TELEVISION AT 70 MILES WITH HOME-BUILT RECEIVER

Television and SHORT-WAVE WORLD

AUGUST, 1937
No. 114. Vol. x.

1/- MONTHLY

3ft. x 4ft. Picture with Cathode Rays

(Page 457)

NOVEL COLOUR TELEVISION

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MINIATURE TELEVISION

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METAL VALVE U.H.F. RECEIVER

BERNARD JONES PUBLICATIONS LTD.
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COMMENT OF THE MONTH

Twelve Months' Progress

ALTHOUGH the actual official opening of the Alexandra Palace was in November last year, the first public television transmissions were made on the occasion of the opening of Radiolympia in August, and so for practical purposes we may assume that high-definition television is one year old this month.

Looking back over this period we are conscious that it has been a period during which a great deal has been accomplished which holds out great promise for the future. Of outstanding importance is the fact that we are now aware that television is no longer tied to the limitations of the studio or its immediate precincts. The success of the Coronation and Wimbledon broadcasts proved this beyond a doubt and opened up an illimitable field for the new entertainment. A year ago such a possibility was a somewhat vague hope—to-day, it is a certainty only requiring development. It seems an anomaly that entertainment, which is ages old, should make such a bad comparison with a technical achievement which may almost be reckoned in months, but the fact remains that it is the entertainment side of television that is retarding the sales of receivers. The ability to go further afield should do much to correct this state of affairs.

The fact that there have been no revolutionary changes in receiver design during the past twelve months is, in our opinion, a satisfactory indication that progress is upon the right lines, but its particular value is that it should do much to remove an idea that is very prevalent in the mind of the public that television receivers, being new, are certain to undergo a considerable amount of modification before approaching any sort of degree of standardisation. Improvements in receivers have certainly been effected, but they have been of such a nature as not to render the early designs in any way obsolete, and in many cases the manufacturers have made modifications to receivers already in use in order to bring them quite up-to-date.

It is gratifying to learn that plans are now under consideration for very considerable modification and improvement of the transmission facilities at Alexandra Palace, plans which involve the construction of new studios and the installation of new plant. The past twelve months may be regarded as a try-out period for television from which it has emerged in a most satisfactory manner.

A Television Word

DURING the whole period of television development there has only been one word which aptly described a television receiver—and this word is "Televisor." The word "Televisor" was, however, coined by Mr. J. L. Baird in 1925 and registered by the Baird Company as a trade-mark, so its general use has been precluded. On another page of this issue we publish an announcement by the Baird Company relinquishing their right to the sole use of this word, and the reason for the step is that the word is so apt and has come into such general use, particularly in the United States, that enforcement of their rights could only result in unfriendly action. We welcome the action of the Baird Company and, in future, propose to make free use of the word in describing television receivers.

TELEVISION AT 70 MILES WITH A HOME-BUILT RECEIVER

By S. West

Here is a description of a home-made receiver built by Mr. S. West of Ipswich. As will be seen by the untouched photographs above results obtained are excellent and they provide proof that the home construction of receivers is quite practicable.

IT is now known that the original estimate of the service area embraced by the television transmitter at Alexandra Palace was conservative and that reception of pictures of real entertainment value is possible at considerable distances.

The following account of some of the writer's experiences and a description of the apparatus used at Ipswich, a distance of a little over 70 miles, will be of interest. As will be seen from the untouched photographs above the results obtained are excellent.

Since the inception of the high-definition television service a large number of tests have been made of various receiver arrangements and the apparatus described is the outcome of these experiments; it gives consistently reliable reception of good quality pictures.

At the outset it was obvious that interference would be the chief reason for poor pictures because of the relatively low field strength of the transmissions. The effect of interference on the picture is well known but interference has also a deleterious effect upon synchronism.

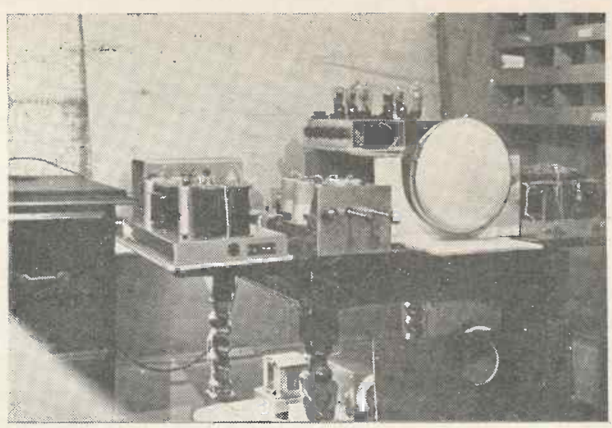
Employing a comparatively efficient R.F. stage before the mixer valve considerably improves the signal/noise ratio and also reduces the noise due to the oscillator valve.

Acorn Valves

It was decided that the superior performance of the Acorn type valve at ultra-high frequencies merited its use in preference to a normal valve. Tests confirmed this conclusively and also revealed that a considerable improvement was effected by employing an Acorn R.F. pentode and an Acorn triode as mixer and oscillator valve respectively. It should be mentioned here that there is some attenuation of sidebands when all circuits are tuned to resonance because of the efficiency of the R.F. stage. As, however, the full gain is rarely required, tuning may with advantage be staggered somewhat. It has been found that this is preferable to damping the circuits. In practice it is only necessary to adjust the tuning controls for the best picture, which is very easily arrived at.

Because of the difficulty of securing stability with a large number of I.F. stages, coupled with the fact that to obtain adequate frequency coverage the gain would be very little higher with a larger number than four, it was decided to use this number. These were followed by a diode detector and almost from the outset good pictures were received.

It was considered, however, that the picture was not bright enough and in spite of the disadvantages of video frequency amplification it was decided to add one stage. Accordingly some experiments were carried out with V.F. amplification with some success. By employing correct values the response of a V.F. stage can be made very good and a useful gain can be secured.



This photograph shows Mr. West's receiver in chassis form.

A NEW SYNCHRONISING IDEA

The final design arrived at is as shown in the schematic drawing.

Synchronising

The arrangement is comparatively straightforward and calls for little comment. The method of securing synchronism is a little unusual and the writer is grateful to Mr. Paul D. Tyers for permission to reproduce the circuit. The following brief explanation will clearly explain its action.

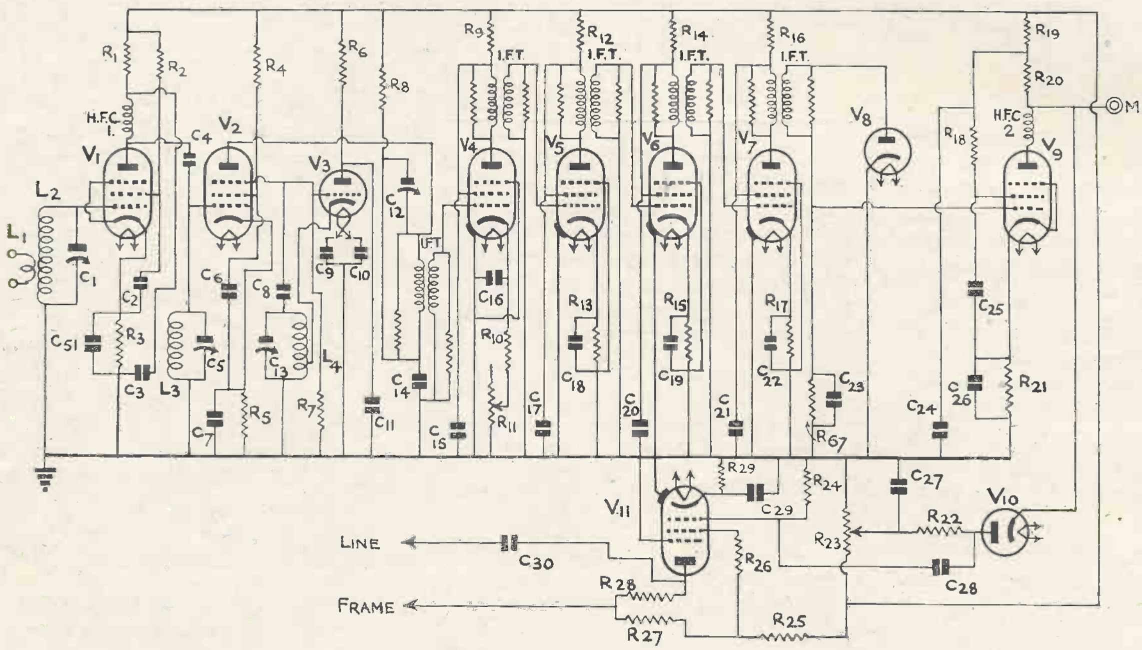
The diode valve V10 is connected so that normally its cathode is at a higher potential than its anode. This through a 0.1-mfd. condenser to the anode of V11 and earth. The potentiometer R23 is then adjusted until the noise due to the picture goes, leaving only the synchronising pulses audible.

A little consideration will show that this arrangement will furnish very stable synchronism and considerable interference and fading will not affect the stability of the picture.

The diode V12 in the diagram reintroduces the D.C. component into the picture. It is the writer's view that this greatly improves picture quality. If this diode is used it is tice with the exception of one or two modifications that are not really essential, although the improvement effected warranted their inclusion. These time bases furnish a good shaped raster and operate with great stability.

The condensers and resistances C31, C39, R43 are simple filter circuits to prevent mutual interference between the time bases. In the writer's experience this is a prime cause of inconsistent operation. The resistances R34 and R47 ensure rapid flyback of the spot.

It has been found that with a cer-



The complete circuit diagram of the receiver.

condition is secured by connecting the cathode to the anode of the V.F. valve V9 and the anode to the slider of the potentiometer R23, which is so adjusted that this condition exists.

It will be seen that any picture modulation will increase the anode potential of V9 and the diode V10 will not conduct. During synchronising pulses, however, the anode potential of V9 falls and the diode conducts, producing voltages across its load. As these voltages are out of phase and require amplification they are fed to the screened-grid valve V11 and it only remains to feed them through the application network to the grids of the time base relays.

Adjustment of the arrangement is quite simple and is best carried out with a pair of phones connected important to note that its heater supply must be insulated to withstand the full tube 3rd anode volts to earth and preferably to arrange for it to be on before the tube H.T. is applied.

It is of interest to note that in the writer's experience it is perfectly satisfactory to reintroduce the D.C. component in this manner. There are other ways of retaining the D.C. component and there is a slightly more complicated way which might be considered preferable when picture modulation is applied to two electrodes. Tests made, however, failed to reveal any improvement and the extra complication was not considered worth while.

The Time Bases

The time bases follow normal prac- tain adjustment of the synchronising pulse filter it is possible to alter the base charge resistances to almost any value without affecting synchronism.

It will be seen that the picture modulation is applied to the grid and 1st anode of the tube. This reduces the voltage required for full modulation. The more normal arrangement can, of course, be used when an adequate signal is available.

For the choke H.F.C.2 one section of an Eddystone 1010 choke is used. These are wound in four sections and it is a simple matter to remove one of these. It is wired as close to the anode pin of the valve as possible. It is important to use a resistance of adequate rating for R20. Two 7,000-ohm Dubilier 2-watt resistances

SIMPLE HOME CONSTRUCTION

connected in parallel were used in the original. A single 2-watt should, however, prove quite satisfactory.

The I.F. transformers are wound with 24 s.w.g. enamelled wire on 1-in. Paxolin formers. No trimmers are used and each winding is adjusted experimentally for the best picture. As a rough guide the windings average 19 turns, close wound, and their coupling is adjusted to approximately ¼ in. Each section is damped with a 5,000-ohm resistance. Mervyn I.F. units have also been used and give excellent results.

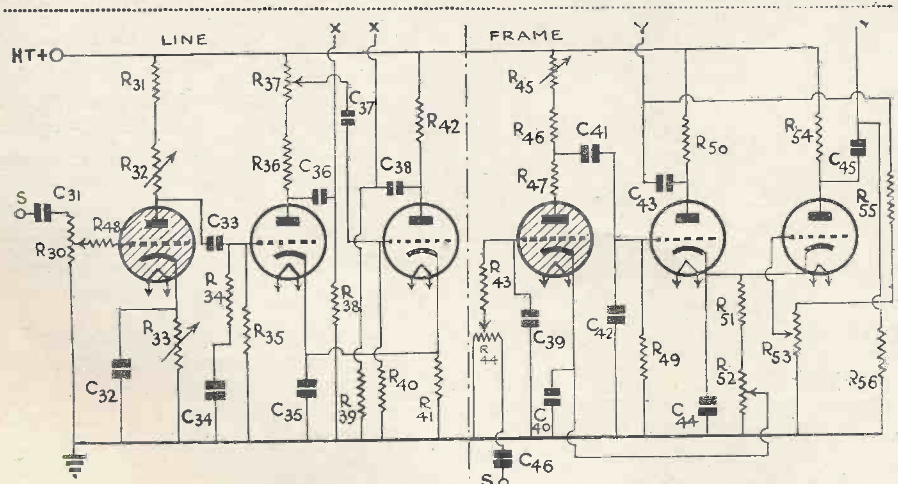
order to retain sharp division of the lines.

The Sound Receiver

No mention has been made of the sound receiver. At the time of writing the design of this is in a state of flux and the writer is endeavouring to construct a receiver embodying noise silencing circuits. Noise in the speaker now that we are accustomed to the silent background of normal listening is intolerable and some form of noise silencing circuit is very desirable where a sensitive receiver must be employed.

As a guide, however, quite a simple arrangement will give adequate volume. A single Acorn R.F. stage followed by a detector and two L.F. stages with pentode output has been used with success. More normally, however, a converter is used in front of an ordinary broadcast receiver. This converter consists of an Acorn R.F. stage and an X41 frequency changer.

In conclusion, the writer would like to express his thanks for the assistance given by Mr. G. Parr, of the Ediswan Co., Ltd., and Mr. Paul D. Tyers; also to Mr. A. H. Croasdale, who gave advice in connection with the photography of the received pictures. In particular is he indebted to TELEVISION AND SHORT-WAVE WORLD for the valuable information given in its pages.



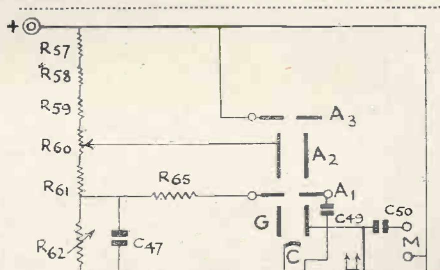
To simplify the diagram no arrangement for centring the raster is shown. The usual methods for performing this are applicable and are easily incorporated in the circuit. The resistances R 38 and R 56 may be connected to the slider of the centre taps of the potentiometers with approximately 200 volts across them. Alternatively a shift voltage may be obtained from the third anode end of the tube supply volts. In the interest of economy this method is preferable and is that used in the original.

Quite a compact layout has been achieved. In the first instance very elaborate screening was used, but it was found entirely unnecessary and simple screening is adequate.

A photograph of the complete layout clearly shows the arrangement adopted. No attempt has been made to incorporate it into a cabinet as continual modifications are being tried.

In spite of the complex appearance of the outfit its construction was a comparatively simple and straightforward task and the very excellent results amply repay the time spent.

The tube in general use is an Ediswan 12H, which gives a bright black and white picture. A 10H tube is also used and the writer personally prefers the smaller picture. With increased 3rd anode volts the detail appears to be more definite; particularly is this so with printed matter and the like. It should be mentioned that the increase in 3rd anode volts with a small picture is necessary in order to retain sharp division of the lines.



Note.—Care should be taken that the resistance R 62 is not so adjusted that the makers recommended volts are exceeded on A 1. The case of C 49 unless insulated to withstand 4,000 volts must not come into contact with earth or C 50.

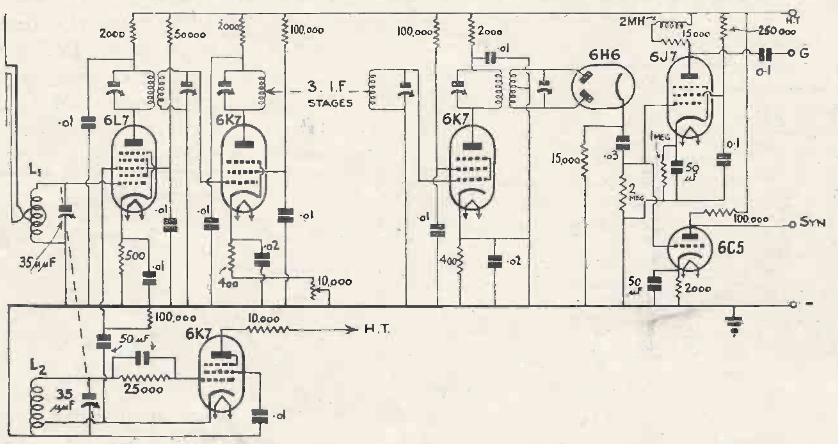
Component Values.

- L1, 2 turns 26 D.S.C. at earthy end of L2.
- L2, 11 turns 16 S.W.G. enamelled on ½ in. former.
- L3, 11 turns 16 S.W.G. enamelled self-supporting.
- L4, 6 turns 16 S.W.G. enamelled cathode tap 2 turns from earth end.
- C1, 25 mmfds. variable.
- C2, 0.0003 mfd.
- C3, 0.0003 mfd.
- C4, 0.0003 mfd.
- C5, 25 mmfds. variable.
- C6, 0.0003 mfd.
- C7, 0.01 mfds.
- C8. 0.0001 mfd.
- C9 and C10, 0.01 mfds.
- C11, 0.001 mfd.
- C12, 20 mmfds. trimmer.
- C13, 25 mmfds. variable.
- C14, 0.005 mfd.
- C15, 0.005 mfd.
- C16, 0.1 mfd.
- C17, 0.005 mfd
- C18, 0.1 mfd.
- C19, 0.1 mfd.
- C20, 0.005 mfd.
- C21, 0.005 mfd.
- C21, 0.005 mfd.
- C22, 0.1 mfd.
- C23, 0.000035 mfd.
- C24, 8 mfd.
- C25, 25 mfds.
- C26, 500 mfds.
- C27, 0.5 mfd.
- C28, 0.1 mfd.
- C29, 0.1 mfd.
- C30, 0.0001 mfd.
- C31, 0.001 mfd.
- C32, 50 mfd.
- C33, 0.001 mfd.
- C34, 0.001 mfd.
- C35, 12 mfds.
- C36, 0.1 mfd.
- C37, 0.002 mfd.
- C38, 0.1 mfd.
- C39, 0.003 mfd.
- C40, 50 mfds.
- C41, 0.5 mfd.
- C42, 0.2 mfd.
- C43, 0.1 mfd.
- C44, 30 mfds.
- C45, 0.1 mfd.
- C46, 0.1 mfd.
- C47, 0.1 mfd.
- C48, 0.1 mfd.
- C49, 0.1 mfd.
- C50, 0.1. mfd. 4,000 D.C. working.
- C51, .01 mfd.
- R1, 20.000 ohms.
- R2, 150,000 ohms.
- R3, 2,000 ohms.
- R4, 150,000 ohms.
- R5, 1,500 ohms.
- R6, 50,000 ohms.
- R7, 50 000 ohms.
- R8, 3,500 ohms.
- R9, 3,500 ohms.
- R9, 3-500 ohms.
- R10, 100 ohms.
- R11, 5,000 Pot.
- R12, 3,500 ohms.
- R13, 250 ohms.
- R14, 3,500 ohms.
- R15, 250 ohms.
- R16, 3,500 ohms.
- R17, 250 ohms.
- R18, 10,000 ohms.
- R19, 1,000 ohms.
- R20, 3,500 ohms. (2w.).
- R21, 100 ohms.
- R22, 2 megohms.
- R23, 100,000 Pot.
- R24, 100,000 ohms.
- R25, 50,000 ohms.
- R26, 10,000 ohms.
- R27, 5,000 ohms.
- R28, 5,000 ohms.
- R29, 250 ohms.
- R30, 20,000 ohms. Pot.
- R31, 1 megohm.
- R32, 0.5 megohms Pot.
- R33, 50,000 ohms.
- R34, 2,000 ohms.
- R35, 1 megohm.
- R36, 80,000 ohms.
- R37, 15,000 ohms.
- R38, 1 megohm.
- R39, 1 megohm.
- R40, 1 megohm.
- R41, 5,000 ohms.
- R42, 100,000 ohms.
- R43, 20,000 ohms.
- R44, 50,000 ohms.
- R45, 2 megohms Pot.
- R46, 750,000 ohms.
- R47, 1,000 ohms.
- R48, 150,000 ohms.
- R49, 2 megohms.
- R50, 200,000 ohms.
- R51, 8,000 ohms.
- R52, 2,000 ohms. Pot.
- R53, 0.5 megohms Pot.
- R54, 200.000 ohms
- R55, 1.5 megohms.
- R56, 1 megohm.
- R57, 2 megohms.
- R58, 1 megohm.
- R59, 0.5 megohm.
- R60, 0.5 megohm Pot.
- R61, 0.5 megohm.
- R62, 0.5 megohm Pot.
- R63, 100,000 ohms.
- R64, 100,000 ohms.
- R64, 100,000 ohms. Pot.
- R65, 1 megohm.
- R66, 250,000 ohms.
- R67, 5,000 ohms.
- V1, Mullard AP4.
- V2, Mullard AP4.
- V3, Mullard AT4.
- V4, V5, V6, V9, Mullard TSP4.
- V8, Osram D42.
- V10, Osram D42.
- V11, Osram MSP4.
- V12, Osram D42.
- HFC 1 Eddystone type 1011.
- HFC 2 See text or approximately 90 turns 39 DSC. on ½ in. former.

MINIATURE TELEVISION

AN ARTICLE DISCUSSING THE POSSIBILITIES OF SMALL RECEIVERS AND CONSEQUENT REDUCTION IN COST

SOME time ago, by the courtesy of the Pacific Radio Publishing Co., we received a copy of *Television with Cathode Rays*, by A. H. Halloran. This book was published in a loose-leaf edition in June, 1936, and subscribers to the volume received additional information in the form of loose leaves as soon as published. The latest addition to the book is Chapter XII, which describes the construction of a cathode-ray television receiver using the R.C.A. miniature cathode-ray tube. The cost of the receiver is very low as a considerable saving is made possible by the use of low voltages for the tube and scanning circuit, apart from the cost of the tube itself (about 37/6 in this country).



