame Sybil Thorndyke, great actress and vital supporter of the legitimate stage, is apprehensive.

" I am quite excited about television as a scientific wonder," she said. " But as a medium for entertaining people I approach it more warily.

" All mechanised art is bad for the theatre, for the music concert hall, and for the people. And I do not mean financially damaging; I mean artistically. No art succeeds unless you make an effort yourself to understand and enjoy it, even if it is only leaving your armchair to go to a theatre.

" I don't think that drama—fine drama that does you good and is a contribution to the age—can ever be brought to the armchair. There is no reaction between the artist and the person, and consequently no vital effect on the person. It will be far easier for television to be bad for the arts than for it to aid them."

Dorothy Dickson is of the opinion that television entertainment has a great future.

Gordon Harker, famous character comedian of stage and film, expects nothing startling.

" I don't think that television will affect the theatres at all, and the cinemas only a little," he told me.

" Nothing, however good, will keep people at home all the time for all their entertainment. It may be convenient to be able sometimes to see a play at home, but when the novelty has worn off people will find they are missing the best part of the enjoyment they derived from seeing plays on the stage. I believe television ought to give more employment in the film world, and increase the variety of cinema programmes. It will run more or less parallel with films, sometimes co-operating with them."

Leonard Henry, famous broadcasting comedian and a proved television star, doesn't expect anything spectacular of television because he sees all manner of problems and difficulties in the new medium.

" It's another case of the machine becoming bigger than the man," he said. " It's bigger even already, when it's only a baby. The possibilities inherent in television are immense and can be rightly construed as threatening to art and entertainers and vested interests, and equally rightly as promising for these.

" Television will have to be very carefully controlled, or else it will just run riot and make an awful mess. I think the B.B.C. will have its work cut out to find enough entertainment to fill three one-hour programmes in the early stages, let alone when a full service has got to be run. The films have educated the public, and after the novelty has gone, people will expect to see on their television screens the same high standard of entertainment, the same wizardry and marvels, as they see at a cinema. There'll be no fun watching an orchestra playing for half an hour, the same face talking at you for ten minutes, or the face of a singer.

"Fabulous wealth, genius-like brains, hundreds of staff, and acres of studios will be required to keep up a constant output of real entertainment. It will be possible, of course, to re-transmit certain programmes, and to broadcast documentary films, but unless the programmes are 90 per cent. good entertainment there'll

DOROTHY DICKSON, JACK HULBERT, JACK HYLTON, and GEORGE ALLISON

be no demand for them, or for television receivers.

"Television faces a far more critical audience than did films or broadcasting when they began, but it is far too big a wonder for me to conjecture about too deeply at the present stage."

Dorothy Dickson, beautiful revue star, is very optimistic.

"I think that the B.B.C.'s new television programmes are going to be the eighth wonder of the world!" she exclaimed. "Television will bring employment to the entertainment profession, and more beauty, humour, and interest to the public in their homes everywhere. I cannot see it ever interfering with the theatre.

"People will always want to see artists in the flesh. To country people, and provincial people generally, television will be a great boon; they will be able to see artists hitherto kept from them and will be able to watch the events that are making history actually happening. For the artist it will have the complementary advantage of giving him a bigger audience than he has ever had, and more scope to win recognition."

Jack Hulbert, England's famous film comedian, foresees the new demands which television will make upon radio stars.

"Television may be a new wonder, but, fundamentally, it is the same old principle—acting. The artist broadcasting uses the voice to stimulate an imaginative picture in the listener; in television he will have to be talented enough to appear facially and in gesture exactly as the listener listening-in has previously imagined him to be. There are artists particularly gifted in expressing themselves facially and by gesture, and they will be the television stars; and there is always plenty of talent, and television will be yet another avenue for its discovery. The profession needs it for that reason, if for nothing else.

"But good voices—or good looks—will not be enough; television, new as it is, will go back to the first essential of acting, the ability to mimic, mime and pull faces."

Jack Hylton famous dance band director, expects televising to be harder work.

"More rehearsal will be required for it, for the effect of the performance will depend as much on appearance as on sound. I don't think it will be harmful to the prestige of a music-hall band; there are two distinct atmospheres in seeing a band on the stage and seeing it on a fireside screen, and the people will appreciate both, and want both."

Will television revolutionise the Englishman's interest in sport?

George Allison ace soccer commentator and manager of the Arsenal, looks upon it very practically.

"As an accomplished scientific fact, there is no getting away from television, but as a means of giving the public its sporting recreation it will have to be kept in leash.

"Television will become as much a recognised part of national life as broadcasting, with the difference that it will have to air individual sporting enterprises which depend on public support, and not replace them. You will never get anything, however wonderful, receiving the sanction of private enterprise if it is going to retard that enterprise.

Gordon Harker does not fear television as a competitor of stage and film.

"Our new stadium at Highbury has been wired for television so that when the Arsenal are playing away from home, the home supporters can come to the ground and still see, by television, the away match which may be taking place, say, at Birmingham. And it is on those lines, I think, that television will co-operate with sport. I certainly cannot see it being allowed to put publicly supported events into private homes."

Our Policy
"The Development of Television."

One Standard of Transmission

The Postmaster-General announces that, as a result of the experience gained of television transmission from the London Television Station at Alexandra Palace, the Television Advisory Committee have recommended that the London experimental period—during which different technical standards of transmission have been used during alternate weeks—should now be terminated and that a single set of technical standards should be adopted for public transmissions from the London Station. This recommendation, which has been approved by the Postmaster-General, provides for the adoption of standards as follows:—

- Number of lines per picture—405 interlaced.
- Number of frames per second—50.
- Ratio of synchronising impulse to picture—30:70.

These standards for the television service from the London Station will not be substantially altered before the end of 1938.

Consequent upon this decision television transmissions from Alexandra Palace of 240 lines with 25 frames per second will be discontinued and all future transmissions will be on the standards set out above, which will be known as the London television standards.

The Radio Exhibition

The Radio Manufacturers' Association has decided that Olympia is a more suitable building for its future radio exhibitions than Earl's Court, and a new contract has therefore been made with Olympia, Ltd., and dates settled for the next four exhibitions, which are as follows.

1937 August 16-September 5.
1938 August 17-September 6.
1939 August 16-September 5.
1940 August 19-September 8.
1941 August 18-September 7.

These dates are the actual tenancy dates and not the times during which the exhibition will be open to the public.

The laboratories and offices of the International Television Corporation have now been removed to Maidstone House, 25-27 Berners Street, London, W.1.

CONTRAST OR PICTURE BRIGHTNESS?

SOME NOTES ON SECURING THE BEST RESULTS

By R. L. Ashmore

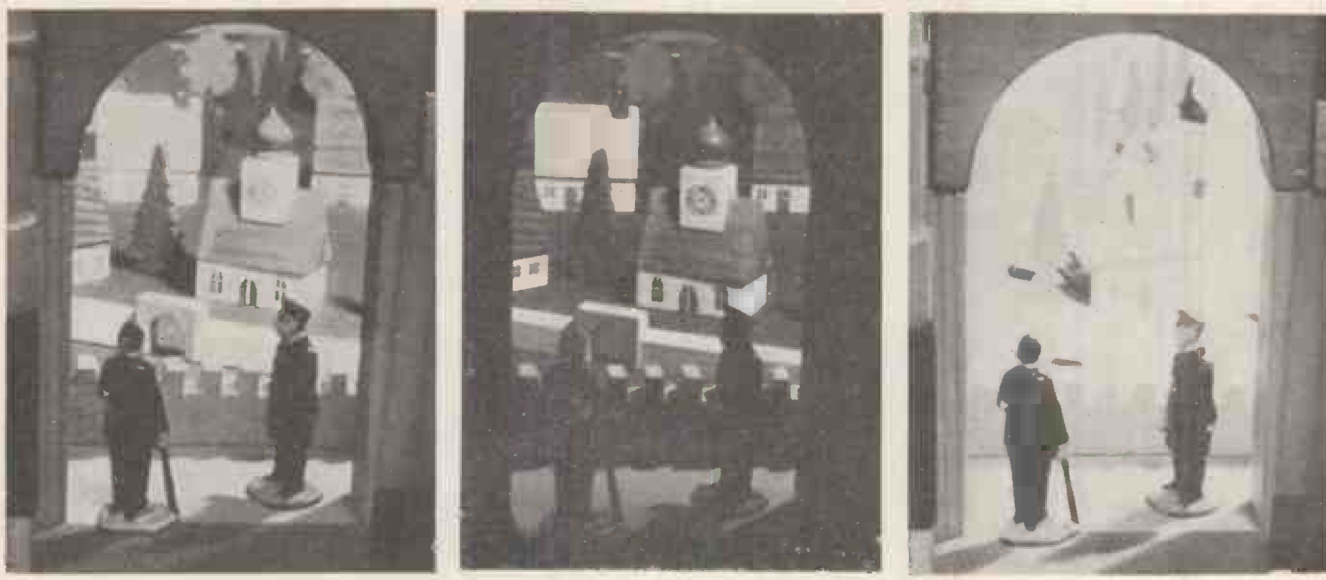
THE subject of tonal contrasts in any picture recording, be it television or photographic processes, is a very extensive subject and in this short article it is only proposed to consider the merest outline in relation to the handling of television receivers now available.

Starting in the studio, the scene to be transmitted consists of various tones or shades ranging from the darkest to the brightest—shadow and high light. Assuming a perfect system of television the characteristic would, amongst many things, be a straight line, that is to say, plotting light intensities of the scene to be transmitted against effect. By "effect" one means signal or final brightness of receiving screen as in Fig. 1. In practice, for various reasons, the actual effect will be more like Fig. 2, a type of curve common to many things. The transmitting station will, of course, endeavour to work on the straight line portion of the curve unless for some artistic effect it is not desirable to do so. The receiving station can, however, reasonably expect a signal which is tonally correct.

In television receivers there are two controls generally termed *brightness* and *contrast*, and it is the setting of these controls which makes or mars the tonal values of the picture. The *brightness* control alters a voltage between certain electrodes, while *contrast* is the equivalent of volume control in sound—that is to say, it controls the strength of the signal.

Now the light produced by a cathode-ray tube is by no means linear with respect to voltage variation across the controlling electrodes, the response curve being generally like that of Fig. 2. From this curve it will be seen that a given input signal voltage will be distorted in the resulting light output in such a manner as to exaggerate the tonal contrasts, or gamma as it is known in the motion picture industry.

Let us try and show this in more detail. Suppose we bias the cathode-ray tube to the point X, Fig. 3a, by means of the brightness control. With no signal on the screen practically no light is produced. On applying a given signal the resulting picture may be compared with that of the photograph A, which may be regarded as what one should receive. Move the bias point to X, Fig. 3b, and the picture B will be the result from the same signal. Notice how more than a third of the darker tones have gone black owing to having been lost round the bottom of the curve. Also the high lights or whites are not so brilliant.

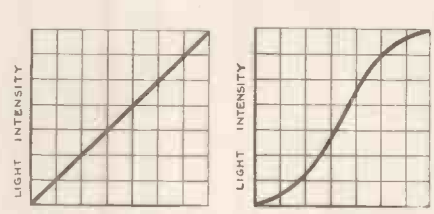


Three photographs, A, B, and C showing the different detail obtainable with too great contrast and C excessive picture brightness.

Finally, consider the bias point at X, Fig. 3c, the pictorial result being picture C. Note here how the high lights of the picture are all practically one tone, while the darker shadowy parts have become lighter. In practice the fly-back stroke of the electronic beam will become visible if brightness control is turned up too much. The three illustrations show what can be done with brightness control for a given input signal.

Obviously everyone has their own opinion as to what is the best setting. Many people might prefer picture B, arguing that the village looks more dramatic if one can see no details of toy castle's interior—just a matter of taste.

The results of the use of the other control, that of contrast, are difficult



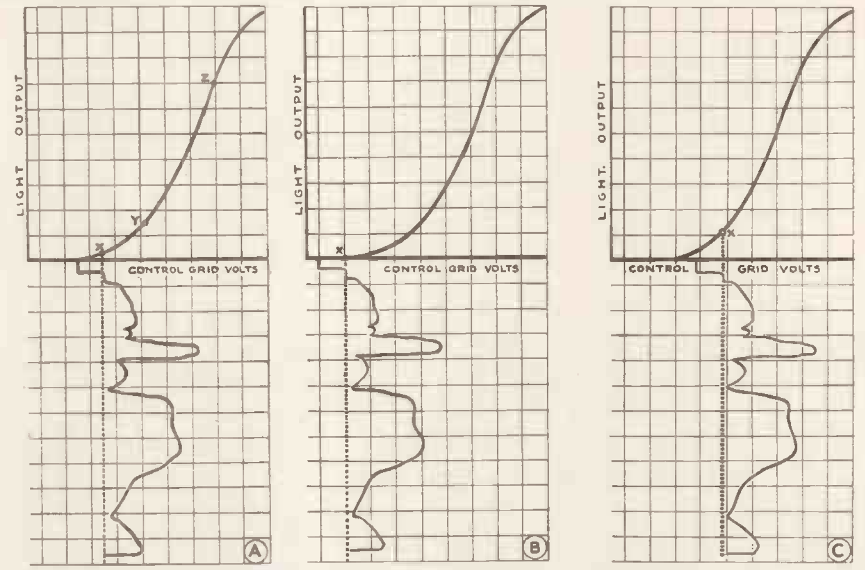
Figs. 1 and 2 Curves showing (1) the ideal and (2) the usual effect obtained.

to show by the aid of a printer's block, so let us return to Fig. 3a. Dividing the maximum light to blackness into 100 different shades or tones there are about forty different tones available for the given signal input, fourteen for half the signal level and ninety-eight for double the signal, all suffering from tonal distortion more or less as inspection of the curve will show.

The writer, who has seen a considerable number of receivers running at various places, is of the opinion that most receivers are run with too much contrast and would advise trying the effect of reducing the contrast control and increasing brightness so as to aim at working between Y and Z, Fig. 3a. It may be objected that the blacks will not be black enough, but don't forget the darkest of shadows have some light in them. If you don't like the suggested setting on studio shows try it on films.

Films are printed with a relatively high gamma or degree of contrast which added to the contrasting effects of a cathode-ray tube become definitely objectionable.

In conclusion, tonal distortion such as dinner jackets, with nearly white lapels, are, of course, not correctable at the receiver as they are due to incorrect tonal reproduction at the transmitting end because of the photo-electric device not having a panchromatic response to colour.



Figs. 3a, 3b and 3c.—Curves showing the effects of varying the bias point of the cathode-ray tube by means of the brightness control.

LUMINESCENCE—
AND ITS APPLICATIONS

An abstract of a paper read before the Royal Society of Arts by J. T. Randall M.Sc., of the G.E.C. Research Laboratories, Wembley.

ENERGY may exist in many forms most of which cannot be detected by the naked eye. When an electric current flows through a wire energy is dissipated; the eye cannot observe this dissipation of energy directly, unless the wire becomes so hot that it radiates in what we call the visible spectrum. A transformation of energy that is invisible to energy that is visible has taken place, and the commonest example of this kind of change is perhaps the electric filament lamp.

Many substances exist, a few of them in Nature, that are capable of transforming the energy of ultra-violet radiations and cathode-rays, for example, into radiations detectable by the eye. This is the study of luminescence, and it is seen that it is only a special branch of the transformation of energy that is invisible into energy that is visible. Sometimes the substances that effect this transformation are referred to as *fluorescent,* sometimes as *phosphorescent,* and less frequently as *luminescent.*

The terms "fluorescence" and "phosphorescence" are frequently vaguely used in a synonymous manner. When ultra-violet radiation of a given wavelength falls on certain classes of matter, visible radiations are re-emitted and continue to be emitted so long as the ultra-violet continues to fall on them. This effect is referred to as *fluorescence.* Some of the materials which show fluorescence continue to radiate light with gradually or rapidly diminishing intensity after they have been removed from the source of exciting radiation; this prenomenon is referred to as *phosphorescence.* A sheet of paper coated with luminescent powder in ordinary light appears white; in the dark it is invisible. If it is placed in a beam of ultra-violet radiation it immediately glows a bright green; it is *fluorescing.* If the fluorescent paper is now removed from the ultra-violet it continues to glow bright green for the best part of a minute. It is the after-effect, the after-glow, that is called *phosphorescence.*

Frequently in describing the subject, it is not necessary to distinguish between fluorescence and phosphorescence, and a convenient term to use on such occasions is *luminescence,* as was suggested by Wiedemann some forty to fifty years ago. Excitation by cathode-rays is usually referred to as *cathode-luminescence.*

The term *bio-luminescence* is used to refer to effects associated with bacteria on decaying foodstuffs, with luminescent insects and deep-sea fish.

Chemi-luminescence is usually observed during the course of rather out-of-the-way reactions involving oxidation between an organic and an inorganic compound. Some types of bio-luminescence are essentially of this type.

Historical

The subject of luminescence in its broader aspects is by no means a new one. What we now call bio-luminescence was certainly known to Aristotle, and there is some evidence to show that Pliny was acquainted with various luminescent minerals. The first serious study of luminescent solids began early in the seventeenth century.

Little progress was made in the study of luminescence until the eighteen-thirty's and forty's when the work of Brewster and Herschel

(*Continued on page* 151)

Scannings and Reflections

BROADCASTING ON 7 METRES

The B.B.C. have now under consideration a plan to broadcast the National and Regional programmes on a wavelength of 7 metres from the short-wave transmitter on the roof of Broadcasting House. From information which we have received it seems likely that the plan will be carried through. Experience with the sound transmissions from Alexandra Palace has shown that much better quality is obtainable. The first transmission would be in the nature of an experiment, but if it is successful it is probable that short-wave transmitters would be erected in many parts of the country to serve local areas. These short-wave transmissions would, of course, be entirely free from long-distance interference.

THE BAIRD BIG SCREEN

The Baird big-screen nights at the Dominion Theatre have proved very popular. This show has been given at 9 p.m. on Fridays and even with the present limitations of the system it has been proved that quite a lot of entertainment can be provided with suitable presentation. The audience are able to join in the fun by asking questions and receiving answers from the images of various comedians on the screen.

MAGNETIC FOCUSING

It seems likely that there will be a revision of ideas in cathode-ray tube manufacture in the near future, the tendency being to go over to magnetic focusing and deflection. From the constructional point of view the magnetic tube has many advantages, chief of which is the relatively simple construction of the electrode system, which only consists of the cathode, anode and cylinder. This eliminates a great deal of work in the very accurate assembly which is necessary in the case of the electrostatic tube. There is also the fact that the characteristics of the tube are not tied up with the electrode structure to the same extent, and correction can be made after the tube is assembled. Additionally the associated equipment can be simpler and this, together with the fact that the magnetic tube is easier to make than the electrostatic type, should make a reduction in tube cost possible.

TELEVISED SHAKESPEARE

Plans are being made for a series of televised Shakespearean excerpts on the lines of Henry V, which was transmitted on February 5. Plays under consideration are *Romeo and Juliet, Hamlet* and *Julius Cæsar,* and each is to be presented by a different producer in order to compare styles.

GOLD MEDAL FOR J. L. BAIRD

At the annual conference of the International Faculty of Sciences in conjunction with The Institution of Electronics and The Institute of Chemimst-Analysts, a gold medal of the Faculty was presented to Mr. John Logie Baird for his contribution to advancement in the science of television.

ICONOSCOPE " MEMORY "

Many readers have drawn our attention to the somewhat faint wording appearing in the sky on the interval signal—a picture of the top of the mast and aerials at Alexandra Palace. We have often noticed this ourselves, the wording being the same as is radiated for fifteen minutes before the transmission. This is due to the image of the previous titling being " remembered " by the photo-electric mosaic of the Emitron camera owing to the long exposure to it and then using the same camera to reproduce the picture of the mast and aerials—which, incidentally, is one of the views from " Television Comes to London," the first film made by the B.B.C. staff. Actually, the effect is very similar to that of the eye. We have all experienced the results of staring at some bright object and looking away and seeing the same object superimposed on the new scene.

SUPER-IMPOSITION

Talking of super-impositions we cannot help strongly criticising some of the transmissions in which this effect is used. Recently Helen Perkins, the pianist, was televised and for nearly seven minutes out of ten super-imposed pictures were radiated, one a frontal side shot of her face, the other her hands on the keyboard—result no clear picture of either and the hands on the keyboard appeared be be scratching the back of the head and neck. Another outstanding misuse of super-imposition was during Geraldo's band performance, which showed a lady announcer through a music stand with a saxophonist on her back during a turn by the Tea Time Swingers; also in the show " Pastiche " something like dark trees or hills grew out of Stuart Robertson's arms. These instances showed the complete lack of manipulation of super-imposition.

UPLIFT

The B.B.C. is always out to teach us. We noticed that Tottenham Court Road should be spelt "Tottenhamcourt," one word—though London Transport does not yet seem to agree—during a recent Underground sketch.

AMBITIOUS PROGRAMMES

Two of the outstanding shows from the studio during February were undoubtedly " Cosmopolitan Café " and " A Dinner Time Floor Show." Both were extremely large set ups for the size of the studio.

But *the* outstanding transmission of the month was undoubtedly the televising of the amateur boxing bouts from one of the halls of the Alexandra Palace. This O.B. called for considerable preparation. A platform some 10 ft. square had to be erected above the heads of the audience in such a way as not to obscure anyone's view. Nests of high power lamps were installed above the ring of such brilliancy that it was not possible to tell if the Club's usual two lamps were on or off. Two cameras were used side by side but with different focal length lens; also two microphones. The results were excellent and a lot of people are wondering where it will all end.

MORE SCANNINGS . . . . . .

THE TUNING NOTE

We have noticed variations in frequency of the sound transmitter testing frequencies at Alexandra Palace. The pre-transmission tuning note used to be 1,000 cycles, then it dropped to a rather uncertain note of about 250 cycles, and on recent test transmissions nothing below 1,000-cycle is used—apparently tuning note variety.

THE CORONATION AND TELEVISION SETS

Despite the fact that up to the present it is only known that the processions before and after the Coronation, and not the actual ceremony itself, will be televised, there are indications that the demand for sets that was anticipated will be maintained.

The General Electric Company state that all the sets they have manufactured to date will be in use. "For some weeks before the official transmissions started," an official of the G.E.C. stated, "we began manufacturing sets on a regular production basis in the same way that we manufacture our wireless sets. In addition to the fact that all the sets we have made to date will almost certainly be in use during Coronation week, we are having to speed up further production."

TELEVISION EXHIBITION AT THE SCIENCE MUSEUM

The first public exhibition devoted solely to the development and modern attainments of television is to be opened at the Science Museum at South Kensington early in June. It is expected that the exhibition will remain open for three months. All the principal British manufacturers interested in the development of television are co-operating with the Radio Manufacturers' Association and the B.B.C. to make the exhibition truly representative, and it is expected that it will do much towards spreading a wider appreciation and understanding of modern television.

The exhibition at the Science Museum will illustrate the development and will show the simple principles of modern television. In addition, demonstrations will be given of the B.B.C. programmes on modern receivers and a local transmitter will be shown in operation so that the receivers can operate when no B.B.C. transmission is available. The Science Museum is open free on weekdays from 10 a.m. to 6 p.m. and on Sundays from 2.30 to 6 p.m.

BAIRD TELEVISION AT B.I.F.

Television was featured at the British Industries Fair this year for the first time. A portion of the Baird stand was built to form a small demonstration room so that parts of the afternoon transmissions could be shown to interested visitors. Equipment enabling the principles of television transmission reception to be demonstrated and explained was also installed, together with parts of the receivers built and designed by Baird Television.

THE TELEVISION SOCIETY

The annual general meeting of the Television Society will be held on March 10, to hear the report of Council and to elect officers for the coming session. After the meeting, it is hoped to arrange for the E.M.I. television receiver to be described and demonstrated by a member of the E.M.I. staff. The meeting will commence at 7.30 p.m.

On Wednesday, March 12, a description of the E.M.I. television receiver will be given by Mr. G. H. Watson, and similarly Mr. E. H. Traub will describe the Mihaly-Traub receiver on Wednesday, April 14.

The Kerr Memorial Lecture will be given on Wednesday, May 19, by Professor J. T. MacGregor-Morris, M.I.E.E., head of the Electrical Engineering Department, Queen Mary College, and the subject will be "The History and Development of the Cathode-ray Tube." Visitors are particularly welcomed to this lecture, which will commence at 7 p.m.

TELEVISING THE CORONATION

No real decision has yet been reached regarding the televising of the Coronation ceremony in Westminster Abbey, although there are indications that some objections have been made by the committee responsible for the Coronation arrangements, chiefly it is supposed on account of the installation of the necessary apparatus and the provision of sufficient light. No final official decision is likely to be made until the return of the Duke of Norfolk, Earl Marshal. It is understood that permission has been given for the taking of news films of the ceremony.

THE FUTURE OF TELEVISION

Following the announcement of the Postmaster-General of the decision to employ one standard of transmission the directors of Baird Television, Ltd., issued the following statement.

"In the discussions with the Television Committee which preceded the decision of the Postmaster-General to adopt a single standard of transmission to be known as the London transmission standard, we were given assurances that this did not mean the setting up of a monopolistic situation either now or in the future. The last word in transmission has not been said. There is, for example, nothing in the present position to prevent the B.B.C. using for new stations a higher standard of above 500 lines on which we are, in fact, working.

"It cannot be too strongly emphasised that the present adoption of a single 'standard' does not mean the adoption of a particular system. Single-standard television will provide more studio room and an economy in working and should therefore result in longer and better programmes.

"Moreover, from a purely commercial point of view, Alexandra Palace transmission, as Sir Harry Greer, the chairman, pointed out at the last Baird Company meeting, is not in itself revenue-earning.

"It will be seen therefore, that the Television Committee's decision in no way diminishes the commercial prospects of the Baird Company or limits its trading policy.

"Our receiving sets are, of course, already designed to receive the newly established London transmission standard, and the supply of these sets is the most important side of the television business.

"Our development department will also continue its promising work in large-screen cinema television, which has already had substantial success, and on military and other non-entertainment applications."

TELEVISION CABLES FROM LEEDS

New underground telephone cables are to be laid between Leeds and Manchester, Leeds and Hull, Leeds and Middlesbrough and Leeds and Newcastle among other extensions, and in these developments regard is being paid to the requirements of television.

REDUCING THE COST OF THE "GUARANTEED RECEIVER"

This article describes how economies can be effected in the cost of building Television's Guaranteed Cathode-ray Receiver of which full constructional details were given in the October, November and December, 1937 issues.

MANY of our readers living in districts of good signal strength and short range of the Alexandra Palace television transmissions have asked us would it not be possible to reduce the number of valves required and so reduce the cost in the case of a receiver to be operated under these conditions.

For some time now careful consideration has been given to this point and many tests have been undertaken to see if it was possible to arrive at a receiver that would contain a minimum of valves and at the same time give a good performance at a shorter distance.

The tests have proved that in cases where the receiver is to be used within a distance of approximately ten miles from Alexandra Palace a very real saving can be effected. It should be understood that the modified receiver does not supersede the nine-valve receiver of the "Guaranteed" instrument, which was designed for service anywhere within the stated range of the Alexandra Palace transmitter.

It has been found that reductions are possible in the receiver, power pack, time base, time base power pack, 4,000-volt exciter unit and control panel, and these, coupled with the fact that only a single system is now broadcast, allows an economy that more than covers the cost of the cathode-ray tube.

Commencing with the receiver it is suggested that the chassis be made for vision only as many readers already have a unit for the reception of the sound.

The circuit diagram for the vision section is retained except for the demodulation valve (2nd detector) and output; also the number of I.F. stages have been reduced to two, instead of four.

With the reduction in the number of stages the value of the decoupling condensers on the H.F. side can be reduced. Instead of .1 mfd. a value of .002 mfd. is suitable.

The demodulator has been changed to an anode-bend rectifier and a triode valve used. This gives a much greater gain than a diode and compensates for the lack of I.F. amplification. This stage requires to be decoupled. The output valve is changed to an Osram N43 with the result that, due to the low anode load resistance, the frequency range is improved.