The suggested circuit of the miniature receiver.

The expense of construction being so low we have considered the possibility of constructing the equipment for British transmissions. There are no doubt a number of readers who would like to experiment with television but are deterred by the high outlay required and the trouble attending the use of high voltage components and it is thought that such an experimental equipment would serve as a useful introduction to the technique of television construction.

It must be pointed out at the outset that the quality of picture obtained from such a small tube falls short of that which is shown on commercial outfits, even if the size is magnified by a lens placed in front of the screen, as recommended by the designer. With this in mind, the receiver can be considered as an experimental one intended for obtaining experience, and the constructor will not be too critical of the results obtained.

The chapter referred to gives full instructions for the assembly of the receiver, including the winding of the coils, and this will be undertaken in the experimental laboratory of this Journal. A report will be issued next month giving the preliminary work done and the modifications which have been made to suit the receiver to the British transmission system.

The Circuit

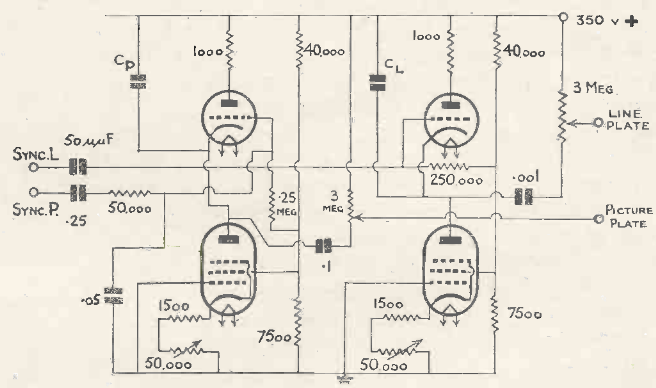
The circuit of the video receiver, which follows conventional practice, is shown by the diagram, Fig. 1. The input is fed to the grid of the frequency changer, a 6L7, a separate oscillator being coupled to G_3. This is shown below—a 6K7. Following the frequency changer there are five stages of I.F. amplification ending in a double diode, 6H6. The output from this is fed to a single stage of video amplification, 6J7, the anode of which has an H.F. choke in series to boost the upper frequencies. In parallel with the grid of the 6J7 is a lead feeding the grid of a 6C5 which acts as an amplifier for the synchronising pulse. This part of the circuit will need modification for the British system as the condenser between cathode and grid cuts out the D.C. component from the synchronising signal.

With the exception of the tuning coils L_1 and L_2 the circuit will require very little alteration to conform to the E.M.I. standard, although on inspection the band width may not be sufficient for full detail. However, the size of picture will limit this before the limit of the tuned circuit is reached.

Scanning Circuit

The scanning circuit is shown in Fig. 2, and again is on conventional lines. The condensers C_L and C_p are charged from a type 58 pentode connected in series with them on the 350 v. supply. The charging rate is controlled by the resistance of 50,000 ohms in the cathode circuit of each valve. The output of the thyratron

The time base circuit



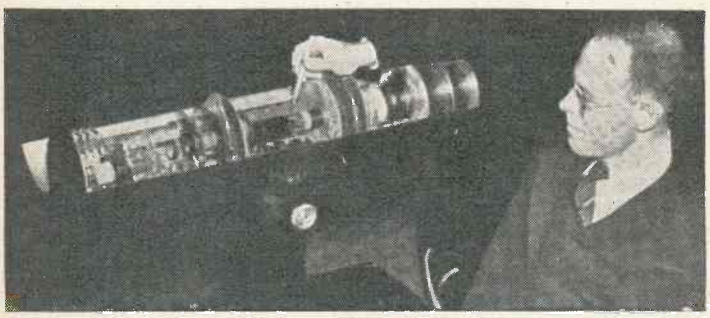
(*Continued on page* 459).

TELEVISION PROJECTION WITH THE CATHODE-RAY TUBE

AN ACCOUNT OF SOME RECENT R.C.A. DEVELOPMENTS

The results of recent research work by the Radio Corporation of America in the production of large pictures by Cathode-ray projection were disclosed at the 25th anniversary Convention of The Institute of Radio Engineers. For a portion of the information given in this article we are indebted to "Electronics," New York.

AT the twenty-fifth anniversay Convention of The Institute of Radio Engineers (U.S.A.) a series of papers on television subjects were read by technicians of the Radio Corporation of America. Of outstanding importance was the paper by Dr. V. K.



A projection tube of the type described being demonstrated.

Zworykin and W. H. Painter on "The Development of the Projection Kinescope."

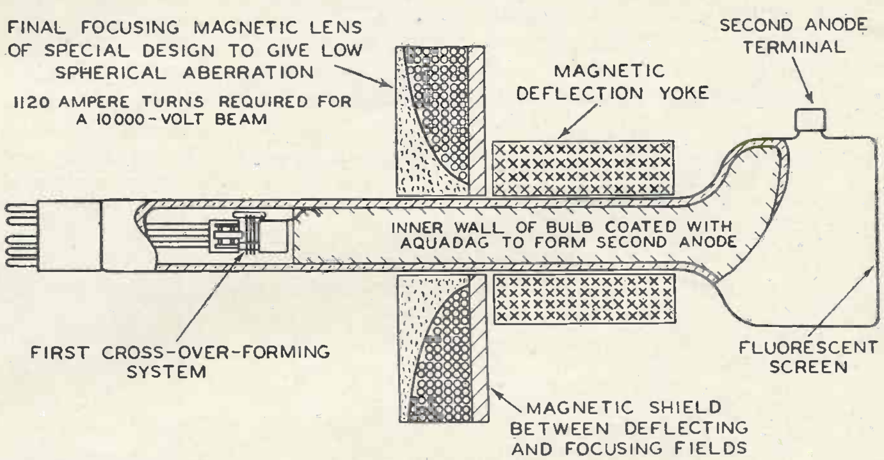
The authors said that several years of research work were required before the problems of designing a suitable projection system were clarified. Actually, the earliest development of this type of television tube dates back to 1930, when conventional cathode-ray tubes were scaled down to produce a small image of great brilliance which might be projected. These attempts were not successful, however, and it was not until a completely new line of attack, including entire redesign of the electron gun, was made that acceptable results were obtained.

During the course of the paper a tube for projection purposes was demonstrated. This tube contains an electron gun capable of delivering 1.0 to 1.5 M/a. at the cathode, of which about 0.4 M/a. is actually delivered to the beam itself. This beam is accelerated by a potential of 10,000 volts on the last anode, producing a spot about 0.005 in. in diameter on the fluorescent screen. The brilliance at the screen surface is about 280 candles per square foot, which when projected is capable of producing a highlight brilliance of about 1.9 foot-lamberts. This compares with a brilliance of 2.7 foot-lamberts for 16 mm. home movies and 2.7 to 5.2 foot-lamberts for commercial motion pictures. The size of the projected picture is normally 18 by 24 in. but much larger pictures can be projected at correspondingly lower brilliance. The actual picture on the fluorescent screen itself, before projection, is about 1½ in. by 2 in. The projection tube is intended for use with a lens of f/1.5 aperture.

The screen material of the projection tube is principally zinc orthosilicate of carefully controlled crystalline structure, which gives a brilliant yellow-green light and which is very stable under prolonged heavy bombardment. Tests with this type of material, under a beam current of 200 M/a. at 10,000 volts, showed a reduction of lighting efficiency of only 27 per cent. in 1,200 hours' operation.

Electron Gun for Projection Tube

An electron gun of the projection tube of unusual design was described by R. R. Law in his paper "A High-current Gun for the Projection Kinescope." The cathode itself is indented and covered with a very small spot of barium-strontium oxide. In front of the cathode are four aligned apertures, each maintained at successively higher potentials with respect to the cathode. The last aperture has a potential of 10,000 volts. The first two apertures nearest the cathode control the brilliance of the spot by their grid-like action on the beam electrons. Both these apertures are operated together as the control grid. The final aperture makes contact with the Aquadag coating which returns the electrons from the fluorescent screen.



Sectional diagram of high intensity cathode-ray projection tube showing the focusing and deflecting coils.

The final electron lens of the focusing system is an electromagnetic lens of unusual design which reduces the spherical aberration to a small amount. The deflection control is entirely electromagnetic, using a conventional scanning yoke.

PICK-UP SENSITIVITY

In the demonstration a vision signal from a secondary emission plate (fixed Iconoscope) was fed to the two control apertures. The vision signal represented a still picture and was sent 30 frames a second 343 lines, without interlacing. A special directional reflection screen, about 3 ft. by 4 ft. in size was used to receive the image from the projecting system, which employed a highly corrected f/1.4 lens of about 3 in. aperture. The brilliance of the image and its high quality were readily apparent. As an additional demonstration the small screen was removed and the image projected on to the standard screen used for the lantern slides. This

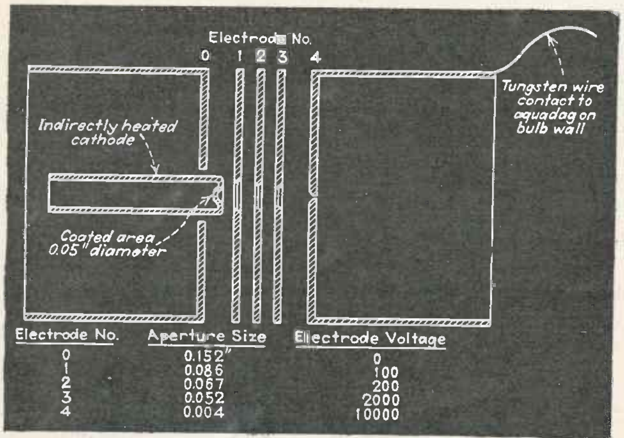


Diagram of the electron gun for projection tube showing beam cross-over electrodes.

screen, about 8 ft. by 11 ft. in size, was competely covered by the image and with a brilliance sufficient to make it readily visible and enjoyable to all those present in the room, which was about 50 ft. long. The picture was later further enlarged so that only a small portion of it filled the entire 8 ft. by 11 ft. screen.

OUTDOOR SCENES AND TELEVISION TRANSMISSION

Two papers were contributed in this special series by Harley Iams, R. B. Janes and W. H. Hickok entitled "The Brightness of Outdoor Scenes and its Relation to Television Transmission." The authors said that until recently devices for converting light into television picture signals have required a very large amount of light to give a useful signal. To-day, it is practical with such electronic devices as the Iconoscope to transmit pictures of outdoor scenes, even on cloudy days.

In the transmsision of outdoor scenes with an Iconoscope a lens is used to focus the picture on the Iconoscope mosaic. The output of the picture pick-up tube depends, among other things, upon the amount of light that reaches it from the scene to be transmitted. This amount of light depends upon the intrinsic brightness of the scene. Studies were made to determine the typical brightness values which would have to be covered in television pick-ups.

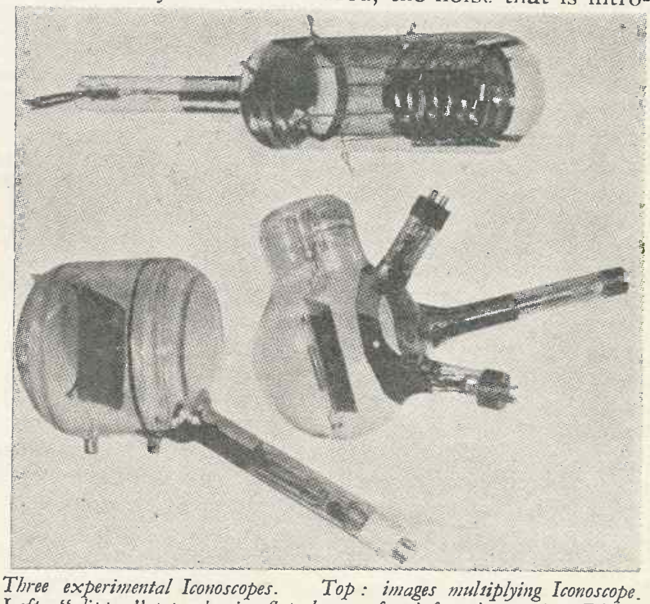
These values vary from nearly 0 to over 1,000 candles per square foot. Typical values recorded by the group were 16 candles per square foot for a football game on a dull day to 100 candles per square foot for a baseball game on a bright day in September and a figure of 2 was obtained in the shadows of tall buildings on a clear day. With recent pick-up tubes (the sensitivity of which is approximately three times as great as those of several years ago) scenes with brightness of 15 candles per square foot can be transmitted with an f/4.5 lens. If the surface brightness falls to a figure as low as 2.5, the scene can be reproduced but it is without entertainment value. The authors held out the hope that in time the Iconoscope type of tube would be able to pick-up and transmit nearly everything the human eye can see, and some things it cannot see.

Dr. V. K. Zworykin, G. A. Morton and L.E. Flory dealt with the theory and performance of the present pick-up type of tube and gave promise of newer tubes now under development. It was pointed out that still greater sensitivity was desirable and that there were two methods by which this sensitivity could be improved One is by use of secondary emission signal multipliers and the second is by using secondary emission intensification.

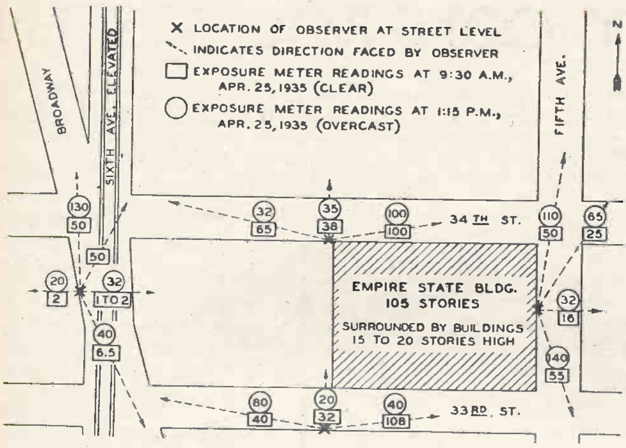
The present overall efficiency of the Iconoscope type of pick-up is about 5 to 10 per cent. and the difficulty in amplifying the tube output to desired levels is the noise. If the signal is 10 times as strong as the noise a good picture will result, but if the noise can be reduced to 3 per cent. of the signal, it is unnoticeable.

Calculations of the light required on the mosaic were given taking into account the tube efficiency, the size of the mosaic, and other factors. The authors showed that excellent pictures may be transmitted of 20 to 50 candles per square foot representing a mosaic illumination of $2\frac{1}{2}$ to 6 milli-lumens per sq. cm.

Increasing sensitivity may be attained by reducing the noise, by increasing the overall efficiency, or by increasing the tube output per unit of light flux. By increasing overall efficiency, laboratory tubes with efficiencies as high as 50 per cent. have been made. The authors discussed the development (purely experimental to date) of two types of new pick-up tubes. By using a secondary emission multiplier instead of collecting the secondary electrons unused, the noise that is intro-



Three experimental Iconoscopes. Top: images multiplying Iconoscope. Left: "dipper" type showing flat glass surface before the mosaic. Right: electron multiplying Iconoscope with T multiplier in each projecting arm.



duced by input and output resistors to the amplifying tube is eliminated completely. In this manner an increase in sensitivity of about three times is possible, and in this case the sensitivity increases with lower values of beam current and leads to the development of mosaics with thicker insulating layers to reduce the capacity per unit area. In practice a T-type multiplier has proved satisfactory.

The second method of increasing sensitivity consists in intensifying the entire image by a secondary emission amplifier instead of multiplying individual electrons. Here the image falls upon a mosaic, the elements of which extend through the mosaic. The scanning beam sweeps across the back of the mosaic removing the stored picture in the usual way, but with increased output. Experimental tubes have a sensitivity about ten times as great as the conventional Iconoscope.

The Baird Trade Mark

The Question of the word "Televisor"

BAIRD TELEVISION, LTD., desires to inform the public and their friends in the trade that in future all their goods will be marketed under the Trade Mark "Baird," which has already been largely used by the company.

As is generally known, the company is the registered proprietor of the trade mark "Televisor," but this word, which was originally invented by Mr. Baird in 1925 and registered by him as a trade mark, has now become in the United States the generally recognised word for describing television apparatus, and although the company has taken the necessary steps to protect its rights in this country it has become apparent to them that to continue doing so would be likely to result in the necessity for unfriendly action on their part against competitors and others without any counterbalancing advantage. Television apparatus is still, comparatively speaking, in its infancy and the company considers that it would be right to use as its trade mark words which will be regarded by all as distinctive of its goods rather than a word which many contend should be available for the use of all as a descriptive word for any kind of television apparatus. Accordingly, Baird Television, Ltd., announces that it is abandoning its registration of the word "Televisor" as a trade mark and that this word will in future be free, so far as they are concerned, for all to use as a word descriptive of television apparatus generally.

The above announcement does not in any way affect the rights of the company in respect of its other registered trade marks which it will continue to use and defend if occasion arises.

"Miniature Television"

(*Continued from page* 456)

(type 885) is taken directly to the plate through the isolating condensers shown. This may lead to a certain amount of defocusing, although it will be tolerable with a very small tube. The amplitude of the sweep is controlled by applying the full thyratron output to a potentiometer and tapping off a portion of this for the plates. The author makes no mention of the exact speed for which the circuit is designed and it will be necessary to make adjustments to the condensers for the E.M.I. system. It also remains to be checked whether the thyratron will operate at full amplitude at 10,000 cycles.

As stated above, a valuable point about the receiver is the economy in H.T. Both the video receiver, sound receiver time base and tube are fed from 350 v. H.T. This value is reduced for the video receiver by a series resistance of 2,000 ohms, the current consumption of this part of the set being about 50 ma.

Reverting to the time base, the synchronising pulses are applied to the grids of the thyratrons in the usual way, a simple filter being inserted in the leads. The H.F. filter is a 50 mmfd. condenser in series with 50,000 ohms, the grid being connected to earth through a .05 mfd. condenser to act as a by-pass.

Experimental Tests

In our experimental laboratory a start is being made with the construction of the H.T. unit and time base and the results with the specified values and the modifications found necessary will be reported in next month's issue.

OUR POLICY
The Development of TELEVISION

Reports Wanted

SCOPHONY, LTD., are desirous of receiving reports on their two radio transmissions taking place daily from Thornwood Lodge, Campden Hill. These transmissions are being sent out to the Science Museum at South Kensington to the apparatus which they are demonstrating to the public. The sound transmitter is operated at 47 megacycles and roughly 100 watts in the aerial. The transmitter is crystal controlled by a number of doubling circuits using 6L6 valves and RK 25's, feeding a pair of Taylor type T55 valves in push-pull. Modulation is applied to the grids and the overall frequency response of the transmitter is flat from 10 to 30 kc. The vision transmitter is identical except that the frequency is 49 megacycles with a special form of grid modulation employed to handle the vision frequencies. The address of Scophony, Ltd., is Thornwood Lodge, Campden Hill, London, W.8.

THE SUPERSONIC LIGHT CONTROL SYSTEM

A SIMPLE EXPLANATION OF THE DEVICE DEVELOPED BY SCOPHONY

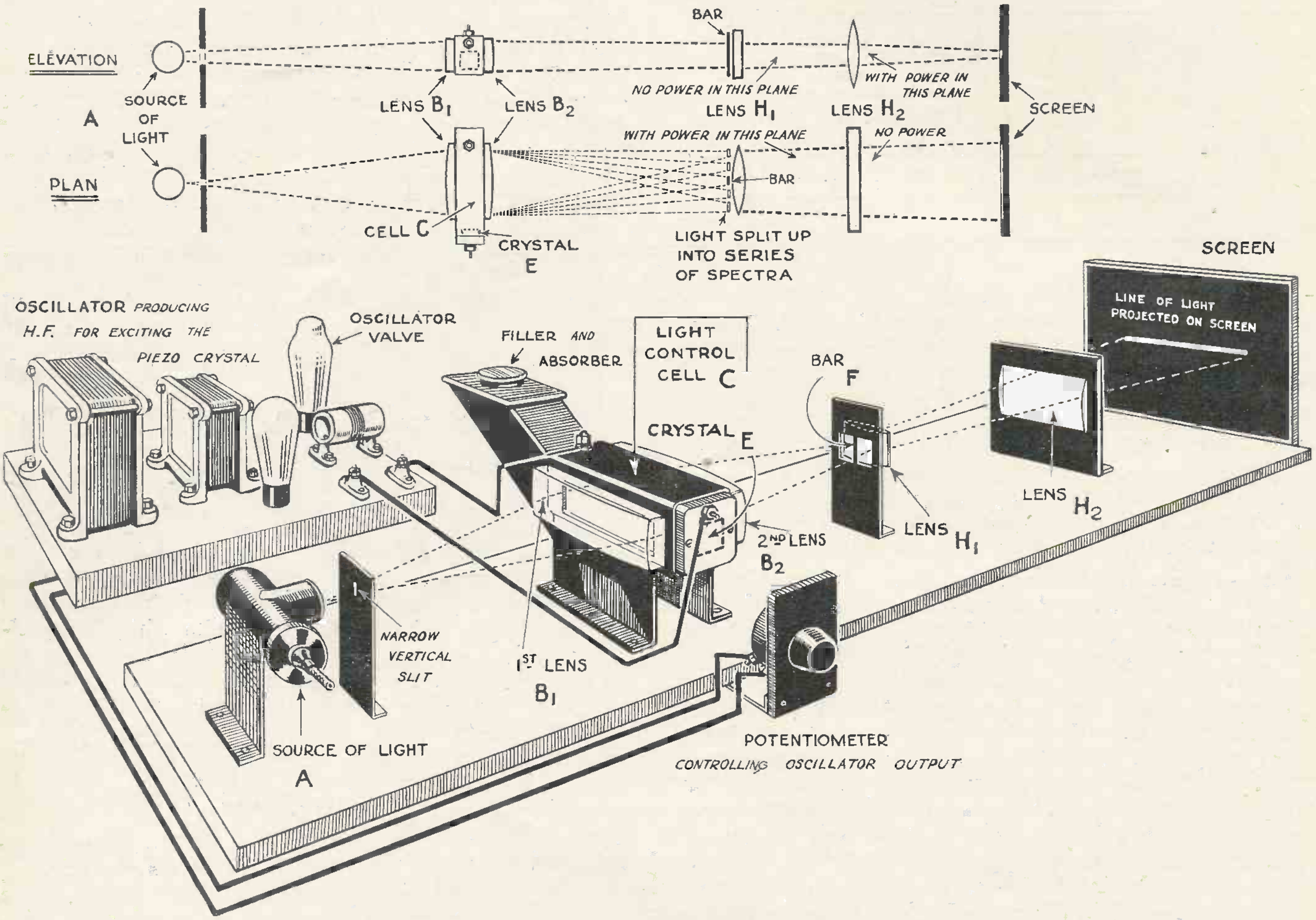


Diagram of a model of the Scophony supersonic light control.

The Scophony System is based on a number of fundamental inventions, which result in the achievement of a far greater light efficiency than has hitherto been possible. It is because of these inventions, some of which are absolutely revolutionary in their character, that Scophony, Limited, has been enabled to produce large-size projected high-definition pictures.

The two most important of these inventions are the Supersonic Light Control and the Beam Convertor, which are illustrated here from models which are at present on view in the Science Museum Television Exhibition.

Present day television is hampered by the unavoidable loss of light through "scanning." As is well known, the picture is scanned in the normal way by a single spot, whether it be at the transmitter or the receiver. This spot has to traverse the whole picture in a certain time. If the picture is made up of 240 lines and contains 320 elements along its line, the number of times the single spot goes into the picture is is about eighty thousand; consequently there is only one eighty-thousandth of the light which could be obtained if no scanning were employed as is the case with the cinema picture. The Scophony light control reduces this deficiency considerably.

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

The action of the control will be clear from the drawing of the model and the following explanation.

The oscillator, shown as a chassis on the left of the diagram, supplies a high frequency to the quartz crystal E.

This quartz crystal, which forms the end of a glass sided cell C, containing a transparent liquid, vibrates *mechanically* at the frequency of the oscillator and thus produces "sound" waves in the liquid, which travel horizontally across the cell at the speed of sound, and are completely damped out by appropriate absorbent material at the far side of the cell.

The light (which is to be controlled in intensity for projection on the screen to form the final picture), is made parallel through the liquid

THE SCOPHONY BEAM CONVERTOR

by the lens B_1 and after passing through the liquid is brought to a focus at F by the lens B_2.

At F there is a blackened bar just the size and shape of the original source of light, and when there are no sound waves in the cell the whole of the light is stopped by this bar, and no light falls on the television screen.

When the crystal is vibrating, however, the compressions and refractions in the liquid cause the light to be very slightly deflected. The oscillator frequency is so high that the wavelength of the sound waves is of the order of 1/10 mm., and the system of waves thus acts as a "diffraction grating."

As a result the light which was previously all stopped by the bar F now passes by on each side of it and is collected by the lenses H_1 and H_2 on to the screen.

The valve oscillator may be modulated with the incoming vision signal by any of the usual methods. The amplitude of the mechanical vibration will be proportional to the signal sent by the transmitter, and therefore the amount of light passing the bar F is also proportional to this signal.

The whole of the light passing through the cell is not brought to a single spot on the screen. The waves take about 100 microseconds to pass from the crystal to the far end of the cell, during which time the television transmitter has completed one full line of the picture. Thus at every instant the wave pattern adjacent to the crystal corresponds to the signal being transmitted, while the remainder of the cell contains, strung out along it, the vision signals of the previous 100 microseconds.

Lens H_1 forms an image of this train of waves on the screen while the high speed scanner (placed near H_1 in a receiver) has a speed of scanning equal and opposite to the velocity of this train of waves at the screen. In this way the scanner performs the double function of (1) scanning and (2) cancelling (or "immobilising") the motion of the liquid waves.

The advantages of this type of light control are :—

(1) Small *controlling* power even for the highest definition television, and for full size cinema screens.

(2) Great increase of light, up to 500 times, since a full line of the picture is projected instead of one spot.

(3) Reliability, freedom from electrical breakdown, etc.

THE BEAM CONVERTOR

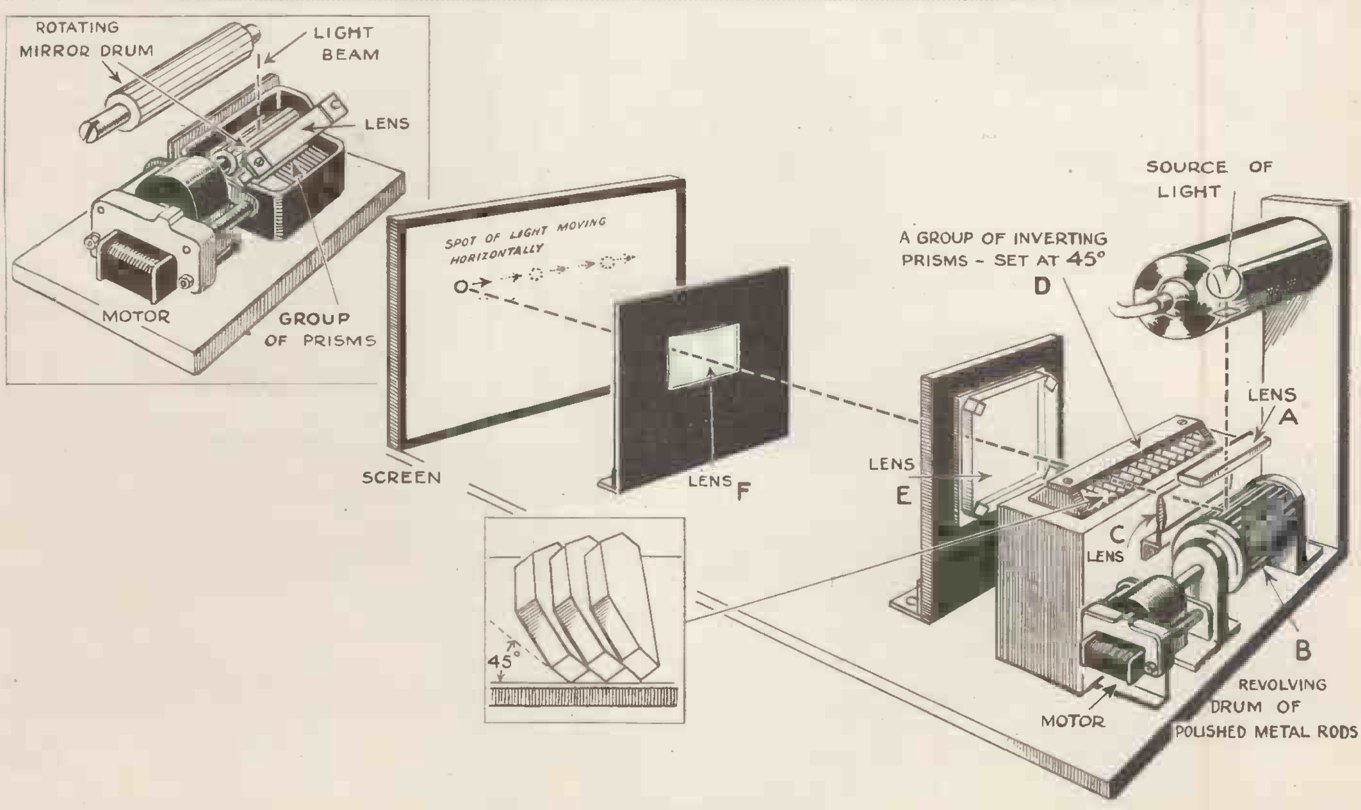
The object of the Beam Convertor is to make possible the use of a small diameter, long scanner instead of the equivalent large diameter, short scanner.

The light leaving the scanner B is in the form of a flat sheet moving downwards across the lens C. When it falls on the beam convertor D it is split up into a number of sections and each section is rotated through a right angle, with the result that the emergent beam of light, still in the form of a flat sheet is now moving in the plane of the sheet, instead of perpendicular to it.

The beam convertor itself consists of a number of right-angle prisms tilted at 45° to the horizontal. Anyone who has the opportunity to handle a right-angle prism will notice at once that on looking "through" the prism—i.e., from short side to short side via reflection at the base, the angle of vertical objects depends on the angle at which the prism is held, and that the objects rotate twice as fast as the prism is rotated.

Thus when the prism is at 45° to the horizontal the objects seen through it have been rotated through 90°—i.e., objects actually moving vertically appear to have horizontal motion.

The main drawing shows an early form of this device with a nove form of scanner consisting of a number of polished metal rods, while inset is a later model, utilising a very small scanner, and a beam convertor having two stages of reflection from serrated surfaces. This latter model, with its 1 cm. diameter scanner, can deal with the same amount of light as a normal scanner 20 cm. in diameter.



Diagrams of models of two types of beam convertor.

VALVE VOLTMETERS— A COMPREHENSIVE SURVEY

By " Microwave."

The valve voltmeter, in one or more of its many forms, is one of the most useful and versatile instruments which the amateur radio or television enthusiast can possess. Moreover, unless specially designed and constructed for some unusual purpose, it is, relatively speaking, one of the simplest and cheapest. This article, which will be published in two parts, reviews some of the types which are of interest from the practical point of view to the amateur.

THE general characteristic feature of the most usual type of valve voltmeter is its great sensitivity, defined as the reciprocal of the power required for full-scale deflection of the indicating instrument.

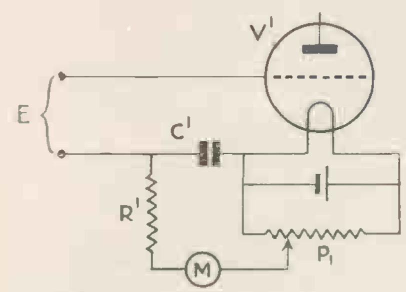


Fig. 1.—Direct-reading diode voltmeter

A reasonably high-grade moving-coil meter, such as would be used for valve voltmeter purposes by the amateur, would give full scale deflection with an input of about 40 microwatts. Used as the indicating

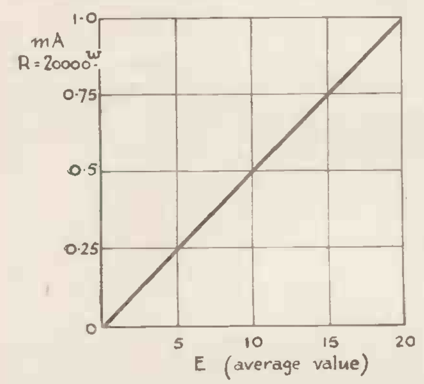


Fig. 1a.—Law of scale of direct-reading diode voltmeter.

instrument for a valve voltmeter of the high-input-resistance type, full scale deflection would be obtained with an input of the order of 0.1 microwatt.

Another characteristic feature (perhaps its most valuable one) is the extremely wide range of frequency over which it may be used, from the lowest A.C. frequencies (about 10 c.p.s.) up to 30 megacycles per sec. The most general type of construction (as described herein) is suitable for use between the limits 50 c.p.s. and 10 mc.p.s., without serious change of calibration. By special design, valve voltmeters have been constructed to work at frequencies up to 150 mc.p.s. A special technique is also needed for voltmeters working below 10 c.p.s. and for D.C. (" electrometer " use).

Lastly, the " law " of the scale indication can be arranged to choice within certain limits.

In the instruments described here the values of the circuit elements are given in the appendix.

The Diode Voltmeter

Structurally this is the simplest type of valve voltmeter, and in practice it takes three forms:—

(a) Direct-reading.
(b) Direct-reading peak.
(c) " Slide-back " peak.

Type (a) is depicted in Fig. 1. It consists essentially of a D.C. voltmeter shunted by a condenser, in series with a diode. Owing to the curvature at the lower end of the anode volts—anode current characteristic of the diode, and the effect of the so-called " contact potentials," it is necessary, if the instrument is to be used for full-scale readings of less than about 20 volts, to use a potentiometer (P_1) to apply a small positive bias to improve the linearity at the lower end of the scale.

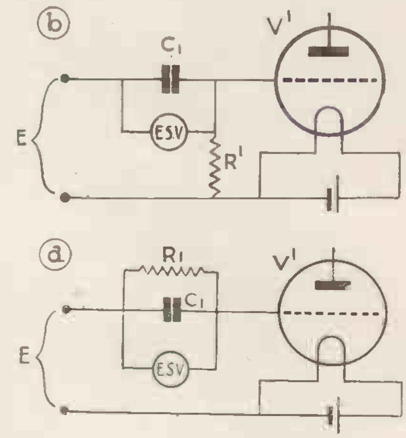
The characteristics of the instrument are as follows:—

The " law " of the scale is a close approximation to linear, as depicted in Fig. 1a. (The reading is proportional to the average value of the applied voltage wave, consequently the error is large for distorted waveforms, if, as is the standard practice, the scale is calibrated in terms of r.m.s. values.

The input resistance is, to a fair approximation, $\frac{1}{2}R_1$, whatever value R_1 may be.

This type of instrument is very useful in cases where a small load upon the source to be measured can be tolerated, as in the case of measurements on power amplifiers.

If, in the case of the instrument shown in Fig. 1, the meter M is omitted, the resistance R_1 made very



Figs. 2a and 2b.—Circuits of two types of direct-reading peak voltmeter.

high (of the order of a megohm or so) and an electrostatic voltmeter placed across it in parallel with the condenser, a very useful and interesting type of instrument results, namely, the *Direct-reading Peak Voltmeter (b)*. This latter instrument is generally arranged as in Fig. 2 (a) or (b).

A suitable electrostatic instrument for amateur use is the Ferranti 0-300 volt 2½ in. scale (for general use) or the 0-600 for testing output stages of small power amplifiers, as described later. The valve is preferably chosen to stand up to the voltage to be measured. A small bright emitter trans-

SLIDE-BACK VALVE VOLTMETERS

mitting valve (T15 or similar) or one of the new small high-voltage diodes, such as the Marconi or Osram U16 or U17 is suitable, if the higher range meter is desired.

This variety of valve voltmeter does not require calibration, the peak volt-

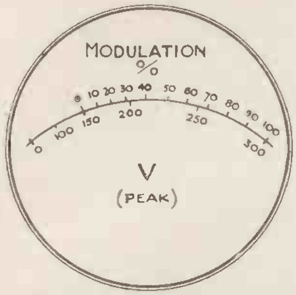


Fig. 3. Arrangement of scale of peak voltmeter.

age being read directly on the e.s. voltmeter. The input impedance is approximately $\frac{1}{2}R_1$, as in the case of the previously described instrument. For use at low frequencies C_1 may be of the order of .1 mfd., but for high-frequency measurements solely, C_1 need not be greater than 0.001 mfd.

Two interesting applications of this instrument are worthy of description :

(1) For measuring the percentage modulation of transmitters.

For this the instrument is coupled, either directly, or by means of an aperiodic coupling coil, to the transmitter to be investigated.

The coupling is adjusted until the reading on the meter is about half full scale or a little less. Modulation is then applied to the transmitter, and the reading will be seen to increase. Let us call these two readings A and B respectively. The percentage modulation is then

$$\frac{100.(B - A)}{A}\%.$$

The meter may be made direct-reading for this purpose by dividing the upper half of the scale into ten main divisions each representing 10 per cent. modulation (with subdivisions if desired). When using this device, the coupling to the transmitter is always adjusted so that with unmodulated carrier the instrument reads exactly half full-scale voltage (corresponding with zero on the modulation scale). When modulation is then applied, the instrument reads the percentage directly on the upper half of the scale. Since most e.s. voltmeters have an approximately " square-law " scale, the modulation readings will occupy the upper 75 per cent. of the actual scale length, which is very convenient. Such a scale (based on the 0-300 voltmeter) would appear as shown in Fig. 3.

(2) For checking the correct loading of l.f. amplifier output stages.

Consider the output valve anode voltage—anode current curve, with superimposed " load-line," shown in Fig. 4. It will be seen that with correct operating conditions the peak anode voltage would be 570 volts, as indicated by the lower extremity of the load-line.

The peak voltmeter (arrangement as Fig. 2b) is connected between the anode terminal of the valve and cathode or earth, and the peak (including of course the D.C.) anode voltage read, whilst an A.C. signal voltage of the correct amplitude (54 volts in the case shown) is applied to the grid of the valve, working under the desired operating conditions. A lower reading of the peak voltage than that shown (for instance) in the curve indicates that the load impedance is too low, a higher reading that the load impedance is too high, in the proportion that the reading is lower or higher than the correct reading indicated on the curve according to the expression

$$\frac{V_p - V_a{}^1}{V_p{}^1 - V^1}$$

where V_p is the peak reading indicated on the curve, $V_p{}^1$ the peak reading according to the voltmeter and $V_a{}^1$ the applied anode D.C. voltage, allowing for the D.C. drop across the output transformer windings.

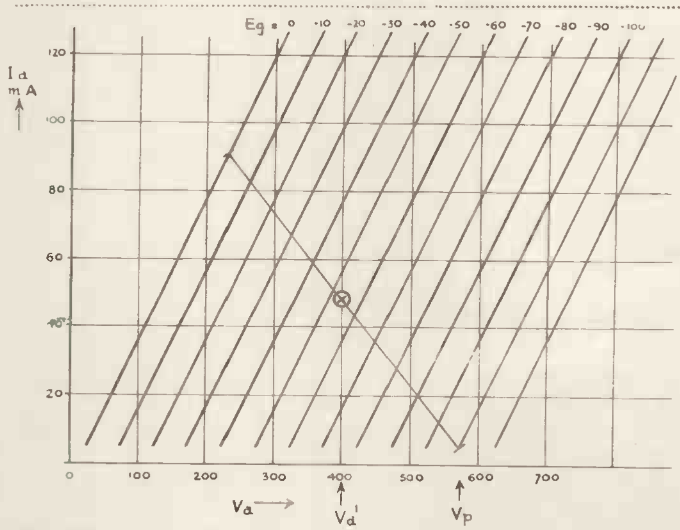


Fig. 4 Anode-current curve with superimposed load line.

Type (*c*), the Slide-back Voltmeter, is shown in Fig. 5a. For the sake of economy, in the instrument shown therein, the circuit is arranged so that by means of the switch S, the same meter may be used for indicating both the rectified current and the value of the slide-back bias voltage. Calibration is not required.

With the meter switch in position 1, and the bias at maximum value, the voltage to be measured is applied, and the bias reduced until the first signs of a reading appear on M. The bias is carefully adjusted by means of P_1 until, so far as can be judged, the rectified current indicated on M is just reduced to zero. The switch S is then thrown to position 2, and the value of the bias voltage read. This latter is then the value, to a more or less close approximation, of the peak voltage applied.

The disadvantage of this instrument is that it is not easy to determine exactly the point at which the rectified current ceases. The instrument becomes more accurate as the indicating instrument (M) is made more sensitive, and/or the anode impedance of the diode (V_1) reduced.

The Triode Slide-back Voltmeter (*Fig. 5b*). One method which was used in order to render the slide-back method more sensitive was to use a triode instead of a diode. So far as this intention is concerned, it is doubtful if there is any advantage, since in order to obtain any increase in sensitivity over the diode, it is necessary that the " slope " (G) of the triode, expressed in mA/V, should be greater than 1/R where R is the anode resist-

GRID RECTIFYING TRIODE VOLTMETERS

ance of the alternative diode, expressed in thousands of ohms. Few if any triodes can fulfil this condition in competition with modern diodes, since the slope at the cut-off point is seldom greater than 1 mA/V, whilst almost any modern small diode can show an anode resistance much less than 1,000 ohms.

The advantage of the triode slide-back voltmeter lies in the fact that the rectified current indicated on the meter is not derived from the load circuit, and since the grid of the triode does not attain a positive voltage in order that rectified current may show, the instrument offers a very high input resistance, which is often desirable for some purposes. Its method

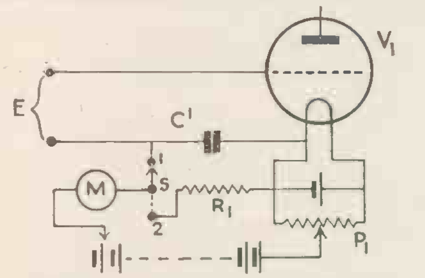


Fig. 5a. The slide-back valve voltmeter.

of operation is exactly as described for the diode slide-back, except that the initial value of bias necessary in order to bring the valve to the anode current cut-off point must be subtracted from the total slide-back bias. With this instrument some increase in accuracy over the diode instrument is perhaps attainable by working to a "false zero," i.e., a small but definite reading of rectified anode current (say, 0.05 mA).*

Slide-back voltmeters may be used for almost any purposes for which the direct-reading peak voltmeter described above) may be used, with the advantage, particularly in the case of the triode instrument, that the input resistance is much higher. The latter instrument may also be used with a grid condenser and leak, as described later, which again offers a further advantage.

The fact that the "slide-back" bias must be at least a little greater than the highest peak voltage which it may be desired to measure renders this type of instrument inconvenient for voltages much in excess of 100.

* A recent version of this instrument gets over the initial current difficulty by using a gas-filled (preferably helium or argon) triode, in which case a peak voltage exceeding the cut-off value of bias by a very small amount causes the full value of anode current to flow immediately. The limiting factor on accuracy here is the constancy of the "firing point" of the gas triode. The circuit is otherwise identical with that given in Fig. 5b.

The Grid Rectifying Triode Voltmeter

The main disadvantage of the direct-reading diode voltmeter is that the power for the operation of the indicating instrument has to be drawn from the source to be measured. Since the power required for the operation of the indicating instrument itself, apart from that dissipated in the series resistance, is of the order of 40 microwatts, this type of voltmeter is not suitable for use in delicate measurements.

To avoid the comparatively large dissipation of power mentioned, one might use a very high load resistance (of the order of several megohms) and use the voltage developed across this to bias the grid of a triode negatively, since the power required to bias the triode would in itself be negligible.

The logical development of this idea leads to the Grid Rectifying Triode Voltmeter, depicted in Fig. 6. Here the grid performs the dual function, acting as a diode to rectify the applied voltage, and by the negative bias set up across the load resistance (grid leak) causing the anode current of the valve to fall.

It is necessary that the grid condenser (C_1) should be of such a value as to offer a small impedance in comparison with the grid leak (R_1) at the lowest frequency at which it is intended to use the instrument. It will be noticed that there are two methods of connecting R_1: (a), across the grid condenser, in series with the input circuit; (b), between grid and filament negative, in shunt with the input circuit. Each method has its own purpose. If connected as in (a), the input resistance of the instrument is of the order of $\frac{1}{2}R_1$. If connected as in (b), the input resistance is of the order of $1/3R_1$, but this latter connection has the advantage that there does not need to be a complete D.C. circuit between the input terminals of the instrument, which is very useful when the A.C. potential across a condenser is to be measured, or the A.C. potential between two conductors between which there is also a difference of D.C. potential.