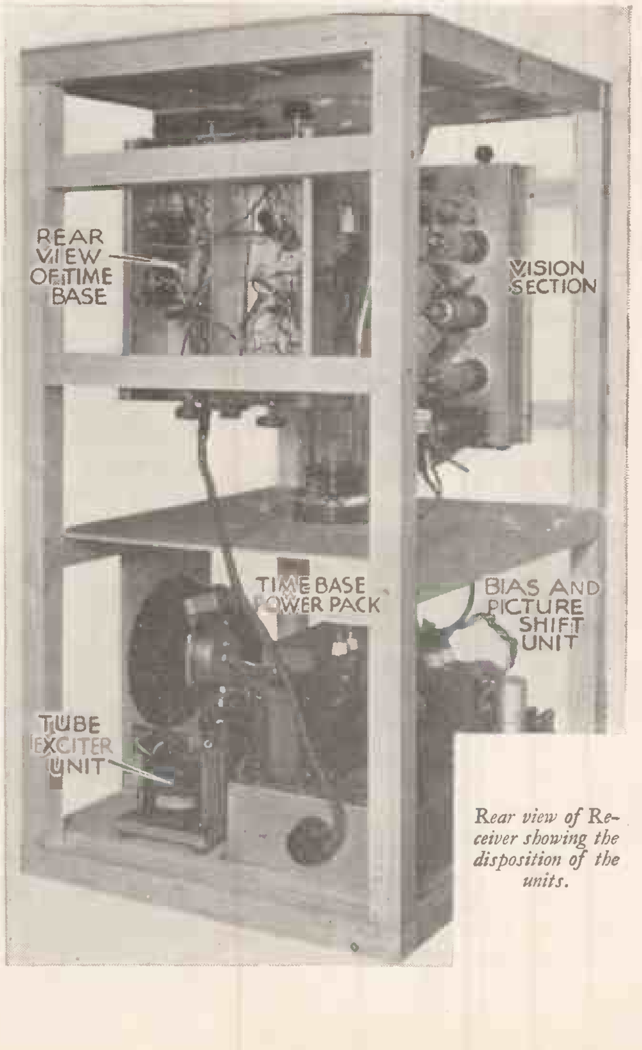
Certain modification are needed to accommodate this valve and this together with the anode-bend stage is given in detail in the circuit diagram, Fig. 1. The fact of using a coupling condenser anywhere in the demodulated circuits, of course, does remove the full effect of a steady D.C. level in the picture, but on observation it does not detract from the results. The coupling of the demodulator by a condenser to the output stage does affect the synchronising of the pictures but only during quick changes from one scene to another. There are ways of overcoming this, and details are given at the end of this article, particularly of a method of using the gas-filled relay as a biased off detector.

Notice should be taken of the 250-ohm resistance in the output anode circuit. This must not be omitted and should be connected directly to the anode pin of the valve holder. The usual result of omitting this is self oscillation resulting in a negative picture, but during all the observations made of this phenomena, the black synchronising bands on the right-hand side of the picture format have remained black and have not been subject to a phase reversal and this is a means of identifying the fault.

The new type of chassis is now obtainable from the Mervyn Sound & Vision Co., and provision is made for an additional I.F. stage to be inserted if required.

The coils, both tuning and oscillator, may be wound using No. 16 s.w.g. tinned-copper wire. This allows the small mica trimmers to be dispensed with and the trimming carried out by opening or closing the coils.

The H.F. stage (MSP4) in front of the frequency changer may be dispensed with, but the measured



Rear view of Receiver showing the disposition of the units.

HOW ECONOMIES CAN BE EFFECTED

gain in this stage is two with the advantage of non-critical aerial matching. This, however, is not advisable unless the receiver location is within three or four miles of the transmitter. In any case erect the aerial as high as possible and use a half-wave dipole consisting of two arms 5 ft. 4½ ins. long with a Belling and Lee feeder.

The power unit for the receiver may be reduced in cost as it does not have to provide a large output. Mervyn have a standard unit that is obtainable ready built, properly fused and housed in a crystalline finished case.

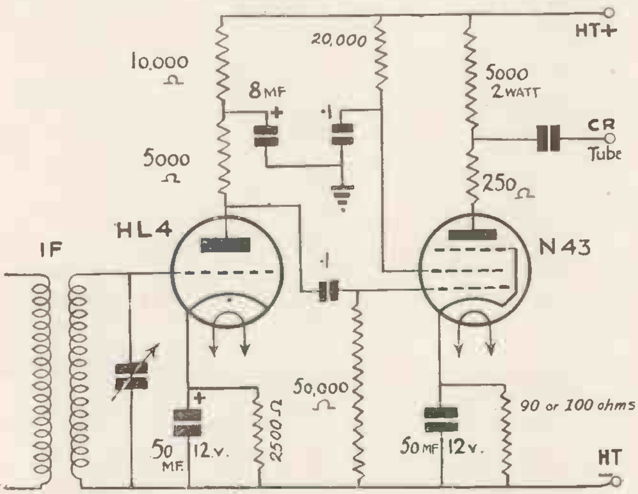


Fig. 1.—The modification to the detector and output circuit showing the details of the anode-bend detector.

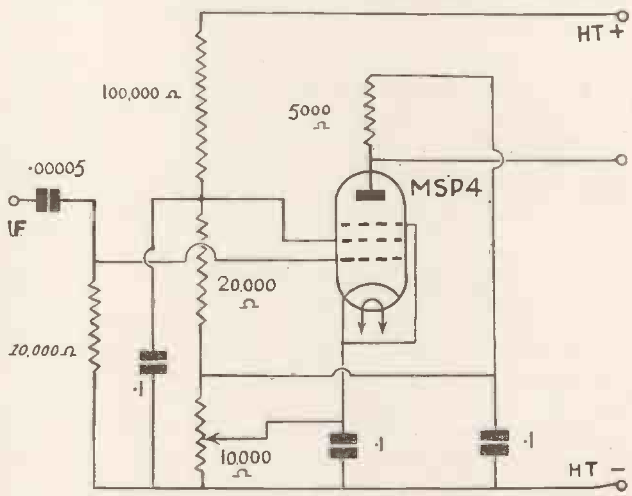


Fig. 3.—An arrangement using a saturated pentode for synchronising pulse selection.

The Time Base

The alternative time base described in the January issue will be found both satisfactory and inexpensive and should be adopted.

With only one system to be received (405 lines 50 frames interlaced) a saving in the cost of this unit can be effected and the operation rendered more simple. Accordingly a few instructions regarding the position of the controls will be given.

The components not required are the changeover switch, several fixed resistances and two 2-meg. potentiometers.

The remaining controls are now rearranged so that the 2-meg. variable resistance in the anodes of the gas-filled relays are placed on top of the chassis and the bias variable resistance placed on the side of the chassis. The holes provided for the changeover switch are used to bring out the leads to the gas-relay grids for synchronising. The spare hole for the variable resistance in the relay anodes can be used for mounting the shift potentiometers if required. The frame frequency being fixed at 50 cycles, .05 mfd. condensers can be used on the frame deflectors instead of .1 mfd.

The variable anode resistances are placed on the top of the chassis as the single system calls for only one setting of the bias control and the finer adjustment possible with the anode resistance adds to the simplicity of control. Mains bias for the gas relays may be adopted immediately.

A further simplification to the line saw-tooth generator may be obtained by making the charging condenser .0005 mfd. and feeding the first valve of the dual phase amplifier through a .005 mfd. connected directly from the relay anode to the grid of the first valve, the grid leak on the valve being left as before.

The power pack for the time base unit may be reduced in cost by making the last two smoothing condensers 4 mfd. each instead of two 8 mfd. and using a thermal delay switch of the type manufactured by Bulgin or Varley instead of using the DLS/1 vacuum type.

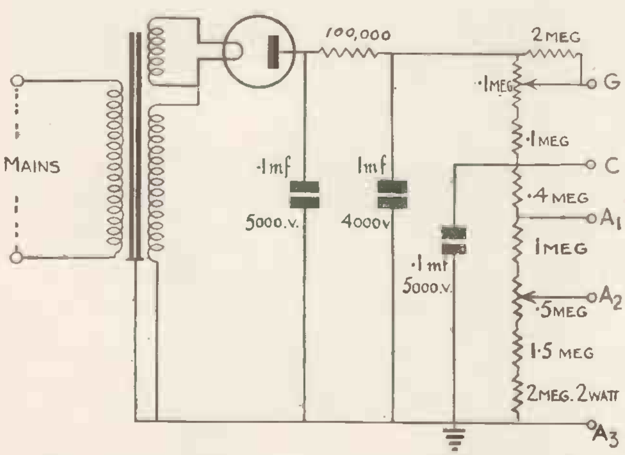


Fig. 2.—A modified circuit for the cathode-ray tube exciter unit.

Exciter Unit

The cathode-ray tube exciter unit and control panel may be further simplified and reduced in cost by a new arrangement of the capacities employed. A revised circuit (Fig. 2) is given and all values marked, and it will be noticed that only one small condenser is used on the control panel and this is a .1 mfd. 5,000-volt working from cathode of the tube to earth. The reservoir condenser on the exciter unit is .1 mfd. 5,000-volt working while the final smoothing capacity is a 1 mfd. condenser.

Synchronising

At the beginning of this article reference was made to a simple way of synchronising the time base using the gas-filled relay as a biased-off triode.

The greatest satisfaction is obtained when the frame relay is synchronised from the A.C. mains in the manner already described. (February issue.) Then to synchronise the line take a lead from the anode of the last I.F. stage through a very small capacity (.0001 or less) and connect it directly to the line relay grid. The scheme is not infallible, but it does work extremely well, particularly when the signal strength is adequate —that is when the cathode-ray tube is fully modulated. The relay does in effect operate as a biased off valve. As radio frequency is fed to its grid the positive half cycle of the synchronising signal is sufficient to fire the relay, especially as the anode voltage to the relay is adjusted to approximately the firing point normally required.

An alternative is to use a saturated pentode (Fig. 3) which acts then as an amplitude filter. If the signal strength fed to the saturated pentode is great enough the top-bend characteristic can be used providing a positive synchronising signal at its output while under conditions of weaker signals the bottom-bend characteristic can be used by taking the cathode to earth on the control. In this latter case the output signal is then negative and can be used directly (with a loss of part of the picture on the left-hand side), or the phase may be reversed either by a further valve stage or L.F. transformer.

The circuit diagram shows an arrangement that has been successfully employed; the picture remains perpectly steady throughout a transmission.

For simplicity in synchronising a new valve is indicated and such a valve would have all electrodes common except the anode which would be split, this would allow selective circuits to be attached to each anode and would assist materially in completely separating the different impulses. It is to be hoped that some enterprising valve manufacturer will produce such a valve.

"Luminescence and Its Applications"

(*Continued from page* 146)

excited the attention of two of the foremost investigators on the subject—Becquerel and Stokes. These two men worked independently of one another along rather similar lines, but Stokes' contribution to fundamental knowledge of the subject was by far the greater. It is to Stokes that we owe one of the most fundamental laws of luminescence, and incidentally the coining of the word fluorescence.

The chief result of Stokes' experiments was the law which now bears his name. Although at the time there was no wavelength scale, the general substance of the law was that it is impossible to obtain fluorescence radiation of shorter wavelength than the incident radiation. To take an elementary example, it would on this idea be impossible to obtain blue fluorescence with incident green light. The word fluorescence was suggested to Stokes by observing that fluorspar from certain districts showed this effect of change of wavelength to a marked degree.

Stokes' Law was first stated about fifty years before the birth of the quantum theory, and it is easy for us to see that the essential feature is concerned with energy and not with wavelengths. The law re-written on an energy basis would be simply:—

"The maximum quantal energy emitted by a luminescent body does not in general exceed, and is usually less than, the maximum quantal energy initially incident on the body."

That such a general law as this is not always true is not surprising. Many organic compounds may be excited to fluorescence by frequencies smaller than that of the maximum of the fluorescent band, and it is generally supposed that the addition of vibrational energy of the organic molecules accounts for the effect. A special example of transformation of this kind is the Raman Effect.

Potentials Required

It is of interest to consider the case of cathode-rays. Let us consider a substance which may be excited by blue light to give fluorescence in the red.

We find (by calculation) that electrons moving under a potential difference of three volts or so should be sufficiently energetic to excite the fluorescence of the material. In practice we know that electrons moving under a potential difference of at least ten volts are required to excite even the feeblest luminescence. The reasons for this are two. Fluorescent bodies are generally very poor conductors and become charged up when electrons fall on them. Secondly, all matter consists of charged particles, and consequently an electron cannot really penetrate a solid body to any extent unless it has a comparatively high energy.

Before concluding this paper, I wish to say one or two words about cathode-ray tube screens. First of all, everyone wants what they call a white screen, and it really is surprising how many whites there are! Tastes of individuals differ remarkably in this field. The general method for these screens is to mix together two or more zinc-cadmium sulphides. The extremely bright yellow-green tube contains willemite. The bright scarlet tube contains magnesium silicate (this compound cannot be excited by the usual sources of ultra-violet radiation). The two remaining tubes exhibit individual powders used in obtaining a reasonably white mixture. There is a bright blue one and a yellowish-green which really contains quite a lot of red. It is important that all powders chosen for this purpose should have a negligible afterglow, otherwise there would be bad definition of the picture.

At this point Mr. Randall went on to discuss the classes of luminescent materials, their spectra and the subject of phosphorescence together with the theory and application of luminescence, the full text of which is published in the Journal of the Royal Society of Arts, copies of which can be obtained price 1s. on application to the Secretary, The Royal Society of Arts, John Street, Adelphi, London, W.C.2.

HOW C.R. TUBES ARE MADE

By STEPHEN LANGSTROTH

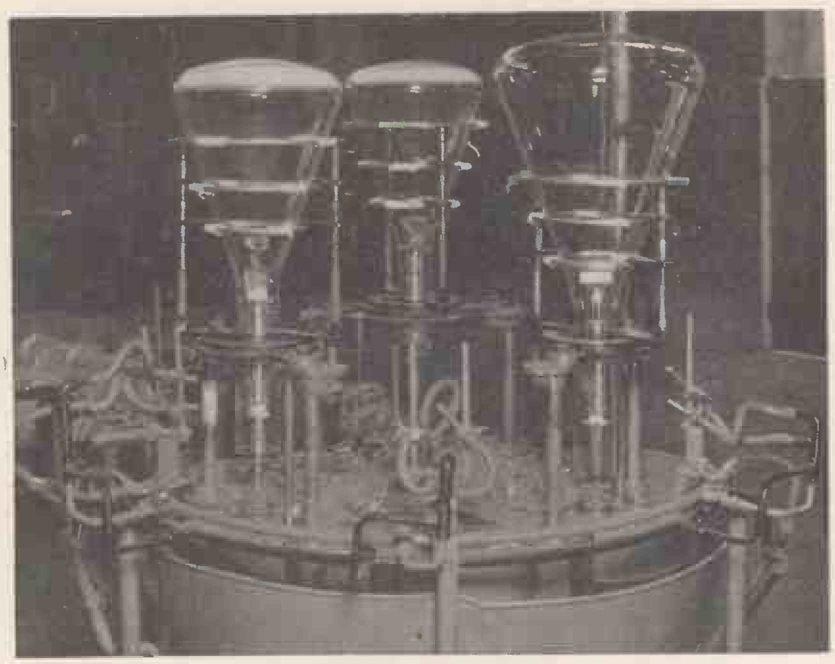
We believe this to be the first article published describing the manufacture of cathode-ray tubes. Considerable secrecy has hitherto been maintained of the details which are given below.

THE cathode-ray tube is daily becoming more and more used in science, and engineering. This is especially so in television. The processes involved in the manufacture of cathode-ray tubes are intricate, involving a high degree of precision, but a general description of the methods used will no doubt be of interest to many readers.

The Electrode Assembly

The first process to be considered is the assembly of the electrode system. In the earlier cathode-ray tubes some of the electrodes were supported by wires which were sealed through the side of the neck of the tube. This system, however, was clumsy and did not lend itself to accurate alignment. It involved a lot of labour and the tubes were not uniform, no two tubes ever being alike in characteristics. The modern method of assembly is known as the unitary system, all the electrodes being built on to a stem or pinch, through which the connections are taken, the whole unit being sealed into the neck of the tube in one operation. The stem also has a length of glass tubing sealed into it, known as the tubulation, through which the tube may be exhausted.

The electrode assembly varies considerably in detail with different makers although the general principles are the same. It consists of a rigid structure of mica discs and supporting wires which hold the electrodes in position. Some or all of the supporting wires are used as connections to the electrodes. It is a general practice to construct the electrode-unit on a jig in order to obtain accuracy in alignment, a matter of importance.



Sealing the electrode units into the bulbs at the Ediswan works.

If the tube is to be of the gas-focused type, the electrode-system consists of a cathode, control electrode, anode and two pairs of deflector plates. The more usual "hard" tube has one or more additional anodes which serve to focus the electron beam. There is also a "getter" which will be described later.

All the electrodes are made of "ferry," a nickel-copper alloy which is non-magnetic. This is essential as the presence of a magnetic field has the effect of deflecting the beam. Before the electrodes are assembled, occluded gases are driven out by heating them to redness in an atmosphere of hydrogen gas. The electrodes are fixed to their supports by a spot-welding machine which passes a large instantaneous localised current between the surfaces to be welded. The mica-spacing rings are located on the supporting wires by collars welded on the latter.

The next process is the preparation of the bulb. The first operation is to coat the end with one of the many compounds which fluoresce under electron bombardment. One method is to spray the end of the bulb with a suspension of fluorescent material to which some binding substance such as potassium silicate has been added. The surplus material is then carefully removed from the sides of the bulb with a gentle water jet, after which the bulb is dried.

Most manufacturers find it advisable to coat the inner walls of the tube (other than the part occupied by the fluorescent screen) with a conducting material as this improves the performance by preventing accumulation of charges on the walls. Often this takes the form of a film of silver which is deposited chemically or may be evaporated on to the walls *in vacuo*. Another process uses a carbon coating which is deposited from a colloidal solution. Colloidal graphite solutions are available commercially under the name of "Aquadag." If the carbon process is used the bulb must be well baked in air before the evacuation process.

The stem carrying the electrode-system is now sealed into the neck of the bulb and the tube is ready to be sealed on to the exhaust system.

A typical exhausting plant is shown diagrammatically in Fig. 1. The rough vacuum is obtained by the use of a rotary oil-sealed pump. The principle of this type of pump is shown in Fig. 2. It consists of a cylindrical structure with a slotted rotor which is placed eccentrically

HOW THE CODE-RAY TUBE IS EXHAUSTED

within the cylinder. The slot in the rotor contains two blades which are pressed on to the walls of the cylinder by an internal spring. As the rotor revolves the blades sweep round the cylinder carrying air from the inlet port and expelling it through the exhaust port. The blades are ground so that they fit the walls of the cylinder very exactly, and the pump is operated in a tank of oil which effectively seals the joint made by the blades and the cylinder wall. A special oil is used for this type of pump, having a very low vapour pressure, and a single-stage pump will exhaust to a pressure of 10^{-3} mm. of mercury. A two-stage pump will produce a pressure as low as 10^{-5} mm. with a pumping speed up to 100 litres per minutes.

The rotary pump is followed by a water-vapour trap which contains phosphorous-pentoxide, a substance which readily absorbs water. The object of this trap is to prevent any water-vapour from entering the rotary pump, which would result in contamination of the oil, greatly reducing the efficiency of the pump.

Next comes the diffusion pump the operation of which is as follows: Mercury, contained in the lower part of the pump (see Fig. 1) is caused to boil by heating either with an electric heater or a gas flame. The mercury vapour passes upwards and emerges from a mushroom-shaped jet. The stream of vapour carries molecules of gas along with it in its downward course and condenses in the water-cooled chamber. The condensed mercury is returned to the boiler and the gas is drawn off by the rotary pump.

Diffusion pumps will not operate against atmospheric pressure and will only work in conjunction with the backing pump which creates the rough vacuum. Under these conditions it is extremely fast and pressures lower than 10^{-6} mm. can be obtained. The more elaborate diffusion pumps have a number of stages which increases the pumping speed.

The next part of the pumping apparatus is the cut-off. This is a U-shaped tube at the base of which is a long vertical tube connecting with a reservoir of mercury. When the exhausting system is in operation the mercury rises in this tube to a height of roughly 30 inches according to atmospheric conditions. By raising the reservoir, the mercury can be driven up into the U-tube, isolating the cathode-ray tube from the pumps. The object of this will be discussed later.

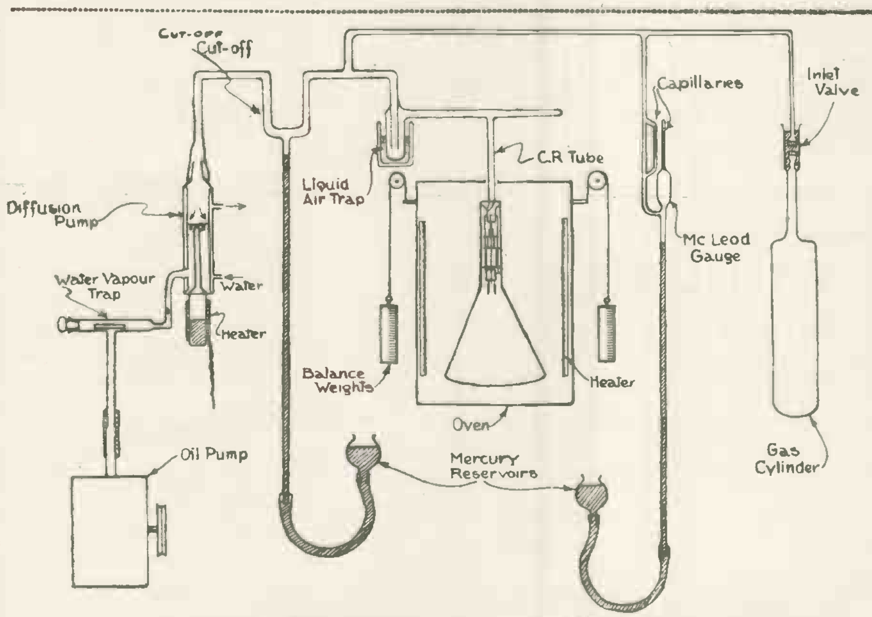


Fig. 1.—A schematic diagram of a complete exhausting system.

Between the cut-off and the cathode-ray tube is the liquid-air trap. This is to prevent mercury vapour from the diffusion pump, cut-off, etc., from reaching the tube. At ordinary temperatures mercury vapour exerts a considerable pressure—at 20° C. it is 10^{-3} mm.—and without the liquid-air trap it would not be possible to obtain a pressure lower than this. At the temperature of liquid-air, however, the vapour pressure of 10^{-6} mm. or less.

Measuring the Pressure

There are several pressure measuring devices for use with vacuum systems, one of the most common being the McLeod gauge. This is connected to the system at a point between the cut-off and liquid-air trap and is clearly shown in Fig. 2. Its

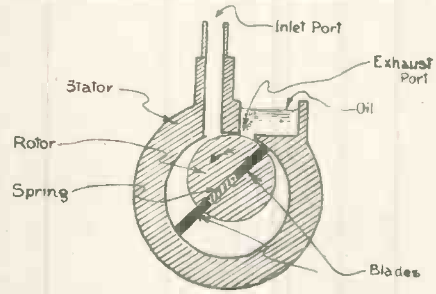


Fig. 2.—Details of rotary oil-sealed pump for obtaining rough vacuum.

action is thus. If the reservoir is raised, the mercury rises and the gas in the bulb is trapped and compressed into the capillary tube at the top of the bulb. The volume of the entrapped gas is thus reduced a thousand times or more and its pressure correspondingly increased. This pressure is read by noting the difference in level between the mercury in the two capillaries. The gauge is calibrated so that the actual pressure of the system may be read in terms of this height.

The only part of the apparatus which remains to be described is the gas-cylinder which is connected to the system at the same point as the McLeod gauge. This cylinder contains an inert gas such as Argon and is normally isolated from the system by a mercury seal. When the cylinder is raised, two porous plugs come into contact under the mercury, and gas diffuses through.

Pumping the Cathode-ray Tube

Having discussed the various components of the pumping system we now come to the process of pumping the cathode-ray tube. After the latter is placed in position and sealed on, the pumps are started. The oven is raised until it surrounds the tube and the heating current switched on. The tube is then baked at a temperature a little below the softening point of the glass, for some hours.

During this time gases which have been occluded on the walls of the tube are driven out. When the outgassing process is complete and the gauge shows that the required degree of vacuum has been attained the heaters are switched off and the oven allowed to coil.

Activating the Cathode

It is now necessary to activate the cathode. There are numerous forms of cathodes suitable for cathode-ray tubes, some being in the form of a short hairpin-shaped filament of nickel wire heated by a current, whilst others are constructed so as to be indirectly heated. These cathodes are tipped with a mixture of barium and strontium-carbonates. During activation a current is passed through the cathode raising it to a bright red heat for a few minutes during which time the carbonates are decomposed, forming oxides. Next, all the other electrodes are connected together and made positive with respect to the cathode. After a short time the cathode begins to emit electrons as a metallic layer is formed on the surface, and a current flows. This current increases continuously and the cathode temperature is gradually lowered until it is only a dull red. The activation is complete when the thermionic current has reached a steady value.

The electrodes are now thoroughly outgassed by surrounding the neck of the tube with a coil carrying high-frequency currents. This coil induces eddy currents in the electrodes which heat the latter to bright redness. The eddy current heater is now used to " fire " the " getter, which is a metal flag containing metallic barium and magnesium. The heating of the getter causes the barium and magnesium to be distilled on to a localised portion of the tube. This metallic film is capable of absorbing residual gas which has not been removed by the pumps. Its main function, however, is to take up any gas which may be evolved by the electrodes or walls of the tube during its life. It may be mentioned here that the getter does not absorb the inert gases argon, helium, neon, etc.

If the tube is one of the " hard " variety the process is now complete except for a test which is carried out whilst the tube is still on the pumps. If this is satisfactory the operator removes the tube from the exhaust system by heating the tubulation with a small hand-flame. As the walls of the tubulation melt they collapse inwards under the atmospheric pressure and the tube is drawn off.

Gas Filling

The gas-filled tube requires a further operation before it is complete. The cut-off reservoir is raised until mercury rises into the U-tube isolating the cathode-ray tube from the pumps. The operator lifts the gas-cylinder allowing a small quantity of gas to enter the isolated part of the system. After allowing a short period for the pressure to become uniform the latter is read on the McLeod gauge. If it is too low more gas is admitted; if too high the mercury is lowered in the cut-off for an instant allowing the excess gas to escape. The tube is then tested under operating conditions and sealed off from the exhaust system.

There is nothing further to do but to cap the tube and it is then ready for service.

It will be realised that the output of such a system as has been described, is very limited. When the demand for cathode-ray tubes is very much greater than it is at present there is no doubt that mass producing methods will be introduced and pumps capable of handling a great number of tubes—on the lines of the rotary systems used in the manufacture of valves—will be put into operation. Nevertheless, the principles described in this account are fundamental and will apply equally to more ambitious exhausting mechanisms.

PROGRAMME CRITICISM

£2 - 2 - 0 FOR A LETTER

In our February issue we invited readers to submit letters commenting on the programmes, etc., transmitted from Alexander Palace by the B.B.C.

These letters should be of a constructive nature that will help to improve the programme matter and presentation, or even be of technical interest.

To the writer of the most useful letter we will pay the sum of two guineas while a selection of the most interesting letters will be published.

The B.B.C. are desirous of knowing viewers' opinions of programmes transmitted and we hope that all readers who have the opportunity of witnessing them will write to us expressing their views.

Letters should not exceed a few hundred words in length and should be sent as soon as possible to the Editor, "Television," 37, Chancery Lane, London, W.C.2.

More Television Stations

Sir Walter Womersley, Assistant Postmaster-General, states in a written answer to a Parliamentary question that he understands that when sufficient experience has been obtained of the working of the service from the London television station, the Television Advisory Committee will consider the establishment of stations in other parts of the country, and will make recommendations.

Cathode-ray Tube Regeneration

It is now possible to have repairs made to cathode-ray tubes, such as new cathodes, screen repairs, new envelopes, re-exhausting, etc., in fact the tube can be given a new lease of life, by up-to-date methods. We learn that Messrs. H. E. Sanders & Co., of 4 Grays Inn Road, have at their disposal technicians and plant, and this work can be undertaken at very reasonable charges. Experimenters who are interested in this should get in touch with this firm, who will be pleased to quote for this work.

362 Valves

An error appeared in the advertisement of the 362 Radio Valve Company last month. The price of the PX25A was given as 25s. whereas the figure should have been 20s., the same as the PX25.

COMPLETING THE "UNIVERSAL" CATHODE-RAY TUBE EQUIPMENT

This is the third and concluding article on the construction of a cathode-ray tube test equipment. The two preceding articles appeared in the January and February issues.

THE hole marked "⅜ths clg." takes the fixing bush of the pre-set resistance R20 in the cathode circuit. The whole of this resistance can be variable if required (10,000 ohms) but a finer control is obtained by connecting a 2,000-ohm variable in series with an 8,000-ohm fixed, as shown in the circuit diagram.

The holes for the terminals and the bush of the 4-way switch can be drilled in the front flap, and before going any further this flap should be "approached" to the inside of the front panel and the holes scribed through to make sure that they register when the panel is screwed on.

The holes along the front edge of the chassis for the connecting leads can be drilled approximately in the positions shown and are not critical except from the point of view of neatness. They should coincide in position with the placing of the components, as shown in the drawing of Fig. 1.

The sketch of Fig. 2 shows the position of the main components. The majority of the fixed resistances are fitted on a Bulgin 10-way group board, which is held off the underside of the chassis by about 1½ in. by means of two lengths of 6 B.A. threaded rod. The decoupling condensers C.9 and C.9V are fixed under two 5-way boards at the corners of the chassis, the boards holding the fixed resistances.