So far as the anode circuit of the voltmeter is concerned, it will be recollected that if this latter part of the circuit contains any considerable impedance at any frequency at which the instrument is to be used, the input impedance will undergo large changes owing to the "Miller effect." To obviate this, the condenser C_2 is connected, and it is important that this condenser should be of good quality, preferably with a mica dielectric, if the instrument is to be used much for very high frequencies.

The simple form of voltmeter shown suffers from the fact that there is a considerable "standing" anode current (of the order of 1.5 mA) the indication of which must be obviated. The simpest scheme for doing this is by means of a series resistance (R_2) and a potentiometer (P_1) across the filament battery, by which a "backing off" current is sent through the meter (M) in the reverse direction to

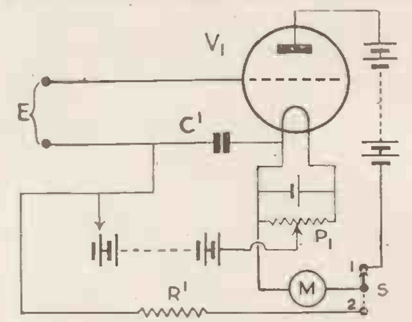


Fig. 5b. The triode slide-back valve voltmeter.

the standing anode current. Since R_2 is virtually in shunt with the meter M, and the potentiometer P is in effect a variable portion of R_2, it is important that the resistance of R_2 should be high in comparison with the resistance of M and P. There is generally no difficulty with this.

Sufficient anode voltage is used to give a standing anode current well in excess of the full scale reading of the meter M. The voltage amplification factor ("μ") of the valve is only of interest in so far as it determines the minimum anode voltage necessary to attain sufficient standing current. For this reason a valve with a low μ is generally more convenient.

The indication on the meter for a given input voltage is directly proportional to the mutual conductance ("slope") of the valve used, so it is desirable to use a valve of good mutual conductance, if sensitivity is required. Beware, however, of choosing a valve on this score alone, since some valves with an exceptionally good mutual conductance "age"

(*Continued on page 506*)

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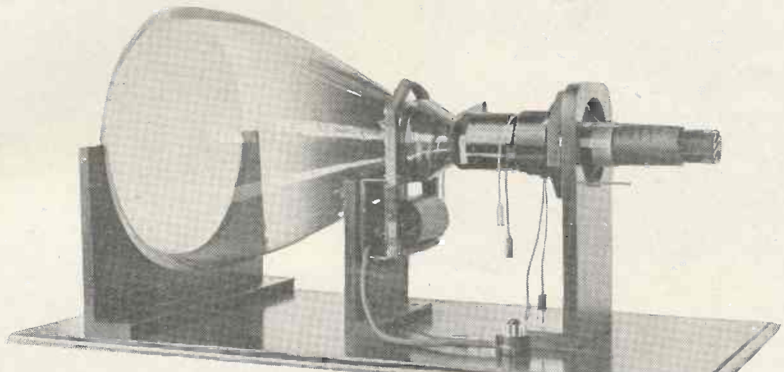

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BAIRD CATHODE RAY TUBES

TECHNICAL DATA	TYPE 15 MW1.
Heater volts	1.8 volts.
Heater amps	2.4 amps.
Peak to peak volts, between black and highlights	30 volts.
Maximum electromagnetic sensitivity	2 mm/AT.
Modulator/earth capacity	2 $\mu\mu$F (approx.).
Modulation sensitivity (slope) ...	6 μA/V.
Anode volts	6,500 volts.
Maximum input power to the screen	3.5 milliwatts/sq.cm
Maximum anode current for highlights still in good focus	100 μA.
Screen colour	Black and white.

The Baird Cathode Ray Tube, type 15 MW1, has a hard glass bulb whose screen diameter is 38 cms., total length 74 cms., and neck diameter of 4.45 cms. Apart from manufacturing processes, stringent tests are made for electrical emission, tube characteristics, filament rating and screen quality, and following normal picture reconstitution under service conditions, the completed cathode ray tube is subjected to a very high external pressure test.

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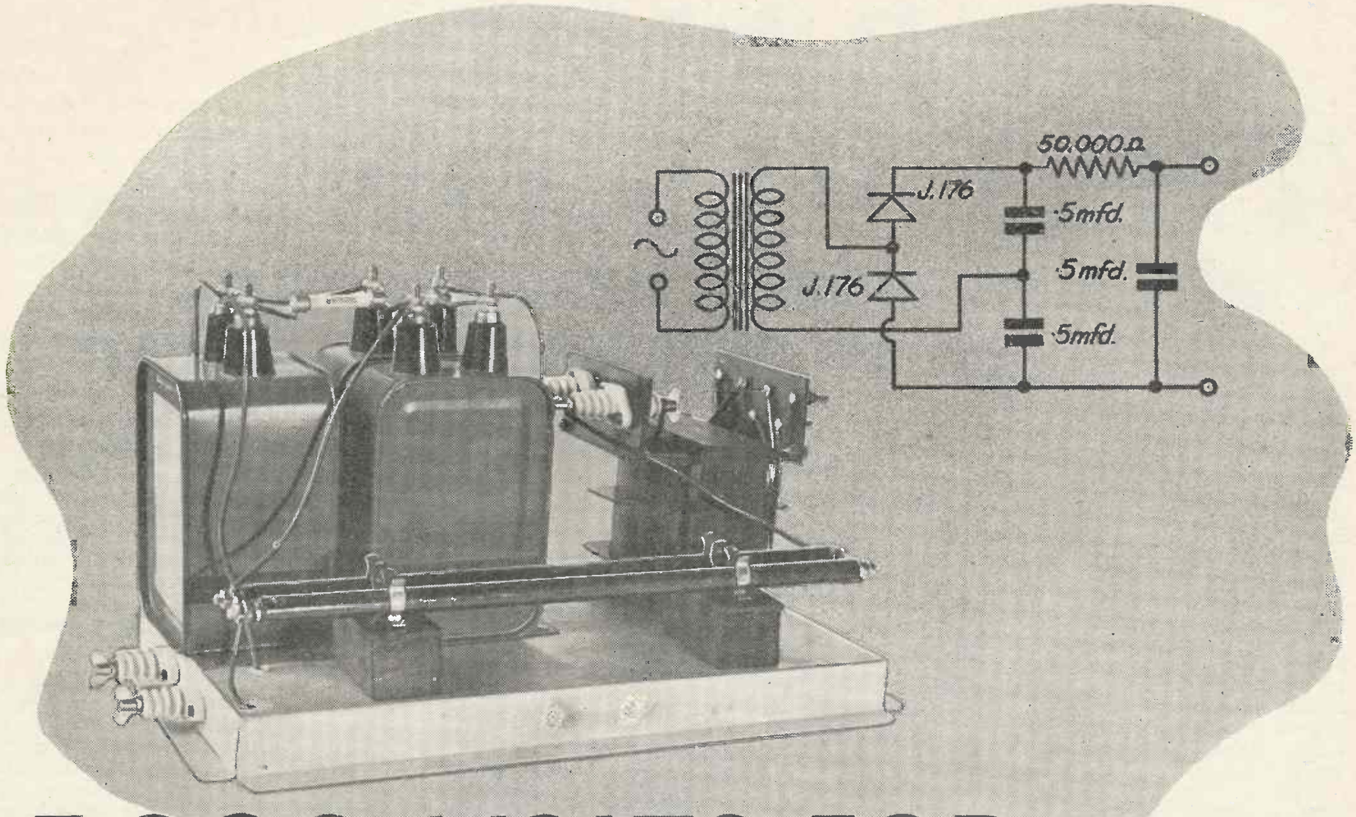

3,000 VOLTS FOR TELEVISION TUBES

The simple and robust unit, for the supply of power to television tubes, shewn above, may be easily constructed by using two J.176 Westinghouse Metal Rectifiers in the voltage-doubler circuit. This enables full-wave rectification to be obtained without resort to the dangerous centre tap method, where the transformer would be called upon to deliver a total of no less than 6,000 volts. The input to the J.176 units is only 1,400 volts, so that the transformer is very much cheaper and less bulky.

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A NEW ELECTRON CAMERA

FIRST DETAILS OF A RECENT DEVELOPMENT COMBINING THE PRINCIPLES OF THE IMAGE DISSECTOR AND THE ICONOSCOPE

AN invention which may have an important bearing on the future development of electron cameras has just been disclosed by the publication of a patent* granted to G. Lubszynski and Sidney Rodda. Although the results of practical experiments have not yet been disclosed, the invention presents so many special features that a description will be of particular interest.

In essentials, the invention represents a combination of the principles of the Farnsworth Image Dissector and the familiar Emitron camera; while both of these forms of electron camera suffer from certain inherent defects, the new invention appears to overcome them. If the practical construction of the new tube can be successfully carried out, it is likely to be a development of the first importance.

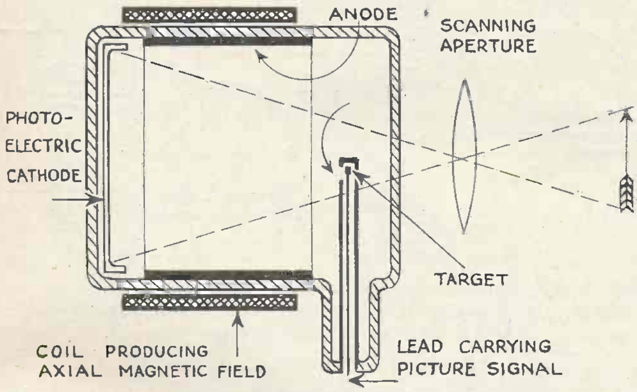


Fig. 1.—Diagram of Farnsworth image-dissector tube.

In the Farnsworth camera (Fig. 1), an image of the scene to be transmitted is projected by an ordinary optical lens on to a photo-electric cathode enclosed in an evacuated tube. Electrons are emitted from every point of the cathode in proportion to the intensity of light, and, by means of a high positive potential applied to the cylindrical anode and by means of an axial magnetic field, the electrons are drawn forward and focused as an electron image at the plane of a small scanning aperture. At the same time, the whole electron image is caused to traverse in horizontal and vertical directions by means of transverse magnetic fields, and the image is thus scanned by the aperture.

In the Farnsworth system the fact that the number of electrons entering the scanning aperture at any instant is only equal to the number released by the corresponding area of the cathode in the scanning time must set a definite limit to the illumination intensity and the order of definition with which the camera may be employed, though this first difficulty can be overcome to some extent by electron multiplication.

In the Emitron type of electron camera (Fig. 3) an image of the scene to be transmitted is projected on to a photo-electric mosaic, thus causing the individual elements of the mosaic to emit electrons in proportion to the intensity of light falling on them. The emission of electrons leaves the elements of the mosaic positively charged, and these are discharged to a uniform potential by the scanning of a beam of cathode rays. Each element of the mosaic forms a minute condenser with the " signal plate " behind the mosaic and the currents which flow on the discharge of each little condenser give rise to a voltage across a resistance in the earth lead of the signal plate. This voltage is applied to the first valve of the train of amplifiers.

One of the principal difficulties of the Emitron type of camera is to construct a mosaic screen of sufficient sensitivity to provide an appreciable voltage for the initial amplifier. The discharge currents of the normal type of mosaic are extremely minute and " noise " in the circuit is liable to be troublesome.

The New Camera Tube

With the new tube it is claimed that the factors which give rise to the lack of sensitivity experienced with both the Farnsworth and Emitron types are eliminated by an ingenious combination of the two systems. One form of the new camera is shown diagrammatically by Fig. 4.

An optical image of the scene to be transmitted is projected on to a plain photo-electric screen, which, however, is made so thin as to be semi-transparent. Although the photo-electric screen is shown as a separate screen in Fig. 4, it is stated that it can be formed on the plate-glass window of the tube by depositing a very thin layer of silver and coating it with a

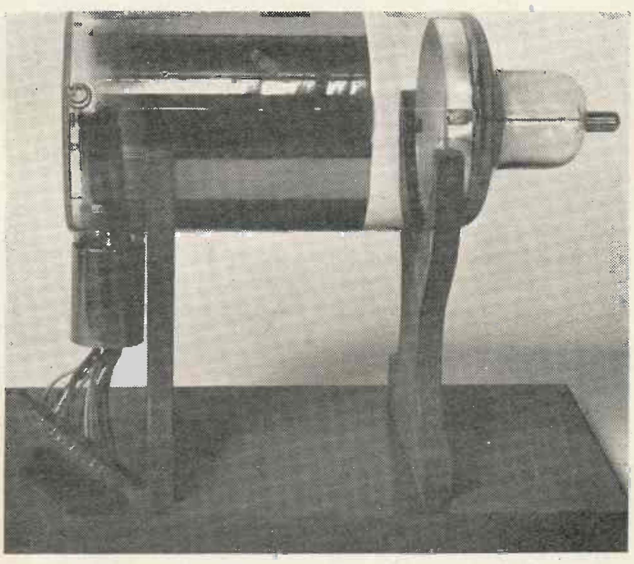


Fig. 2.—Photograph of image dissector as made by Baird Television, Ltd.

*B. Patent No. 442,666.

OVERCOMING THE "KEYSTONE" EFFECT

layer of photo-electric caesium. Alternatively, the screen may be made of a very fine wire mesh upon which is deposited a photo-electric coating of caesium.

Whichever form of construction is adopted, the electrons which are emitted under the action of the incident light are drawn forwards, i.e., away from the scene being transmitted, by means of high positive potentials applied to the cylindrically shaped anodes. The electrons are caused to preserve their relative positions and

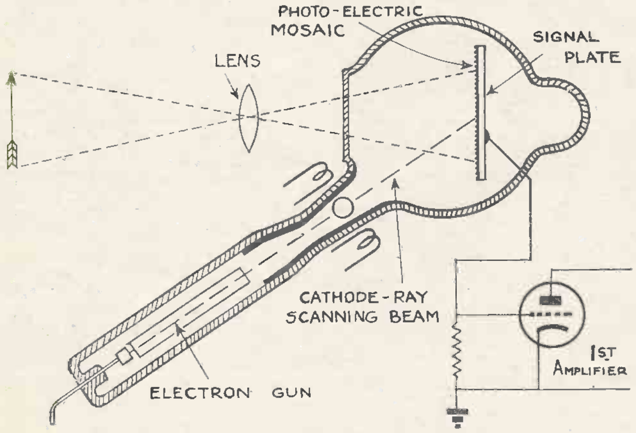


Fig. 3.—Diagram of Emitron television camera.

are thus "focused" by means of an axial magnetic field on to a mosaic electrode shown on the right in Fig. 4. On reaching the mosaic electrode, the high velocity which has been imparted to the electrons by the positive potentials on the anodes causes each electron to produce the emission of several secondary electrons from the mosaic surface, thus charging the elements of the mosaic at a potential three or four times as great as they could attain without the principle of secondary multiplication.

As in the case of the Emitron camera, the mosaic electrode consists of a thin sheet of mica, upon the front face of which is deposited a very large number of minute metallic globules, generally of silver. By a special process, these globules are coated with a photo-electric surface of caesium and caesium-oxide. On the back of the mica sheet is deposited a layer of aluminium or silver which forms the "signal plate," and with which all the individual globules of the mosaic form separate little condensers. When an optical image is projected on to the mosaic surface, as in the case of the Emitron, or when it is bombarded by an electron image from the photo-electric cathode of the new camera, the individual globules are caused to emit electrons. Since the electrons consists of negative particles of electricity, the globules are left more or less positively charged, the amount of the charge being proportional to the intensity of the illumination of each part of the image.

To obtain the actual picture signal, the mosaic is scanned in a conventional manner by means of a beam of cathode rays which discharges each globule of the mosaic in turn by restoring to it sufficient electrons to bring its charge back again to a neutral level. The discharge current is thus dependent on the charge accumulated by the globule since the last scan and, as the scanning beam sweeps over the multitude of tiny globules, voltages are developed across the resistance in the earth lead of the signal plate which are proportional to the illumination intensity of the corresponding points of the image.

One of the difficulties of the Emitron camera, and also of the type of camera illustrated by Fig. 4 is due to the fact that the angle subtended at the point of deflection of the cathode beam by a horizontal line of given length at the top of the picture is smaller than the angle subtended by a line of the same length at the bottom of the picture. This difficulty arises from the acute angle of scanning which must be adopted, and to avoid the distortion which would otherwise result a special form

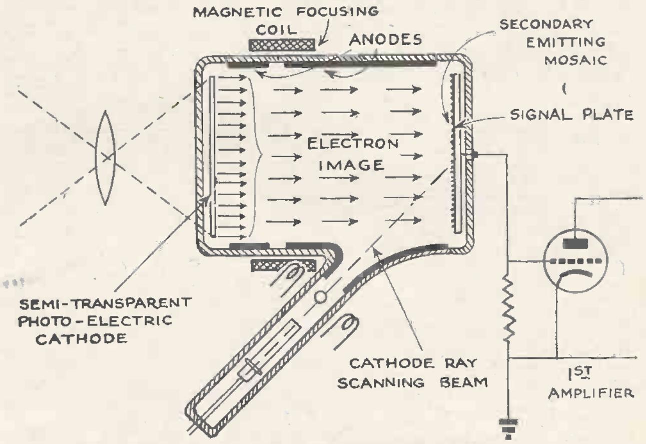


Fig. 4.—The new electron camera, a combination of the Farnsworth and Emitron systems in which the principle of secondary-emission multiplication is used at the mosaic to obtain increased sensitivity.

of generator known as the "Keystone generator" has to be employed to control the deflection of the cathode-ray beam.

This defect is avoided in a second form of the new type of camera which is illustrated in Fig. 5 and in which a new form of mosaic is employed which is scanned from the back. Such a mosaic presents very considerable difficulties in its construction, but if the practical difficulties can be overcome, it seems probable that such a camera would not only be more sensitive than the present types, but would also require less complicated apparatus for its operation.

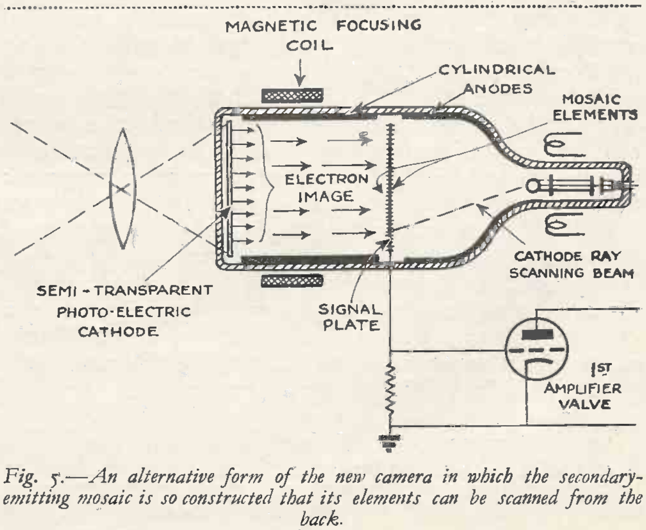


Fig. 5.—An alternative form of the new camera in which the secondary-emitting mosaic is so constructed that its elements can be scanned from the back.

Scannings and Reflections

DAVIS CUP MATCHES TELEVISED

ALTHOUGH normal television programmes closed down for three weeks on July 24, special relays from Wimbledon took place on July 26 and 27. The Davis Cup Challenge Round was also televised in order to include the whole of this series.

As before, two cameras were used at Wimbledon, one near the southwest corner of the court to give near and panoramic views, and the other in a fixed position at the other end of the court to give a general view of the play and the spectators.

The mobile television unit at Wimbledon employed a radio link to Alexandra Palace. No film was employed, transmission being instantaneous.

"THE MAN WITH A FLOWER IN HIS MOUTH"

Pirandello's unusual play, "The Man with a Flower in his Mouth," which was televised in the afternoon programme on July 20 and in the evening of July 22, made television history on two previous occasions. It was the first play to be televised by the low-definition system in 1930, when it was produced by Lance Sieveking, with Val Gielgud as "The Man"; shortly afterwards it was seen on the same flickering screen in a puppet presentation by Jan Bussell, who, incidentally, is now a television producer at Alexandra Palace.

Viewers who can remember the early television production of the play will be impressed by the contrast in production methods. In the old days only one camera could be used and it could not track forwards or backwards. In producing "The Man with a Flower in his Mouth," Royston Morley employed all the devices of modern television and introduced a concealed camera taking shots through the window.

TELEVISION DRAMA

Excerpts from "Peer Gynt" are to be televised in the autumn with William Devlin in the name part. This will be the first Ibsen play to be presented in the Alexandra Palace studios. William Devlin, who took the part of Peer Gynt during two seasons at the Old Vic, is almost a regular visitor to the television studios. He was seen as Clemenceau in "The Tiger," and as Michael Ransome in the mountaineering play "The Ascent of F6," by W. H. Auden and Christopher Isherwood.

Jean Forbes Robertson will be seen as Juliet in Shakespearean excerpts to be televised on August 16.

PROGRAMME RECEIVED AT COVENTRY

For the first time the entire television programme from Alexandra Palace was received at Coventry ninety miles away, more than three times the official reception range. This is by far the greatest distance, so far, at which television has ever been received satisfactorily. The programme was received by the G.E.C. works at Coventry, and the set was a standard G.E.C. receiver with some small modifications, including the use of a different type of high efficiency valve. A perfectly standard aerial assembly was used.

"Although we have often received signals and snatches of programmes, this is the first time that we have held synchronisation throughout," said Mr. W. H. Peters, G.E.C. chief radio engineer. "It must be admitted that the programme was not of a complete entertainment value, but it was recognisable and the reception showed that the long distance from the transmitter is not a basic technical difficulty but only a practical problem. If three or four times the output wattage power were being used, then I think it might be possible to get a really good picture."

PHASE SHIFT IN THE SYNCHRONISING SIGNALS

It has been found by Scophony, Ltd., that there is a considerable amount of irregular timing and phase shifting in the synchronisation signals radiated from Alexandra Palace, and this has made them unsuitable for receivers using scanning systems possessing inertia. Representations have been made on the subject to the Television Advisory Committee and the B.B.C., and the B.B.C. are, we understand, taking steps to remedy the defect. As soon as this trouble has been overcome, Scophony commercial apparatus will become available.

DEVELOPMENTS IN CANADA

The question of television was discussed during the Convention of the Engineering Institute of Canada, held on June 16 in Montreal. Mr. H. Ouimet, of the Canadian Broadcasting Corporation, said that great progress had been made, and that television was, in the opinion of European experts, far enough advanced to justify its inauguration as a public service. Mr. Ouimet gave it as his opinion that, while it might cost a hundred million dollars to provide the whole country with television, that was no reason why cities could not have installations; radio was first developed for local service and the same thing should apply to television. He said that the idea of starting only when it was available everywhere was new in engineering, for in the past progress had been made from small beginnings.

THE SCOPHONY SUPER HIGH-PRESSURE MERCURY LAMP

A super high-pressure mercury lamp is the latest product of the laboratories of Scophony Electronics, Ltd. This is the latest development in illumination technique and it is the most efficient and brilliant light source known. For television purposes the Scophony mercury lamp is operated from a D.C. source at a voltage of 70 with a consumption of only $3\frac{1}{2}$ amperes, the total consumption being approximately 250 watts. The brilliancy of this light source is such that an efficient carbon arc consuming 500 watts would only give one-third to one-fourth of the light obtained with the mercury lamp. In use in the receiver the mercury lamp is first focused on to the light control, from the light control to the high speed scanner (a stainless steel polygon) and from there on to the low speed scanner which gives the picture repetition frequency, and through a projection lens on to the 2 ft. screen. Very few optical bodies are used and no corrected lenses of any sort are embodied in the apparatus.

TELEVISION IN GERMANY

The existing telephone-television service between Berlin and Leipzig is to be extended to include Hamburg, Munich, Kiel, and Frankfurt. Also, it is understood that the two transmitters on the Feldberg and the Brocken will begin operations during the coming autumn, probably using 441 lines definition.

TELEVISION AND THE DEAF

The introduction of television would appear to offer great possibilities for those unfortunate people who are deaf and cannot obtain entertainment from radio. For the first time serious experiments have been made to ascertain to what extent television, which depends upon sound as well as vision for its full effect, would appeal to the totally deaf.

As a result of suggestions made to the General Electric Company by those interested in the welfare of the deaf, a series of practical tests with television are being carried out. A set was installed by the G.E.C. at the Tower House Home for Deaf and Dumb Men at Erith, and the results have been most promising.

The programme was first shown to about thirty men, most of whom have been totally deaf from birth. In order that those conducting the experiment should share to some extent the reactions of the deaf people, the sound was cut out and only the vision shown. The programme consisted of a fashion parade, a showing of zoo animals, a news bulletin and a short play. As the vision appeared on the screen, the men turned to each other excitedly gesticulating and one after another they began to put their thumbs up, the sign in their language meaning " good." Only the play appeared to suffer from the lack of sound, but it made little difference to the deaf men who followed it intently and then burst into spontaneous applause at the end.

Later, through an interpreter, the men explained their reactions to television. All of them were delighted with it and they wanted to know whether they would be able to see important events, particularly football matches. All appreciated the possibility of having this source of news and entertainment continually available. After further tests have been made it is probable that a complete report will be sent to the B.B.C. in the hope that it will be possible so to arrange programmes that each session contains at least one item which does not depend on sound.

SCOPHONY TRANSMITTING EQUIPMENT

The Scophony transmitting equipment, which is used for the transmissions to the Science Museum Exhibition, consists of a main film projector which incorporates the " split focus " principle, there being only one scanner similar in size to the receiver scanners. The light source is an arc lamp of the low-intensity type and the film is continuously moving. The sound head is, of course, also included in the projector. The spot of light after passing through the film, falls on to a photo-electric cell of the electron multiplier type. With a normal film, one-tenth of a volt is obtained across the photo-cell resistor after the electron multiplier. The vision signals are amplified by a three stage amplifier which feeds directly into a line amplifier with an output impedance of 100 ohms. This is then fed to the radio transmitter through a co-axial cable.

TELEVISION AT NEW YORK'S WORLD'S FAIR

David Sarnoff, President of the Radio Corporation of America, and Grover Whalen, President of the 1939 New York World's Fair, have signed an agreement whereby television will be given a public demonstration by the Radio Corporation of America and the National Broadcasting Company at the 1939 World's Fair. Millions of visitors to the Fair from the far corners of the earth will have an opportunity to watch demonstrations of every aspect of radio and television. The N.B.C. television transmitter on the Empire State Building, will televise outstanding World's Fair events, and will bring to visitors joint demonstrations of the marvels of sound and sight broadcasting.

The signing of the agreement, the ceremony by which television is assured as a major attraction of the Fair, was televised in the television studio of the National Broadcasting Company in the R.C.A. Building where representatives of the Press both saw and heard the major participants, Mr. Sarnoff, Mr. Whalen and Lenox R. Lohr, President of the National Broadcasting Company.

Mr. Sarnoff said: " The progress we are making daily in the development of transmitting sight through space gives promise that by the time the World's Fair opens in 1939, television will be greatly advanced over its present-day position. While the problems of developing a nation-wide television system are enormous, we have faith in the future of this new radio art."

Speaking on behalf of the Fair Corporation, Mr. Whalen said: " Personally, I can imagine no greater scientific accomplishment than the broadcasting of sight, and in this ceremony this afternoon, you are giving visible evidence of your ability to achieve this miracle. This business of sitting in front of a television camera and having someone see and hear me far away, is both wonderful and fearful in its potentialities. I am not only impressed, I am over-awed. I know our Fair visitors will be similarly affected."

THE CLOSE-DOWN PERIOD

During the television close-down period from July 26 to August 14, inclusive, there will be two test transmissions daily, with the exception of Saturdays, when the morning transmission alone will be given. These will be solely for the benefit of the radio industry. There will be no transmission on Sundays or on Saturday, July 31, or Monday, August 2. The transmissions will be radiated from 11 a.m. to 12 noon, and from 2 to 3 p.m., and will consist of the television demonstration film, short magazine films and news reels, accompanied by sound, and exterior shots from the balcony with gramophone records, all of which will be interspersed with periods of cruciform pattern with tone on the sound transmitter. If the exterior conditions are

. . . . AND MORE REFLECTIONS

bad, a set scene from the studio will be substituted for the outside shot.

From August 16 to 21 inclusive normal programme hours will be followed. On August 23 and 24 there will be three hours' transmission of film with sound announcements from 11.30 a.m. to 12.30 p.m., 3 to 4 p.m., and 9 to 10 p.m.

RADIOLYMPIA TRANSMISSIONS

During Radiolympia, from August 25 to September 4, inclusive (Sundays excepted), there will be three hours' transmission daily as follows:—11.30 a.m. to 12 30 p.m., film; 4 p.m. to 5 p.m., actuality transmission; 9 p.m. to 10 p.m. actuality transmission.

After Radiolympia, from September 6 onward, normal programme hours (3 to 4 p.m., and 9 to 10 p.m.) will be given, with an extra morning hour purely for trade purposes made up as follows:—10.30 to 11 a.m., cruciform pattern with tone; 11 a.m. to 12 noon, demonstration of magazine film with sound.

GERMAN TELEVISION DEMONSTRATION AT THE PARIS EXHIBITION

The Press were recently invited to view a demonstration of German television at the Paris Exhibition, under the auspices of the Reichspost. In their opinion the results were excellent and comparable with those seen in London. The visitors were present at a scene taken on the pavilion terrace by direct vision camera and were later conducted to the hall where the image was reproduced by wire link.

The pictures were reproduced by the Telefunken system, giving 375 lines, 25 frames interlaced scanning, and the panoramic shots gave an excellent view of the whole of the Exhibition grounds. Films were then shown on the same system, using a direct scan from the Iconoscope and continuous film. The results were equally good apart from a slight blurring of the background, due, as explained by the engineer in charge, to wandering of the focus of the film.

The principal attraction was the "visio-telephone" of the Reichspost, similar to that installed between Berlin and Leipzig last year. In this the scanning is by flying spot with a definition of 180 lines, 25 pictures per second.

The illumination required is not high, owing to the dim interior of the cabinet, and a 6-amp. arc is used.

It is considered that 180-line definition is sufficient for the visio-telephone for the present, since only heads or head-and-shoulders at the most are transmitted; nevertheless the Telefunken Co. are investigating the possibility of transmission at greater detail.

THE NORTH POLE WIRELESS STATION

Reports have at last been received regarding the transmissions broadcast by the Soviet scientific expedition, which has erected a short-wave station approximately at the North Pole. This station, which operates on approximately 20 metres, with a power of 70 watts, has been heard by an amateur living in Norway and by one or two commercial bodies in London. We have so far not been able to receive reports from amateurs in this country who have been fortunate enough to pick up this interesting station. Who will be the first listener to receive a QSL card from the North Pole?

SHORT WAVES AND ATLANTIC FLYING BOATS

It is quite well known that both the *Caledonia* and the American *Clipper III* were using radio to keep in contact with base stations. Both planes use 900 metres for the first hour or so of their journey, later switching over to short-waves. We are not permitted to give the exact wavelength used by these planes, but already amateurs have accidentally fallen on the correct frequency and have been able to follow the progress of the *Caledonia* and the *Clipper* across the Atlantic.

A NEW COMMERCIAL SHORT-WAVE STATION

Hicksville, a hitherto unknown American town, has now come right into the news owing to its new short-wave station, W2XBE, which is operating on approximately 17 metres. For some reason as yet unknown, this station is putting over a signal to Europe at a strength twice that of the average commercial broadcasters on the same wavelength. This station can be heard most evenings between 5 and 7 p.m. even when conditions are poor.

THE PALEY REWARD

William S. Paley, of the Columbia Broadcasting System, is presenting an annual award to the amateur who, through amateur radio, has contributed most either in research, technical development or operating achievement. The first award has been won by Walter J. Stiles, W8DPY, for his services during the Pittsburgh floods at the end of last year. W8DPY maintained communication from a town entirely cut off from the rest of the country. Not only did he maintain a portable station, but he travelled through many miles of flooded country before the station could be erected. The whole of the gear and the power supply was portable, and it says much for his arrangements that continuous service was maintained.

A TELEVISION THEATRE

A new radio store is being opened in Oxford Street, London, consisting of six floors devoted to radio and television. In addition to the television demonstration room there is to be a television theatre fully equipped so that complete programmes can be seen by intending purchasers. This will be one of the most central television demonstration rooms in London.

TELEVISION AND THE RADIO EXHIBITION

The first real show of television will be at the R.M.A. Exhibition at Olympia which opens on August 25, and carries on until Saturday September 4. Provision has been made for no less than 50,000 people to see television broadcasts for the first time, and no fewer than fourteen manufacturers have booked space so that they can demonstrate their receivers. This is the first time that television on a large scale has been shown by the Radio Manufacturers' Association.

TELEVISION PROGRAMMES

Although many viewers still criticise some of the programmes transmitted from Alexandra Palace, it is generally agreed that television fulfils its most useful purpose when there are transmissions of an unusual type. One of the most popular broadcasts during the past month was the televising of the new L.N.E.R. streamline train *Dominion of Australia*. A tele-photo camera picked up this train at a distance of three-quarters of a mile travelling at 60 miles an hour.

DEATH OF MARCONI

A BRIEF HISTORY OF HIS ACHIEVEMENTS


The Marchese Marconi.

WE regret to announce the death of the Marchese Marconi, which took place in Rome on July 20. Death was due to heart failure. Guglielmo Marconi was born at Bologna on April 25, 1874. His father was an Italian country gentleman who, in 1864, married Miss Annie Jameson, of Daphne Castle, County Wexford, Ireland. He was educated privately at Bologna, Florence and Leghorn. As a boy he took a keen interest in physical and electrical science. In 1895 the idea became firmly rooted in his mind that a system of telegraphy through space could be provided by means of electric waves, the existence of which had been foreseen mathematically by Clerk Maxwell in 1864 and later investigated experimentally by Heinrich Hertz, Oliver Lodge, Righi, and others.

Early Experiments

In the early summer of 1895, Marconi conducted a number of experiments at his father's country house at Pontecchio, near Bologna. These experiments, made with crude and inefficient apparatus, soon began to give results which appeared to Marconi to be remarkable, communication being established in that year over distances in excess of a mile.

In 1896, Marconi came to England, and on June 2 of that year took out the first patent ever granted for wireless telegraphy based on the use of electric waves. He continued his experiments in London, and in the same year demonstrated his invention before officials of the Post Office and other representatives of British and Foreign Government departments. These demonstrations were first carried out on the roof of the General Post Office, St. Martin's-le-Grand, London. Later experiments for the Post Office were carried out on Salisbury Plain and across the Bristol Channel

In June, 1897, at the invitation of the Italian Government, Marconi went to Spezia, where a land station was erected and communication with Italian warships was established up to a distance of 12 miles. He was then invited to demonstrate his apparatus in Rome, where successful tests were carried out. Other tests also took place at the Italian Chamber of Deputies.

The time was now almost ripe for wireless telegraphy to be applied to commercial and utilitarian purposes, and in July, 1897, a company was formed in London to acquire the Marconi patents in all countries except Italy. This company was called the Wireless Telegraph and Signal Co., Ltd., which in 1900 changed its name to that of Marconi's Wireless Telegraph Co., Ltd. For some time the company's efforts were confined to furthering Marconi's pioneer work.

Wireless telegraphy was first used for commercial purposes in 1898, when the Kingstown regatta races were reported for the *Dublin Express* by Marconi by means of wireless apparatus installed on a tug which followed the yachts in the Irish Sea.

The utility of wireless in saving life at sea was demonstrated for the first time when, on March 3, 1899, a steamer collided with a lightship. The accident was at once reported by wireless to the South Foreland, enabling lifeboats to be promptly sent to the assistance of the light vessel. In March, 1898, Marconi established communication across the English Channel between England and France. During this year wireless was also first utilised in the naval manœuvres for communication between warships over distances of 74 miles. The first military application of wireless took place during the South African war.

A Famous Patent

During this period numerous improvements embodied in patents taken out by Marconi were utilised. On April 26, 1900, he applied for a patent for "tuned or syntonic telegraphy as well as multiplex telegraphy with a single aerial." This patent, the number of which was 7,777, became famous in the history of wireless, and its validity was upheld in the High Court.

In October, 1900, the erection of a long distance wireless telegraph station in Cornwall was commenced by Marconi and preliminary tests were carried out up to a distance of about 200 miles. On December 12, 1901, Marconi, on his first attempt, succeeded in transmitting and receiving signals across the Atlantic Ocean from Poldhu in Cornwall to St. John's, Newfoundland. This achievement completely confirmed Marconi's opinion that electric waves would not be stopped by the curvature of the earth and therefore could be made to travel any distance separating any two places on our planet, a view he had held for many years in the face of considerable opposition. The wireless conquest of the Atlantic may be regarded as the culminating point of Marconi's pioneer work.

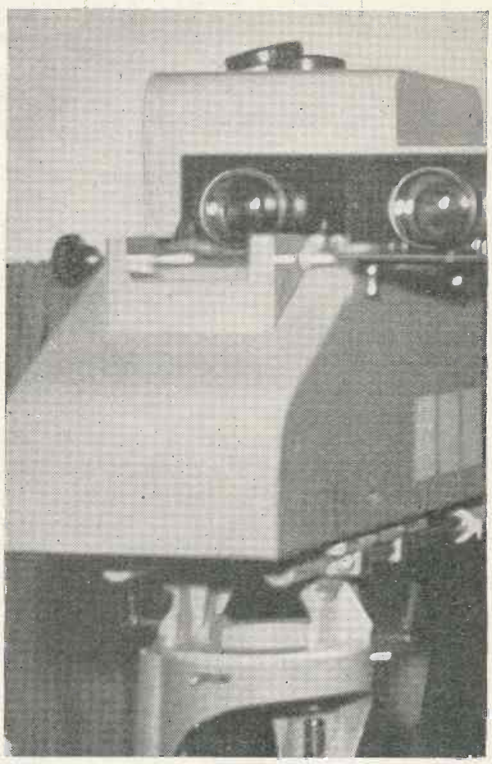
In 1916, during the world war, experiments were commenced by Marconi in Italy with very short waves, with the object of devising a directive, or beam system, of wireless telegraphy for war purposes. This was a principle on which he had also worked during his earliest experiments, but work on these lines had been put on one side in favour of the use of longer and longer waves combined with higher power. Later, in England, with the assistance of Mr. C. S. Franklin, important results were obtained by the use of 15-metre waves between London and Birmingham.

The anticipations of Marconi were fully justified by the results obtained since that time with short waves by British and foreign experimenters. Marconi was the first to discover in October, 1924, that short waves of the order of 30 metres in length could be transmitted and received over the greatest distances during daylight.

The value of Marconi's work has been recognised by governments, universities and learned societies all over the world.

THE TELEVISION CAMERA.

HOW THE PHOTOGRAPHIC EMULSION AND THE PHOTO-ELECTRIC MOSAIC COMPARE



The Emitron camera as used at the Alexandra Palace.

IN the June issue an article was published comparing the television camera with the ordinary photographic type. It will now be interesting to compare the photo-electric mosaic of the former with the photographic film or plate.

Considering the photographic plate first, the emulsion consists of very small particles of silver bromide suspended in gelatine. The exact methods of commercial manufacturers are not divulged though the general principles are the same for all. A solution of potassium bromide in gelatine is first prepared, to which is added a solution of silver nitrate. A reaction takes place which results in a precipitate of silver bromide and potassium nitrate in solution, the latter being washed out of the emulsion.

The actual crystals of silver bromide are about 1/10,000 of an inch across and there are several thousand millions to the square inch on a normal plate or film. What actually happens to the silver bromide on exposure to light is still not definitely known, though many theories have been put forward. Certain principles are, of course, well known in the working of the emulsion. For example, it is necessary to have a certain intensity of light before any recording is possible, while the effect produced is not by any means instantaneous in the proper sense of the word, the " effect " being the product of time and light intensity; there is also a point where no further effect takes place (see Fig. 1).

Obviously tonal or " effect " distortion will take place if the light image projected on to the emulsion is above or below certain limits of intensity. It is for this reason that pure white or black is rarely seen in film studios from which the highest photographic quality is required.

The " effect " or latent image on an exposed plate remains for a considerable time, though in the course of some years, under normal storage conditions, it will fade. It can also be destroyed by heat. A very important factor in the working of photographic emulsions is the effect of different coloured lights. Simple emulsions are only affected by ultra-violet and blue light and for many years were all that photographers had to work with, with the result that objects of pure red or green came out black in the monochromatic reproduction, while blue was reproduced far too light. The public accepted such photographs as they had never seen anything better. The defect was gradually remedied, principally by the effect of certain dyes on the emulsion till to-day the modern emulsions have a fairly even response to all visible colours.

A serious defect in photographic work, and one which is not realised by the vast majority of photographers, is that of halation. The term is often used to cover defects for which it is not responsible.

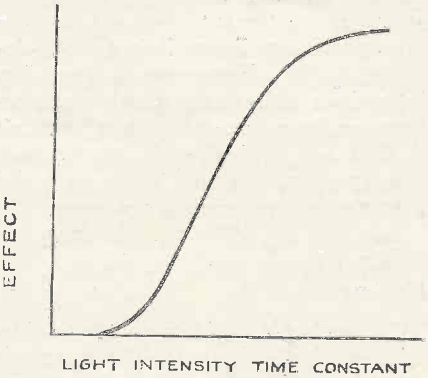


Fig. 1.—Curve showing that " effect " is a product of time and light intensity.

When the optical image falls on the emulsion the light rays are finally mostly absorbed into the emulsion, but not immediately. Scattering takes place on the surface and during its penetration into the emulsion with the result that in such cases where the optical image has a bright area adjacent to a black one, with a sharp dividing line, the dividing line often appears somewhat blurred and close inspection shows the bright area has encroached into the dark one. While this defect is unnoticeable in most photographs, in the recording of sound for the " talkies " it produces a certain amount of poorness of quality, especially in the higher frequencies and it is interesting to note in passing how the R.C.A. has overcome it by the use of ultra-violet light, which scatters considerably less on striking the emulsion and is entirely absorbed in the thinnest of emulsions, thereby reducing halation to a minimum.

Before leaving the photographic emulsion a word about development, the process by which the silver bromide is reduced to silver. The general reaction of development is

$$\mathrm{Na\,R} + \mathrm{Ag\,Br} \rightleftarrows \mathrm{Ag} + \mathrm{Na\,Br} + \mathrm{R}^1$$

THE PHOTO-ELECTRIC MOSAIC AND COLOUR

The sodium salt of the reducing agent is symbolised by R while oxidisation product is R[1] and sodium bromide. Unfortunately all commercial developers increase the grain size, that is to say, the actual silver bromide crystals during the process of development conglomerate into relatively large masses putting a limit on the fineness of detail which could be recorded if the conglomerating effect did not take place. This grain limitation is particularly noticeable if too near a cinema screen. The latest photographic research, however, is hopeful of doing away with grain, the final image, as far as films are concerned, being produced by a dye system.

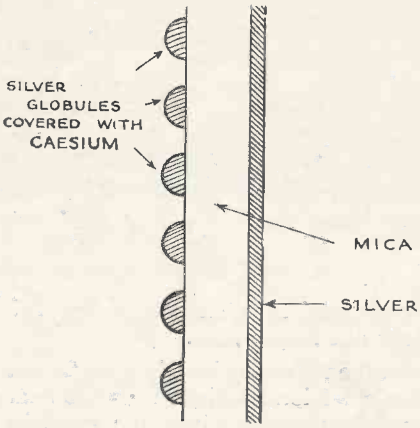


Fig. 2—Diagram showing construction of photo-electric mosaic.

The Television "Plate"

Now let us turn to the television equivalent of the photographic plate, the photo-electric mosaic, which in physical size as used to-day is something under 5 × 4 inches enclosed in an evacuated glass vessel.