The paraphase connections are taken from two potentiometers R.13 and R.13V, which are mounted on Eddystone insulated brackets approximately in the positions shown. The knobs will then be flush with the rear of the chassis and can easily be pre-set. It is desirable, though not essential, to include a single-pole fuse in the H.T. feed to the time bases, and this can be hung in the wiring at any convenient point.

The amplifier decoupling condenser C5 will have to be fitted on the top of the chassis owing to its size. Two angle brackets can be bent to secure the condenser flat on the metal, the terminals facing inwards.

One of these terminals is connected direct to chassis and the other to the anode resistance, as shown.

The values of the components required are as follows:—

R. 1.—5 megohm ½ watt (Bulgin)	C. 1.—0.1 mfd. (T.C.C.).
R. 2.—5 „ ½ „ „	C. 2.—0.1 mfd. „
R. 3.—5 „ ½ „ „	C. 3.—0.1 mfd.
R. 4.—1 „ 2 „ (Erie)	C. 4.—50 mfd., 12 v. wkg.
R. 5.—1 „ 2 „ „	C. 5.—4 mfd., T.C.C. type. 131
R. 6.—2 „ Reliance Potr.	C. 6.—0.1 mfd.
R. 7.—2 „ „ „	C. 7.—0.1 mfd.
R. 8.—5 „ ½ watt (Bulgin).	C. 8.—0.1 mfd.
R. 9.—100,000 w., 2 watt (Erie).	C. 9.—0.1 mfd. T.C.C. type.
R.10.—1,000 w., 1 watt (Erie).	C.10.—25 mfd., 25 v.
R.11.—50,000 w., 2 watt (Erie).	C.11.—50 mfd., 12 v.
R.12.—1 megohm, Reliance Potr.	C.12. 0.1
R.13.—20,000 w., Reliance Potr.	0.05.
R.14.—200,000 w. 2 watt (Erie).	0.01.
R.15.—220,000 w., 2 watt (Erie).	.001.
R.16.—2 megohm, ½ watt (Bulgin).	.00005.
R.17.—25,000 w., 1 watt Erie)).	C.13.—.001 mfd.
R.18.—1 megohm, Reliance Potr.	
R.19.—2 megohms, 1 watt (Erie).	
R.20. 8,000 w., 1 watt (Bulgin).	
2,000 w., Reliance Potr.	
R.21.—20,000 w., ½ watt (Bulgin).	
R.22.—2 megohms, 2 watt (Erie).	
R.23.—2 megohms, Reliance Potr.	
R.24.—1 megohm, Reliance Potr. w. switch.	

All the above will require duplicating for the two time bases, *except* the following:—

R.1—R.12 inclusive.

C.1—C.5 inclusive.

In addition the following extra components will be needed:—

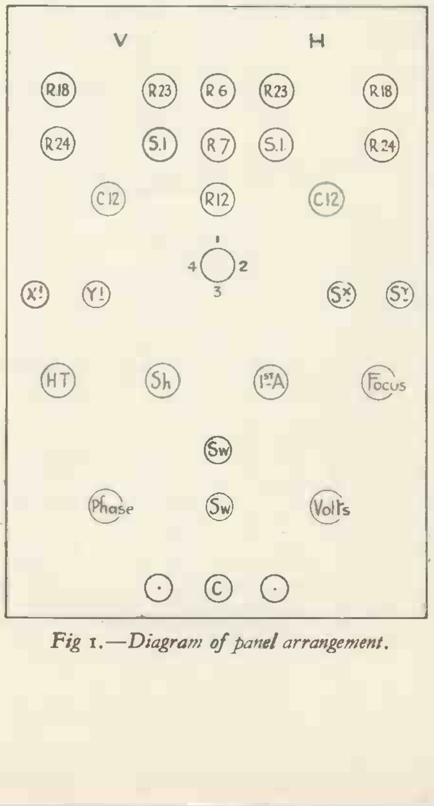


Fig 1.—Diagram of panel arrangement.

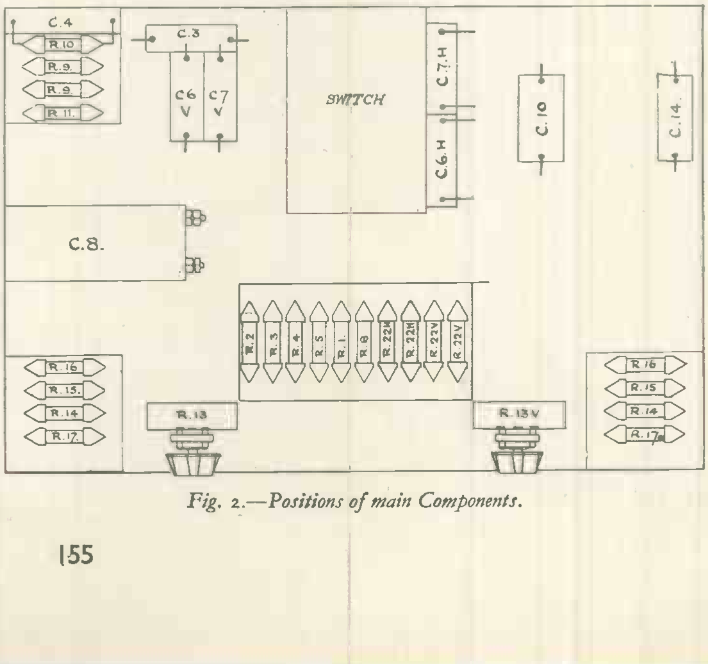


Fig. 2.—Positions of main Components.

Multi-contact switch (see above).
7.—5-pin chassis valveholders (Bulgin).
2.—Rotary On-Off switches (Bulgin).
1.—10-way group board (Bulgin).
3.—5-way group boards (Bulgin).
1.—Mains plug and socket (Bulgin Type).
1.—Steatite 4-pin valveholder (Bulgin).
1.—9-way plug and socket (Belling-Lee).
4.—Terminals marked X.1.Y.1. ; Syn ; Syn ; (Belling-Lee).
6.—B. A. threaded rod and 6 B.A. 1 in. round head screws.
Nuts, washers, soldering tags, insulated wire (see previous article) and
24.—Bakelite Discs 2 in. diameter with $\frac{3}{8}$ in. centre hole (Bulgin)

Fitting the Front Panel

The objection to the use of metal construction in high-voltage circuits is the necessity for careful insulation in the variable resistance fitted to the panel and chassis. Although the spindles of the Reliance potentiometers specified are insulated from the rotating contact the makers will not guarantee them against break-down at voltages of 1,000 or over, and it is necessary to provide extra insulation where the bushes pass through the panel. This insulation can be in the form of a micanite bush and washer having a $\frac{3}{8}$ths clearing hole for the bush of the potentiometer, the hole in the panel being enlarged to $\frac{1}{2}$ in. to take the insulation where it passes through the panel. Suitable washers can be obtained, but with difficulty as the quantities are small, and it was therefore thought advisable to use larger insulating plates, which can be fixed to the panel by rivets or small screws and which will leave ample clearance between the nut of the potentiometer and the metal itself.

These insulating discs are shown in the list of sundries and can be obtained from Messers. Bulgin. On examining the circuit diagram (reproduced in Fig. 3 for convenience) the following resistances will be noted to be at approximately earth potential:

R.18 (both); R.12; R.24.

It will not, therefore, normally be necessary to insulate the bushes of these beyond the insulation provided by the makers, and the holes may be drilled $\frac{3}{8}$ths. clearing only. All the other holes in the panel should be drilled and enlarged to $\frac{3}{4}$ in. to clear the fixing nuts.

Incidentally the switch for the condensers C.12 can be connected in the reverse way to that shown in the diagram of connections which enables the spindle to be secured without an extra bushing, relying on the maker's insulation. This avoids the necessity of enlarging hole C.12 on the panel. The hole for the switch does not need enlarging as the spindle is adequately insulated. The panel can now be marked out according to the drawing of Fig. 4. After drilling small centring holes in each point, the ones previously indicated can be enlarged to $\frac{3}{8}$ths clearing and the remainder to $\frac{3}{4}$ in. with a washer cutter.

The discs are now placed centrally on each hole and the fixing holes marked on the panel and drilled. Small aluminium or tubular rivets are most suitable for fixing. The two switches marked Sw. which are seen below the meter in the photograph of Fig. 3 (January) can be mounted on a common strip of $\frac{3}{8}$ths paxolin, which is secured by four screws through the corners (see Fig. 4).

After the discs have been fixed the resistances can be fastened in and the assembly of the whole unit commenced.

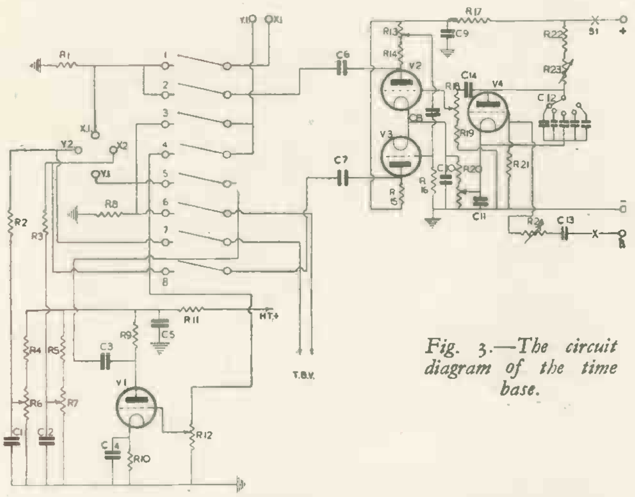


Fig. 3.—The circuit diagram of the time base.

Complete Assembly

The lower rack containing the condensers and H.T. supply sockets has already been wired, or should have been. This is now fastened to the panel by the two screws at the sides and the wiring to the resistances completed through the holes which have been drilled

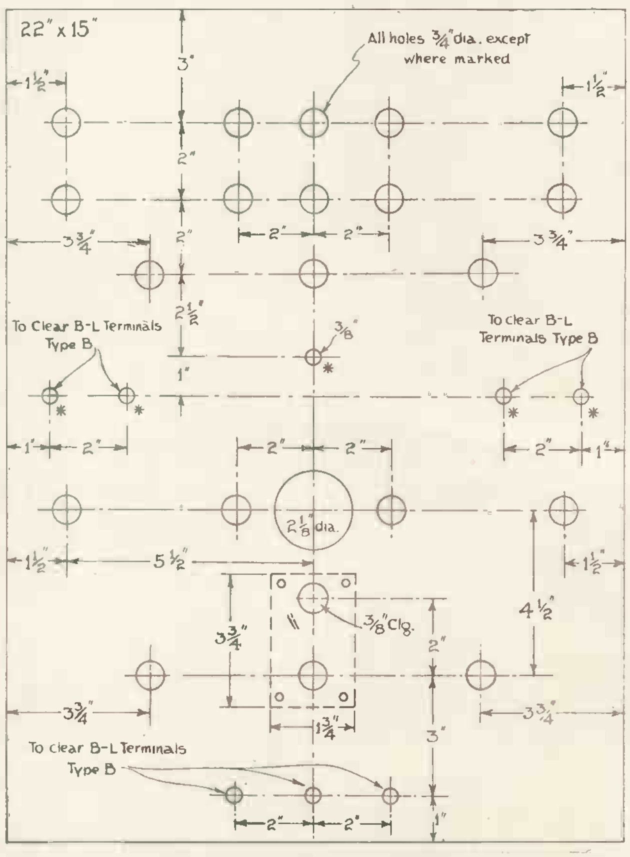


Fig 4.—Drilling diagram of front panel.

near the front edge for the purpose. Care must be taken that the insulation of the wire is not damaged by scraping through the holes. When this wiring is completed, add the second rack and screw on the two back angle supports to steady the whole frame while the wiring proceeds. The second rack is held rigidly to the front panel by the switch bush (which passes through a hole in both flap and panel) and the four Belling-Lee terminals which have already been allowed for in the panel drilling. The insulation of these terminals will require special attention as they are for the deflector plate circuits and it is advisable to put extra micanite washers under the nuts at the rear of the panel. Clamp soldering tags under at the same time to facilitate connections. The whole rack can now be turned upside down to finish the wiring, the leads being threaded through holes in the flap as before. After the wiring, the top metal frame should not be put on until the circuit has been tested through or it will be difficult to get at the wiring for adjustments.

Testing Out

An electrostatic voltmeter is invaluable for testing the circuit and the constructor is advised to obtain one. A maximum range of 1,000 volts will allow low readings to be taken and the range can be doubled by connecting two 5-meg. resistances together across the H.T. to be measured and taking the voltmeter connections to the junction and one end. The accuracy will be sufficient for a rough test to be made of the H.T. supplies for the tube.

Take care that the right plugs are inserted in the sockets for the time base supply and the tube supply respectively. The time base H.T. is applied to the condensers and valves through the switches S1 and time should be allowed for the heaters to warm before the H.T. is switched on.

When the time base is operating satisfactorily the glow of the thyratron will be seen and this glow should alter in frequency as the resistance R23 is adjusted. If the speed is too fast on final test (and 25 cycles per second should be needed) the speed can be altered by increasing the bias of the thyratron (R.20) or by adding extra series resistances in the R.22 resistance chain.

Tube Tests

With two anode tubes such as the Ediswan 5H or the smaller Cossor tubes, the terminal marked A.1 is not used and the socket connections are fed to the appropriate contacts on the tube base.

After allowing the cathode time to heat, the spot should appear on the screen and should be able to be cut off completely by adjusting the knob marked " shield " (see diagram of connections in the January issue). If the tube fails to focus sharply and all the controls are in order the resistances in the chain may be altered by a small amount to bring the voltages right. The time base can then be switched on and the switch for changing the deflector plate connections checked to see that it is performing its job. The amplifier should be capable of enlarging the wave to full screen diameter without distortion and the bias may need adjustment. 4-volt A.C. from a transformer can be used for this check. The double time base position of the switch should give a good line screen free from trapezium distortion but it may be found that the screen appears better with one connection to the deflector plates than another. Each position of the tube and each deflector plate connection should be tried until the best result is obtatined. In a later article it is hoped to give some examples of the use of this equipment in radio and television tests.

PHOTOGRAPHS of the EIFFEL TOWER 180-LINE TRANSMISSIONS




These photographs of the Eiffel Tower 180-line transmissions taken by a French correspondent, M. R. LAURENT, provide an interesting comparison with those of the Alexandra Palace transmissions published in the January issue. Note how clearly the scanning lines appear. The following particulars were sent by our correspondent. Tube : Philips. Screen : Green. H.T. 5,400v. Lines : 180. Pictures : 25 per second. Exposure : 1/5 to 1/10 second.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

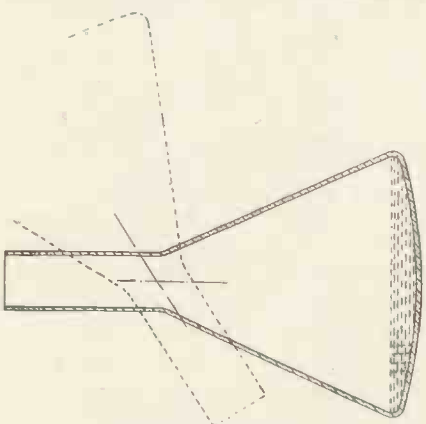
Specially Compiled for this Journal

Patentees :- Marconi's Wireless Telegraph Co. Ltd. :: N. V. Philips Gloeilampenfabrieken :: Marconi's Wireless Telegraph Co. Ltd. and A. A. Linsell. :: H. G. Lubszynski and J. E.Keyston. The General Electric Co. Ltd., N. R. Campbell and L. C. Jesty :: A. G. D. West and Baird Television Ltd. :: E. D. McConnell and Baird Television Ltd.

Fluorescent Screens

(Patent No. 456,755.)

The fluorescent substance known as willemite is ground to a very fine powder and is suspended in an electrolyte solution of ammonium carbonate. The solution is then poured over the base of a cathode-ray tube, so that the fluorescent particles gradually settle down and cover the surface of the glass in a uniform layer.



Method of coating cathode-ray tube. Patent No. 456,755.

The use of the electrolyte solution is essential in order to ensure a perfectly homogeneous coating. If water is used, it is found that small particles, such as those in question, acquire "static" changes which cause them to repel each other and so give rise to irregularities in the resulting layer. By using an electrolyte, these charges are dissipated and a more uniform distribution of the particles is ensured. When the settling-down process is completed, the glass tube is slowly tilted into the position shown in dotted lines in the figure, when the superfluous liquid is drained off.—*Marconi's Wireless Telegraph Co., Ltd.*

Cathode-ray Tubes

(Patent No. 456,629.)

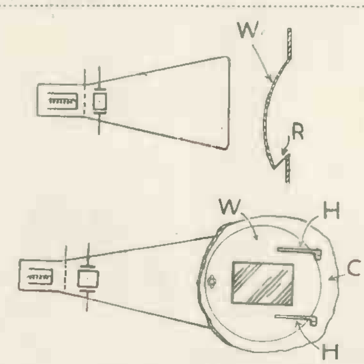
It is usual, in many cases, to provide a conducting black layer on the inner surface of the side-wall of a cathode-ray tube, generally of carbon or graphitic material. This material has, however, the disadvantage of evolving gases when the tube is being used due to the decomposition of the binding material.

To avoid this difficulty the inner wall of the tube is first coated with a silver layer, on which is deposited a coating of copper oxide; or the second coating may consist of silver sulphide deposited from solution. Alternatively the silver layer may be covered with a deposit of another metal, such as molybdenum or nickel, in black form, for instance, as a sulphide.—*N. V. Philips Gloeilampenfabrieken.*

A Cathode-ray Window

(Patent. No. 457,274.)

The "screen" end of a cathode-ray tube is mounted behind a protecting window W of unbreakable glass, such as Triplex, which is hinged at H, H, Fig. 1, to the panel of the cabinet C. Preferably the window W is made concave as shown in Fig. 1 A, and is formed with a recess R which has a matt or black surface facing the screen. This serves to absorb any light that may be reflected back from external objects in the room on to the surface of the window, and so prevents it from affecting the clearness of the televised picture.



Figs. 1 and 1A.—Method of protecting cathode-ray tube. Patent No. 457,274.

This is of some importance, particularly as the light intensity of the picture is generally not high. When the window is swung open about its hinges, a switch automatically cuts off the high-tension supply to the cathode-ray tube. This also occurs should the window be accidentally broken.—*Marconi's Wireless Telegraph Co., Ltd.*, and *A. A. Linsell.*

Cutting-out Interference

(Patent No. 457,800.)

The effect of pick-up interference, when added to the signal voltage, in a cathode-ray receiver, is to overmodulate the electron stream and thereby cause it to produce bright "flashes" on the fluorescent screen. In addition to the disturbance so caused, the flashes tend to damage the fluorescent coating of the screen.

Accordingly steps are taken to prevent any applied voltage from exceeding a predetermined "safe" limit. A diode valve is inserted between two of the amplifier valves, and is so biased that for normal signal voltages it passes no current. On the arrival of a pulse of "static" or other interference, however, the diode develops a biasing voltage which cuts down the amplification of one of the amplifiers, and so reduces the signal voltage to normal or "safe" limits.—*A. G. D. West* and *Baird Television, Ltd.*

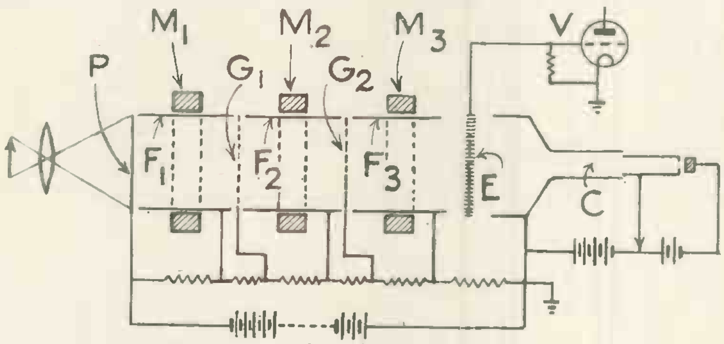
Electron Multipliers

(Patent No. 457,493.)

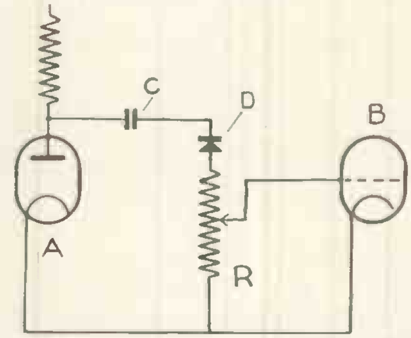
The image of the picture is focused upon a photo-electric screen P, and the electrons so liberated are amplified by secondary emission as they pass through a succession of open-wire grids G, G1, under the control of the magnetic fields from windings M1, M2, M3 and the electrostatic fields from a series of electrodes, F1, F2, F3.

The amplified electron stream impinges upon a mosaic-cell electrode E, where it is scanned by the stream from the "gun" of a cathode-ray tube C, the resulting current being fed to the grid-cathode circuit of the amplifier V. The windings M1, M2, etc., may be enclosed in magnetic shields formed with annular gaps so as to concentrate the field in the desired direction.

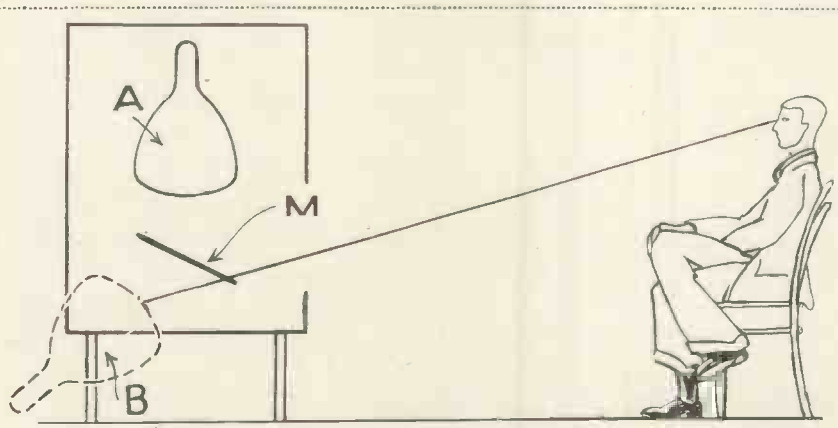
The apparatus may be used for detecting the presence of a warm body in a dark room, or for detecting the presence of objects in a dense fog. Or it may be used to detect an object emitting rays of only one colour, say red, and reproducing the image in blue. In this sense it functions as a light "transformer." It is also of value in micro-photography. —*H. G. Lubszynski* and *J. E. Keyston.*



Electron multiplier. Patent No. 457,493.



Separating television signals. Patent No. 457,812.



Position of viewing screen. Patent No. 457,510.

Viewing Screens

(Patent No. 457,510.)

It is usual to set the viewing screen of a cathode-ray receiver vertical, or substantially so, though this is not the most convenient position for an observer to look at it when seated. Accordingly means are provided whereby the plane of the image appears to be tilted upwards at an angle of about 15°, so that a seated observer sees it in more or less the same position as he reads the printed page of a book.

As shown in the figure the desired effect is obtained by arranging a plane mirror M to reflect the image from the cathode-ray tube A as though it were, in fact, in the position shown in dotted lines at B. Alternatively the picture may be viewed directly in a cathode-ray tube, which is so mounted that the plane of the bulb end of the tube, and therefore of the fluorescent screen, can be mechanically tilted upwards by means of a screw projecting from the underneath part of the cabinet.—*The General Electric Co., Ltd., N. R. Campbell,* and *L. C. Jesty.*

Separating Television Signals

(Patent No. 457,812.)

Signal and synchronising signals are separated by passing them through the valves A, B, which are coupled through a link circuit comprising a condenser C, a dry-contact rectifier D, and a resistance R. The picture signals are so "poled" that they tend to throw the grid of the valve B positive. Since that valve is already biased to the top of its curve, these signals can have little or no effect on the output current.

The synchronising signals, on the other hand, are "poled" to throw the grid of the valve B more negative, and therefore produce their full effect on the output current. To increase the separation effect, the rectifier D is arranged so that it offers a high impedance to the flow of the picture signals, and a low impedance to the passage of the synchronising impulses.—*E. D. McConnell* and *Baird Television, Ltd.*

Summary of Other Television Patents

(Patent No. 455,927.)

Arranging the deflecting plates of a cathode-ray receiver so that they project partly into the enlarged or bulb end of the tube.—*Marconi's Wireless Telegraph Co., Ltd.*

(Patent No. 456,135.)

Method of modulating in television wherein the picture signals are separated by intervals of "zero" carrier-wave.—*A. D. Blumlein* and *E. A. Nind.*

(Patent No. 456,136.)

Directional aerial system for transmitting television signals.—*E. L. C. White* and *W. S. Percival.*

(Patent No. 456,288.)

Means for suppressing the cathode-ray beam during the "fly-back" stroke in scanning.—*E. Reader* and *L. Glass.*

(Patent No. 455,598.)

Improvements in scanning a trapezium-shaped area in cathode-ray television.—*Telefunken Ges. fur drahtlose Telegraphie m.b.h.*

THE TELEVISION ENGINEER

THE DESIGN OF VISION-FREQUENCY AMPLIFIERS

By P. NAGY, G.I.E.E., Research Dept., International Television Corporation Ltd.

This article, the first of a short series, sums up the principles which govern the design of any picture frequency amplifier. High and low frequency correction is dealt with in detail. The correctness of the theoretical considerations has been proved by measurements in conjunction with several R.C. coupled photocell amplifiers, used for the amplification of signals generated by a television film transmitter. It was found that the push-pull resistance coupled amplifying stage has several advantages against other solutions.

A WELL constructed R.C. coupled picture-frequency amplifying stage will combine good frequency response with stability, at the highest possible gain.

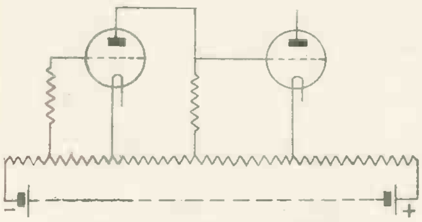


Fig. 1.—A D.C. amplifier.

Low-Frequency Correction

As is generally known, only the D.C. amplifier of Fig. 1 will be able to amplify, without distortion, low frequencies; even the slowest contrast changes in the picture are reproduced in an ideal way. The R.C. coupled amplifier, as seen in Fig. 2, will not amplify these low frequencies because of the attenuating effect of the grid coupling condenser C. The useful voltage across the grid leak resistance Rg decreases as the grid coupling condenser is developing its charge.

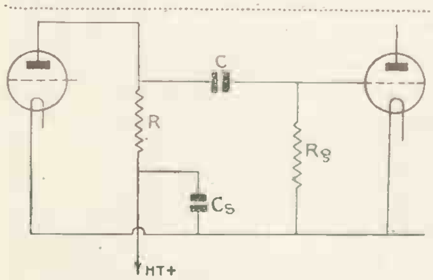


Fig. 2a.—An R.C. coupled amplifier.

Fortunately, as practice shows, the lowest frequency of importance for the reproduction of a good quality picture apart from the D.C. component is the frame frequency. For instance, in the case of the 240-line 25-pictures-per-second transmission the lowest important frequency will be 25 cycles per second.

By increasing the value of C and Rg (Fig. 2) it is theoretically possible to achieve perfect low-frequency response; experience shows, however, that the increase of these values over a rather sharply defined limit will cause instability. This instability will mostly appear in the form of a so-called relaxation oscillation. Already nearing this critical point, the amplifying stage develops a very undesirable sensitivity to the smallest changes in the supply voltages and we would notice a continuous and irregular wobbling of a milliammeter measuring the anode current.

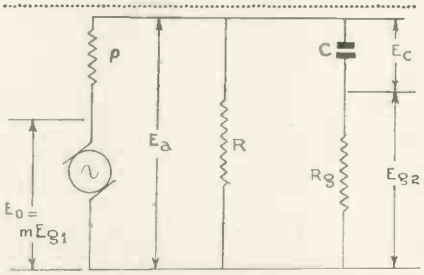


Fig. 2b.—A.C. diagram of an R.C. coup'd amplifier.

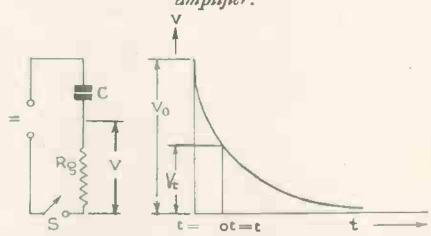


Fig. 3.—Diagram and curve explaining the meaning of "time constant."