The basis is a mica plate which is coated on both sides with metallic silver, the coating on one side, however, being considerably thicker than the other. This prepared plate is now heated and at a certain temperature the thinner of the silver surfaces undergoes a physical change, inasmuch as the silver separates into minute globules arranged in fairly regular formation while the other side remains intact. This prepared mica-silver plate is then fixed into position in its glass chamber into which caesium is distilled, and the latter, having a particular affinity for silver, condenses on the globules, the final result being a plate of mica on one side of which are hundreds of thousands of these caesium coated silver globules and the other a piece of plain silver sectionally shown in Fig. 2. Now the electrical engineer will realise that the silver globules and silver plate with the mica between are the physical conditions for an electrical condenser so we can redraw Fig. 2 as in Fig. 3, to represent the globules as condensers.

If light falls on any of these caesium coated globules, while at the same time they are subject to a positive potential, such as the anode plate A Fig. 3, electrons will be released and drawn off on to the anode with the result that the globule condensers will become positively changed. The number of the electrons released will be proportional to the amount of light falling on the caesium, so that if twice the amount of light falls on globules 1, 2, 3, as compared with 4, 5, 6, they will in a given time assume twice the change.

By this means we can record an optical image projected on to this plate of myriads of condensers in the form of electrical changes just as the light image produces a latent image in the photographic emulsion. Obviously if the condensers are perfect as regards insulation, on the light image being removed the image of charges should be retained indefinitely.

As in the photographic emulsion, the effect or equivalent change is a product of light and time and a point can be reached where no further changing effect will take place; to use a photographic term the plate would be over exposed. The curve of light and effect of Fig. 1 is also fairly representative of the photo-electric mosaic which may seem a strange statement when vacuum photo-cells are linear in output to incident light. However, at very low intensities of light the number of electrons released are very few per unit of time and the leakage of the globule condenser may be of such an order that the condenser never charges.

Effect of Colour

The effect of colour on photo-electric mosaics is similar to photographic emulsions, inasmuch as, the effects vary with different colours. Early photo-cells with potassium as the active agent were most sensitive to the blue end of the spectrum, while with caesium, the most active of photo-electric elements, the greatest sensitivity is generally in the red or infra-red part of the spectrum. The cameras at Alexandra Palace appear to have become considerably less red sensitive since the test transmission periods.

The colour sensitivity is most noticeable on outdoor shots. Foliage, which is largely green to the eye, reflects large quantities of infra-red rays and if recorded on any device sensitive to that part of the spectrum appears unduly light. Actually though most caesium photo-electric cathodes are red sensitive, by using a very thin caesium coating on silver they have even been made to peak in the blue region, and there seems little doubt that television photo-electric mosaics will eventually be as panchromatic as modern photographic emulsions.

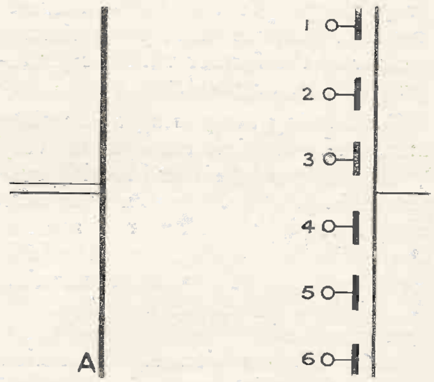


Fig. 3—Diagram showing the working principle of the photo-electric mosaic.

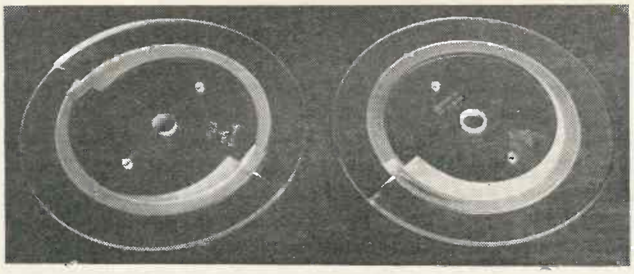
It has been pointed out that halation is due to the scattering of light at the surface and through the emulsion. In the photo-electric mosaic scattering also takes place at the surface though there is no equivalent to the passage of light through the emulsion. Unfortunately another type of halation occurs, namely, that brought about by electrical leakage from one globule condenser to another. A condition may also arise when considerable difference of potential may exist, say, between 3 and 4 (Fig. 3), 3 being so strongly positive as to attract electrons from 4, which should have gone to the anode. A little thought will

(*Continued at foot of page 476*)

TELEVISION HISTORY AT THE SCIENCE MUSEUM EXHIBITION

This article is supplementary to that published last month in which a general review of the exhibition at the Science Museum was given. Below, items of historical interest that are on view are dealt with.

IN last month's issue of TELEVISION AND SHORT-WAVE WORLD we gave a general account of the Exhibition of Television which was opened at the Science Museum on June 10, and which will remain open until some date yet to be announced, but which will probably be about the middle of September. We understand, however, that if the present good attendance continues in September, it is possible that it will remain open until October.



A pair of " Prismatic Discs " invented by the late C. F. Jenkins. The edges of the discs are ground to the form of a prism, the angle of which changes continuously round the periphery. They were used in the Jenkins scanning system.

In this issue, we propose to concentrate on some of the more historical objects of interest in the Exhibition, for the benefit of those who are not able to visit the Exhibition itself, and as a permanent record for future reference.

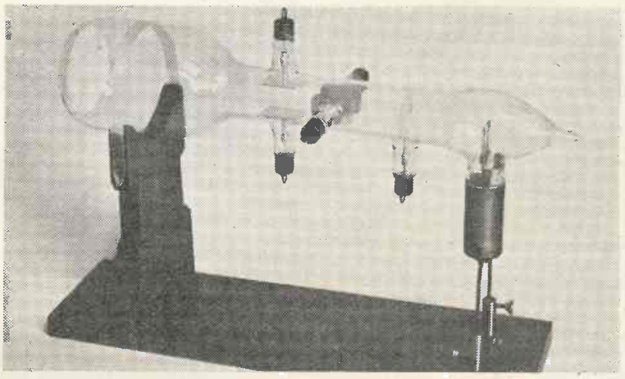
The historic Baird apparatus has often been described and illustrated before, but there were a number of other pioneers whose work, if less well known, was of considerable importance in contributing to the early development of television. The work of several of these is illustrated by exhibits in the Exhibition.

Of first importance to the pioneers of photo-telegraphy and television are the names of May and Willoughby Smith, the discoverers of the photo-sensitivity of selenium. The discovery was actually made by May, but he seems to have got so little credit for it at the time that his other names have been forgotten! The discovery, however, was communicated to the Society of Telegraph Engineers (which later became the Institution of Electrical Engineers) by his chief, W. Willoughby Smith, and a photographic copy of his communication to the Society forms an interesting exhibit.

The discovery of the photo-sensitivity of selenium caused almost a glut of ideas, mostly wildly impractical, for systems of distant vision by means of electricity. These were, of course, doomed to failure, chiefly because selenium was not sufficiently sensitive or rapid in its response. But if selenium was useless for television, it could be used in a primitive system of photo-telegraphy which was invented by Shelford Bidwell, a man who devoted much though to the subject in later years and who was indirectly responsible for Campbell Swinton's proposal in 1908. Shelford Bidwell's apparatus has been preserved and forms an interesting introduction in the Television Exhibition to the more modern inventions.

Early Scanning Apparatus

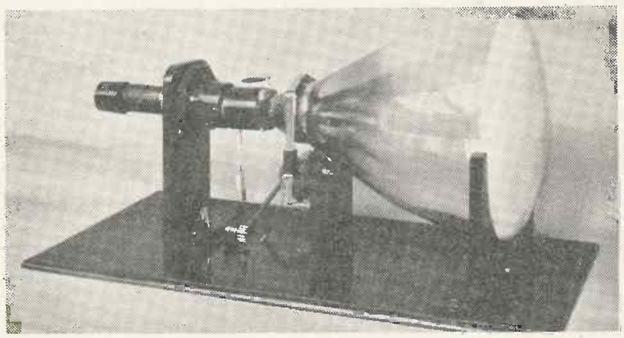
Even the earliest of the pioneers realised the necessity for some system of scanning, and it is interesting to see a copy of the original German Patent No. 30,105 granted in 1884 to Paul Nipkow for a system of distant electrical vision. It is common to regard Nipkow as the inventor of the celebrated spiral disc, and so he was, but his patent is of almost greater interest on account of the working of his receiver. For his transmitter, he proposed to use the spiral perforated disc in conjunction with a selenium cell—an impractical suggestion—but his receiver was far more ingenious. Faced with the problem of light modulation, he proposed to use a polarising prism, followed by a crossed analysing prism, the two being placed on either side



A Wehnelt cathode-ray tube of 1905. Prior to that date, an induction coil had to be used to obtain an electron beam from the cold cathode, but Wehnelt introduced a platinum strip filament which was coated with lime oxides, and the electron beam could be produced with low anode voltages.

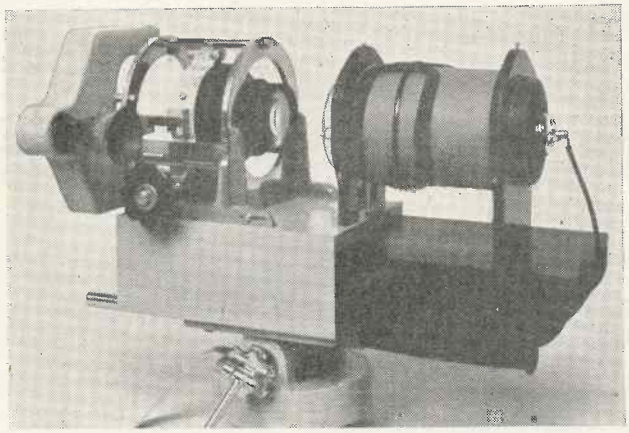
of a piece of heavy flint glass. A magnetic field was arranged to traverse the flint glass and modulation of the magnetic field caused rotation of the plane of polarisation of light passing through the combination. At the time, his whole scheme was impractical, but it is of interest to remark that Nipkow's receiver is almost identical with that used by Baird only five or six years ago. Baird, of course, used the Kerr effect, instead of the Faraday effect, but the principle is identical.

One of the prettiest devices which have ever been devised for scanning purposes was the prismatic disc invented by C. F. Jenkins, an American, about 1917. A pair of these discs, believed to be the only pair in existence in the world, are now on exhibition at the



A large Baird cathode-ray tube having a diameter of 15 ins. It reproduces a picture 12 ins. by 10 ins. and employs magnetic focusing and scanning. With a maximum anode voltage of 6,500, a brilliant black and white picture is obtained.

Science Museum Exhibition although they were not on view when it was first opened. As the illustration shows, the discs consist of flat discs of plate glass, the periphery of which is ground to the form of a prism



A view of the Baird electron camera with the cover removed. The lens and focusing arrangements may be seen on the left while on the right is the Farnsworth image dissector tube which converts the optical image into electrical impulses.

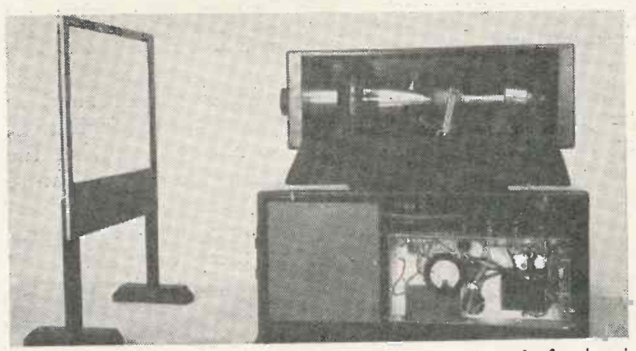
of which the angle changes continuously round the circumference. If an object is viewed through the prismatic portion as the disc rotates, the object appears to have a linear motion in the direction of the radius, intermittent, of course, at the point where the prism angle suddenly changes.

For scanning purposes, two discs were used, one rotating at high speed to give the line scan, and the other rotating more slowly to give the frame scan. They were so arranged that the two rings overlapped each other and the scanning aperture was situated behind the prismatic peripheries at a point where they cross at right angles. The rings were only suitable for low-definition scanning on account of the limited rotational speeds to which they could be subjected. The beauty and ingenuity of their construction, however, has to be seen to be believed and as the machine which was used to grind them has now been destroyed, these two specimens are unique.

Another interesting series of exhibits from the scanning point of view are those provided by International Television Corporation. These illustrate the development of an optical-mechanical system of reproduction, which, if certain difficulties can be overcome, may be applicable for larger screen television. A skeleton 180-line Mihaly-Traub receiver is shown, and also the scanning unit of a 405-line receiver.

Cathode-ray Tube Development

The development of cathode-ray tubes is another aspect of television which has provided scope for a special section of the Television Exhibition and it is of considerable interest to be able to witness the earliest types of Crookes tubes, dating from 1887, actually in operation. The Braun tube of 1897 and its successor, the Wehnelt tube of 1905 are of special interest since these were the first cathode-ray tubes to be of practical use for laboratory measurements, although, in an experimental form, a similar tube had been used by J. J. Thomson in his classical researches



An experimental Baird receiver which employs a projection tube for throwing an image of the cathode-ray tube onto a screen measuring 18 ins. by 14 ins. A lens having an aperture of f/1.5 is used.

on the electron in 1884. The Wehnelt tube shown in our illustration was the first type of cathode-ray tube to have a heated filament for the emission of the electron stream; previously, an induction coil had been necessary to provide the very high voltages required.

All the important stages in the development of the cathode-ray tube are illustrated in the Exhibition—the Johnson tube of 1921, the Bedford tube of 1930, and the von Ardenne type. Of the modern tubes, there are examples of a Cossor television tube and a Baird 15-inch tube with magnetic focusing and deflection of the electron beam.

"The Television Camera"

(*Continued from page 474*)

show that all sorts of complications may arise if any sort of leakage takes place from globule to globule. In practice, scenes with large mosaics of black or white often appear with strange misty fog-like patches as radiated from Alexandra Palace, and this defect is thought to be due to this reason.

In television there is no development as in the photographic sense of the word, though the next process, namely, that of scanning, has the effect of increasing the grain just as the chemical developer does in photography. The scanning is brought about by discharging a relatively large number of globule condensers by systematically sweeping the mosaic with a cathode beam which discharges each group of condensers in turn, the current from the discharge producing a voltage across an external resistance. The discharge current varies according to the amount of light.

THE DESIGN OF THE PHILIPS' RECEIVER

By C. L. Richards

This is a description of an experimental receiver produced by the Philips Company

A TELEVISION receiver differs fundamentally from an ordinary radio receiver in that for the reception of television pictures a receiver must give a uniform amplification over a very wide frequency range. It is therefore not possible to use circuits with a high selectivity, so that there is a marked reduction in the amplification which can be obtained per stage. Furthermore, in receiving vision—as opposed to the reception of sound—any phase displacement which may be obtained during amplification must not alter the mutual positions of the oscillations with different frequencies from which the picture signal is built up. On the other hand, television reception is simpler than sound reception inasmuch as pronounced non-linear distortion is permissible. As a result, the carrier wave and one of the side bands are, for instance, quite sufficient for good reception. This offers the important advantage that the frequency band to be treated is only half as wide, so that the amplification in the individual stages is practically doubled.

Circuit of the Receiver

In a television receiver the wave on which the picture is modulated must be picked up, amplified and rectified; the vision signal obtained in this way must then modulate the voltage at the control electrode of a cathode-ray tube in such a way that the scanning spot on the fluorescent screen always has the same intensity as that of the corresponding point in the original picture. In addition, a scanning arrangement consisting of two saw-tooth generators is required, so that the scanning spot will cover the whole surface of the screen; a device is also needed responding to the synchronising signals picked up and thus synchronise the operation of the scanning device with that of the transmitter. Finally, the sound which is modulated on another carrier wave must also be picked up, amplified, rectified and finally passed to a loud-speaker.

In the receiver described here, a cathode-ray tube is used giving a picture measuring 25 by 18 cms. The tube operates on an anode tension of 5,000 volts. The cathode-ray is deflected in both directions by electrical means through the agency of two pairs of deflecting plates; the requisite deflection voltage being approximately 1,000 volts. The modulation voltage at the control electrode of the tube is approximately 30 volts.

A schematic circuit of the receiver is shown in Fig. 1. The two carrier waves for vision and sound are picked up with the same aerial and both amplified in the same frequency stage by an amplifying valve V_1; the frequency characteristic of this stage must naturally be sufficiently broad for this purpose.

To separate the picture and sound signals the heterodyne principle has been introduced. The two signals are passed to the mixer valve V_2 together with an auxiliary frequency generated by the oscillator V_3.

Two new carrier waves are produced in the mixer valve, each with a lower frequency than the two primary carriers. Vision is modulated on one intermediate-frequency carrier wave and sound on the other. The two carriers are passed together to the grids of two intermediate-frequency amplifying valves V_4 and V_7.

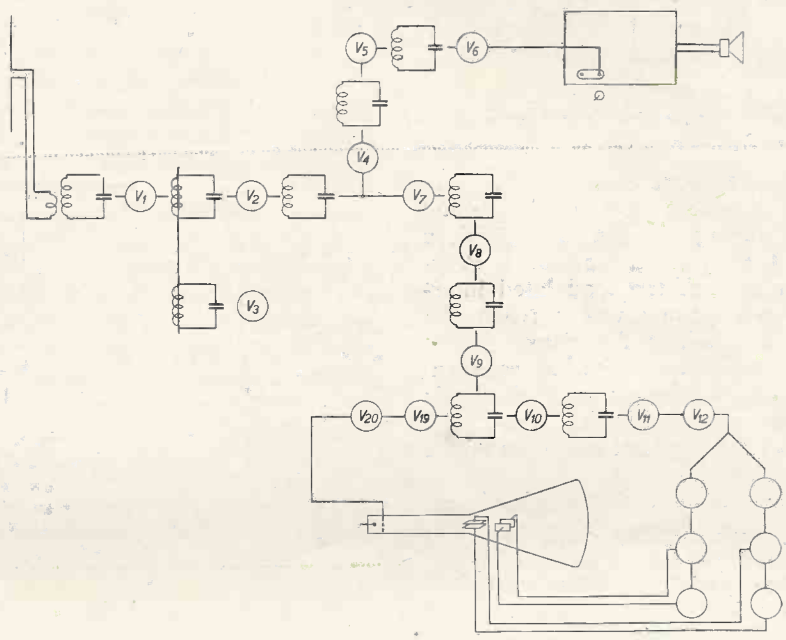


Fig. 1. Circuit diagram of receiver for vision and sound. V_1 Ultra-short wave amplifying valve for vision and sound. V_2 Mixing valve with oscillator V_3. V_4 to V_6 Amplification and rectification of sound signals. V_7 to V_9 Amplification of vision and synchronising signals. V_{19} and V_{20} Transmission of vision signals to the control electrode of cathode-ray tube. V_{10}, V_{11}, V_{12} Amplification of synchronising signals and transmission to saw-tooth wave generators.

The anode circuit of V_4 is tuned to the sound intermediate frequency and has such a narrow frequency characteristic that the vision signals are no longer able to pass. In this connection it should be remembered that behind the mixer valve the signals are transmitted on an entirely different carrier. The intermediate-frequency carrier modulated with vision is further amplified in V_5 in the usual way and rectified in the diode V_6, the low-frequency signal so obtained is applied to the gramophone pick-up sockets of a standard radio receiver equipped with loudspeaker and volume control.

As already indicated, the two intermediate-frequency carriers are also passed to the grid of the amplifying valve V_7. The circuit following this valve, as well as the two succeeding amplifying stages with the valves V_8 and V_9, together furnish a frequency characteristic of the required type, so that in the anode circuit of the valve V_9 there remain only the picture and synchronising signals. Behind V_9 a separation again takes place. Passing to the left the modulated intermediate-frequency waves reach the valve V_{19}, which functions as an anode rectifier. Following rectification picture signals are obtained; they are amplified by V_{20} and finally passed to the control electrode of the cathode-ray tube.

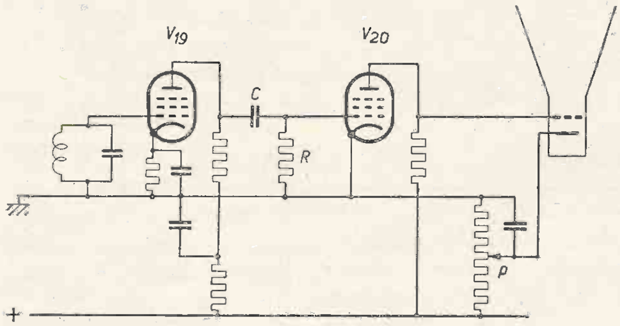


Fig. 2.—Circuits of valves V_{19} and V_{20} which apply the vision signal to the control electrode of the cathode-ray tube.

Since this part of the circuit requires closer attention, it has been reproduced separately in Fig. 2. The picture-frequency signals furnished by the anode rectifier V_{19} are passed through a condenser C to the grid of V_{20}, this grid is connected to the cathode through a high resistance R; as long as no signal is received the grid is at zero potential with respect to the cathode. If now the picture-frequency signal is applied to the grid, grid current will flow and produce a voltage drop in the resistance R, as a result of which the mean grid bias becomes negative. This is shown in Fig. 3a; the grid voltage adjusts itself in such a way that the peaks on the right, which in this case correspond to the base of the synchronising signal, just fall within the region in which grid current flows. For each line scanned the vision signal is of different form and in general exhibits marked fluctuations in modulation depth, as shown, e.g., for two lines in Fig. 3a. On the other hand, the synchronising signals always have the same modulation depth, so that the broken lined marked *1* and *2* will always occupy the same positions. In consequence, the values V_1 and V_2 (Fig. 3b), of the voltage at the anode of V_{20}, corresponding to the grid voltages *1* and *2* will also always be the same irrespective of the modulation of the vision signals. The control electrode of the cathode-ray tube is connected directly to the anode of V_{20}. By applying a suitable negative tension (adjusted with the potentiometer *P*) between the control electrode and the cathode, the picture-frequency signal can be applied to the control electrode of the cathode-ray tube in the manner shown in Fig. 3c; it is seen that the line *DE* corresponding to the perfectly dark picture occupies such a position that current just fails to pass through the cathode-ray tube, while modulation to the right of *DE* allows a beam current to pass, which is approximately proportional to the modulation and thus increases and diminishes with the brightness of the radiated picture.

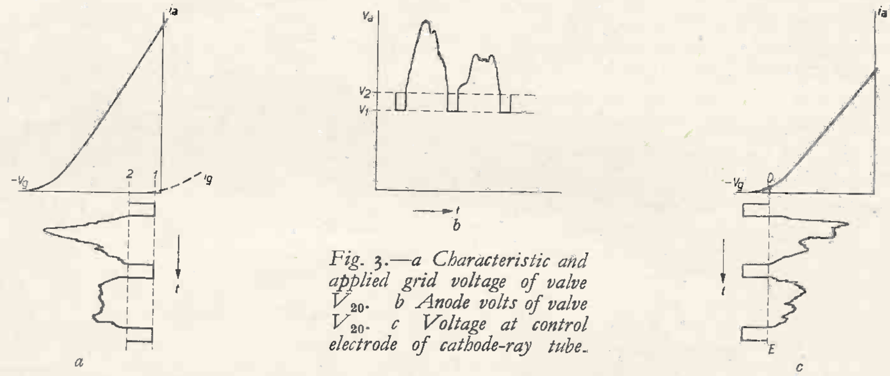


Fig. 3.—a Characteristic and applied grid voltage of valve V_{20}. b Anode volts of valve V_{20}. c Voltage at control electrode of cathode-ray tube.

Correct tuning is obtained by adjusting the oscillating circuit of the oscillator, shown next to V_3 in the circuit diagram, in such a way that the loudspeaker reproduces the sound picked up, i.e., tuning is done on the sound and not on vision, since the circuits in the receiver have much sharper resonance curves than those of the television receiver.

Synchronising Signals

In discussing the receiver circuits in reference to Fig. 1 it was mentioned that an intermediate-frequency carrier on which the picture and synchronising signals are modulated is obtained in the circuit behind V_9. The carrier wave is amplified by the valve V_{10}, V_{11} is a triode with incorporated diode (Fig. 4). The incoming signal is rectified in the diode giving a picture-frequency signal at the resistance R_1. As shown in the figure the signal is also applied at the same time to the grid of the triode. The characteristic of the triode is so chosen (Fig. 5) that the amplitudes of the vision signals all fall within those grid voltages as no anode current flows, while the opposite is the case for the synchronising signals. The anode current of the triode is thus of the form shown in Fig. 5b. It is seen that the synchronising signals are almost completely separated from the vision signals proper.

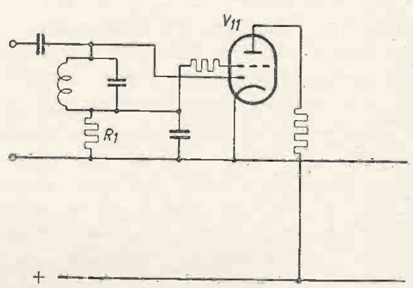


Fig. 4.—Circuits of the diode-triode V_{11}. The short line represents the diode anode. In this stage the synchronising signals are separated from the vision signals.

The circuit shown in Fig. 4 is followed by the stage V_{12}, which serves for the still more complete separation of the synchronising signals from the vision signals. Following V_{12} are filters in which the line and picture synchronising signals can be separated from each other on the basis of their frequency difference; finally, each is applied to one of the saw-tooth wave generators for deflecting the cathode-ray.

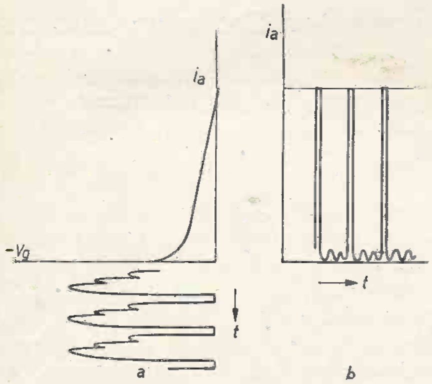


Fig. 5.—a Characteristic and applied grid voltage of the diode-triode valve V_{11}.
b Anode current of triode section of V_{11}.

Saw-tooth Wave Generators

In the circuit diagram the saw-tooth wave generators are represented by two groups each composed of three circuits (not specifically indicated) on the right of the cathode-ray tube. Each of the two generators contains a condenser which is charged through a resistance and discharged by a valve (top circuit). The saw-tooth voltage of the condenser is amplified by the two amplifying valves following it, and which apply the scanning voltage to the deflection plates of the cathode-ray tube. The circuit containing the two amplifying valves is so arranged that the saw-tooth generators automatically continue in operation, even in the absence of synchronising signals. Means are also provided for improving the linearity of the saw-tooth waves. Each saw-tooth generator is actually duplicated in order to be able to employ different scanning methods, a point already indicated at the outset.

Assembly of Components

The cathode-ray tube (*f* in Fig. 6) is mounted horizontally in a chassis *a*, on which the various amplifying stages and the saw-tooth generators are also fixed.

Four control knobs serve for the adjustment of the television receiver (in the actual apparatus these are combined to a pair of twin knobs *h* and *l*), and with which the following adjustments can be made: 1, Adjustment of the amplification of the vision amplifier, permitting a variation of the amplitude of the picture-frequency signal at the control electrode of the cathode-ray tube (see Fig. 3c) and thus increasing or reducing the brightness of the picture; 2, adjustment of the potentiometer *P* in Fig. 2, permitting the line *DE* (Fig. 3c) corresponding to a dark screen to be brought into the correct position, viz., just at the current cut-off point of the cathode-ray tube; 3, tuning of the oscillating circuit; 4, changing over from one scanning system to the other.

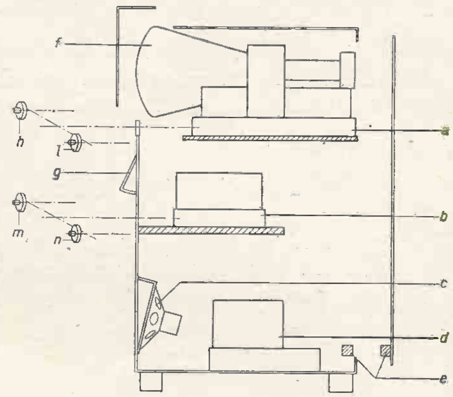


Fig. 6.—Diagrammatic section through the receiving set.
a Vision receiver. b Broadcast receiver. c Loudspeaker. d Anode current unit. e Safety contact. f Cathode-ray tube. g Tuning scale of radio receiver.
Vision controls: h Picture adjustment. l Tuning and selecting of scanning method.
Radio controls: m Volume and band width. n Tuning and wave range; on and off switch; changeover for radio or television reception.

All high-tension leads are provided with metallic screening throughout the set; protection against high-tension shocks is also provided, the mains voltage being cut off and the high-tension condensers discharged when the cabinet is opened.

New German Standards

A decision has been reached by the German Reichpost regarding future standards for television in that country. It has been decided to employ 441 lines with 50 pictures per second, interlaced. The picture ratio is to be 5 to 6.

Delay Fuses

RADIO fuse designers have for years tried to produce a fuse which is capable of withstanding the surges which occur when switching on a radio receiver, and at the same time be rated low enough to protect the receiver against a small continuous overload. The usual faults which occur in a radio receiver result in a heavy current in only *one* secondary winding of the mains transformer, so that the resulting overload current in the primary of the transformer is not high enough to blow the ordinary house fuses, nor an insensitive radio fuse, but is nevertheless high enough to cause severe overheating and even fire in the radio receiver.

What is required is a fuse of about ½-amp. rating, but with a delay characteristic which prevents it blowing on a short period overload reaching 1 or even 2 amps. for a fraction of a second.

Recently one of the Belling and Lee engineers hit on a bright idea. He took a non-oxidising filament of high melting point wire (nickel, to be precise), and mounted on it some tiny explosive blobs of powdered magnesium held in a suitable binder. The melting point of the nickel is some 1,500° C., but the flash point of the magnesium is only 650° C., and on burning it instantly generates some 3,000° or 4,000° C. Thus an overload of appreciable duration heats the blobs of magnesium up to their flash point, and on burning they melt the nickel filament and clear the fuse. High overloads of short duration, however, do not create sufficient heat to raise the blobs of magnesium to firing point; in fact the blob acts as a short period lagging on the wire which can actually be seen to reach red heat in between the blobs for a fraction of a second while the short overload persists.

The result is that one of these new "Mag-nickel" fuses of ½-amp. rating will resist the same surges as a 1 amp. conventional radio cartridge fuse, and yet will blow on a 75 per cent. overload if the overload persists for one second.

Further advantages of this new fuse are that its nickel filament is mechanically robust and does not oxidise or deteriorate after long periods of service.

A NOVEL SCHEME FOR TELEVISION IN COLOURS

By Viktor A. Babits, A.M.I.E.E., M.I.R.E., Dr. Techn. University of Technical Sciences Budapest.

The idea of television in natural colours has engaged the attention of a number of inventors but up to the present no successful scheme has been evolved. This article is a description of a system which it is claimed can be adapted to existing methods of transmission and reception.

MANY suggestions have already been made, indicating how coloured television might be realised, but owing to their complication none have yet reached the stage of practical development.

The suggested system about to be described is a combination of the "Kodacolor" method for coloured films and the existing television systems.

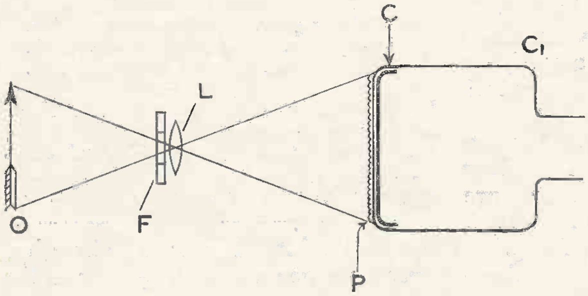
The device consists of two parts: one of them being combined with the scanning apparatus, the other with the receiver where the picture is reconstituted. In Figs. 1 and 2 the combination of the device with the usual cathode-ray scanners is shown, and in Fig. 3 the combination with the apparatus for reconstructing the picture (receiver).

The principle of the system will be understood if explained in connection with Fig. 1, in which is shown diagrammatically Farnsworth's first image dissector modified so as to make it suitable for the transmission of colour television.

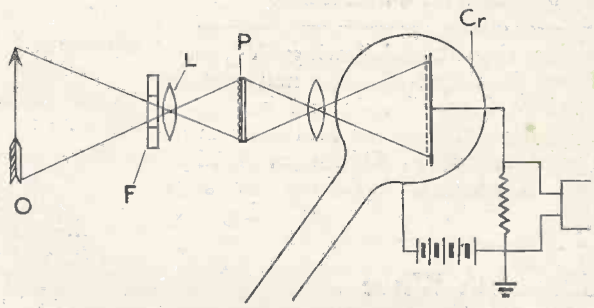
In this diagram O is the coloured film or object to be transmitted by television, which object is reproduced by means of the lens L on the photo-electric layer C. In front of the glass plate with the photo-electric layer there is a prism-screen P, which is composed of cylindrical rods, and which contains exactly the same number of rows as the number of picture lines.

Again, in front of the lens L there is an optical filter F, of different colours placed one beside the other. This filter is composed of at least three differently coloured filters, that is red, green, and a blue.

It will be understood that each single picture line of the object O is reproduced through three differently coloured filters on the photo-electric layer C. However, in front of the cathode the prism-screen is placed, which causes rays of different colours to be refracted at different angles. Consequently, if, for instance, to each picture line there corresponds one cylindrical rod, then each picture line, after having passed through the three differently coloured filters, is reproduced on the photo-electric cathode in three separate differently coloured picture lines, situated one beneath the other.



Figs. 1 and 2.—The system adapted for use with the original Farnsworth image dissector and the Iconoscope.



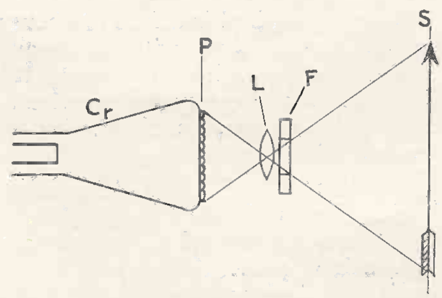


Fig. 3.—A modified arrangement for use with the Iconoscope.

If the photo-electric layer of the scanner were panchromatic, and the fluorescent screen of the picture receiver in Fig. 3 emits white light, then, corresponding to each picture line of the object O, three picture lines lying one under the other appear on the fluorescent screen of the receiver. If a similar prism-screen is placed on this too, reproducing the fluorescent picture by means of the lens L through a filter F, consisting of the same colours and being arranged in the same way as that of the scanner device, on the screen S, then on the screen S the coloured picture of the object O will appear.

The usual photo-electric cathode is not panchromatic, but a panchromatic photo-electric cathode can be produced by placing under the prism-screen, on which three differently coloured picture lines are reproduced one beneath the other, three photo-electric layers of differently selective photo effects; these layers might, for instance, consist of natrium, rubidium and caesium. The resulting effect of such photo-electric cathodes approximates the panchromatic effect.

When the prism-screen cannot be placed on, or in the immediate neighbourhood of the photo-electric layer, as, for instance, in the case of the Iconoscope (Fig. 2), then the images of the spectra of the picture lines can be reproduced on the plane side of the prism-screen, and then by means of a second lens system on the photo-electric layer. A similar solution can also be applied in the case of Farnsworth's recent image dissector.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

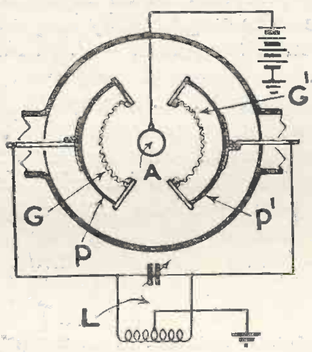
Specially Compiled for this Journal

Patentees:—Farnsworth Television Inc. :: Marconi's Wireless Telegraph Co., Ltd., and G. Baldwin :: Radio-Akt. D. S. Loewe :: C. Lorenz Akt. :: I. Shoenberg

Electron Multipliers

(Patent No. 463,514.)

AS shown in cross-section an electron-multiplier is fitted with two perforated grids G, G1, which are arranged on opposite sides of a central anode A, and a pair of collector electrodes P, P1 are set outside the grids and connected across an external turned circuit L. When a ray of light strikes the photo-sensitive surface of one of the grids, it releases electrons which are attracted towards the positive voltage on the anode A, but pass right across to the opposite grid.



Electron multiplier. Patent No. 463,514

Here they produce more electrons by secondary emission, which are in turn accelerated back towards the positive anode and past it on to the second grid. This to-and-fro process is repeated until a surging crowd of electrons fills the space between the two grids. Some of the electrons pass out through the perforations in the grid, and are collected by the electrodes P, P1. These build up oscillating currents in the output circuit L, the oscillations being maintained because the grids G, G1 are in phase-opposition across the circuit.—*Farnsworth Television Inc.*

Time-base Circuits

(Patent No. 463,625.)

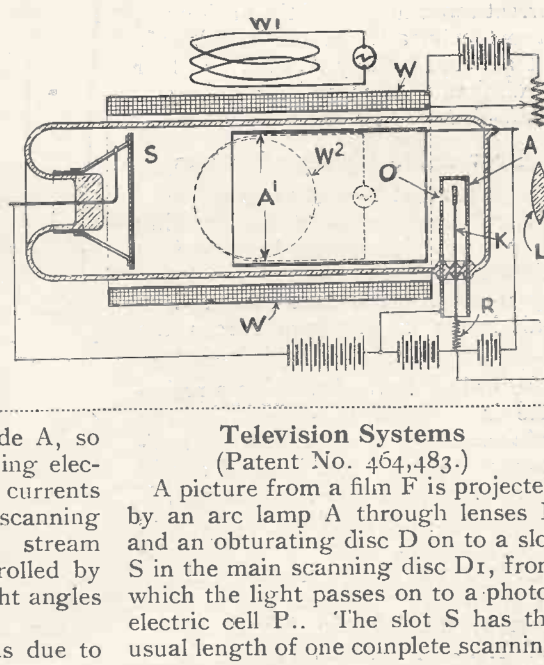
The control-grid and anode circuits of a screen-grid valve are back-coupled to produce oscillations. The resulting grid current is used to charge up a condenser in the grid-cathode circuit so that it periodically blocks the valve, until discharged through a resistance. The result is to produce saw-toothed voltage variations, suitable for scanning, across the plates of the condenser.

Synchronising impulses are applied to the screening grid, and one of the advantages of the circuit is that these will be effective even if of comparatively small amplitude. A second set of square-topped voltages are automatically generated at the terminal of the screen grid, and are used to suppress the cathode-ray stream during the "flyback" stroke in scanning. —*Marconi's Wireless Telegraph Co., Ltd.*, and *G. Baldwin.*

Television Transmitters

(Patent No. 463,829.)

A picture to be televised is projected through a lens L on to a photo-electric screen S, and the electrons emitted from the latter are focused by an external winding W and swept to and fro across a scanning aperture O in the anode A, so that they fall on to a collecting electrode K, and create signal currents in a resistance R. The scanning movement of the electron stream across the aperture is controlled by windings W1, W2 set at right angles to each other.



Television transmitter. Patent No. 463,829

Any slow-moving electrons due to secondary emission from the electrodes are collected by an anode A1 which is biased to a high potential. This prevents them from mixing with the high-speed electrons forming the main stream, where they would tend to produce distortion.—*Farnsworth Television Incorporated.*

Preventing Distortion

(Patent No. 463,967.)

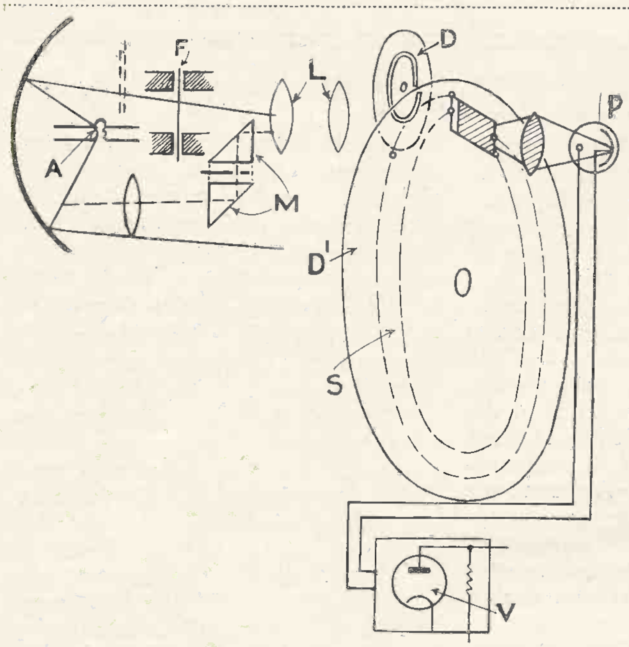
It is found that pictures transmitted from the Iconoscope camera are liable to appear too dark in certain parts and too light in others. For instance, one corner of the picture may look too black, whilst the opposite corner shows too faintly. This is partly due to a peculiarity of the Iconoscope tube, and partly to the alternating component of the light used for illuminating the object in the transmitting studio.

According to the invention the trouble is overcome by superposing a suitable saw-toothed oscillation on the picture-signals produced at the output of the Iconoscope transmitter tube.—*Marconi's Wireless Telegraph Co,. Ltd.*

Television Systems

(Patent No. 464,483.)

A picture from a film F is projected by an arc lamp A through lenses L and an obturating disc D on to a slot S in the main scanning disc D1, from which the light passes on to a photo-electric cell P.. The slot S has the usual length of one complete scanning line, but is several lines wide. The usual synchronising signal is derived from a white margin on the film F and is projected on to the same photo-electric cell P through reflecting prisms M. The object of the arrangement is to ensure that the synchronis-



Scheme for keeping the intensity and amplitude of the synchronising impulses constant. Patent No. 464,483

ing impulses reduce the current in the last valve V of the amplifier to zero.

This keeps the intensity and amplitude of the synchronising impulses constant, in spite of other fluctuations, because both are definitely determined by the cessation of current from the amplifier V. Also it ensures correct reproduction of the half-tones, since the linearity of the amplifier is not affected by any A.V.C. or other regulation that may be required.—*Radio-Akt D. S. Loewe.*

Preventing Flyback Streaks

(Patent No. 464,610.)

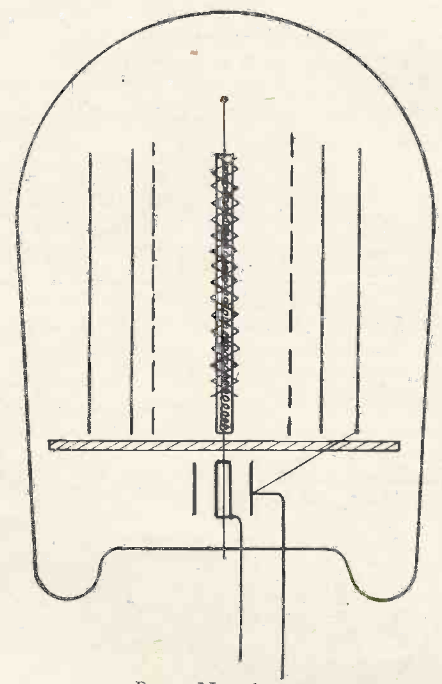
The flyback stroke of the scanning beam should, if possible, be kept right off the fluorescent screen of a cathode-ray receiver, as it tends to produce undesirable bright lines across the picture.

According to the invention a resistance is inserted in series with the main condenser of the time-base oscillator, and the voltage induced across it, when the condenser discharges, is applied to the grid of one of the amplifying valves in the set. This results in a momentary blockage of the valve, which produces the desired effect by making the flyback stroke invisible.—*C. Lorenz Akt.*

Television Transmitters

(Patent No. 464,692.)

In the Iconoscope type of transmitter the picture to be televised is focused on to a mosaic electrode, which is composed of a great number of tiny photo-electric cells. The pic-



Patent No. 464,483

ture is, of course, projected on to the side of the electrode which faces the electron stream used for scanning, and this, in turn, means that the electrode must be set across or at an angle to the stream.

On the other hand it would be much simpler, from the point of view of scanning, if the electrode could be set straight, so that the electron stream would strike it everywhere at right angles. But this can only be done by projecting the picture obliquely through the optical system.

The invention relates to a lens system for securing the desired result, and for applying the necessary corrections to ensure a uniform distribution of the light from the picture before it is scanned.—*I. Shoenberg.*

Summary of other Television Patents

(Patent No. 463,642.)

Method of fixing or mounting the fluorescent screen of a cathode-ray tube.—*Ferranti, Ltd.,* and *M. K. Taylor.*

(Patent No. 463,896.)