Let us calculate the amplitude and phase distortion at 25 cycles in a practical case, where the value of Rg and C are safe, but already near to the instability limit. If in Fig. 2a the H.T. smoothing condenser Cs represents a short circuit at 25 cycles, the diagram of Fig. 2b will be equivalent to Fig. 2a. The valve is substituted by the usual generator developing a zero-load voltage Eo ($E_o = E_{g1}.m$, where E_{g1} = input voltage and m

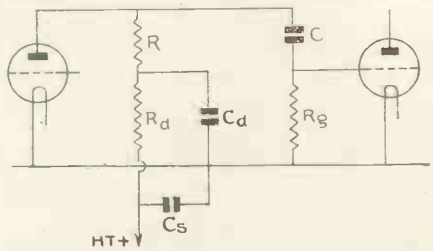


Fig. 4.—A means of obtaining phase correction

= amplification factor) and having in series the valve impedance ρ

The load impedance Z is:

$$\frac{1}{Z} = \frac{1}{R} + \frac{1}{\frac{1}{j\omega C} + R_g} \qquad Z = \frac{R}{1 + \frac{R}{\frac{1}{j\omega C} + R_g}}$$

Only the term $\frac{R}{\frac{1}{j\omega C} + R_g}$ will alter its value with the frequency. In a well constructed television amplifier,

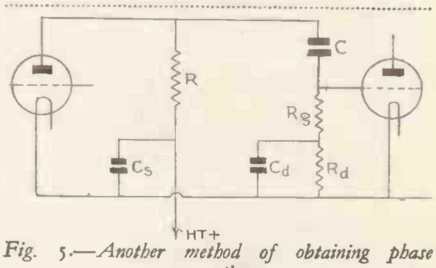


Fig. 5.—Another method of obtaining phase correction.

however, R_g is always 10 to 20 times larger than R and so the influence of $\frac{R}{\frac{1}{j\omega C} + R_g}$ can be neglected, i.e., there is no amplitude or phase distortion between E_{g1} and Ea. But as we already mentioned the grid coupling condenser C will seriously attenuate the useful output voltage E_{g2} across R_g:

$$\frac{Eg_2}{Ea} = \frac{Rg}{Rg - j\frac{1}{\omega c}} = \frac{Rg}{\sqrt{Rg^2 + \frac{1}{\omega^2 c^2}}} e^{j\gamma} \qquad j = \sqrt{-1} \quad (1)$$

$$\gamma = \tan^{-1}\frac{1}{\omega c\, Rg} \qquad (2)$$

Let us take R_g = 100,000 ohms
c = .1 microfarad
f = 25 cycles/sec.
$\omega = 2\pi f$.

The amplitude attenuation from equation (1):

$$\frac{Eg_2}{Ea} = \frac{Rg}{\sqrt{Rg^2 + \frac{1}{\omega^2 c^2}}} = .84 \text{ or}$$

100 — 84 = 16%.

and the phase distortion from equation (2):

$$\gamma = \tan^{-1}\frac{1}{\omega c\, Rg} = 34^\circ.$$

From equation (1) we can also write:

$$\frac{Eg_2}{Ea} = \frac{Rg}{\sqrt{Rg^2 + \frac{1}{\omega^2 c^2}}} = \frac{Rg}{\sqrt{Rg^2 + \frac{Rg^2}{\frac{4\pi^2}{t^2} c^2 Rg^2}}}$$

$$= \frac{1}{\sqrt{\left[1 + k^2\left(\frac{t}{c\, Rg}\right)^2\right]}} = \frac{1}{\sqrt{1 + k^2\left(\frac{t}{T}\right)^2}}$$

and equation (2)

$$\gamma = \tan^{-1}\frac{1}{\frac{2\pi}{t} cRg} = \tan^{-1} k\frac{t}{cRg} = \tan^{-1} k\frac{t}{T}$$

where

$$t = \frac{1}{f};\quad k = \frac{1}{2\pi};\quad T = cRg.$$

As we now see our amplitude and phase distortion depends on the actual "time" t in which one full period of the alternating voltage is completed and on the product of C and R_g called the "*time constant*" T.

We can perhaps still better visualise the meaning of the expression "time constant" by calculating the voltage attenuation of a D.C. impulse across C and R_g, applied by closing the switch S in Fig. 3.

$$\frac{Vt}{Vo} = e^{-\frac{t}{CRg}} = e^{-\frac{t}{T}}$$

The time constant T will give us the correct measure of the low-frequency response of any amplifying stage and its introduction will simplify our correction calculations. Experience shows that it is unsafe to increase the value of T over .01.

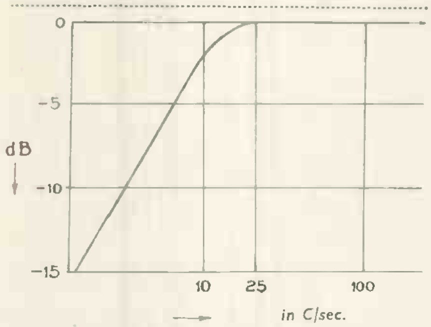


Fig. 6.—Curve showing frequency response of uncorrected amplifying stage.

In our example, T = 100,000 ohms .1 . 10^{-6} farad = .01, and as the calculations have shown, this value of T will already introduce 34 degrees of phase shift and 16 per cent. amplitude

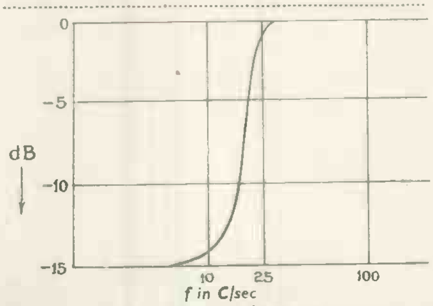
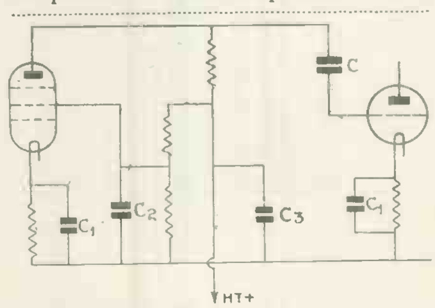


Fig. 7.—Curve showing frequency response of corrected amplifying stage.

attenuation. Phase distortion at low frequencies will cause a very disturbing displacement of the actual picture components. The amplitude distor-



f in C/sec.

Fig. 8.—Decoupling condensers cause phas e and amplitude distortion.

tion results chiefly in contrast differences, thus phase correction must be regarded as far more important. The phase shift of successive amplifying stages should be added to each other to receive the resultant phase distortion. Five degrees phase shift can hardly be noticed in a one-stage amplifier, but will cause serious distortion in six successive stages.

Fortunately there are simple and efficient means of obtaining satisfactory correction, as for instance, the introduction of a decoupling circuit Cd—Rd in series with the anode or grid leak resistance, as shown in Figs. 4 and 5.

All the necessary details and a thorough theoretical treatment of this type of correction was published in the "Marconi Review," No. 54, 1935. It is possible to correct the time constant of T = .01 almost absolutely and the uncorrected phase shift of 34 degrees at 25 cycles per second can be reduced to less than half a degree. The correction method of Fig. 4, in particular, has a great number of practical advantages:

(1) The use of a small capacity value as grid coupling condenser. The small size is in most cases a great constructional advantage and it will also reduce the "hum" danger. As is well known, resistance coupled amplifiers are liable to pick up hum caused by 50 or 100 periodic supply voltages; a large grid coupling condenser would pick up additional hum.

(2) Due to the low time constant the value of R_g can also be kept relatively low, thus reducing the hum danger and eliminating grid charging effects.

(3) In an amplifying stage with a large time constant the quality of the grid coupling condenser is of great importance, especially with regard to low D.C. leakage current, which might charge the grid positive and cause instability. Applying correction, i.e., a small C, this effect can be eliminated even in cases of imperfect condensers.

(4) The correction resistance and condenser Rd and Cd is an ideal decoupling device between the stages, thus eliminating high- and low-frequency instability caused by inter-stage couplings.

(5) Rd and Cd also represents a very efficient smoothing device for 50 or 100 periods.

(6) A very agreeable characteristic of a low-frequency corrected amplifier is the disappearance of an effect which we can term "the grid choking effect." An amplifier composed of several stages using large time constants will respond in an undesirable way to changes of the volume control which, causing strong D.C. impulses, will develop surge voltages and charge the grids positive or nega-

(*Continued at foot of next page*).

STUDIO & SCREEN

A MONTHLY CAUSERIE on Television Personalities and Topics

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

THE important announcement made early last month that a decision had been reached regarding the choice of transmission system at Alexandra Palace may have come as a surprise to some members of the public. But in trade circles, and particularly among artists who had performed at Alexandra Palace, it was generally anticipated.

I think it had been evident to everyone who had done a television programme that the two-system arrangement, with its cumbersome double studios and other complications, was one which placed exceedingly onerous restrictions upon production and which, in the best interests of the B.B.C. and lookers alike, should be altered at the earliest possible moment.

My own impression, on the several occasions I have been privileged to watch productions at the Palace, was that we were, so to speak, back again in the old Marconi House days of wireless, when everything was jumbled together in one little room. It just struck me that way. The equipment and facilities at Alexandra Palace, of course, are of first-rate design and quality, but from the point of view of programme production, I have been astonished, on each occasion I have been there, at the tremendous difficulties with which the producers have to contend. You have a man, say, reading broadcast news in the same studio that other people in another corner are getting ready for a variety show—so reminiscent of the way things were done in the very early days of sound broadcasting.

There was no sense, but rather much waste of time and money, in continuing these preliminary arrangements, which hampered the provision of good programmes, one week longer than was actually necessary.

* * *

As a general result of this change, so far as the studio and production side is concerned, television will have progressed relatively from what corresponds to the old Marconi House days to the equivalent of the Savoy Hill period of sound broadcasting.

It will now be possible to quicken up the television programmes considerably, and they will be much easier to produce because a set can be prepared in one studio whilst transmission is in progress in another.

Naturally, everyone at Alexandra Palace is anxious to get the new arrangements into full working order with the least possible delay.

Besides doubling the space available for the productions staff, make-up problems will in future be much simplified because, of course, there will be only one system to deal with; while from the point of view of ease of working, one of the principal advantages which will be immediately appreciated at Alexandra Palace is that there will be no change of routine each week as there is at present. Until now, I am told, it has seemed almost like starting all over again each Monday!

The ever popular Western Bros., who made a hit with their first television performance.

Gerald Cock, Director of Television, told us in a recent broadcast talk something about his future programme plans. There is no concealing the fact that many people are not finding the programmes up to the standard they expect.

The D.T. admitted that in planning his programmes for the immediate future, he had come up against a regrettable dearth of suitable light

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"The Design of Vision-frequency Amplifiers"

(Continued from preceding page.)

tive so that the valves will cease to amplify. The amplifier might be choked for several seconds; as a matter of fact if this choking effect is combined with a certain instability of the amplifier, which in itself does not cause trouble, both disturbances might result in a perfect choking of the amplifier for an unlimited time.

The curves of Figs. 6 and 7 show the frequency response of a corrected and uncorrected amplifying stage with similar response above 25 cycles per sec. We see that the corrected stage practically ceases to amplify frequencies below 25 cycles per sec., thus slow surges caused by volume control changes are not amplified and the choking effect disappears. It is possible to obtain almost immediate response between control and amplification.

In our calculations we had as a condition that the decoupling condensers —for instance, C_1, C_2, C_3 in Fig. 8— be large enough to represent short circuits at the lowest important frequency. Generally this is not the case. As we shall see the additional phase and amplitude distortion caused by decoupling condensers can be perfectly eliminated in a push-pull R-C coupled amplifying stage.

(To be continued.)

PROGRAMMES ON SUNDAYS?

entertainment material, but promised that he would repeat such successful performers, as for instance, Gillie Potter, Yvonne Arnaud, Frances Day, George Robey, Billie Houston, Sophie Tucker, Noni, The Western Brothers, Hermione Baddeley, and others of a like calibre.

Mr. Cock's forecast did not warrant any geat hope that there would be any major changes in programme construction in the immediate future. He mentioned that the fortnightly cooking series by Marcel Boulestin would continue; David Seth-Smith is to continue his zoo programmes, and John Hilton his series on social planning. He hopes also to enrol Howard Marshall as a kind of Sports Editor to introduce celebrities. "Picture Page" seems to have come to stay.

* * *

Fashion broadcasts will continue to occupy a prominent place in the programmes, and there is little doubt that as soon as more television receivers are in service these fashion broadcasts will soon become extremely popular. For the "New Fashions in Furs" programme, at the end of January, I understand that furs to the value of about £10,000 were taken to Alexandra Palace for the mannequin displays. An example of the topical interest that can be fused into these programmes is that several of the furs which the mannequins wore were specially designed for wearing over Coronation dresses.

Yolande Proctor in a television mask dance.

I am told that another interesting fashion programme is scheduled for March 4, which this time will deal with hats and hairdressing. The hat designs will include several special creations for wear at Ascot, and before each hat is fitted a hairdresser will show with a living model how the hair should be arranged.

Frances Day, Popular Television Star.

* * *

One of the best shows of the month—I should call it sensationally good—was the amateur boxing programme which provided television's first outside broadcast of a competitive sporting event. Televiewers saw contests staged by the Alexandra Boxing Club in the Concert Hall at A.P. All the competitors televised were not the people named in the preliminary announcements by the B.B.C., but that did not matter. It all came through wonderfully well. The special interest from a technical point of view was that special lighting was employed and the scene was connected to the control room of the Palace by some 250 feet of cable.

Everyone was expecting to see a glorious knock-out actually occur before their eyes. But I am afraid televiewers were disappointed, because although the televised bouts were intensely interesting and exciting, no K.O. occurred, although, by a curious coincidence, there were some earlier in the part of the evening's programme which was not televised.

Consideration is now being given, I hear, to the question of television programmes on Sundays, and also the provision of an extra hour on weekdays; but at the time of writing these notes no definite decision has been made.

I believe that any imminent changes are unlikely, because the extension of programme time is largely contingent upon provision of additional staff at the Palace, the arrangement of which naturally will take time and has to be gone into by the Broadcasting House chiefs.

* * *

Writers in the lay Press are continuing to indulge in considerable speculation about the televising of the Coronation, and in many quarters it has been asserted that the idea has definitely been abandoned. I am told that this is by no means true, and, in fact, am assured it is now highly probable that at least parts of the Coronation ceremonies will be seen by televiewers.

From the point of view of public interest in television, the month's most important news is the marketing of receivers at 55 and 60 guineas, and on hire-purchase terms requiring a nominal deposit and payment of as little as £1 a week. Another factor which I am sure will hasten the sales is the abandonment by the H.M.V. Company of the mass-demonstration idea. In future, I learn, demonstration by this company of receivers will not be given to small crowds, but will be arranged in showrooms for the benefit of individual prospective purchasers, or in their homes.

The B.B.C. and the Television Service

Major Tryon, the Postmaster-General, in a written reply to Mr. Temple Morris, stated recently that it is not intended that the B.B.C. should be responsible for accepting or rejecting any television transmitting system which may be discovered in the future. The Television Advisory Committee, he stated, is charged with the duty of advising the Postmaster-General on this and other points arising in connection with the development of the broadcast television service.

ELECTRON OPTICS

At the Television Society's meeting on Wednesday, December 9th, a paper on "Electron Optics" was read by Mr. S. Rodda. Mr. G. Parr, the Lecture Secretary, was in the Chair. The following abstracts are taken from the paper, which will be published in complete form in the Journal of the Television Society.

It is well known that geometrical optical theory can proceed on the assumption, made by Newton, that light consists of "luminiferous corpuscles" emitted by a luminous object. The phenomena of refraction of a ray of light as it passes from one optical medium to another can be explained if it is supposed

(1) That the corpuscle has a different speed in the second medium compared with the first.

(2) That the accelerations of the corpuscle are normal to the interface between the two media.

Assumption (2) is equivalent to saying that the velocity parallel to the interface is unchanged.

Suppose the speeds in the respective media are $\mu_1 V$ and $\mu_2 V$. Then if the angles of incidence and refraction are θ_1 and θ_2 we must have $\mu_1.V.\sin\theta_1 = \mu_2.V.\sin_2$, since these are the velocities parallel to the interface. Thus

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{\mu_2.V}{\mu_1.V} = \frac{\mu_2}{\mu_1} \text{ (Snell's Law).}$$

The path of an electron will follow exactly the same law if it passes suddenly from a region where its velocity is proportional to μ_1 into a region where its velocity is proportional to μ_2, provided that the only forces acting on it are normal to the interface.

Calculation of Electron Velocity

This equation can be written in terms of potentials very simply, since the velocity of an electron at a point where the potential is with respect to the cathode is given by

$$V = \frac{2E^{\frac{1}{2}}\phi^{\frac{1}{2}}}{m}$$

where E is the charge on the electron in E.S.U. $= 4.77 \times 10^{-10}$

,, m is the mass of the electron $= 9.01 \times 10^{-28}$ gm.

,, ϕ is the potential in E.S.U. 1 E.S.U. = 300 volts.

$$\text{Thus } V_1 = \frac{2E^{\frac{1}{2}}\phi_2^{\frac{1}{2}}}{m}$$

$$\text{and } V_2 = \frac{2E^{\frac{1}{2}}}{m}\phi_2^{\frac{1}{2}}$$

$$\therefore \frac{\sin\theta_1}{\sin\theta_2} = \frac{\phi_2^{\frac{1}{2}}}{\phi_1^{\frac{1}{2}}}$$

If then $\frac{\phi_1^{\frac{1}{2}}}{\phi_2^{\frac{1}{2}}} = \frac{\mu_2}{\mu_1}$ the electron path will be the same as that of the ray of light.

Generally, optical systems are characterised by a sudden jump in refractive index from one medium to another, for instance, in passing from air to glass and then back to air—the corresponding refractive indices being 1.0, 1.5, 1.0. In order to simulate such an optical system "electron optically," it is necessary to use meshed electrodes of the same shape as the boundaries of the optical media.

If the inner mesh is at a lower potential than the outer mesh, its refractive index is less than the outer, and the lens becomes divergent.

Such lenses have been constructed, but they are not generally used, owing to the obstruction offered by the mesh to electron flow, and to electron deflections at the wires of the mesh, which have been neglected in the present treatment.

Potential Fields form Regions of Varying Refractive Index

In general the potential distribution about an electrode system is not characterised by discontinuous jumps in potential, but the potential varies gradually from point to point. As one would expect, the corresponding optical system must have the refractive index also varying gradually from point to point, in such a manner that μ is proportional to $\phi^{\frac{1}{2}}$.

The problem divides itself into two parts:—

(1) The calculation of the potential distribution due to the given electrode arrangement, given potentials being applied to the various electrodes.

(2) The calculation of the trajectories of electrons passing through the potential field,

(a) without an applied magnetic field;

(b) with an applied magnetic field.

Focal length for Circular Aperture.

If the potential ϕx along the axis is given

$$\phi x,r = \phi x - \frac{r^2}{4}\frac{d^2\phi}{dx^2} + -$$

$$\frac{d\phi}{dr} = -\frac{r}{2}\frac{d^2\phi}{dx^2}$$

if r is small. (Fig. 1.)

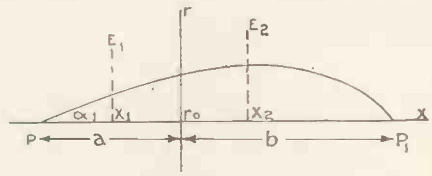


Fig. 1.

If the electron appears to originate at the point P situated on the axis at a distance "a" to the left of the aperture, then

$$\frac{dr}{dx}\Big/_{x_1} = \frac{r_0}{a}$$

Similarly, if the electron appears after traversing the aperture to cut the axis at P1 a distance "b" to the right of the aperture

$$\frac{dr}{dx}\Big/_{x_2} = \frac{-r_0}{b}$$

$$\therefore \frac{-r_0}{b} - \frac{r_0}{a} = \frac{-r_0}{4\phi x}\left(\frac{d\phi}{dx}\Big/_{x_2} - \frac{d\phi}{dx}\Big/_{x_1}\right)$$

or

$$\frac{1}{b} + \frac{1}{a} = \frac{E_2 - E_1}{4\phi_x}$$

where E_2, E_1 are the final and initial intensities.

If "a" is infinitely large, P_1 will be the focus so that $\frac{1}{f} = \frac{E_2 - E_1}{4\phi_x}$.

It will be noticed that the result is independent of r_0, and therefore of x_1, at least for small values of x_1; so that all the electrons appearing to originate at P will, after traversing the aperture, appear to pass through another point P_1 on the axis. The system behaves, therefore, as a true lens.

If E_2 is greater than E_1, f will be positive, and the lens will be convergent.

If E_2 is less than E_1, f will be negative, and the system will form a divergent lens.

If E_2 equals E_1, there will be no deviation of the electrons passing through the aperture.

The Motion of Electrons in a Potential Field

Suppose that the equipotential lines in the neighbourhood of a point Q have been mapped out, ϕ and $(\phi + \Delta\phi)$ being adjacent equipotentiols (Fig. 2).

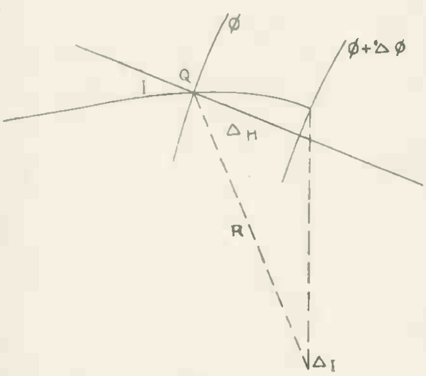


Fig. 2.

Suppose that an electron has arrived at the point Q from a direction making an angle I with the normal to the equipotentials at Q. The force acting on the electron is directed along the normal and is of magnitude $E \dfrac{d\phi}{dh}$.

The component of this force resolved normal to the direction of flight of the electron is

$$E\frac{d\phi}{dh} \sin I.$$

This force is balanced by the centrifugal force of magnitude $\dfrac{mv^2}{R}$ where R is the radius of curvature of the trajectory at Q.

If the electron is deflected through an angle ΔI (I is diminished by ΔI)

$$QQ^1 = -R\Delta I.$$

But

$$QQ^1 = \frac{\Delta h}{\cos I} \therefore -\Delta I = \frac{QQ^1}{r} = \frac{\Delta h}{R\cos I} = \frac{\Delta h . \frac{d\phi}{dh}}{2\phi} . \frac{\sin I}{\cos I}$$

In the limit $-\dfrac{dI}{\tan I} = \dfrac{d\phi}{2\phi}$.

By integration $\sin I = \text{const.}\ \phi^{-\frac{1}{2}}$ or $\phi^{-\frac{1}{2}} \sin I = \text{constant}.$

Position of the Image

A *real* image is formed at the position in which an electron originally starting from a point on the axis again cuts the axis.

A *virtual* image is considered to exist at the position where the tangents to the direction of motion of such an electron appear to cut the axis.

In order to find the linear magnification and the position of the image for paraxial rays it is only necessary to trace the trajectory of one electron, viz., an electron emitted from the axial point. The whole problem is thus reduced to finding the trajectory of such an electron in the given electrostatic field.

Applications of the Helmholtz Sine Law

(1) *Co-axial Tube Problem.*

The expression for linear magnification

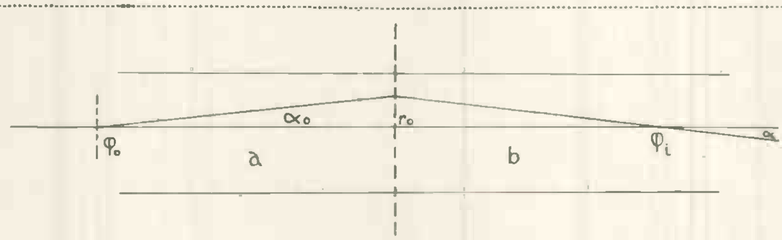


Fig. 3.

$$\frac{y}{y_0} = \frac{\phi_0^{\frac{1}{2}} \sin \alpha_0}{\phi_i^{\frac{1}{2}} \sin \alpha}$$

is immediately applicable to single lens systems of the type which are field free at each end, e.g., the co-axial tube problem (Fig. 3).

Let "a" be the distance from the object to the lens.

Let "b" be the distance from the lens to the image.

Suppose an electron emitted from the object where it is intersected by the axis crosses the lens at a distance r_0 from the axis. Then since the electron has traversed a field free tube it moves in a straight line, except in the neighbourhood of the lens.

Thus $\alpha_0 = \dfrac{r_0}{a}$

Similarly $\alpha = -\dfrac{r_0}{b}$ after traversing the lens.

$\therefore$ Linear Magnification

$$\frac{\phi_0^{\frac{1}{2}} \frac{r_0}{a}}{\phi_i^{\frac{1}{2}} \frac{r_0}{b}} = \frac{b}{a} \frac{\phi_0^{\frac{1}{2}}}{\phi_i^{\frac{1}{2}}}$$

where ϕ_0 is the potential at the object plane.

,, ϕ_i is the potential at the image plane.

Suppose an electron is emitted with an initial velocity in the r direction equal to $\dfrac{(dE)^{\frac{1}{2}}}{(m)} \phi_1^{\frac{1}{2}}$ and assume that it is emitted normally to the cathode, so that the angle $\alpha_0 = 90°$.

The electron will not change its velocity in the r direction in moving across to Plane I, since there are no forces acting on it in the r direction.

Thus $\dfrac{dr}{dt} = \dfrac{dE^{\frac{1}{2}}}{m} \phi L^{\frac{1}{2}}$

$\therefore \dfrac{dr}{dt} = \phi_L^{\frac{1}{2}}$ and $r = \phi_L^{\frac{1}{2}} T_1$

Put $T = T_1$: When at Plane I

$$r = \phi_L^{\frac{1}{2}} T_1 \text{ and } \frac{dr}{dT} = \phi_L^{\frac{1}{2}}$$

Putting these conditions in the equation $r = A \cos KT + B \sin KT$ it is found that: $A = \phi_L^{\frac{1}{2}} T_1$, $B = \dfrac{\phi_L^{\frac{1}{2}}}{K}$ if the equation be written $r = A \cos Kr + B \sin Kr$ where $r = T - T_1$.

It can be shown that subsequent to the II plane there is no change in the image size (except due to other distorted fields).

Thus $M = \dfrac{1}{\cos KT - KT_1 \sin KT}$

If M is large, the conditions are requisite for obtaining a good electron microscope, but for a cathode-ray tube we require as small an image of the cathode as possible.

The magnification is independent of the scale size of the system. This means that in order to get an image of the cathode which is small, the

(*Continued on page* 191)

A Metal-valve Communication Receiver

This six-valve receiver is suitable for amateur use in any part of the world. It has been designed to withstand hard usage, embodies components suitable for tropical use while filaments can be run from either an accumulator or A.C. mains. The designer is **J. W. Paddon, G2IS.**

THE super-heterodyne described in this article is designed for a man whose job takes him all over the world. This fact mainly controls the specification.

The circuit chosen provides a total of six valves; a regenerative first detector, first oscillator, regenerative intermediate-frequency amplifier, anode-bend second detector, triode second oscillator and triode output stage.

American metal valves have been chosen first because they are more readily available abroad than British valves, and secondly, and most important, the fact that the man in question drives an automobile having a six-volt accumulator.

The set will, at times, be battery operated, and the use of four-volt filaments would have meant not only a heavy amperage demand, but also the use of a large filament rheostat. A third consideration was the reduced likelihood of valve breakage with the type mentioned.

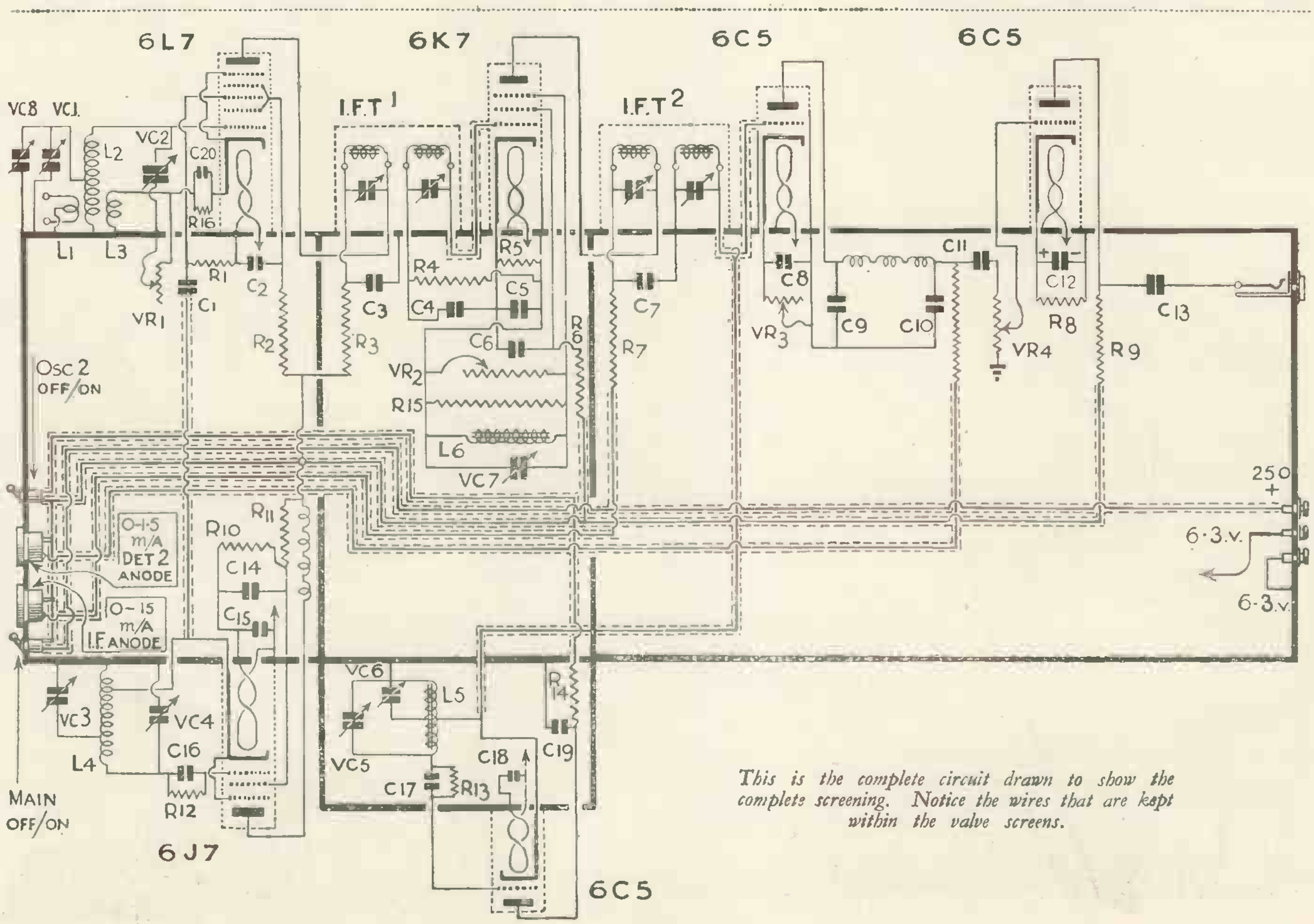
Regenerative Detector

The first detector is type 6L7 and H.F. pentode fitted with an "injector grid." This valve has a high conversion gain and is quite free of "pulling" between oscillator and first detector circuits. Regeneration is applied to do away with the need for a first H.F. stage with its attendant increase in H.T. consumption. There is no question but that H.F. stage would be desirable, but other considerations outweighed.

The first oscillator is a 6J7, a straight H.F. pentode, in a conventional electron coupled circuit. At first an attempt was made to run the screen through a simple series resistor, but in the interest of stability it was found essential to use a fixed potential divider. This divider adds only 2 m/a to the H.T. demand.

The I.F. stage uses the 6K7, which is a variable Mu H.F. pentode. The variable-mu factor is not used as this stage is also regenerative. Regeneration is applied not only to increase the overall gain, but also to improve selectivity. The means of obtaining regeneration is unusual. The system of tapping the cathode high above earth on the grid coil and varying the screen potential was not used because it involved a further potential divider and also because it seemed logical that the overall gain from this stage would be reduced if the screen was run at a reduced voltage as is necessary with this type of regeneration.

The system decided upon was to connect the suppressor grid to earth through a tuned circuit set at the same frequency as the I.F. transformer. A variable resistance is shunted across the tuned circuit and the varying damping applied across the tuned circuit effectively controls regeneration with-



This is the complete circuit drawn to show the complete screening. Notice the wires that are kept within the valve screens.

Anode-bend Detector :: R.C. Low-frequency Stage

out causing any noticeable detuning to the I.F. stage proper.

The second oscillator is a simple triode of the 6C5 type. This valve is run at a very low anode voltage to prevent an excessive "rush" in the output when the BFO is switched on.

Another 6C5 is used as the second detector which is operated as an anode bend detector. The use of a diode would have somewhat reduced the H.T. consumption, but the damping and lack of gain inherent to this type of detection offset the saving.

The L.F. amplifier is a third 6C5 with standard resistance coupling in both grid and anode circuits.

It would be well to consider a number of practical points regarding the physical construction of the set before going into a detailed analysis of the electrical circuits.

Chassis Construction

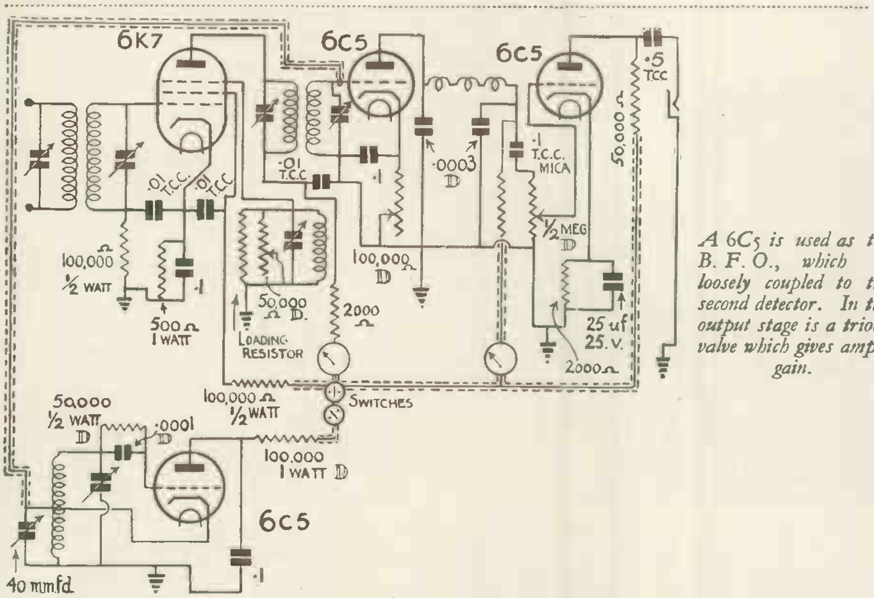
The chassis is of generous dimensions since it is my opinion that crowding is an invitation to unwanted inter-circuit coupling which causes instability and high noise level. The material used throughout the shielding is 16 gauge lead coated steel. This is brutal metal to work and the constructor is advised to use aluminium which is a kinder metal. Steel is used in this instance for mechanical strength. Lead coated steel was chosen for its corrosion resisting properties. All faces of the chassis and screening are covered with baked enamel. Care is taken that all mounting screws and nuts seat on metal which is scraped bare of enamelling. When all are tight and snug the screw heads are painted with non-corrosive paint.

All by-pass condensers, resistors, etc., are housed inside the chassis. A study of the photograph of the underside of the set will show a number of screening partitions which isolate—the Det. 1. and Osc. 1. circuits—the I.F. circuit—the Osc. 2. circuit and Det. 2. and L.F. circuit from each other.

H.T. supply leads are run in screened single conductor wire and the cable form frequently bonded to earth. The somewhat elaborate under chassis screening and the screening of the H.T. leads were done to improve stability.

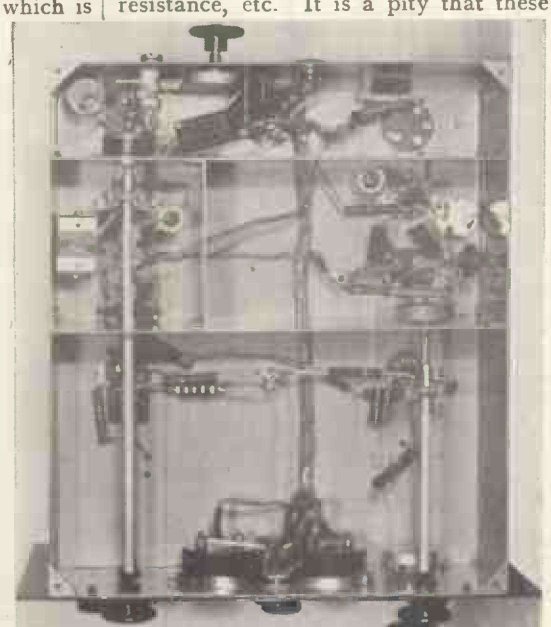
Filament wiring is done in an unusual and unorthodox manner. The wiring was put in with some misgiving as it seemed contrary to the rules, but in practice has proven itself to have the minimum of hum level. One side of each filament is taken straight to chassis by the shortest possible route. The "high" side of the filament circuit is run in best grade treated linen insulating sleeving. The feeder is run tight against the underside of the chassis and secured with small clips. It is probable that the reactance of the return through the body of the metal chassis is less than it would be through a feeder and that this explains the extraordinarily low-hum level.

All by-pass condensers are taken straight back to chassis by the shortest possible route. In many cases the Eddystone .1 by-pass condensers are used. These have a metal body which bolts straight on to chassis. The other lead is taken to a terminal on top of the tubular container and this terminal is not only convenient for soldering, but also provides a strong support for decoupling resistance, etc. It is a pity that these



A 6C5 is used as the B. F. O., which is loosely coupled to the second detector. In the output stage is a triode valve which gives ample gain.

On the left is an illustration of the chassis, showing the clean lay-out.

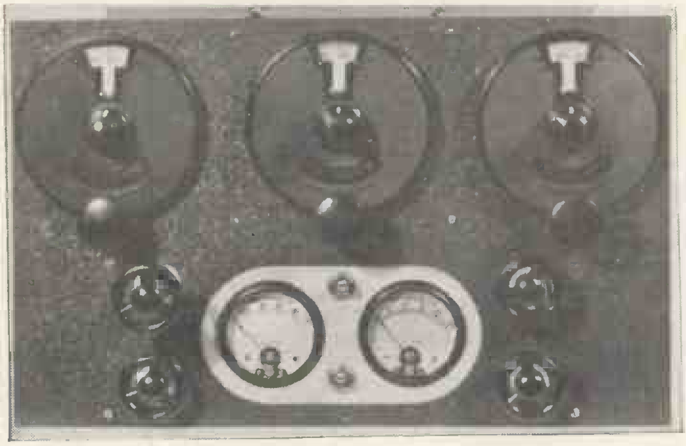


On the right is the underside of the chassis, the wiring of which is very simple for such a sensitive set.

Complete Screening :: The I.F. Circuits

condensers are not available in other capacities.

The first basic consideration to be examined is that of the physical layout of the receiving network. The front compartment bounded by the first "cross" position contains the bottom of the Det.1 and Osc.1 valve holders. All by-pass condensers and resistors associated with these two circuits are grouped as close to the valve-holder pins as possible. There is no screening between the two valve holders as these two circuits are electrically coupled and, in any case, there is ample spacing. The grid ends of the valves are, of course, above deck and—as will be described later—are adequately screened.



The panel lay-out gives a very commercial appearance while in practice there is only one tuning control after the band-spread condensers have been preset.

The cable form of screened single conductors, which feed the meters and switches on the front panel of the chassis is clearly visible between the valve-holders.

Leads which are carried through the deck from the valve-holder pins—such as cathode tap to coils and regeneration circuit of Det.1 are run as short as possible. Where a lead passes through the deck it is covered with a short length of sleeving as a precautionary measure. All holes passing these wires are drilled well oversize and each wire positioned centrally to its hole in order to reduce capacity effect as well as any danger of shorting to earth.

Litz Wire Transformers

The Varley type I.F. transformers are fitted with ceramic insulated air spaced variable condensers. The inductances are Litz wound on high permeability powdered iron cores. The coupling is varied by changing the angular relationship of the two coils.

The transformers are made up in neat rectangular aluminium cases with rounded corners. The two condensers are adjustable from the top by means of a screw driver. The coupling is varied by a small knob on the end of the screening case.

All connections are made on a group of terminals on the centre of the paxolin bottom plate of the transformer. The transformer assembly is secured by two threaded rods fixed to the ends of the casing. A centre hole of large diameter is cut in the top of the chassis to pass the group of terminals and two securing holes pass the threaded fixing rods which are taken up tight on the underside of the chassis. Since the casing is separated from the chassis by the paxolin bottom plate, we have only two earthing points at the threaded rods. This reduces a tendency to stray coupling and promotes stability.

The I.F. stage is laid out with the centres of I.F. transformers and I.F. valve holder on a line through the centre of Det.1 valve holder and parallel to the side of the metal chassis. Starting from the front we find that Det.1 valve holder has been placed so the anode pin is nearest the first cross chassis partition. A very short lead passes from this pin through the partition and direct on to the "high" end of the primary coil of the first I.F. transformer.

From the "cold" end of the primary a lead is taken straight to chassis through tubular by-pass condenser C3. A 2,000 ohm isolating resistor is made on to the same point and suspended on its own leads to the top of $1\frac{1}{2}$ in. Eddystone stand-off pillar which carries two soldering tags. The second soldering tag terminates the screen H.T. feeder for this point.

The "high" end of the secondary winding of the first I.F. transformer is connected to the top grid cap of the I.F. valve. This connection is made through a Belling-Lee screening lead and cap.

It will be found that the contact jaws fitted to the screening cap have an inside diameter too great to secure to the grid cap of the IF (6K7) valve. This can be corrected by carefully pinching in the three contact leaves.

(To be continued in next issue.)

Components for A METAL VALVE COMMUNICATION RECEIVER.

CHASSIS.
1—Steel to specification (Peto-Scott).

CONDENSERS, FIXED.
1—50 mmfd. type Mica (C1) (Dubilier.)
1—.01 mfd. NI tubular (C2) (Dubilier).
1—.01 mfd. NI tubular (C3) (Dubilier).
1—.01 mfd. NI tubular (C4) (Dubilier).
1—.1 mfd. type single contact (C5) (Eddystone).
1—.01 mfd. NI tubular (C6) (T.C.C.)
1—.01 mfd. NI tubular (C7) (T.C.C.).
1—.1 mfd. type single contact (C8) (Eddystone).
1—.0003 mfd. type Mica (C9) (Dubilier).
1—.0003 mfd. type Mica (C10) (Dubilier).
1—.1 mfd. Mica (C11) (Dubilier).
1—25 mfd. 25 volt electrolytic type 3016 (C12) (Dubilier).
1—.5 mfd. NI tubular (C13) (T.C.C.).
1—.01 mfd. NI tubular (C14) (T.C.C.)
1—.0005 mfd. NI tubular (C15) (T.C.C.).
1—.0001 mfd. Mica (C16) (T.C.C.).
1—.0001 mfd. Mica (C17) (T.C.C.).
1—.0005 mfd. NI tubular (C18) (T.C.C.).
1—.1 mfd. single contact (C19) (Eddystone).

CONDENSERS, VARIABLE.
1—40 mmfd. type 900/40 (VC1) (Eddystone).
1—100 mmfd. type 900/100 (VC2) (Eddystone).
1—40 mmfd. type 900/40 (VC3) (Eddystone).
1—100 mmfd. type 900/100 (VC4) (Eddystone).
1—40 mmfd. type 900/40 (VC5) (Eddystone).
1—Preset type SW95 (VC6) (Bulgin).
1—Preset type SW95 (VC7) (Bulgin.)
1—40 mmfd. type 900/40 (VC8) (Eddystone).

COIL FORMS.
4—4-pin type 936 (Eddystone).
4—7-pin type CT7 (Raymart).

CHOKES, HIGH-FREQUENCY.
2—Type SW69 (Bulgin).

DIALS.
3—Standard pattern (B.T.S.).
6—Special knobs with quarter insets (Radiohm).

HOLDERS, VALVE.
1—4-pin ceramic type chassis less terminals (Clix).
1—7-pin ceramic type chassis less terminals (Clix).
6—Octal ceramic holders (Clix).
1—5-pin chassis (W.B.)

METERS.
1—Type 506 milliameter 0-1.5 M/A (Weston).
1—Type 506 milliameter 0-15 M/A (Weston).

PLUGS, TERMINALS, ETC.
2—Valve cap connectors type 1156 (Belling-Lee)
1—Screened valve connector (Belling-Lee).

RESISTANCES, FIXED.
1— 50,000 ohm $\frac{1}{2}$ watt (R1) (Dubilier).
1— 15,000 ohm 1 watt (R2) (Dubilier).
1— 2,000 ohm 1 watt (R3) (Dubilier).
1—100,000 ohm $\frac{1}{2}$ watt (R4) (Dubilier).
1— 500 ohm 1 watt (R5) (Dubilier).
1—100,000 ohm $\frac{1}{2}$ watt (R6) (Dubilier).
1— 2,000 ohm 1 watt (R7) (Dubilier).
1— 2,000 ohm 1 watt (R8) (Dubilier).
1— 50,000 ohm 1 watt (R9) (Dubilier).
1— 50,000 ohm 1 watt (R10) (Dubilier).
1— 50,000 ohm 1 watt (R11) (Dubilier).
1— 50,000 ohm $\frac{1}{2}$ watt (R12) (Dubilier).
1— 50,000 ohm $\frac{1}{2}$ watt (R13) (Dubilier).
1—100,000 ohm 1 watt (R14) (Dubilier).
1— 60,000 ohm $\frac{1}{2}$ watt (R15) (Dubilier).
1— 200 ohm 1 watt (R16) (Dubilier).

RESISTANCES, VARIABLE.
1— 2,000 ohm (VR1) (Erie).
1— 50,000 ohm (VR2) (Erie).
1—100,000 ohm (VR3) (Erie).
1—500,000 ohm (VR4) (Erie).

SUNDRIES.
1—Coil screened connecting wire (Bulgin).
1—Single circuit jack (B.T.S.).
4—Flexible couplings type 1009 (Eddystone).
2—Insulators type 1019 (Eddystone).
2—Toggle switches type S1 (B.T.S.).
5—Valve screens type VS (Raymart).

TRANSFORMERS, I.F.
2—Air tuned 465 Kc. type BP95 (Varley).

VALVES.
1—6L7 metal (Premier Supply Stores).
3—6C5 metal (Premier Supply Stores).
1—6K7 metal (Premier Supply Stores).
1—6J7 metal (Premier Supply Stores).

HEADPHONES.
1—Pair super-sensitive (Ericsson).

Programmes for The Short-wave Listener

By A. C. Weston.

Owners of all-wave receivers will find that there will be many more programmes to be heard on short-waves this year at times suitable for the English listener than ever before.

WHAT with the C.B.S. stations increasing their power and Boundbrook using a new aerial directed on Europe, American programmes will be even more easily received during the next few months. Apparently there is quite a lot of interest in Great Britain at the moment in American variety programmes, while as a considerable influx of American visitors are expected, the American broadcasting groups apparently are going to do all they can to put over the strongest signals ever on short-waves.

Fred MacMurray has taken the place of Dick Powell in the Hollywood Hotel hour relayed from Hollywood through Wayne every Friday.

In addition to all this, programmes are being arranged far in advance so that instead of short-wave programmes being shrouded in mystery, the approximate schedules for March and April are already known.

For this reason listeners should make a note of some of the programmes and compare them with the variety bill of some of the English stations. Favourite film stars are devoting more and more time to programmes over the air, for their fan mail by this medium is almost as great as from their film exploits.

Fred MacMurray has now succeeded Dick Powell as Master of Ceremonies in "Hollywood Hotel," which is heard on Fridays over the Columbia network, short-wave outlets for which are W2XE, New York, and W3XAU, Philadelphia. This programme always includes a number of guest stars in addition to Frances Langford, Anne Jamison, and Raymond Paige and his Music. "Hollywood Hotel" is the star Friday night feature of C.B.S.

Alice Faye is another star that can be heard in Hollywood Hotel.

Some Good Short-wavers

Boston	W1XAL	25.45/49.67
Huizen	PHI	16.88M.
Moscow	RNE	25.0M.
Paris	TPA2	19.68M.
Pittsburgh	W8XK	19.72M.
Pittsburgh	W8XK	25.26M.
Pittsburgh	W8XK	48.86M.
Rome	2RO	31.13M.
Schenectady	W2XAD	19.57M.
Schenectady	W2XAF	31.48M.
Zeesen	DJB	19.74M.

Boundbrook, W3XAL, is a very popular station for it can be picked up at great strength after 3 p.m., and carries programmes sponsored by the National Broadcasting Co. Here are some of the items than can be picked up regularly during March. On Sunday at 5.30 p.m., is the Radio City Music Hall, followed by Magic Key of R.C.A. at 7 p.m., Col. Stoopnagel and Budd at 10.30 p.m., with "Believe It or Not" Ripley plus Ozzie Nelson's Orchestra at 12.30 a.m.

On Mondays are featured the U.S. Navy Band at 7 p.m., the Rochester Civic Orchestra at 8 p.m., Anne Hard, the physiologist, at 10 p.m., news at 11 p.m., and Lowell Thomas at 11.45 p.m.

The N.B.C. Music Guild comes on the air every Tuesday at 7.30 p.m., with the U.S. Marine Band at 8 p.m., and variety until after midnight.

News Flashes

At 10.30 p.m. every Wednesday is the Singing Lady, with Midge Williams 11.15 p.m., Lowell Thomas 11.45 p.m., and the Easy Aces at midnight. Although I have only given three specific items, this station is full of novelties from as early as 3 o'clock in the afternoon.

The Five Star Revue features Meri Bell twice a week through Philadelphia.

Star features for Thursdays are the Light Opera Co. at 8.45 p.m., the Metropolitan Opera Guild 9.30 p.m., news flashes 11 p.m., and Lowell Thomas again at 11.45 p.m. Make a point of hearing the N.B.C. Music Appreciation Hour at 7 p.m. every Friday, and fol-

This is Harry Richman Atlantic flyer, dance band leader and variety star who can be heard over the C.B.S. twice weekly.

Programmes from America

low this up with Concert Favourites at 9.45 p.m., and Swing Music at 11.15 p.m.

As in this country, Saturday is a great day for variety. There are Slim and Jack as early as 11.45 a.m., with Sammy Fuller's Starlets at 2.30 p.m. A relay from the Metropolitan Opera in New York is scheduled for 7-10 p.m., every Saturday, while the Southernaires are another N.B.C. regular feature at 9.45 p.m. All these programmes are from Boundbrook, but there are even more from the General Electric's stations in Schenectady.

For example, every Sunday at 5.30 p.m., there is a relay from the University in Chicago, followed by a novelty programme, Melody Matinee, at 6.30 p.m., Thatcher Colt at 7.30 p.m., and Grand Hotel, 8.30 p.m.

The first good programme on Mondays is Joe White at 6 p.m., with Jane Courtland 7.30 p.m., and the Hour of Charm at 9 o'clock. The Hollywood High Hatters at 6.15 p.m., Jerry Marlowe and Irma Lyon 6.30 p.m., and Personal Column of the Air at 7.45 p.m. are three good items for Tuesdays.

Dick Fidler's Orchestra, Hollywood High Hatters, Happy Jack, and the N.B.C. Music Guild are all on the air between 6 p.m. and 8 p.m. every Wednesday. Personal Column of the Air at 7.45 p.m. is a star feature for Thursdays, while there is a series of variety programmes scheduled from 6 p.m. until 9 p.m. every Friday. On Saturdays at 2.30 p.m. there are the Manhatters with Arthur Lang and Harold Nagel's Rumba Orchestra at 5 p.m. After this, between 7 and 10 p.m. comes the Metropolitan Opera.

All these programmes are through Schenectady on 19.56 metres, which goes off the air most days at 9 o'clock. If later programmes are needed, switch over to the alternative Schenectady station on 31.48 metres, which starts up at 9 o'clock and goes on until 5 in the morning.

Some Famous Film Stars

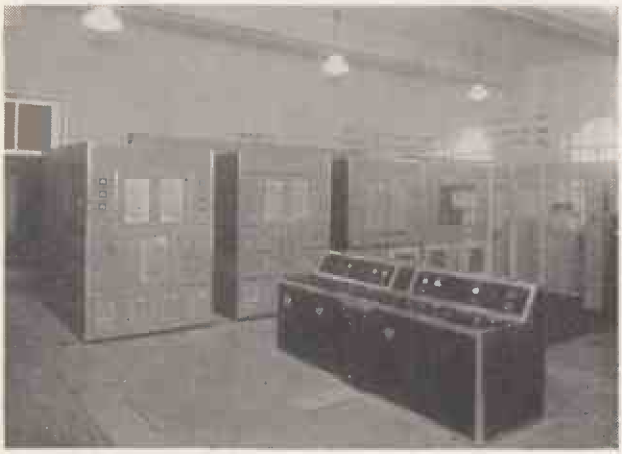
Jack Benny and Mary Livingston are co-starring in a novelty programme at midnight every Sunday, while Tom Mix is featured every evening at 10.15 for a fifteen-minute period. Chick Webb's Orchestra at 9 p.m. most Tuesdays is another good feature, while the Short-wave Mail Bag at 11.45 p.m. is most interesting; 10.30 most nights and every Wednesday evening brings Jack Armstrong, the All-American Boy, with Flying Time at 11.45 p.m., a new series which are very exciting.

A popular orchestra is George Hesberger's Bavarian's, featured at 9 p.m. every Thursday, with Amos 'n Andy at midnight all the week round. For those listeners who are up very late, make a note of Rudy Vallee at 1 a.m. for a whole hour, Lanny Ross at 2 a.m., and Bing Crosby's Music Hall for an hour at 3 a.m.

Schenectady is on the air every Friday from 9 p.m., and from this time until midnight there are no less than eight separate variety programmes, all of outstanding interest. Similarly on Saturdays, when the station starts up at 5 p.m.—there is an organ recital, Metropolitan Opera, Lee Gordon's Orchestra, Saturday Night Party, and several other features during the course of the evening.

Boake Carter is perhaps the most famous American news commentator, who is heard at 12.45 a.m. all the week round from Monday to Friday. His contract has just been renewed by Philco, his sponsors, for a further period of 52 weeks.

Columbia have introduced Eleanor Howe, director of Home Maker's Exchange, heard over Wayne station, every Tuesday and Thursday at 4.45 p.m.



Rome operates on 25.4 and 31.13 metres and is well heard in this country. The programmes are of a varied type in several languages.

A Week's Programme

Music of the Theatre at 7 p.m., is a regular Sunday feature, as is Guy Lombardo and his Orchestra at 10.30 p.m. Joe Penner with Gene Austin is relayed from Hollywood at 11 p.m., with Rubinoff, Jan Peerce, and Virginia Rea at 11.30 p.m. from New York. All of these programmes can be heard through Wayne or Philadelphia. On Mondays, Columbia present Five Star Revue at 6 p.m., featuring Merie Bell and Morton Bowe; Make Believe, a variety programme at 6.30 p.m., and the Chicago Variety Hour at 9.30 p.m. Gogo de Lys is another firm favourite at 11.30 on Monday nights, for she is well known as the soloist who very often supports Paul Whiteman in his broadcasts.

Listen to the Tuesday Jamboree, a novel variety programme at 8 p.m. on Tuesdays. Also the St. Louis Syncopators at 10.30 p.m., and the Dinner Dance at 11.35 p.m. Wednesdays bring a Five Star Revue at 6 p.m., also Art Giles and his Orchestra at 6.15, which is relayed from Pittsburgh. Emery Deutsch presents Melodic Moments at 8.30 p.m., and this is a feature of which the C.B.S. are very proud.

The Thursday Matinee programme at 8 p.m. is a regular feature all the year round, while George Hall and his Hotel Taft Orchestra at 11.35 is another regular broadcast. Major Bowes puts on his Amateur Hour every Thursday over the Columbia System, but this, unfortunately, does not come on until 2 a.m. If anyone is listening at this time tune in to the Philadelphia station on 49.5 metres.

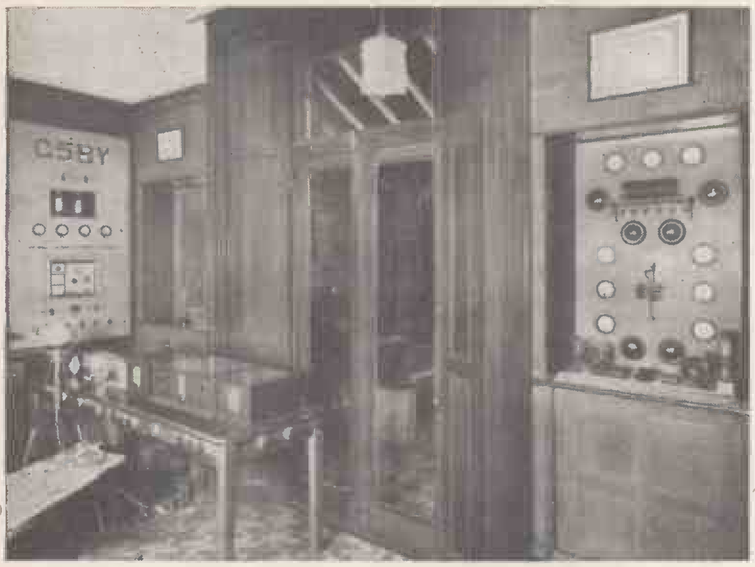
Gogo DeLys is a popular American vocalist who can be heard at 11.30 p.m. through Wayne on Mondays.

Dr. Allan Roy Dafoe is on every afternoon at 4.45 through Wayne, and he tells all about the progress of the

(*Continued on page* 185)

A 5-metre Record

This account of G5BY's recent activity on 5 metres will supply the answer to those U.S. amateur stations who have been wondering just what has happened to G5BY on 10 and 20 metres. This station is owned and operated by Hilton L. O'Heffernan, of Croydon.



Left to right. 500-*watt modulator and control panel for all transmitters. On table, monitor, frequency meter,* 5 *metre receiver,* 160, 80, 40, 20 *metre receiver,* 10 *metre receiver. The transmitter on the right is the* 250 *watt* 80, 40, *and* 20 *meter crystal controlled arrangement with* 100 *per cent. modulation on phone. Above this transmitter is the first British WAC—for phone certificate, while the trophy in the window is G5BY's most treasured possession, the A.R.R.L.,* 1929 *Award for the world's best amateur station.*

IN our February issue we mentioned very briefly how G5BY had been heard in America by the amateur station, W2HXD, in New York. This has now been confirmed, also that the signal strength averaged R5.

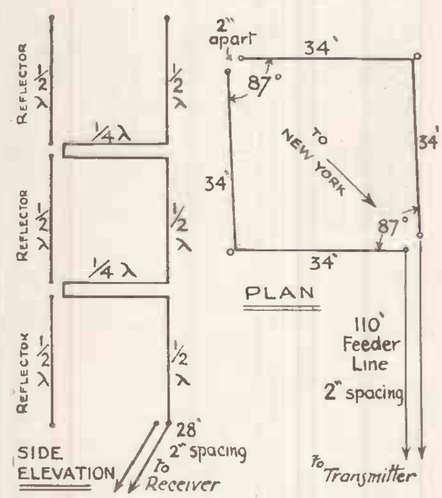
This is the second time that G5BY has established a world record on 5 metres, the first time being on August 12, 1933, when his telephony signals transmitted from the summit of Mount Snowdon were received 200 miles away. This distance exceeded by 60 miles the previous best obtained in America.

Within a year of this record being set up American stations had increased the record to 400 miles until last May when they succeeded in spanning 1,400 miles.

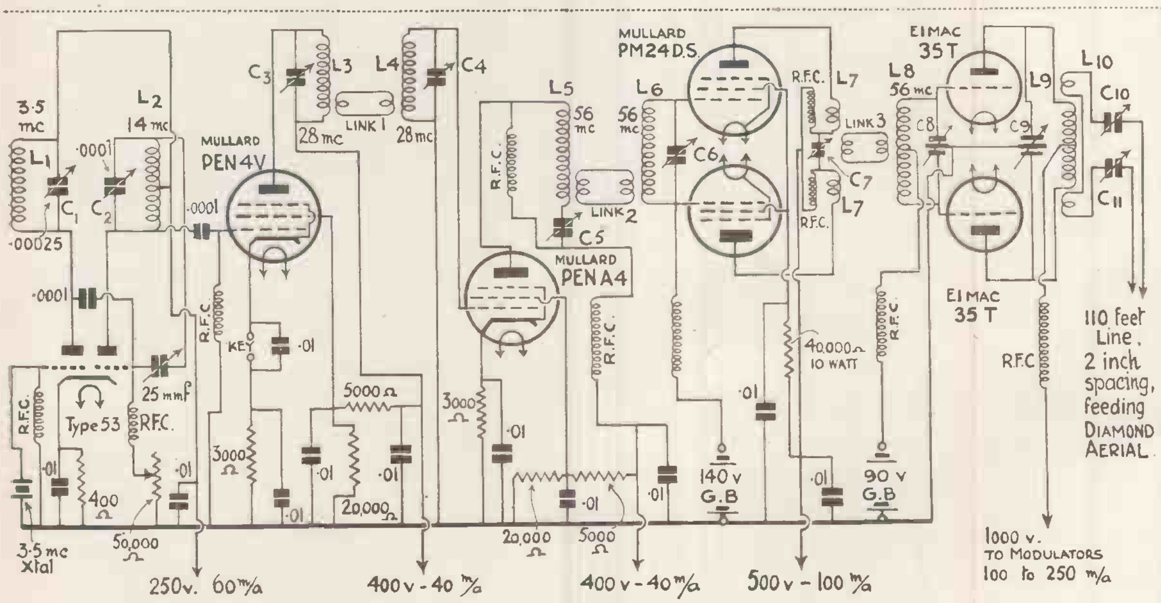
For some considerable time G5BY has been experimenting with crystal controlled equipment on 5 metres coupled to effective radiating systems of a new type. Ultimately he evolved the circuit shown on this page, which is suitable for an input of up to 250 watts.

Crystal Control

In common with all apparatus in this station, a crystal having a frequency within the 80-metre band is employed. A type 53 twin triode valve with one half as an 80-metre crystal oscillator is capacitively coupled to the second half. The second half with regeneration acts as a quadrupler to 20 metres. The 25-mmfd. variable condenser in this circuit controls the amount of feed-back and the capacity has to be less than that at which the circuit oscillates at the natural frequency of the second triode tuned circuit. The grid leak in the second triode section when quadrupling should be variable in order to obtain optimum R.F. output.



To the left is the Diamond aerial for transmitting and on the right the Franklin receiving aerial.



Left to right. Type 53 *as* 80 *metre C.O. and frequency quadrupler to* 20 *metres, Pen4V as doubler to* 10 *metres, PENA4 as doubler to* 5 *metres two PM24D's in push-pull as buffer stage on* 5 *metres, and finally, two Eimac* 35*T's in push-pull. The transmitter is remotely controlled.*

75 Per Cent Efficiency :: A Diamond Aerial

Series Tuning

Keying takes place in the cathode circuit of the PEN4V, while the output from this stage at 10 metres is link coupled to the grid circuit of the PENA4. It will be noticed that the output circuit of the PENA4 stage is most unusual on 5 metres, for in order to maintain a high L/C ratio it is series tuned. It is essential that the R.F. choke feeding the anode be a good one as otherwise losses will occur. It has been found throughout this circuit that the larger the inductance of the coils the better has been the efficiency. Hence the series tuning.

Link coupling is again used from the PENA4 stage and the succeeding buffer, which is also on 5 metres and consists of two PM24D's in push-pull. The grid circuit is deliberately unbalanced and fed at a hot point in preference to symmetrical feeding at the centre of the grid coil. Only a single tuning condenser then becomes necessary and this arrangement has been found to give a far better grid drive to the PM24D's than any of the usual circuits.

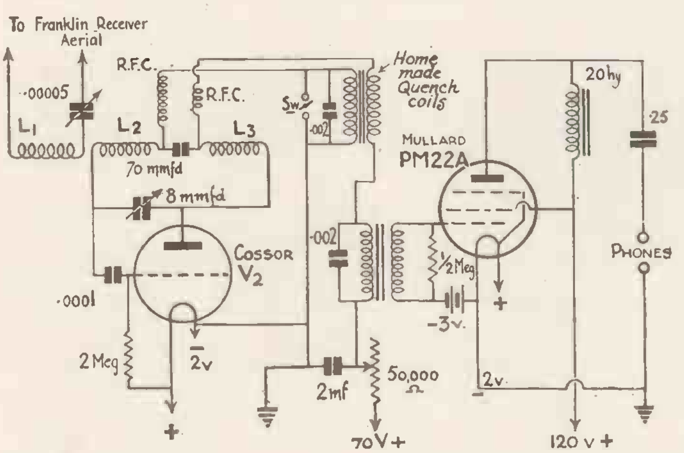
High Inter-Electrode Capacity

The highly unconventional anode circuit enables *six turns of 1⅜ in. diameter* to be used as the tank inductance. This despite the fact that the PM24D's have an inter-electrode capacity so high that in a normal circuit arrangement they would be almost unusable on 5 metres as only two turns or so would be possible in the tank circuit.

The secret is again series tuning and the circuit shown has been specially developed by G5BY to overcome the problem of using ordinary power valves as high efficiency radio-frequency amplifiers on ordinary short wavelengths.

Two PM24D's operated at maker's ratings have a power gain of between 6 and 8, 4 watts of grid drive producing some 24 to 32 watts of radio-frequency output. There should not be any extra spacing between the two halves of their tank circuit, only sufficient space being left to enable a single turn of insulated wire to be interposed for link coupling.

To terminate the end of this link coupler, a single turn has to be wound around the centre of the grid coil of the two Eimac 35T's which are used in push-pull as the final output stage.



The receiver can be used either as a super-regenerator or straight depending on the type of transmission to be picked up. As a straight it is far superior on stabilised transmissions than a super-regenerator and vice-versa.

75 per Cent Efficiency

So much drive is available for the grids of these valves that they are biased to three times cut-off and in consequence operate at an efficiency of better than 75 per cent. Grid current, even with three times cut-off bias, is 16 M/a per valve.

In view of the high radio-frequency voltages available and the need for a low-minimum capacity, a special home-made tuning condenser has been used in the anode circuit. It consists of two fixed plates mounted on small stand-off insulators, each plate being connected to its respective anode. Two rotor plates are mounted on collars, one each side of a central bearing, which is earthed, so maintaining a symetrical arrangement. Spacing between adjacent rotor and stator plates is 5/16 in.

The anode coil is mounted directly on to the stand-off insulators which carry the stator plates, while a single turn at each end of this coil provides the necessary coupling to the aerial, the feeders being series tuned.

Bread-board construction is very suitable for ultra high frequency transmitter construction. A cover is used to box the whole equipment after it has once been adjusted.

Input and Feeder Current

Feeder current to a tuned Diamond aerial is 1.25 amps. with an input of 100 watts to the 35T's which rises to about 2 amps., with the same input, when feeding vertical half-wave elements in phase.

Up to 250 watts input, keyed, has been successfully handled by these valves, whilst 150 watts input with 100 per cent. voice modulation, does not cause the anodes to heat up to their rated limit—35 watts loss for each valve.

The Diamond Aerial

Although this transmitter is most effective and the efficiency is of a high order, all the work done would have been wasted unless a satisfactory radiator was also in use. An aerial that has proved to be far in advance of any other type is the tuned Diamond which is highly directional, and owing to its physical dimensions is suitable for ultra high-frequency work. This aerial has 34 ft. sides and is in a horizontal plane, being 33 ft. above ground at each of its four corners. Unlike the conventional Diamond, no terminating resistance is used, but the feeder length has to be such that resonance with series tuning can be obtained. This point need not be considered when the Diamond is terminated in the usual way. The aerial is directional both away from and towards the end at which the feeders are fixed.

The Receiver

Although a super-het receiver is most satisfactory on the ultra short-waves, owing to the lack of stabilised trans-

(*Continued from page 185*)

A Special 4-band Receiver

A Wide-range Short-wave Three

This receiver is of special interest to the constructor for it is one of the few that includes coil switching from under 5 metres to over 90 metres. It has been designed for the beginner by Kenneth Jowers.

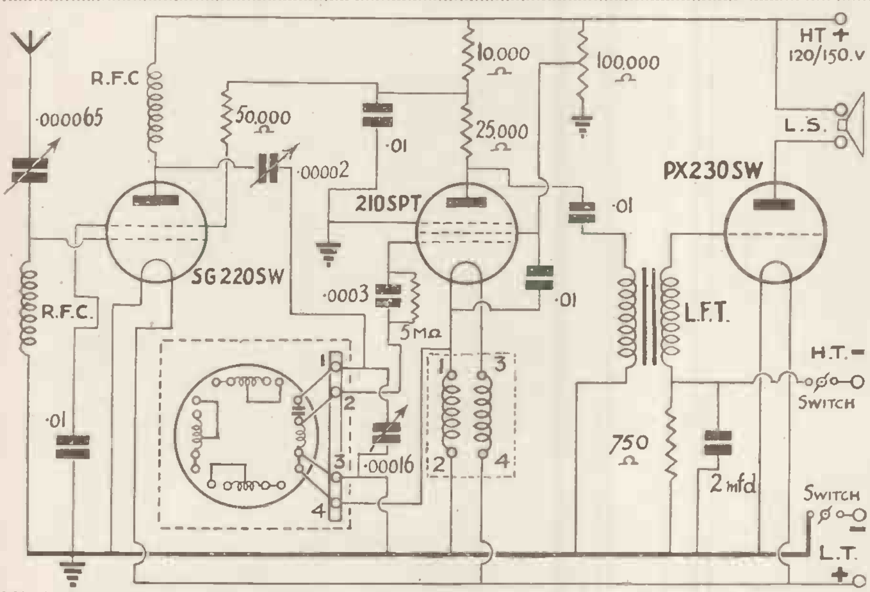
VERY few short-wave receivers tune down much below 15 metres, so that constructors are barred from listening to amateur stations on the 10-and 5-metre bands, and also from hearing, when within range, the sound programmes from Alexandra Palace.

The possibilities on ultra-short wave-bands, which are ignored in most receivers, are limitless, and although freak reception of 5-and 7-metre signals has been reported up to 6,000 or 7,000 miles, I believe that there is a possibility of reliable reception at over 100 miles with a simple receiver of this kind.

Opportunities for record-breaking on amateur bands are negligible except on 5 metres, where one hears reports of DX results which are often verified. Elsewhere in this issue are some details of reception by an American station of G5BY, who operates on 5 metres. This shows that there is great scope on the ultra-short wavebands, and for that reason I am sure that this receiver, which includes the ultra-short wavebands as well as the normal wavelengths, will be of more than usual interests.

Valve Line-up

The receiver has many points of interest. Firstly, there is an untuned radio-frequency stage using a screened-grid valve which provides a certain amount of gain down to 20 metres. Between 20 and 4.8 metres it acts as a buffer that effectively isolates the detector from the varying aerial load. In this way, oscillation is smooth and remains reasonably constant. This is the first time that I have designed a receiver for the amateur using electron coupling owing to the difficulty which constructors have experienced in obtaining satisfactory results. However, refer to the detector circuit of this receiver and see just how it has been connected. The heart of the circuit is the Lissen rotary coil unit which is of low-loss construction, having ceramic end plates, switch supports and most efficient coils.



The heart of this unit is the 4-band tuning coil which goes down to 4.8 metres. Reaction is controlled by a variable resistance.

These coils have been tapped at the correct point for electron coupling and providing the correct detector valve is used, there is no possibility of lack of regeneration. On the ultra-short wave band which covers from 4.8 metres the receiver can be used as a flatly tuned super-regenerator for reception of amateur signals.

Coupling between the anode circuit of the radio-frequency amplifier and the pentode detector is by means of a pre-set condenser. This condenser has a maximum capacity of .0003 mfd., and on the average approximately .0002 mfd., are required to give maximum volume with level reaction on the four wavebands. It is essential that this condenser be pre-set for it is most unlikely that the correct value of fixed capacity will be obtained.

Component Values

The grid condenser and leak have a value of .0003 mfd., and 5 megohms, and although these values are flexible on the three lower frequency bands, it is important to adhere to this specification if satisfactory results are to be obtained on the 5-metre band.

A double-wound choke of low resistance is connected in series with the two filament leads to the detector valve. This choke takes the place of the normal filament choke in the positive lead of the average battery-operated electron coupled receiver.

As a pentode valve is used in the detector circuit, this rules out the

Most of the components are beneath the baseboard while the aerial series condenser can be adjusted through the chassis.

possibility of using a straightforward transformer-coupled low-frequency amplifier, for the impedence of the transformer primary as compared with the A.C. resistance of the pentode is so low that gain would be negligible. To overcome this difficulty a combination of resistance capacity and transformer coupling is used. In the anode circuit of the 210SPT detector is a 25,000-ohm resistance for a load impedance, which, although it is still on the low side as compared with the valve impedance, is infinitely superior to the transformer.

This resistance is followed by a 10,000-ohm resistance for decoupling, the junction of the two being by-passed to earth by a .01-mfd. condenser.

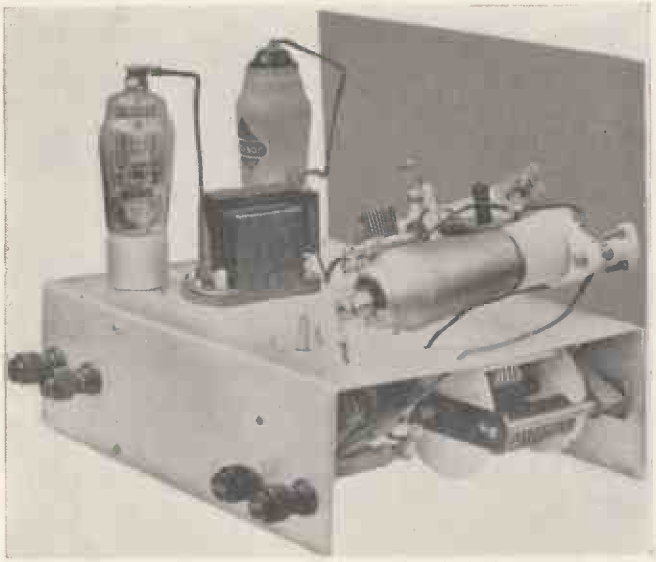
The value of load resistance is governed by the high-tension voltage available, for if a mains unit were used giving up to 250 volts high tension, then the resistance could be increased in value giving a very appreciable increase in gain. This point should be remembered by users of mains high-tension units.

Correct Screen Voltage

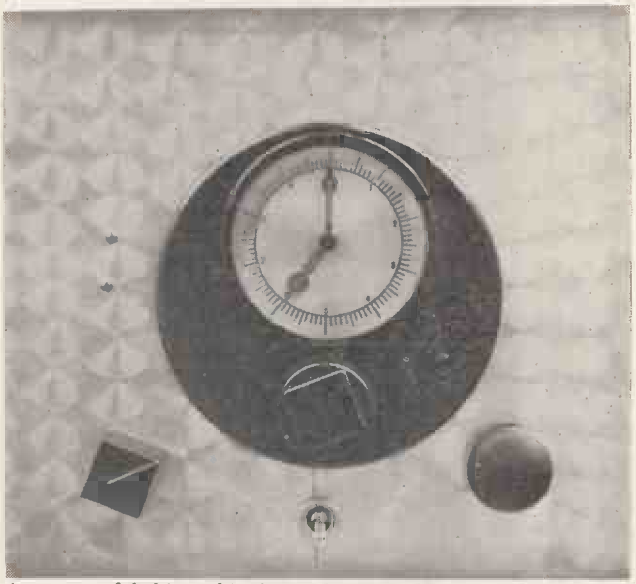
Screening voltage for the radio-frequency amplifier is obtained by means of a 50,000-ohm series dropping resistance, the high-tension end of which is tapped into the junction of the 10,000-ohm and 25,000-ohm resistances in the detector anode circuit. In this way the correct screen voltage is obtained without having to use too high a value of resistance. This is a great advantage over the usual method whereby the screen voltage is taken direct to the high-tension positive. A potentiometer can, of course, be used, but this means wasting high-tension current which is not advisable in an inexpensive receiver of this kind.

When connecting up the pentode detector there are one or two points that should be borne in mind. First of all, this valve can be obtained with either a 4-pin or 7-pin base. With a 4-pin base, the auxilliary grid is connected internally to the metallised screen, but with a 7-pin base, all electrodes, including the metal coating, are brought out to separate pin contacts. The valves, however, are identical in performance and it is immaterial which type is used.

The output from the detector is fed into the inter-valve transformer through a .01-mfd. buffer condenser. This gives ample bass response, but it has been kept at a fairly low value in order to give clear speech on weak signals. For quality reception, however, this value can be increased up to 1 mfd., for extra bass boosting.



The tuning unit is fitted beneath the chassis so that the leads to the condenser and detector valve are kept short.



A new type of dial is used in this receiver which enables stations to be listed according to dial reading.

No De-coupling

There is no need for grid or anode decoupling in the output stage. The cap connection from the PX230SW is taken directly to the grid terminal on the transformer, while the earthy end of the secondary goes to high-tension negative and to earth through a 750-ohm resistance. This provides bias automatically to the output triode and providing it is shunted with a 2-mfd.. condenser as shown, does not cause any complications.

A double-pole-make-and-break switch is a necessity, otherwise there will be a constant leak from the high-tension battery. This is owing to the fact that a 100,000-ohm variable potentiometer is used to provide the correct screening voltage for the detector and also to control regeneration. As this resistance is

Components for the WIDE RANGE S.W. THREE

CHASSIS AND PANEL.
1—Aluminium chassis 10 in. x 8 in. x 3 in. (Peto-Scott).
1—Aluminium panel 10 in. x 8 in. (Peto-Scott).

CHOKES, HIGH-FREQUENCY.
1—Special S.W. (Mervyn)
1—Type SW68 (Bulgin).
1—Double wound type 5645 (Lissen).

COILS
1—Rotary 4-band unit type 5649 (Lissen).

CONDENSERS, FIXED.
5—.01 mfd. type tubular (Dubilier).
1—.0003 mfd. type tubular (Dubilier).
1—2 mfd. type BB (Dubilier).

CONDENSERS, VARIABLE.
1—.00016 mfd. (B.T.S.).
1—.0002 mfd. type CP3 (Bulgin).
1—000065 mfd. type 978 (Eddystone).
1—0003 mfd. type 2150 (Jackson Bros.).

DIAL.
1—Type 5655 (Lissen).

HOLDERS, VALVE.
1—Type VH8 (Bulgin)
1—7-pin type ceramic chassis less terminals (Clix).
1—5-pin type ceramic chassis less terminals (Clix).

PLUGS, TERMINALS, ETC.
3—Plug top connectors type 1175 (Belling-Lee).
4—Insulated terminals type B marked Aerial, Earth, LS and LS (Belling-Lee).

RESISTANCES, FIXED.
1—50,000 ohm type ½ watt (Erie).
1—25,000 ohm type ½ watt (Erie).
1—10,000 ohm type ½ watt (Erie).
1—750 ohm type 1 watt (Erie).
1—5 megohm type ½ watt (Erie).

RESISTANCES, VARIABLE.
1—100,000 ohm type potentiometer (Erie).

SUNDRIES.
2—Coils Quickwyre (Bulgin).
24—6BA round head bolts with nuts and washers (Peto-Scott).
4—Yards 1 mm. flexible wire (Peto-Scott).

SWITCH.
1—Double pole toggle (B.T.S.).

TRANSFORMER, LOW-FREQUENCY.
1—1.3.5 ratio (B.T.S.).

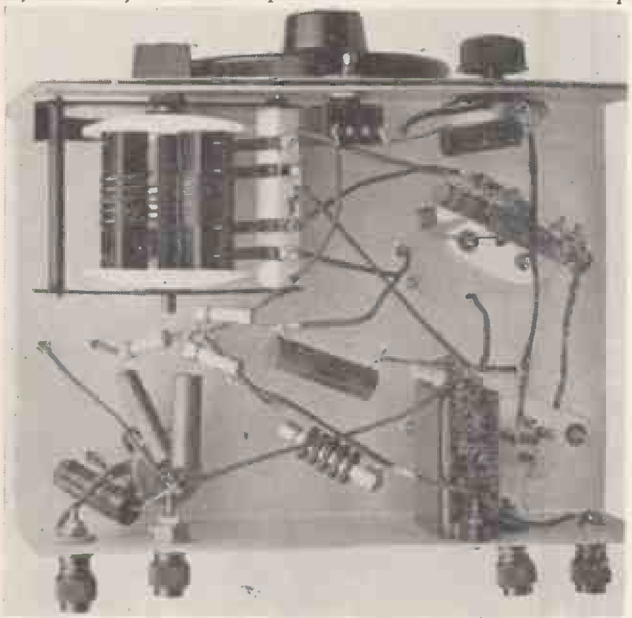
VALVES.
1—SG22OSW (Hivac).
1—210SPT Met. (Cossor).
1—PX230SW (Hivac).

LOUDSPEAKER.
1—Type Stentorian 39 B (W.B.).

Auto Bias :: Wave Ranges :: Running Costs

connected across H.T. positive and H.T. negative, there will be a current flow of approximately 1.5 M/a as long as the receiver is in action. By breaking both H.T. negative and L.T. negative, however, this leak is prevented.

The new type Clix valve-hoders are bolted underneath the chassis and not on top as with the original type. If these holders are bolted to the top of the chassis there is a tendency for the metal inserts to pull out.



How the components are fitted can be seen from this illustration. Note most of the smaller components are in the air.

Except for the bias resistance, the remainder are of the ½-watt type which are amply large enough considering the low voltage and current in this circuit. At the same time it reduces the cost by almost half. Still further to reduce cost, no output filter circuit has been employed, for with the W.B. loudspeaker a matching transformer is an integral part, so that as long as this loudspeaker is used there is no need to modify the output circuit in any way. If headphones are used, however, it will be advisable to embody a 1/1 ratio output transformer or the conventional choke-capacity filter circuit.

The entire receiver is made up on a 10 by 8 by 3 ins. chassis with a 10 by 8 ins. aluminium panel. This enables the coil unit to be mounted underneath the chassis, so that the connections to the valve and tuning condenser are comparatively short. Also beneath the panel are the regeneration control and toggle switch arranged in a symmetrical manner.

A Bulgin VH8 valve-holder is specified for the screened-grid valve in the first stage, for this valve is mounted horizontally. When this holder is not available it is quite a simple matter to mount a conventional chassis type valve-holder on two midget stand-off insulators, which are in turn bolted to the panel.

With the exception of the 2-mfd. condenser for shunting the bias resistor, all the chokes, resistors, and by-pass condensers are mounted in the wiring, so that the whole circuit can be built in well under two hours.

Arrange the high-frequency amplifier so that the grid, that is, the top cap connection, is almost directly over the .000065-mfd. aerial series condenser, for then the connecting wire is only approximately 1 in. in length. Also, the pre-set condenser between the first and second stage is mounted directly between the anode of the valve and the fixed plates of the tuning condenser. Here, again, less than 1 in. of connecting wire is needed.

The tuning condenser is mounted on a bracket supplied with the tuning drive, so that theoretically there is no need for a separate earth connection to the rotary plates, but in practice, the receiver is unsatisfactory on the 5-metre band unless the spindle is separately earthed to the chassis.

Wave Bands Covered

Although the waveranges covered by this coil unit will vary somewhat according to the way in which the receiver has been wired, the approximate wavelength covered by each coil are as follows: Range 1, 4.8 to 7 metres, covering the 5-metre amateur bands and both television channels; range 2, 6.6 to 17 metres, covering television sound, 10-metre amateurs, and the 13 metre commercial band; range 3, 16.6 metres to 42 metres for the 16, 19, 25 and 31-metre commercial bands, plus 20 and 40-metre amateur bands. The final range is for 37 to 91 metres, covering the 80-metre amateur band, 49-metre commercial and the shipping around 70 metres.

It can be seen from these figures that the unit will cover all of the more important short-wave channels, but should any constructor feel that he would like to hear the 160-metre amateurs and the police stations on that band, a spare coil can be obtained to take the place of the least required coil supplied as standard in the unit.

With 125 volts high tension, the total consumption from the battery is approximately 18 m/a, of which 15 m/a are taken by the output triode, so that a reasonable sized high-tension battery is required if the receiver is to give trouble and noise-free reception.

Almost any length of aerial can be used in this receiver owing to the inclusion of the buffer high-frequency stage, but the series aerial condenser should be carefully adjusted to give maximum gain or maximum selectivity as required. Then the inter-stage coupling condenser should be adjusted so that the maximum capacity is used which will permit of level oscillation on the four wavebands. In the original model of this receiver the second coil, that is tuning from 6.6 to 17 metres, needed the least capacity, so it will be a good plan to adjust this band first.

The approximate layout can be visualised from the illustrations showing the under-side of the chassis and the plan view. Keep all connections as short as possible, particularly those to the coil unti and tuning condenser, otherwise it may upset the minimum wavelength on the ultra-short waveband.

Exeter and District Radio Society

Owing to a large increase in membership this society has been obliged to obtain new quarters.

In future all meetings will be held at the Y.M.C.A., 3 Dix's Field, Southenhay, Exeter. A full programme of lectures has been arranged, full details of which can be obtained from the Hon. Secretary, W. J. Ching, 9 Sivell Place, Heavitree.

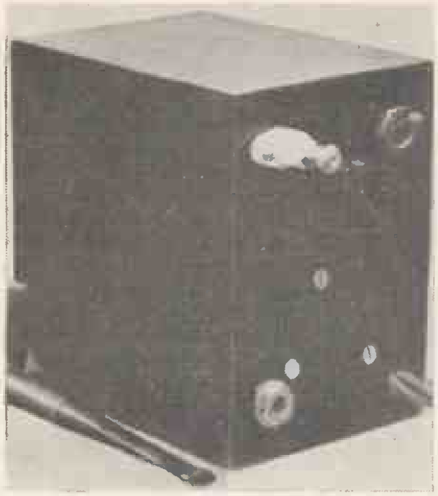
Chadwell Heath and District Radio Society

Meetings of the society are held every Tuesday evening at 3 Geneva Gardens, Chadwell Heath, Essex. Amongst members are G6NG, G6ID, G8DS, 2BDI, 2BZB and many others, who are all willing to help new members obtain full transmitting permits.

At the last lecture G2ZT described the activities of the Coventry Radio Society's National Field Day. A competition for listening stations is being held in the near future so any readers interested in this and the other activities of the society should write to the Hon. Secretary, R. C. E. Beardow, 2BZB, 3 Geneva Gardens, Chadwell Heath.

An Ultra-short Wave Midget Receiver

This midget receiver is surprisingly efficient and has a low noise-level. It can be recommended for field day and portable work and has been designed by G2HK.



The compactness of this little receiver can be appreciated by the comparison with the pipe alongside.

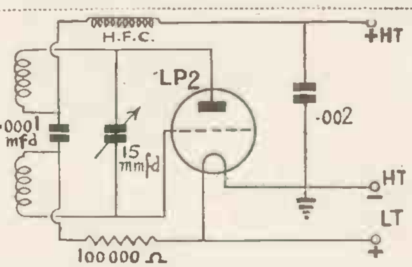
SURPRISING results can be obtained with a single valve self-quenching receiver providing the correct value of condenser and leak are obtained. For some time I have been experimenting with designs for 5-metre receivers, and have come to the conclusion that the two-valve super-regenerator with self-quencher is not really worth the additional cost over the single valve self-quencher.

Admittedly the self-quencher requires more input to reduce the quench noise, but then very little long-distance work is done with the super-regenerative type of receiver, whether of the single or double-valve type.

For that reason I have come to the conclusion that this single valver is ideal for local-distance amateur work for it is cheap, comparatively quiet, and at the same time is sufficiently selective for duplex working.

Standard Components

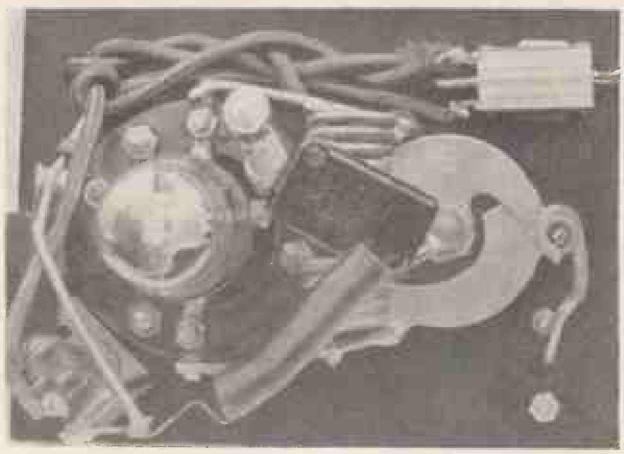
The majority of amateurs have the components on hand with perhaps the exception of the main tuning condenser which has a maximum capacity of 15 mmfds. As a general rule the .0001 mfd. condenser between coils is of the pre-set type, but in this particular circuit almost any capacity is satisfactory between .000075-mfd. and 00015-mfd.



A midget headphone jack should be connected in series with the main H.T. lead while the on/off switch can be omitted to save cost.

As can be seen from the illustration, the high-frequency choke is home wound and consists of 50 turns of 26-gauge enamel-covered wire wound on a fountain pen and then suspended in the wiring.

Actually most of the small components are in air for this reduces losses, takes up far less space and reduces the length of connecting leads. Two coils are mounted across the rotor and stator plates of the tuning condenser and are coupled together across the ends of the .0001-mfd. condenser. The tuning condenser is then wired to the grid and anode contacts of the valve-holder by 14-gauge copper wire so as to make the connections absolutely rigid. The high-frequency choke, 100,000 ohms resistance and anode by-pass condensers are also connected into circuit without the need for extra wiring, so that the entire receiver is mounted on the panel which is only $3\frac{1}{2}$ by 5 ins. The box is $5\frac{1}{2}$ by $3\frac{1}{2}$ by 4 ins., while even this can be reduced if a midget valve is used. Tests are now being made with a Hivac midget valve having the connections soldered directly to the valve base, so reducing losses, length of connections and omitting the valve-holder.



All the components are mounted on the panel or in the wiring as shown.

60-volts high-tension are ample to produce super-regeneration over the entire tuning scale, providing that the aerial is very loosely coupled to the grid coil. In the original receiver sufficient coupling was obtained by merely winding 2 turns of the lead-in wire round the fixing rod for one side of the stator plates on the tuning condenser. With the coils specified, the tuning range is approximately 4 to 6 metres.

A stand-off insulator is bolted straight on to the panel and a vertical aerial, quarter wavelength long is connected to this. Tests have shown that there is no material increase in volume when the length of aerial is increased beyond quarter wavelength, while a tendency for uneven oscillation becomes noticeable.

The circuit as it stands is only suitable for headphone operation, but a low-frequency amplifier can be added without upsetting the efficiency of the circuit. As the receiver was originally intended for portable use, loud-speaker volume was not required.

A headphone jack is connected in series with the H.T. supply and this jack should be of the B.T.S. midget type, otherwise there will not be sufficient space with the panel size as suggested.

Also the toggle switch is a doubtful refinement for with portable equipment it is just as simple to disconnect one lead from the low-tension accumulator.

The following types of components will be found most suitable, for size is an important factor. Tuning condenser, Raymart type VC15X; coupling condenser, .0001 mfd., Mica, T.C.C.; 100,000 ohm leak, Bulgin, $\frac{1}{2}$ watt; .002 mfd. by-pass condenser, Dubilier, tubular; phone jack, B.T.S. midget; on-off switch, Bulgin, toggle; valve-holder, type 949 Eddystone; valve, Osram LP2.

A 200-watt Positive-drive Circuit

Those interested in public address equipment and transmitter modulation at high power will appreciate this first released information on a new circuit arrangement developed by the General Electric and Marconiphone Co's.

A PAIR of Marconi or Osram DA100 triodes will give an output of 200 watts at the very high power efficiency of 67 per cent. when they are driven into the region of grid currents by a special low-impedance driver stage. The valves are operated in a balanced push-pull circuit 1,000 volts. A large grid input voltage, sufficient to drive the grids to about 100 volts positive, is obtained from a low-impedance driver stage consisting of two cathode loaded PX25 valves. These are in turn fed from two ML4's coupled via a loaded push-pull inter-valve transformer. The circuit for this is shown in Fig. 1.

An important point is the anode-to-anode load which is fixed at 8,000 ohms. A lower value than this is not desirable as it will cause the valves to be subjected to a very high peak anode current. Another point is that the no-load primary inductance of the transformer T2 should be at least 15 henries in order to avoid losses at 50 cycles. To prevent loss at high audio frequencies, the leakage inductance should also be kept as low as possible. By the use of a centre-tapped choke—L5—independent adjustment of bias is obtained on the DA100's. The resistance of this choke should be as low as possible and in no circumstances more than 200 ohms, while the inductance at full load should be not less than 60 henries.

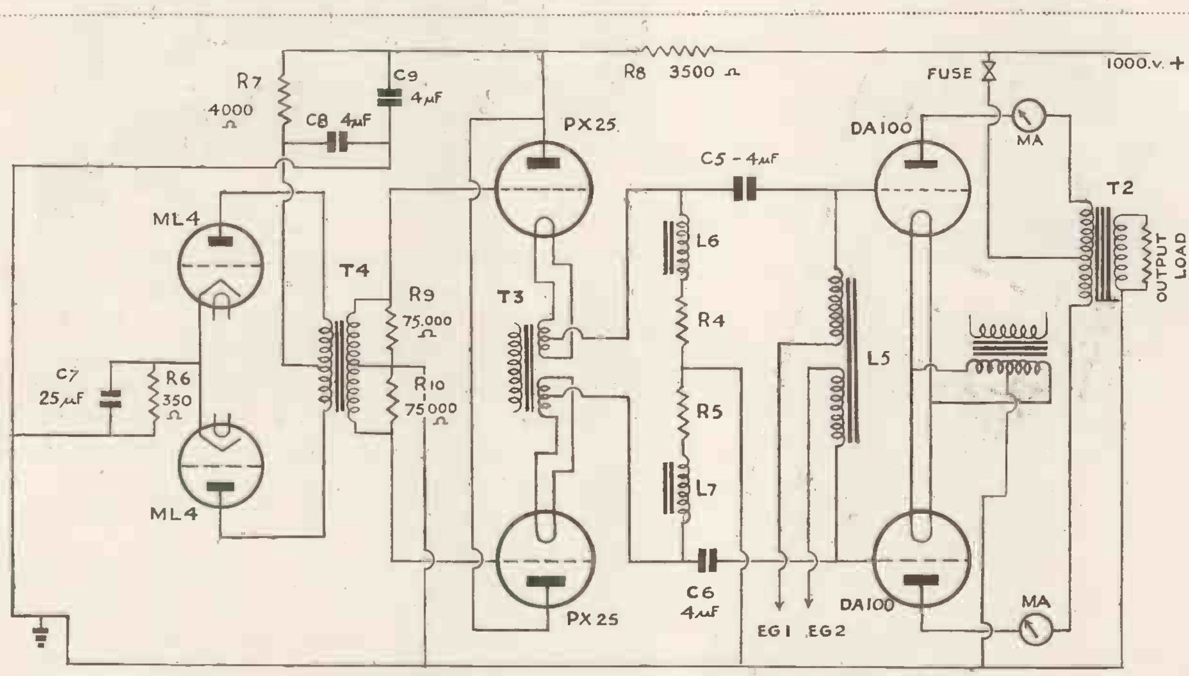


Fig. 1.—In addition to providing ample drive the use of push-pull in each stage helps to reduce hum level. Transformer constructional data is given in the text.

The Output Stage

At full load the two DA100 valves take approximately 300 ma. anode current with 1,000 volts on the anode and a grid input of 250 volts peak. On no load the anode current required is only 200 ma., so that there will be a slight rise in high-tension voltage above 1,000 volts except when the H.T. supply has perfect regulation. This rise in high tension is allowable so long as the maximum anode dissipation of 100 watts is not exceeded. The grid bias on no load must be adjusted until this condition is fulfilled.

Driving the Output Stage

To secure the full output of 100 watts, the grids of the DA100 valves should be driven at about 100 volts positive, causing a large grid current to flow. It will be realised from this that unless the impedance of the previous stage is very small, harmonic distortion results and the point at which grid current commences to flow is very apparent to the ear.

If transformer coupling is used there is an objectionable oscillation effect which takes place at each grid once in every cycle when grid current ceases to flow. This is very noticeable in some of the conventional high-power class B circuits. To overcome these two objections to "positive drive" the driver circuit is direct coupled to the output valves by means of chokes and condensers, so that the impedance of the driver circuit—as seen by the grids of the output valves—is reduced to approximately 70 ohms by placing the driver load in the driver cathode circuit and allowing the voltage developed in this load to be fed back into the grid circuit.

The only disadvantage of this method is the slight attenuation created by this stage. Two PX25 valves are used as drivers with the chokes L6 and L7 in their cathode circuits acting as the load impedance. Each choke should have an inductance when under maximum operating conditions of at least 25 henries. The resistance of these chokes should be 530 ohms, which is the value of the automatic bias resistance of the PX25. Should a lower resistance choke be used, then additional resistances, shown as R4 and R5, should be included to bring the total resistance of the circuit up to 530 ohms.

With the maximum anode voltage at 400, this driver stage will give an out-

P.P. Input :: P.P. Driver :: Class B Output

put of 250 plus 250 volts peak before the PX25's go into grid current.

The ML4 Input Circuit

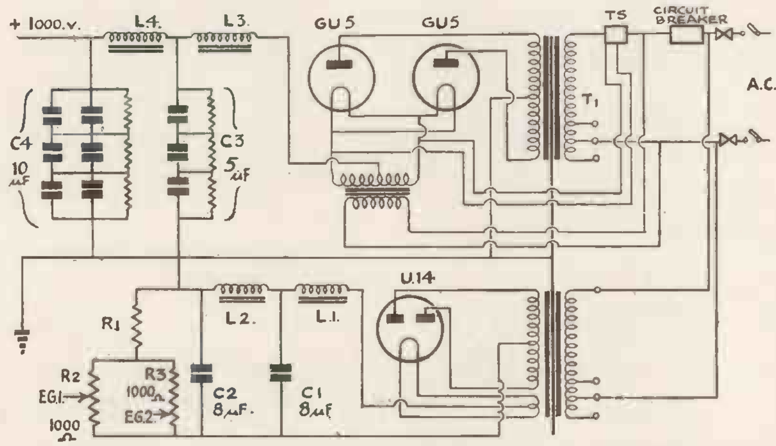


Fig. 2.—The D.C. internal resistance of this power pack must not be more than 1,00-ohms otherwise there will be distortion at maximum output.

The full output of the PX25 driver unit requires an output of 280 plus 280 volts peak and this can be obtained from a pair of ML4 valves operating in push-pull, with an anode voltage of 250 and coupled to the PX25's by means of a loaded inter-valve transformer, shown as T4. The input required at the grids of the ML4's for full output from the DA100's is 14 plus 14 volts peak.

Many amateurs fail to obtain the best results from positive drive owing to the use of the high resistance/poor regulation H.T. supply unit. The H.T. supply must be capable of providing 300 ma. at 1,000 volts, while if the whole amplifier is fed from the same supply, a total of 445 ma. must be provided. The regulation should be such that the voltage does not rise above 1,100 volts on no-load so that the maximum D.C. internal resistance cannot be more than 1,000 ohms. Higher no-load voltages will mean increased bias with consequent increase of distortion without increase in power output.

A suggested circuit is shown in Fig. 2, where two GU5 gas rectifiers feed into a choke input circuit. Although electrolytic condensers used in series parallel banks with 50,000-ohm leaks have been found satisfactory by the designers of the amplifier, we do not feel that the saving is really worth the possibility of breakdown, and we are advised by the condenser manufacturers that single oil-immersed units would be far more satisfactory.

To ensure that a sudden power increase causes no serious momentary voltage drop, the capacity of the final condenser C4 should be at least 10 mfd., irrespective of whether the supply is rectified or taken from a D.C. generator.

A time delay switch is necessary in the H.T. transformer primary or secondary circuit to allow the rectifiers to warm up before the H.T. voltage is applied. To protect the DA100's in the event of bias failure, a fuse of the Microfuse metal film type with a maximum carrying capacity of 300 ma. is connected in the H.T. feed lead to the output transformer.

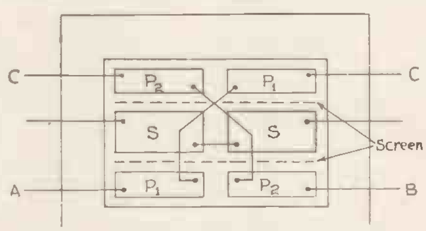


Fig. 3. Windings in the output transformer must be sectionalised and arranged in this manner.

Bias Supply

A mean voltage of 146 to 168 volts is required for bias, depending on the regulation of the H.T. supply employed. It is an advantage to make provision for a 20 per cent.. variation to allow for a change in H.T. voltage and/or valve characteristics.

The bias voltage should not be increased by more than 10 volts when the full load DA100 grid current of 10 ma. flows in each grid circuit, otherwise increased distortion will be apparent at full load. The bias circuit is shown in Fig. 2 where a U14 rectifier running at 120 ma. gives ample regulation providing the choke feed circuit is employed with low resistance chokes.

Potentiometers R2 and R3 should not exceed 1,000 ohms in value, while R1 should have a resistance that will cause a current flow of 120 ma.

Most of the components are available from Messrs. Bryan Savage, or Sound Sales, but the following constructional details will probably be of interest. The main H.T. transformer, T1, should have a primary winding designed for 0.55 kVA, and the secondary for 0.8 kVA, at 1,300-0-1,300 volts.

Transformer, T2, has a core of No. 41 stalloy, square section, no gap, with a primary of 1,016 plus 1,016 turns of No. 22 s.w.g. enamelled and single silk covered wire. The secondary winding is variable and should be designed to suit the loudspeaker or the transmitter input circuit employed.

For a load of 50 ohms, the secondary should consist of two coils exactly 161 turns each of 16 d.c.c. in parallel. For any other load the windings can be obtained from this simple formula:

$$2{,}032 \sqrt{\frac{\text{load impedance}}{8{,}000}}$$

As a safety measure an earth metal screen can be interposed between primary and secondary windings. The windings should be sectionalised and arranged as shown in Fig. 3. The filament transformers, T3, for the PX25 valves must have two separate secondaries, each centre-tapped and capable of delivering 4 volts at 2 amps.

As an inter-valve transformer a core consisting of a No. 40 stallow square section with no gap is needed. The primary is wound with 1,450 plus 1,450 turns No. 34 enamelled and single silk covered wire. The windings are arranged and sectionalised as shown in Fig. 3, while the secondary requires 4,650 plus 4.650 turns of 42 s.w.g. enamelled and silver silk covered wire.

Chokes, L1 and L2, should have an inductance of at least 7 henries at 120 ma. with a resistance of not more than

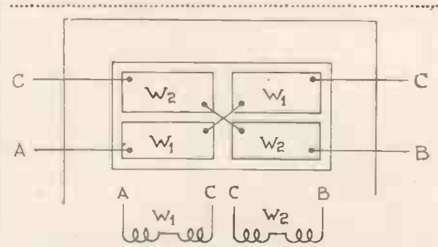


Fig. 4. Choke L5. for the grid circuit of the DA100 valves, is wound in this way on four bobbins.

50 ohms, while chokes, L3 and L4, in the smoothing circuit should be 10 henries at 300 ma. D.C., with a resistance of no more than 100 ohms.

(Continued on of page 192)

PREMIER SUPPLY STORES

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HIGH-GRADE TRIAD for which we are sole British Distributors. The following types all **5/6** each: 2E5, 6E5, 2G5, 6G5, 6D7, 6E7, 6B6, 1A6, 1C6, 2A3, 2A5, 2A6, 2A7, 2B7, 6A4, 6A7, 6B7, 6C6, 6D6, 6F7, 00A, 01A, 11, 12, 15, 18, 19, 20, 22, 24A, 26, 27, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39/44, 40, 41, 42, 43, 45, 46, 47, 51, 53, 55, 56, 57, 58, 59, 71A, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 89, V99, X99, 112A, 1VO, 5Z3, 12Z3, 25Y5, 25Z5, 6A6, 185R.

Also **6B5**, High Gain Triode, will give 15 watts per pair in Push-Pull with only 300 anode volts, **5/6** each.
All the new Metal-Glass Octal Base tubes: 6N7, 6L7, 6N6, 6A8, 6K7, 6J7, 6C5, 6Q7, 6F5, 524, 6D5, 6B6, 6H6, 6Z6 (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.

All the valves specified for the Metal-Valve Communication Receiver in this issue can be supplied from stock.

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, 3 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., H., HL., 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, **3/6.**

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PREMIER wire-end type with screened primaries, tapped 200-250 v. Centre-tapped **Fil**aments. Guaranteed one year. **H.T. 8** & **9** or **H.T. 10** with 4 v. 4 a. C.T. and 4 v. 1 a. C.T., **8/6.** **250-250 v. 60 m.a.** or **300-300 v.,** 4 v. 1 a., 4 v. 2 a. and 4v. 4 a., all C.T., **8/6.** **350-350 v. 120 m.a.,** 4 v. 1 a., 4 v. 2 a. and 4 v. 4 a., all C.T. **10/6.** Any of these transformers with engraved panel and N.P. terminals, **1/6** extra. **500-500 v. 150 m.a.,** 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 2-3 a., 4 v. 3-4 a., all C.T., **17/6.**
Super-shrouded model, **21/-.** 500-500 v. 200 m.a., 5 v. 3 a., 4 v. 2 a., 4 v. 2 a., 4 v. 3-5 a., all C.T., 25/- (for use with 83 or 523 rectifier, cost only **5/6** to obtain 500 v. 200 m.a. 500-500 v. 150 m.a., no L.T.'s, **12/6.** 1,000-1,000 v. 150 m.a.) no L.T.'s, **19/6.**

SPECIAL OFFER. 350-350 **v.** 120 m.a. wire-end transformers with 4 v. 2 a. 4 v. 3-5 a., all C.T., **9/6** each.

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FILAMENT TRANSFORMERS, Tapped Primaries, 200-250 v. All secondaries C.T. 4 v. 3 a., **7/6**; 4 v. 5 a., **8/6**; 7.5 v. 3 a., **7/6**; 6 v. 3 a., **7/6**; 2.5 v. 8 a., **7/6**; 6.3 v. 3 a., **7/6**; 5 v. 3 a., **7/6.**

SMOOTHING CHOKES, 25 m.a. **2/9**; 40 m.a., **4/-**; 60 m.a., **5/6**; 150 m.a., **10/6.** 2 500 ohms, 60 m.a. Speaker Replacement Chokes, **5/6.** 250 m.a. Chokes, **21/-.**

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COSSOR NEON TUNING INDICATORS, 3/6 each.
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PREMIER L.T. CHARGER KITS for A.C. mains, including Westinghouse Rectifiers and Tapped Mains Transformers. 8 volts at ½ amp., **14/6**; 8 volts 1 a. **17/6**; 15 volts 1 a., **19/-**; 15 + 15 volts 1 a., **37/6**; 15 + 15 + 15 volts 1 a., **50/-**; 8 volts 2 a., **29/6.**

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NEW 1937 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. VALVE GIVEN FREE!**
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!**
A.C./D.C. S.W. SUPER-HET CONVERTER, 14-50 metres. Completely self-energised. Will operate with any Receiver, **30/-. VALVE GIVEN FREE**
NEW 1937 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!**
BAND-PASS TUNING PACK, comprising set of Telsen 3-gang iron-cored coils with switching, mounted on steel chassis with 3-gang condenser, illuminated disc-drive and 4 valve holders. **25/- the lot.** All Mains or Battery circuit. **FREE!**
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1936 TELSEN 3-gang iron-cored Band-Pass coils with integral switching, 200-2,000 metres, **12/6** set.

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Reisz pattern. Large output, exceptionally fine frequency response with low hiss level. Frequency range, 45-7,500 cycles, plus or minus 2DB, 30/-.
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MOVING-IRON flush type milliamp meters in 2½-in. Bakelite Case, to read A.C. or D.C. Ranges, 10, 20, 30, 50, 100, 150, 250 and 500 m.a., also 1, 3, 5 and 10 amps., 6, 16 volts all **5/9** each. 0-250 v., **8/6.**
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ROLA latest type P.M.'s, **15/-. GOODMANS'** 8-in. mains energised, 1,000 ohms field, **10/6** each.
JENSEN P.M. Speakers, **10/6. R. and A.** energised Speaker, 7½-in. diameter, 2,500 -Ω- field. Pentode Transformer, strongly recommended, **11/6.**
ENERGISING UNIT for any above energised speakers, **10/-.**
MAGNAVOX "33," "33 Duodes" and "66" **Speakers can** always be supplied from stock.
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TELSEN BINOCULAR H.F. CHOKES, Bakelite case, 200-2,000 metres, **1/3** each.

The Short-wave Radio World

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

Cathode-Ray Monitoring

W9HYO, writing in the current issue of *QST*, gives a very simple circuit showing how the small 3-in. type of cathode-ray tube can be used to advantage by the amateur. In normal circumstances, owing to the difficulty in obtaining such tubes, the amateur would be unable to take advantage of this scheme, but the Mullard Co. are now in a position to supply a suitable C.R. tube.

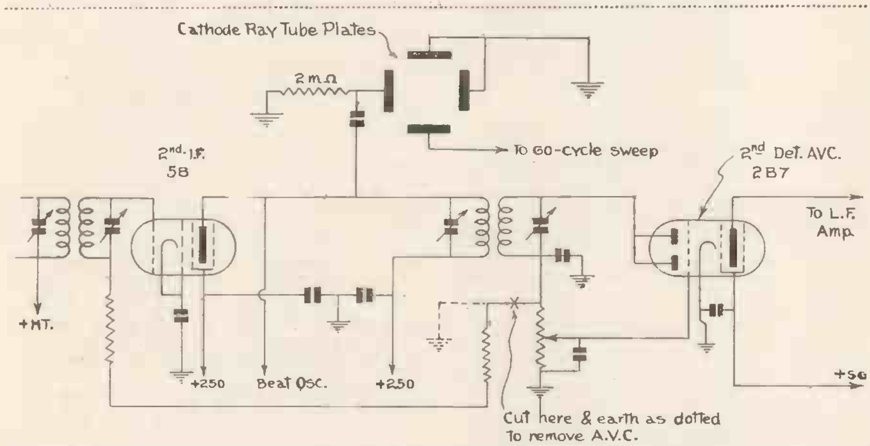


Fig. 1.—A station that has a cathode-ray tube for checking purposes is able to give accurate measurements. The C.R. tube has many uses and the small 3 in. tube is a good investment for the amateur.

The circuit shown in Fig. 1 is quite straightforward and the tube can be used to show up many faults in a transmitter or receiver. It will show an over-peaked condition due to possible lack of neutralising and self oscillation in the final amplifier. It can indicate a class B linear stage where the excitation is excessive and where the power output has not been quartered.

Another good point is that it will show positive peaks that do not exceed the carrier amplitude which would indicate carrier shift with downward modulation. An A.C. hum which may be inaudible on a loudspeaker is also shown up in such a way that the operator can tell if or not the hum level is sufficient to be audible to DX operators.

Fading can readily be observed while as a signal strenfth indicator it is without equal. A celluloid scale can be cut and marked in R strengths and fixed to the fluorescent screen. In this way measurements of fair accuracy can be made.

Any good receiver with two or more L.F. stages should develop sufficient R.F. voltage for deflection. If the receiver has automatic volume control, considerably increased output can be obtained by cutting the A.V.C. out of circuit.

Also the tube anode voltage should be reduced to a low value, so giving increased beam sensitivity. It is most important that the linearity of the receiver be checked up to the point where it is fed into the C.R. tube, for without it the results cannot be of a reliable nature. Suitable power packs and times bases for this C.R. tube have been published from time to time in previous issues, but if any reader is in difficulty we shall be glad to help with suitable circuits.

An Ultra-short Wave Meter

Most amateurs use the Lecher wire system of frequency measurement under 6 to 7 metres, but they do not always obtain satisfactory results with this system. The absorption arrangement is not always satisfactory, particularly when used with a transmitter, for it does not give an accurate indication of frequency, while it also tends to pull the circuit out of tune.

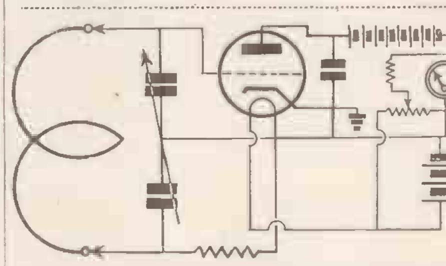


Fig. 2.—This meter is a variation of the original absorption but with the snags overcome. It is suitable for 3-10 metre working.

For that reason we were interested in a new circuit suitable for wavelengths of between 3 and 12 metres, which was published in *L'Onde Electrique*. This meter is accurate to within 0.1 of 1 per cent. over its entire wave range. It consists of a triode valve acting as a detector, the anode current of which varies with signal input. A balancing of zero adjusting resistance circuit is embodied so that there is no current read until a signal is picked up.

As can be seen from the circuit in Fig. 2, the coils are tuned by a split-stator condenser with a vernier dial. Although the circuit is only a variation of the conventional absorption, it is highly accurate and can be used with super-regenerative or super-heterodyne receivers, providing the operator is careful to pick up the incoming signal rather than the signal from the local oscillator in the receiver under test.

A 3-10 Metre Receiver

The *Societe des Radioelectriciens* have evolved a rather unusual single valve super-regenerator in which the valve performs as a radio-frequency

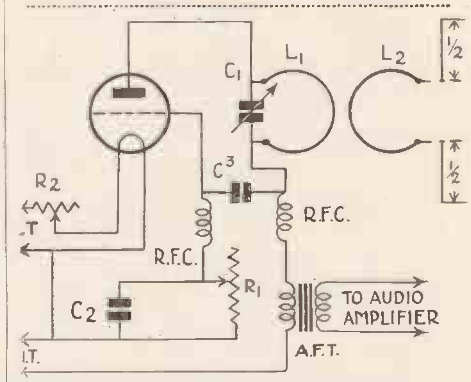


Fig. 3.—The triode valve in this circuit works as a radio-frequency oscillator, quench oscillator and detector.

oscillator, quench oscillator and detector. The beat frequency is controlled by the variable resistance, R1, while the tuned circuit is connected in the anode of the valve with a small condenser, C3, giving the necessary grid-anode coupling needed for oscillation. Constructors interested in ultra-short wave working should consider this circuit for it is very simple to build, and providing the coils are accurately made, no trouble should be experienced in obtaining accurate results.

Those who are fortunate enough to have an Acorn type of valve will find this an advantage on the higher frequencies. Also, a low-frequency amplifier can be incorporated to give loudspeaker volume providing that a triode valve is used. We do not intend to infer that a pentode is unusable, but from experiments made with this circuit, it is rather difficult to obtain optimum results with anything but a triode output valve. The circuit is shown in Fig 3.

5-metre E.C. Circuit :: A 6L6 Transmitter

Electron Coupling on 5 Metres

A receiver that is midway in efficiency between the super-regenerator and the super-het is that which includes an electron-coupled detector which is particularly good for C.W. operation. The circuit shown in Fig. 4 uses a 6C6 or 954 Acorn as a detector followed by an indirectly-heated pentode in the output

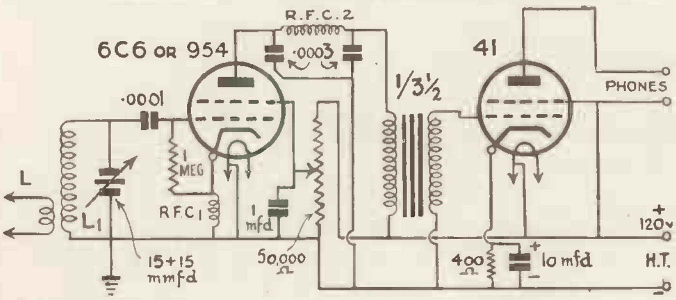


Fig. 4.—Electron coupling on 5-metres is very popular in America and Australia. This circuit is designed by VK2NO who has broken one or two Australian records with it.

stage. Regeneration is controlled by a 50,000 ohms screen voltage potentiometer, while oscillation is obtained by placing the cathode of the detector valve above earth through a U.H.F. choke.

The designer, Don. B. Knock, VK2NO, strongly recommends that the tuning condenser be of the split-stator type, consisting of 15-mmfd., each section. Coil, L1, is made up of 7 turns 14-gauge copper ½ in. diameter and is soldered directly across the tuning condenser. With low-capacity valves of the Acorn type, L1 may need as much as 9 turns. The 5-metre choke R.F.C.1 and 2, consist of 35 to 40 turns of 36 D.S.C. wound on a pencil.

Transformer coupling, although unusual when following a pentode valve, works satisfactorily and a very high gain is obtained.

The aerial is coupled to the grid end of L1 by wrapping a turn or so of the feeder wire around the grid lead. Where doublet coupling is required, an additional coil, L, is needed.

Reaction control is very smooth and the 954 pentode super-regenerates with 135 volts H.T., so that the receiver is also suitable for reception of modulated oscillator signals for which a straight receiver is too selective.

A 6L6 Transmitter

QST, November issue, describes a very interesting single-valve transmitter using the new 6L6 valve which is now available in this country. This valve is used as a tritet oscillator, as shown in Fig. 5, having a crystal in the grid-cathode circuit, with a tuned circuit at fundamental frequency in series with the cathode. The anode is then tuned to a harmonic of the cathode circuit, so that with a 40-metre crystal, the transmitter will work on 20 metres, or by shorting the cathode circuit, the output can be on the crystal fundamental.

Beginners will appreciate this simple circuit, for it gives quite a high output with low voltage and as it is crystal controlled will give stable signals on amateur bands. Constants are as follows:—L1, 11 turns of No. 30 D.C.C. wire, scramble wound to a diameter of 1½ ins.; L2, 26 turns of No. 18 enamelled wire on a 1½ ins. former, spaced to occupy a length of 1½ ins.; C1, .0001-mfd.; Cc, .00014 mfd.; C3, .002 mfd.; C4, .005 mfd.; R1, .25 megohms; R2, 50,000 ohms; R3, 3,000 ohms, 10 watts.

The entire transmitter is mounted on a chassis 9 by 6 ins.; while most of the wiring can be beneath the baseplate. A standard 4-pin plug-in coil is suitable

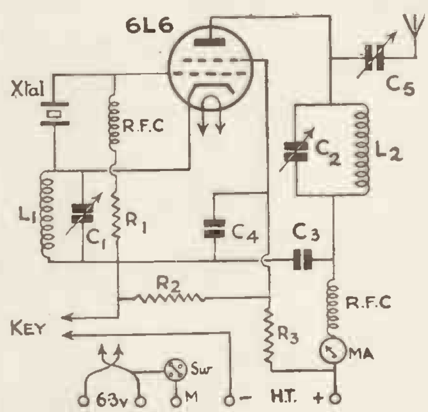


Fig. 5.—A good circuit for the 6L6 valve. It will give a high output on 20-metres.

for the cathode circuit, while a ceramic coil form is an advantage in the anode.

A U.H.F. Converter

With the increasing interest in ultra-short wave working, many amateurs need a converter that can be added to their existing short-wave receiver. W6BXR, has designed a most effective converter that is suitable for reception of signals between 4 and 8 metres. The coils are all wound on the same former with a gap of 2 in. between L2 and L3 which provides sufficient coupling between the oscillator and detector. This can be seen in Fig 6.

The aerial coupling coil consists of 2 turns of No. 14 S.W.G. air spaced to ½ in. diameter. L2, 3 and 4 are all approximately 4 turns of similar wire and diameter, but these windings depend very much on stray capacity and the valve in use. The tuning condenser, C1, has a value of 15 mmfd., while C3 is 100 mmfd., split stator. The oscillator valve is a conventional triode of the AC/HL type, while the detector is a screened grid with VMS4B characteristics.

If this converter is used with a short-wave receiver, the receiver should be tuned to approximately 200 metres, for this gives a high degree of gain with complete stability. Plug-in coils of the Eddystone 1050 type can be used to advantage in this converter, for it can then be used to cover 2½, 5, 10-metre and television bands.

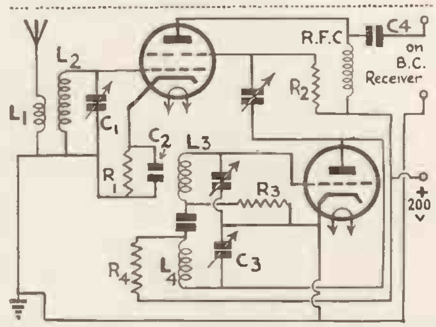


Fig. 6.—Reception of ultra-short wave signals is made easy if this converter is coupled to the standard short-wave receiver.

Kingston and District Amateur Radio Society

This society has formed a special 56Mc group under the management of Mr. L. E. Manders, 129, Manor Lane, Sunbury, to whom all interested in ultra-high frequency work should apply for details.

At a recent meeting Mr. J. H. Edwards, of the 362 Radio Valve Co., Ltd., lectured on "Radio Frequency Pentodes and how to make use of their increased efficiency." The Hon. Secretary is Mr. Richard Sheargold, G6RS, "Reculver," Manor Lane, Sunbury-on-Thames.

The Cardiff and District Short-Wave Club

At the first annual dinner at Cardiff when 36 members attended, including some from Swansea, Neath, Port Talbot, Merthyr and Newport. Mr. D. Low, the oldest transmitter in South Wales, spoke on transmitting in the early days, which was followed by a few words from G8AM.

The ordinary meetings of this society are held every Thursday at 8 p.m., and all interested should write to the Hon. Secretary, H. H. Phillops, Esq., 2BQB 132 Clare Road, Cardiff.

"Programmes for the Short-wave Listener"

(*Continued from page* 170)

quintuplets. This is an exclusive C.B.S. feature. Billy Mills and his Orchestra are also very popular at 8.30 p.m. on Fridays, while the Three Consoles at 9.15 p.m., are also worth hearing.

The most important Saturday relay is the Saturday Night Swing Club starring Bunny Berigan and guest artistes, which comes on at 11.45 p.m. on either Wayne or Philadelphia, but in addition to this programme are several others including Ann Leaf at 9 p.m., The Dictators at 10 p.m., and the Eton Boys at 10.45 p.m.

The short-wave station, Rome, which operates on 25.4 metres and 31.13 metres, radiates generally from midday until 2 and 3 a.m., but every evening from 7.5 until 10 p.m. there is a variety programme selected from different Italian stations.

The Australian station, Lyndhurst, on 31.34 metres, radiates a programme every day for English listeners between 1.45 and 2.45 p.m. At 2 p.m. for the five days scheduled for the fifth Test Match they are to relay a potted commentary on the day's play. For these transmissions there will be an increase in power, so the relays should be picked up quite easily.

"A 5-Metre Record"

(*Continued from page* 192)

mitters in this country, such a receiver is not really warranted, although it is interesting to note that W2HXD received G5BY's transmissions on a 7-valve super-het with resistance coupled I.F. stages.

A super-regenerative receiver has a very high noise-level and is only of value when copying a signal with bad frequency modulation. The receiver used by G5BY is more or less conventional but includes several refinements. It was designed primarily for straight operation with a switch to short out the grid circuit quench coil except when the receiver is used as a super-regenerator.

This type of straight receiver will not be of much use with the normal amateur unstabilised transmitter, but gives an excellent account of itself both on crystal control and on long-line arrangements. Extreme attention has been paid to mechanical construction of the detector tuning portion, to obviate vibration. Actually 12 s.w.g. copper wire is used for all wiring in this circuit. As a result, harmonics from 10-metre crystal-controlled stations up to 20 miles come in with stability—and in some cases strength—equal to that on their fundamental.

Crystal-control 5-metre stations with well modulated phone produce a far better signal on this straight receiver than they do on every type of super-regenerator tried out in direct comparison.

The Receiving Aerial

A Franklin aerial with Zepp feed is used for 5-metre reception and as with Diamond for transmitting, gives a remarkable increase in efficiency

This Franklin aerial consists of three half-wave vertical sections with two quarter-wave phase reversers. Three vertical half-wave reflectors, a quarter-wave behind add considerable directive properties.

This aerial was used by G5BY for portable operation last summer at Strumble Head, South Wales, when G6YQ on Mount Snowdon, 87 miles distant, was worked with R9 plus phone signals at each end.

The consistently good results obtained by the Post Office on ultra short-waves have long been recognised, but amateur stations have been assuming that these results were due to high power and expensive apparatus.

Results obtained by G5BY show that with reasonable input but with good design, amateurs should be capable of spanning 100 miles or so, which would be a great improvement on the poor results generally obtained.

The Dial Ratio and Short-wave Tuning

By

D. R. Parsons, Grad.I.E.E.

SINCE the early days of short wave listening, the dial ratio of the tuning condenser has been taken as the property indicating ease of tuning. A set incorporating a high-ratio slow motion dial has usually been looked upon as the ideal receiver. It is not generally appreciated that the type of tuning used influences the ease with which stations can be tuned in to a much greater extent. It will be shown later that it is quite possible for a receiver with a slow motion dial having a ratio of 8 : 1 to be as effective as one employing a 100 : 1 ratio dial, provided that the electrical tuning circuits of the two sets under consideration are different.

TABLE 1.

Condenser - 7—140 $\mu\mu$F.
Tuning Range - 18900—9160 Kc/s.
15.85—32.7 Metres.
Band Covered - 9740 Kc/s.

DIAL RATIO	K/R RATIO	S/R RATIO
1/1	19,480	2,165
8/1	2,435	271
17/1	1,145	127
22/1	886	98
30/1	649	72
40/1	487	54
60/1	325	36
80/1	243	27
100/1	195	22

Consider the three types of short wave tuning commonly used :—

(a) In a receiver designed solely for short wave reception, it is customary to use a 0.00014 or 0.00015 mfd. tuning condenser in parallel with the whole of the tuning inductance.

(b) In all-wave receivers, a large tuning capacitance is incorporated, generally a value of 0.00035-0.0005 mfd. is employed in place of the lower value used in short wave receivers, the idea being to limit the number of switched coils required to cover a given wave-range.

(c) Some receivers use a small capacitance in parallel with the main tuning capacitance. The former usually has a value of about one tenth of the latter. The band required is selected by the large capacitance and the final tuning done on the small vernier capacitance. Such a system is known as "Band-spreading."

Consider the effect of the dial ratio upon the ease with which stations can be received in the three types of tuning outlined above.

Added Capacities

In a commercial short wave receiver incorporating ganged tuning, the inductance of the tuning coils was 1.74 Microhenries. Wiring, valve and trimming capacitance amounted to 33.7 m.mfd. The maximum and minimum capacitances of the tuning condenser were 140 and 7 m.mfd. respectively.

Figure 1(a) shows the circuit theoretically while 1(b) illustrates the equivalent electrical circuit at minimum and maximum settings of the dial C. The minimum capacitance of C seems to be on the low side, but it should be remembered that the tuning capacitance given are for the condenser only, valve and other capacitance being allowed for in the value of 33.7 m.mfd. already assigned to C_0.

The minimum frequency in kilocycle/sec. is given by :—

$$f_{min} = \frac{15.9 \times 10^4}{\sqrt{L.C.}}$$

where L is in Microhenries
C is expressed in Micro-microfarads.

$$\text{Therefore } f_{min} = \frac{15.9 \times 10^4}{\sqrt{1.74 \times 40.7}}$$

= 18,900 Kc/s.

TABLE 2.

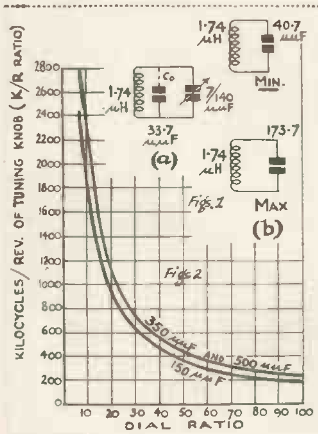
Condenser - 15—350 $\mu\mu$F.
Tuning Range - 17,300—6,160 Kc/s.
17.35—48.8 Metres.
Band Covered - 11,140 Kc/s.

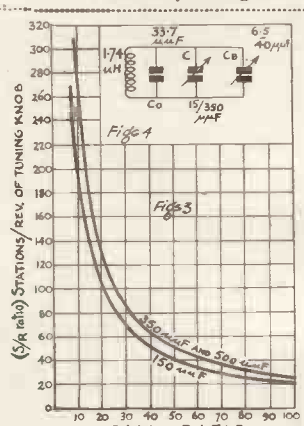
DIAL RATIO	K/R Ratio	S/R RATIO
1/1	22,280	2.475
8/1	2,790	310
17/1	1,395	155
22/1	1,013	113
30/1	743	83
40/1	557	62
60/1	371	41
80/1	279	31
100[1	223	25

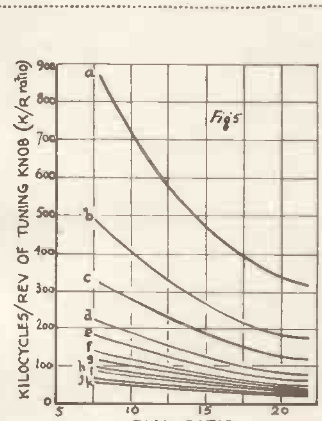
$$\text{Similarly } f_{max} = \frac{15.9 \times 10^4}{\sqrt{1.74 \times 173.7}}$$

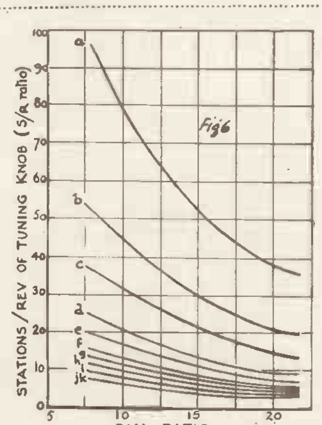
= 9,160 Kc/s.

The tuning range is therefore (18,900-9,160) Kc/s. or 9740 Kc/s. Assuming that the tuning condensers are rotated through 180 geometrical degrees as they are tuned from minimum to maximum capacitance and that an ordinary plain 1 : 1 dial is used, then 9,740 Kc/s are passed through for half a revolution of the latter. The Kc/s/revolution of the









(*Continued from page* 186)

tuning knob ratio is therefore 19,480. Telephony stations should be separated by 9 Kc/s. and since every modern receiver should have a selectivity of this order, it can safely be assumed that there is room for $\frac{19,480}{9}$ stations per revolution of the tuning knob. Physically, of course, stations are again retuned after the 180° mark if tuning is continued, but since the dial ratio is considered per revolution of the driven shaft, this method appears to be the clearest way of expressing this figure.

TABLE 3.

Condenser - 20—500 μμF.
Tuning Range - 16,470—5,220 Kc/s.
18.22—57.5 Metres.
Band Covered - 11,250 Kc/s.

Dial Ratio	K/R Ratio	S/R Ratio
1/1	22,500	2,500
8/1	2,810	313
17/1	1,325	147
22/1	1,022	114
30/1	750	83
40/1	563	63
60/1	375	42
80/1	281	31
100/1	227	25

TABLE 4.

Condenser - - 215—390 μμF.
Tuning Range - 16,220—5,850 Kc/s.
18.5—51.28 Metres.
Band Covered - 10,370— Kc/s. in 11 unequal steps.

Capacitance Range	Freq. Covered	Band Width	Dial Ratio	K/R Ratio	S/R Ratio
	Kc/s.	Kc/s.			
(*a*) 55.2–88.7 μμF.	16,220–12,800	3,420	1/1	6,840	760
			8/1	855	95
			17/1	403	45
			22/1	311	35
(*b*) 88.7–122.2 μμF.	12,800–10,920	1,880	1/1	3,760	418
			8/1	470	52
			17/1	221	25
			22/1	171	19
(*c*) 122.2–155.7 μμF.	10,920– 9,640	1,280	1/1	2,560	285
			8/1	320	36
			17/1	151	18
			22/1	116	13
(*d*) 155.7–189.2 μμF.	9,640– 8,780	860	1/1	1,720	191
			8/1	215	24
			17/1	101	11
			22/1	78	9
(*e*) 189.2–222.7 μμF.	8,780– 8,080	700	1/1	1,400	156
			8/1	175	19
			17/1	82	9
			22/1	64	7
(*f*) 222.7–256.2 μμF.	8,080– 7,530	550	1/1	1,100	122
			8/1	138	15
			17/1	65	7
			22/1	50	6
(*g*) 256.2–289.7 μμF.	7,530– 7,080	450	1/1	900	100
			8/1	113	13
			17/1	53	6
			22/1	41	5
(*h*) 289.7–323.2 μμF.	7,080– 6,700	383	1/1	760	84
			8/1	95	11
			17/1	45	5
			22/1	35	4
(*i*) 323.2–356.7 μμF.	6,700– 6,375	325	1/1	650	72
			8/1	81	9
			17/1	38	4
			22/1	30	3
(*j*) 356.7–390.2 μμF.	6,375– 6,110	265	1/1	530	59
			8/1	66	7
			17/1	31	3
			22/1	24	3
(*h*) 390.2–423.7 μμF.	6,110– 5,850	260	1/1	520	58
			8/1	65	7
			17/1	31	3
			22/1	24	3

Using a S.L.F. condenser, the station/revolution of tuning knob ratio is $\frac{19,480}{9} = 2,165 : 1$. A 3 in. diameter dial would have to be rotated .0045 in. to separate two stations working on adjacent channels! Such a state of affairs would not popularise short-wave tuning. Slow-motion dials were therefore designed in which a small knob has to be turned 'n' number of times, while the main driving spindle of the condenser is turned round one revolution, 'n' being the ratio of the dial.

Since most condensers have 180° rotation—there are a few with 270° movement, the dial ratio can be defined as being twice the number of times the tuning knob has to be rotated while the condenser is moved from minimum to maximum capacitance.

Therefore, if a 17:1 ratio dial is used on a 0.00014 mfd. condenser, the number of Kc/s/revolution of the tuning knob will be reduced from 19,480 to $\frac{9,748}{8.5}$ or 1,145. Similarly, a 100:1

(*Continued on page* 190)

(*Continued from page* 188)

ratio will reduce this figure to 194, giving a station/turn ratio of 22 as against 2,165 stations/turn when a 1 : 1 dial is used.

For the sake of simplicity call the kilocycle/revolution of tuning knob ratio, the K/R ratio, and the number of stations/revolution, the S/R ratio.

Table 1 shows the K/R and S/R ratios for commonly used dial ratios from 1 : 1 up to 100 : 1, when used in the circuit of Fig. 1.

As previously mentioned, in an endeavour to cover the main short wave broadcast wavelengths in one waveband, a large tuning condenser of about 0.00035 mfd. capacitance is often used. Assuming a minimum capacitance of .000015 mfd. and a maximum capacitance of 0.00035 mfd., the tuning range, with the original circuit capacitance and tuning inductance of 1.74 Microhenries, will be given by the following two equations :—

$$f_{min} = \frac{15.9 \times 10^4}{\sqrt{1.74 \times (15 + 33.7)}}$$

$= 17,300$ Kc/s.

$$f_{max} = \frac{15.9 \times 10^4}{\sqrt{1.74 \times (350 + 33.7)}}$$

$= 6,160$ Kc/s.

The tuning range is now (17,300-6,160) Kc/s. or 11,140 Kc/s.

Table 2 shows calculations made for the latter circuit and they should be carefully studied and compared with Table 1.

Table 3 shows a similar set of readings calculated for a 0.0005 mfd. condenser having a minimum capacitance of .00002 mfd.

In Figure 2 is a curve showing the relation between the K/R ratio and Dial Ratio for the three tuning capacitance which have been considered, while Figure 3 shows a similar curve with the S/R ratios as ordinates.

The following deductions can be made from these curves,—

(a) Dial ratios under 8 : 1 should never be used in short-wave receivers.

(b) There is no practical difference in the ease of tuning when the tuning capacitance is increased from 0.00035 to 0.0005 mfd. The latter capacitance increases the minimum wavelength very slightly due to the higher minimum capacitance, while the maximum wavelength is increased considerably. With the 0.0005 mfd. capacitance, nearly all the "worth while" short wave stations are covered in one range.

(c) If the dial ratio is increased from 1 : 1 to 30 : 1, tuning becomes 30 times as easy, while the increase from 30 : 1 to 100 : 1 only increases the ease of tuning slightly more than 3 times.

Band Spreading

How can tuning be made less difficult? Earlier in this article, a system of tuning known as "Band-spreading" was mentioned. Consider Fig. 4. Here is a inductance of 1.74 Microhenries with the residual capacitance C_0 across its ends. In parallel with this circuit is a large variable capacitance C and a small vernier variable capacitance C_B. These capacitances are variable between the limits set by their respective minimum and maximum values. Assume that these are 15 to 350 m.mfd. and 6.5 to 40 m.mfd. Suppose a plain knob dial is fitted to C and a slow motion dial fixed on the spindle of C_B. Let C and C_B be turned to their minimum positions. The capacitance across L is now $(33.7 + 15 + 6.5) = 55.2$ m.mfd. The minimum frequency is therefore 16,220 Kc/s. If the slow motion dial on C_B is rotated till maximum capacitance is reached, we are tuning with 88.7 m.mfd., giving a resonant frequency of 12,800 Kc/s. The band width covered is only 3,420 Kc/s.

Frequency Range

Turn C_B back to 0° on the dial and then increase C until 12,800 Kc/s is reached, *i.e.,* when $C + 6.5 + 33.7 = 88.7$ m.mfd. If C_B is rotated to maximum capacitance, a frequency of 10,920 Kc/s is obtained. This gives a frequency range of only 1,880 Kc/s. Continue the above procedure 11 times and the complete wave-range of L is covered, the number of Kc/s band-spread decreasing until only a width of 260 Kc/s is tuned in the last position. Table 4 shows the results tabulated for the circuit of Fig. 4.

Wider Coverage

These results are plotted in Figs. 5 and 6 from which the effect of "Band-spreading" is at once apparent. Taking as an average Curve d, it will be seen that a S/R ratio of 24 is obtained with an 8 : 1 slow motion vernier dial on condenser C_B. With ordinary tuned circuits, Tables 1, 2 and 3 show that this condition is usually met when a 100 : 1 ratio is used. In circumstances (j) and (k), a K/R ratio of about .25 is found for a 22 : 1 dial. With normal tuning, a 800 : 1 dial ratio would be required!

Another advantage of "Band-spreading" is that in a kit set, it overcomes ganging difficulties. It is extremely awkward for the "man in the street" to gang up a super-het incorporating normal tuning. If two large separate condensers are used for setting the signal and oscillator frequency circuits correct for the intermediate frequency used, the actual tuning may be done on a double .000015 m.mfd. gang condenser.

It is hoped that this article has shown that the dial ratio is not an absolute indication of the ease with which stations can be tuned in. A high ratio always causes easier tuning than a low one, whether the former is necessary depends on the tuning constants employed. A new term is required, either the K/R or the S/R ratio should be specified for each wave-range. It has been found that a figure of not more than 850 is satisfactory for the K/R ratio, while the S/R ratio should be no greater than 90 for easy tuning. This article has dealt with the electrical considerations of a short wave dial but mechanical properties are just as important. A 2 in. tuning knob seems essential and the movement should be smooth and without back-lash. Finally, there should be *no* noise during rotation *even after weeks of use.*

Electron Optics

(*Continued from page* 165)

only way to do it (having once found the best shape of electrodes) is to use the smallest possible diameter cathode.

The motion of electrons in magnetic fields is more complicated than in the electrostatic systems we have hitherto considered, since it can be shown that the electron trajectories will take a spiral form.

The required homogeneous field is produced by a long solenoid surrounding the tube.

Suppose that a group of electrons pass through a point P, the electrons having a constant velocity V_x down the tube, but various velocities normal to the axis. It will be shown that these electrons will again pass through another point P, farther down the tube, so that P_1 is the " image " of P (Fig. 4).

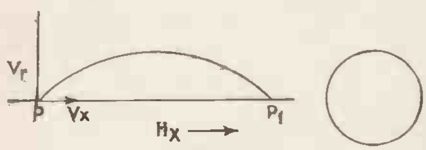


Fig. 4.

The motion can best be represented by imagining the trajectory to be projected upon a plane normal to the axis, i.e., by taking an end view.

The force acting on the electron is $H_xE\ V_r$ in a direction normal to its direction of motion. This force does not alter the speed of the electron, which, therefore, (inside a tube maintained at a constant potential) must remain constant.

The trajectory of a particle moving with constant speed and acted upon by a force normal to its direction of motion is a circle.

Let P be the radius of this circle. Then centrifugal force

$$= \frac{m V_r^2}{p} = H_xE\ V_r$$

$$\therefore V_r = \frac{p\ H_xE}{m}$$

The time (r) taken to describe a complete circle is

$$\frac{2\pi p}{V_r} = \frac{2\pi p M}{H_xEp} = \frac{2\pi M}{H_xE}$$

which is independent of Vr.

During this time the electron moves down the tube a distance of $x = r\ V_x$.

All electrons leaving P, whatever their initial values of V_r will again meet at P_1, a distance rV_x down the tube, i.e., P_1 is an image of P.

The electrons can each describe several circles and then meet again at successive points P_1, P_2, ... etc., down the tube.

Alternatively for a given position of the screen at P_1, the H field can be adjusted so that the electrons leaving P can reach P_1 after describing several circles, so that many values of H can be found to give a definite focusing effect.

If the field is supposed to be short and homogeneous, the electron trajectory, as viewed from the end of the tube, will be divided into three sections (Fig. 5).

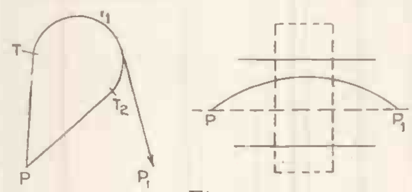


Fig. 5.

(1) A straight segment PT—straight since the electron is moving in a field free region.

(2) A circular arc TT_1 in the magnetic field.

(3) A straight segment T_1P_1 tangential to the arc at T_1, where the electron leaves the magnetic field.

"A 200-Watt Position Drive Amplifier"

(*Continued from page* 180)

The choke, L5, in the DA100 grid circuit has a core of No. 4 stalloy, square section, no gap, and is wound with 2,250 plus 2,250 turns of No. 28 enamelled and single silk covered wire with windings as shown in Fig. 4.

Chokes, L6 and L7, in the cathode circuits of the PX25's are also No. 4 stalloy, square section, with 6/1,000 in. gap per limb of core, and wound with 9,000 turns of 34 s.w.g. enamelled and single silk covered wire.

The following operating details giving the output at full load show that a maximum of 208 watts are available with a total current of 165 ma. per valve.

Conditions at Full Load: (250 V. peak to each DA. 100 grid)

Anode volts	1,000	1,000	1,000
Anode current of each valve—milli-amps.	165	150	145
Anode dissipation of each valve—watts	60	50	50
Power output—watts	208	200	190
Total harmonic distortion	4%	4%	4%
Load resistance—ohms (anode to anode)	8,000	8,000	8,000

These figures assume that the bias pack has reasonable regulation so that the bias voltage does not increase by more than 10 volts between no load and full load. The DA100 valve requires 2.7 amps. filament current at 6 volts, has a maximum anode dissipation of 100 watts, a slope of 3.9 ma. per volt and an amplification factor of 5.5.

L.C.C. New Fire Brigade Headquarters.

The L.C.C. have awarded the contract for the whole of the new battery charging equipment for the fire appliance batteries at the above, to Westinghouse Brake & Signal Co., Ltd. This equipment, which will, of course, be of the metal rectifier type, will be supplied through the electrical contractors, The Bower Engineering Works (Electrical & General), Ltd., of 14 Nicholas Lane, E.C.4.

The Beginner's Transmitter and Modern Amateur Communication Receivers.

We regret that owing to pressure of space the concluding articles under the above headings have been held over until the April issue, published on March 31. In that issue the full circuit of the Beginner's Transmitter will be given, including the circuit for anode modulation. Also some interesting information regarding new American receivers with circuits will conclude the article on Modern Amateur Communication Receivers.

Mr. W. E. Carman, of 69 Valencia Circus, Dagenham, Essex, is deirous of obtaining back issues of TELEVISION AND SHORT-WAVE WORLD. If any reader can oblige will he send a postcard giving the numbers available and the price to the above address.

INDEX TO ADVERTISERS

MISCELLANEOUS ADVERTISEMENTS

The charge for advertisements in these columns is 12 words or less 2/-, and 2d. for every additional word. 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.

BINDING CASES AND INDEXES FOR 1936

Binding cases and indexes for the 1936 volume of "Television and Short-Wave World" are now available. The binding 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
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