Cathode-ray receiver with the fluorescent screen set at an angle to the scanning screen, so as to allow the picture to be magnified by lenses from the front of the screen.—*P. T. Farnsworth.*

(Patent No. 463,971.)

Television receiver in which the synchronising signals appear across the cathode circuit of a valve, in reversed polarity to the picture signals in the anode circuit of the same valve.—*Baird Television, Ltd.,* and *L. R. Merdler.*

(Patent No. 463,973.)

Television receiver with a common source of supply for the anode of the amplifier valve, the control grid of the C.R. tube, and the winding used for focusing the electron stream.—*Baird Television, Ltd.,* and *L. R. Merdler.*

(Patent No. 464,049.)

Rotating-disc method of interlaced scanning from a cinema film having vertical and horizontal marginal strips.—*Radio-Akt. D. S. Loewe.*

(Patent No. 464,141.)

Generating saw-toothed scanning oscillations with a shortened "flyback" stroke.—*Ferranti, Ltd.,* and *J. C. Wilson.*

(Patent No. 464,286.)

Combined sound and picture receiver having a common local oscillator and frequency-changer for both carrier waves.—*Marconi's Wireless Telegraph Co., Ltd.*

(Patent No. 464,492.)

Method of automatically regulating the degree of amplification in a television receiver, so as to compensate for fading.—*Radio-Akt. D. S. Loewe.*

(Patent No. 464,637.)

Correcting the disturbance caused by external and internal stray fields on the electron stream of a cathode-ray tube.—*Fernseh Akt.*

STUDIO & SCREEN

A MONTHLY CAUSERIE on Television Personalities and Topics

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

DEMURE, charming Elizabeth Cowell, standing nonchalantly in a corridor outside the studio at Alexandra Palace the other day, spoke to me with a definitely reproving look in her fascinating dark eyes.

"You got me wrong," she said, or words to that effect.

"Why on earth do you persist in calling me 'Betty'? Will you please understand that I don't like it."

It is quite true that on various occasions in these notes I have referred to this delightful young lady, who is well known, of course, as the announcer-hostess at Alexandra Palace, by the name "Betty," but I have always done so with no suspicion of her dislike for the name.

"Gee! Call me 'Lizzy' if you like. Call me anything, but not 'Betty'," she went on, following me up and down the corridor. "Anyway, what's wrong with 'Elizabeth'?"

"You must be crazy," she continued. "If you call me 'Betty,' why don't you call Jasmine Bligh, 'Jazzy'?"

"'Jazzy'," I whispered, pricking up my ears, "not a bad name, either."

"You *dare* call her 'Jazzy' and see what she says."

Of course, I would never be so naughty.

Poor Jasmine, at the time of writing these notes, is in the Isle of Wight recovering from an operation for tonsilitis. Leslie Mitchell, the other announcer, is also away on a well earned holiday. Where he has gone nobody knows. All I could gather was that letters will not be forwarded. Fans, please note!

* * *

The occasion of meeting Elizabeth again was a visit to Alexandra Palace. It is some while since I was there, and I was greatly impressed by the changes which I noticed on every side. I was fortunate in being able to see part of the broadcast of "Derby Day," the comic opera by A. P. Herbert, which was being played by a distinguished cast, including Frank Drew, George Baker, Tessa Deane, Esther Coleman, Gordon Little and others who are well known to ordinary listeners.

I had not realised how little make-up was now necessary in television, and many of the actors and actresses were so slightly made-up that it was hardly noticeable. I observed a policeman, for instance, who took part in this delightful production, who did not appear to be made up at all.

Photograph taken at Brighton of Miss Elizabeth Cowell as seen in a television receiver by Mr. E. Westhead.

* * *

At one end of the studio, underneath the control window behind which producer Stephen Thomas directed operations, sat the orchestra conducted by Alfred Reynolds himself. Alfred evidently was enjoying himself immensely. He wore a pair of trousers and a shirt, but not much more, and swayed about as he conducted, evidently living in his own creation. Members of the orchestra, most of whom were also working minus waistcoats and jackets, responded in a marvellous manner to the inspiration of the conductor and, generally speaking, I was much impressed by the precision, clean definition and slickness of this orchestra. It does great credit not only to the individual members but to Hyam ("Bumps") Greenbaum who, by the way, was on holiday at the time in the south of France.

Vera Lennox of the Television Follies.

Despite the great heat in the studio, the orchestra seemed to work with a noticeable easiness and perfect unity.

In front of the orchestra was a row of seats where we were sitting, and between these and the other end of the studio the players were acting their parts and being televised. At the far end, in the middle, the scenery represented the Inn, and on the two sides were two other scenes.

The Emitron cameras surveyed these three sides of the square formed by the scenery, and at any given moment the action was proceeding in front of one of them. While the scene in front of one side of the studio was being shot, the players were assembling in front of one of the others in readiness for the fading in of the next.

I began to wonder how the players knew exactly when to begin, as there seemed to be so many scenes shot by the different cameras, all cleverly dovetailed into one another. So far as I could see there were no indicator lights or anything of that sort. They simply had to watch the cameraman who gave them the signal when to start and stop by raising his finger. During the time the action was proceeding in front of any one scenery piece, the camera-man moved forward or backwards in order to get closer up or further away, as was required. He observes the scene on a fairly large focusing screen on the left side of the camera, which shows the figures upside down in the same way as the focusing screen of an ordinary camera.

What amazed me about this show was that in spite of the complication of the continuous changes from one scene to another, all the artists seemed to know exactly what was happening or when it was due to happen, in quite a miraculously detailed manner. They went through the whole thing apparently seeing and hearing nothing other than what they were doing, and quite oblivious to the fact that there were a few spectators.

Dennis van Thal, composer, pianist, conductor. Pianist in the Television Follies.

Anyone would think from looking at them that they had rehearsed their parts hundreds of times, until it was absolutely second nature, and on inquiring into this I found that it was not very far from the truth. The direction of the whole programme, of course, was entirely in the hands of Stephen Thomas, who, from his control gallery, not only could see everything that was going on, but was in communication with the cameramen all the time. These assistants wear headphones and are told precisely when the various changes are taking place. A cameraman's job at Alexandra Palace is no sinecure, for a slight delay or misunderstanding on their part could upset everything.

* * *

As readers of these notes know, I have always expressed great admiration for Stephen Thomas, and I came away from Alexandra Palace on this occasion with my admiration for his work, energy and capacity for detail, considerably heightened. He has done a tremendous number of programmes within the last three or four months, and I hear that he often spends whole Sundays of his spare time in perfecting his productions and frequently goes to the homes of the artists for private rehearsals of their parts.

I had a little chat with Stephen after the show, but found, as usual, that he does not like talking about himself. The upshot of the conversation, however, was that I realised that here is a man who simply cannot produce a show unless he has put his very best into it. Call it artistic conscience, if you like. Stephen Thomas has a great future in television. See if I am right.

* * *

Mr. D. H. Munro, the popular productions manager, was also away on holiday, but he did not go to Aberdeen, as I prophesied last month. I heard that he was motoring across Europe instead. The human dynamo found it very difficult at the last moment to tear himself from work, and I was secretly informed that he popped in again two days after he was supposed to have gone, and gave a spot of work to somebody.

* * *

I have not yet drawn attention to the new Television Follies, which was formed about a month ago, and which already has done some remarkably good work. At the time of writing, I think they have made four appearances, and so far as I can gather they are making a study of the television presentation of a concert party, for, as regular televiewers know, they perform as pierrots. The six members are Michael North, an extremely accomplished pianist, who also used to be in the "Co-optimists" with Davy Burnaby; Pat Denny, Dennis van Thal, George Benson, Vera Lennox and Richard Murdoch. Gordon Crier, a newly-appointed Studio Manager, whom I have already mentioned in these columns, produces the show.

Gordon wears a dark blue shirt and a somewhat blasé manner. In his spare moments he is a song writer, and that he has secretly written a song called: "Television Lady," which has been set to music by Michael North.

I managed to get the words of this intriguing little ditty.

Here they are:—

TELEVISION LADY.

Words by Michael Crier.

Music by Michael North.

I'm a very ordinary viewer
But there are fewer
Are quite so keen
Rain or shine
Sharp at nine
I'm switching on my new machine
Though I like the plays
And the talks and cabarets
I've seen
I can do without them
For the nicest thing about them
Comes between.

Television Lady
In your little screen
Do you ever wonder
What a smile from you can mean
Once I went to viewing-rooms
Now I have my own
So when I come home at night
We two can be alone
Television Lady
If I had my choice
I'd look in to nothing
But your picture and your voice
All I ask of Science
When my busy day is through

Michael North, another member of the Television Follies who has written the music for Television Lady.

Television Lady,
Is the sight and sound of you.

Verse Couplet.

When you softly murmur
"Good-night—that's the end"
I love ever'y little look
Every tilt and bend.

"Television Lady" is going to be put over to Radiolympia, and so far as I can see is likely to be a big hit in the B.B.C.'s television programmes. Incidentally, Gordon told me that he has not yet done anything about getting the song published. What a chance for one of the enterprising magnates of Tin Pan Alley!

An Ultra-short Wave Receiver with Metal Valves

In response to requests, we have designed this 6-valve 3-10 metre super-het on the basic circuit produced by Epoch and described in our July issue.

IN our July issue we published an interesting description of a 3-10 metre super-het receiver using resistance-capacity coupling throughout. This receiver, designed by Messrs. Radio Development Co., has caused very

Only three controls are required, these being screen voltage, tuning and cathode bias. The cabinet is a special Eddystone product which is supplied complete with dial and loudspeaker fret.

great interest amongst amateurs, particularly in view of the recent ultra-short wave field day where the necessity for good short-wave receivers was made very evident.

The original receiver was incomplete as regards power pack and loudspeaker, and it appears, from requests received from readers, that a complete receiver, entirely self-contained but on similar lines, would be a distinct advantage.

A Complete Receive

We have, therefore, built this 6-valve super-het receiver complete with its own power pack and loudspeaker, and have made arrangements that Messrs. Radio Development Co. will supply a complete kit of components as required.

A special cabinet already drilled to take the tuning dial and loud-speaker fret was supplied by Messrs. Stratton, and this cabinet gives the receiver a professional appearance. As, however, space is limited the chassis has to be cut along its front face to allow for projections, such as the base of the miniature loudspeaker, and the bracket on the tuning dial.

Construction

Both variable controls are mounted through the panel on to the front lip of the chassis; while a small angle bracket anchors the righ-hand side of the chassis to the front panel. Still further to prevent chassis movement, a metal bracket anchors the centre of the chassis to the front panel. These two sections then become one rigid unit so that the receiver can be wired up with heavy gauge wire without difficulty.

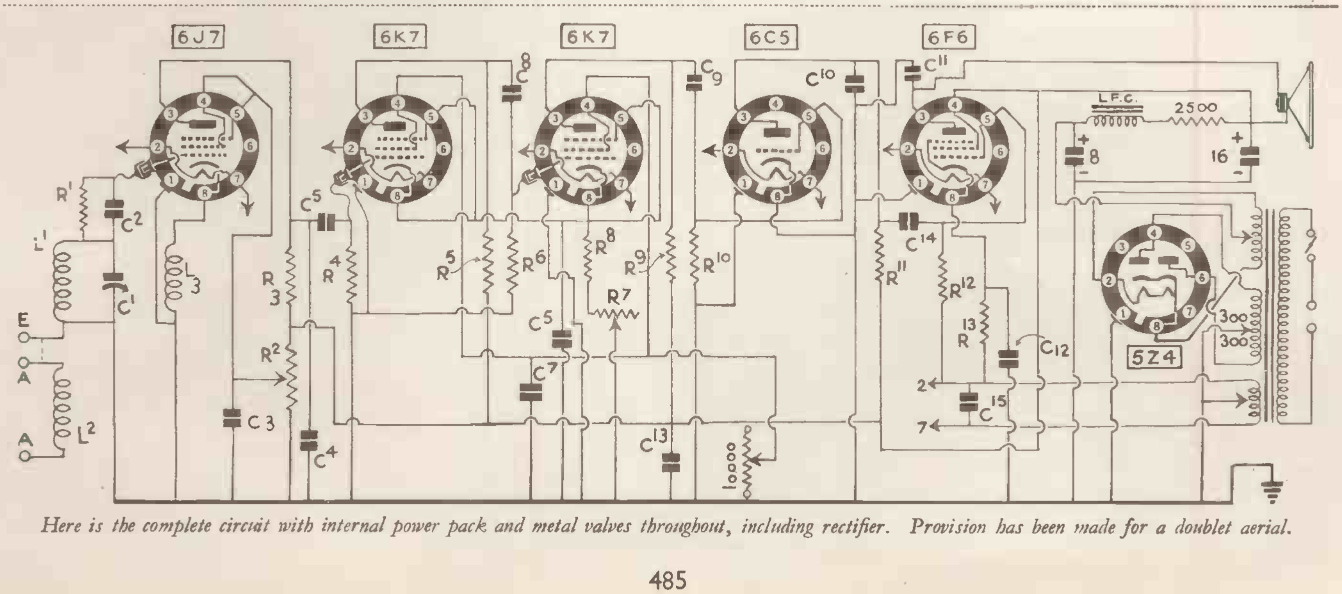
First of all, mount the tuning dial and volume controls on the front panel. Above the tuning dial fix the dial light with its ½-in. centre hole and three 8 B.A. fixing holes.

The hole for the loudspeaker and its associated fret are already cut and the fret mounted by the makers, but the Baby W.B. loadspeaker has to be fitted to the baffle board behind the fret. Arrange this loudspeaker so that the matching transformer is towards the middle of the panel, as can be seen from the photographs, so that the connections are kept short.

Mounting the Transformer

Next comes the drilling of the larger holes. The six holes for octal valve bases can be cut with a carpenter's centre bit to approximately 1 in. diameter, but it is a little more difficult fitting the mains transformer.

This transformer is so arranged that it bolts through the chassis and has all of the connecting wires coming out through the bottom. In this way the appearance of the top of the chassis is



Here is the complete circuit with internal power pack and metal valves throughout, including rectifier. Provision has been made for a doublet aerial.

Common Earth Points :: Optional Headphones

greatly improved, while there is no need to drill holes through which to take connecting wires, so obviating the possibility of a short circuit to earth.

A large square hole has to be cut in the chassis to take the projecting section of the transformer, but once the size has been marked then it is a fairly simple matter to cut out the square with a fretsaw. Special fretsaw blades by Hobbies for cutting aluminium should be used, and providing these are oiled they retain their cutting edge, and difficult holes of this kind can soon be cut.

A double electrolytic condenser of the block type, having 16 and 8-mfd. in one unit, has to be fitted underneath the Ferranti choke; that is, on the underside of the chassis. A small bracket made out of strip brass or aluminium can be cut to size, so this condenser is rigidly fixed.

Bulgin power resistors, one of 10,000 ohms and one of 3,000 ohms are also mounted underneath the chassis, but they can be fixed between odd bolts which already hold other components in position.

Full Smoothing

As headphones are often used with a receiver of this kind, it is essential that smoothing of the power supply be particularly complete. So in addition to the 24-mfd. capacity we have included an unusually good smoothing choke in the Ferranti type B1.

It so happened that in the position shown for this choke that there is no hum pick-up from the mains transformer, but in a subsequent model of this receiver it was found that the smoothing choke had to be moved very slightly from the original position in order to keep the hum level down to minimum. Constructors should remember this point when testing the receiver.

No increase in amplification was experienced by having a higher voltage than 200 applied to all valve anodes, so that the transformer gives slightly over 300 volts a resistance of 3,000 ohms was connected in series with the H.T. supply. This resistance is of the preset type and should be adjusted so that 200 volts are applied to the H.T. side of the various anode resistances.

By using a special transformer, all connecting leads have been kept beneath the chassis.

Between 60 and 70 volts give maximum gain with complete stability on the screening grids, and to obtain this voltage a potential divider has to be used. This potential divider is actually a high-wattage 10,000-ohm Bulgin resistance with a floating clip that is adjusted along the resistance until the correct voltage is obtained. As there is approximately a 25 m/A. current flow across this resistor do not attempt to economise by putting in one of low-wattage rating.

As regards the two controls on the front panel, looking from the front, the left-hand one is R2, which varies the screen voltage to the 6J7 valve only. The right-hand control is R7, which adjusts the auto-bias on the I.F. valves and also includes an on-off switch connected in series with one side of the mains input.

As the valves have 8-pin bases with the grid to the top cap wiring is rather difficult owing to the fact that the grid leads are inclined to float unless anchored, so a point to remember is that pins Nos. 1 and 6 are left blank and either of these can be used to anchor grid components.

The close-up view of the wiring indicates just how the components have been closely interconnected with the minimum amount of wire. Wherever possible additional wire has been omitted,

Components for AN ULTRA-SHORT WAVE RECEIVER WITH METAL VALVES.

CHASSIS AND CABINET.
1—Special chassis, aluminium, 16½ ins. by 8½ ns. by 3 ins. 16 gauge (A.P.A.).
1—Special cabinet type 1034 fitted with loudspeaker fret and drilled for type 1070 dial (Eddystone).

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

CHOKE, LOW FREQUENCY.
1—Type B1 (Ferranti).

COILS.
2—3-turn type 1050 (Eddystone).
1—4-turn type 1050 (Eddystone).
1—5-turn type 1050 (Eddystone).
1—6-turn type 1050 (Eddystone).
1—8-turn type 1050 (Eddystone).

COIL HOLDER.
1—Type 1051 (Eddystone)

CONDENSERS, FIXED.
1—.0001-mfd. type 690W (C2) (Dubilier)
1—.1-mfd. type 4423/S (C3) (Dubilier).
1—.0001-mfd. type 690W (C4) (Dubilier).
1—.0001-mfd. type 690W (C5) (Dubilier).
1—25-mfd. type 3016 (C6) (Dubilier).
1—.1-mfd. type 4423/S (C7) (Dubilier).
1—.0001-mfd. type 690W (C8) (Dubilier).
1—.0001-mfd. type 690W (C9) (Dubilier).
1—.002-mfd. type 690W (C10) (Dubilier).
1—.006-mfd. type 691 (C11) (Dubilier).
1—25-mfd. type 3016 (C12) (Dubilier).
1—.1-mfd. type 4423/S (C13) (Dubilier).
1—.01-mfd. type 691 (C14) (Dubilier).
1—.003-mfd. type 620 (C15). (Dubilier).
1—16-8-mfd. type 312 (C16) (Dubilier).

CONDENSER, VARIABLE.
1—Type 900/20 (Eddystone).

DIAL.
1—1070 (Eddystone).

HOLDER, FUSE.
1—Type F11 (Bulgin).

HOLDERS, VALVE.
6—Type Octal (Clix).

PLUGS, TERMINALS.
3—Crocodile clips (Bulgin).
1—Terminal type B marked Earth (Belling-Lee).
2—Terminals type B marked Aerial (Belling-Lee).

RESISTANCES, FIXED.
1—1-megohm 1 watt (R1) (Erie).
1—20,000-ohm 1 watt (R3) (Erie).
1—250,000-ohm type 1 watt (R4) (Erie).
1—50,000-ohm type 1 watt (R5) (Erie).
1—250,000-ohm type 1 watt (R6) (Erie).
1—500-ohm 1 watt (R8) (Erie).
1—50,000-ohm 1 watt (R9) (Erie).
1—250,000-ohm 1 watt (R10) (Erie).
1—100,000-ohm 1 watt (R11) (Erie).
1—250,000-ohm 1 watt (R12) (Erie).
1—500-ohm 1 watt (R13) (Erie).
1—3,000-ohm type PR8 (R14) (Bulgin).
1—10,000 ohm type PR11 (R15) (Erie).

RESISTANCES, VARIABLE
1—500,000-ohm type B (R2) (Dubilier).
1—10,000-ohm with switch type J (R7) (Dubilier).

SUNDRIES.
1—Adjustable bracket type 1007 (Eddystone).
1—Flexible coupler type 1009 (Eddystone).
1—Extension outfit type 1008 (Eddystone).
2—Insulating pillars type 1029 (Eddystone).
1—Insulated jack (Bulgin).
1—Dial light type D35 (Bulgin)
1—Coil quickwyre (Bulgin).
2—1¾ ins. engraved dials (Eddystone).
2—Metal brackets (Bulgin).

TRANSFORMER, MAINS.
1—To specification with wire ends (Premier Supply Stores).

ACCESSORIES

VALVES.
1—6J7 metal (Premier Supply Stores).
2—6K7 metal (Premier Supply Stores).
1—6C5 metal (Premier Supply Stores).
1—6F6 metal (Premier Supply Stores).
1—5Z4 metal (Premier Supply Stores).

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

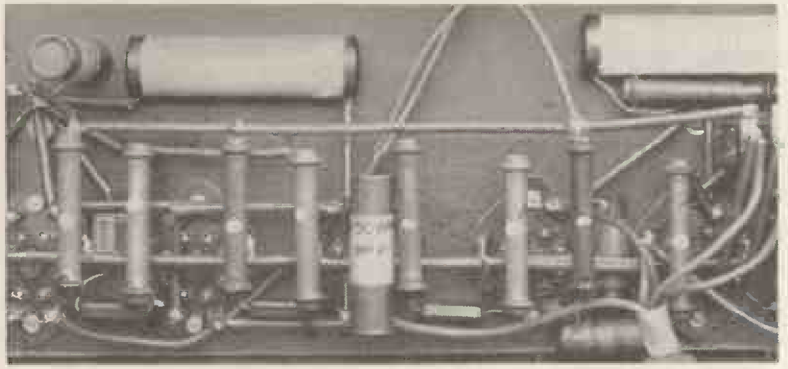
LOUDSPEAKER.
1—Type Baby (W.B.).

Wave Range :: Metal Valves :: Low Noise

using only the long leads on condensers and resistances.

Earth Connections

A common bolt is used for all earth connections. Do not in any circumstances take earth returns to the nearest point on the chassis. All earthy connections go back to one point, including the rotor on the tuning condenser. This condenser—C1—does not make automatic earth contact to the panel. In fact, it has to be carefully insulated and earthed directly to the common bolt. The external earth connection should be taken to this bolt, or to an insulated terminal on the front panel.



Wire the I.F. stages in this manner without additional connecting wire other than that supplied with the components concerned.

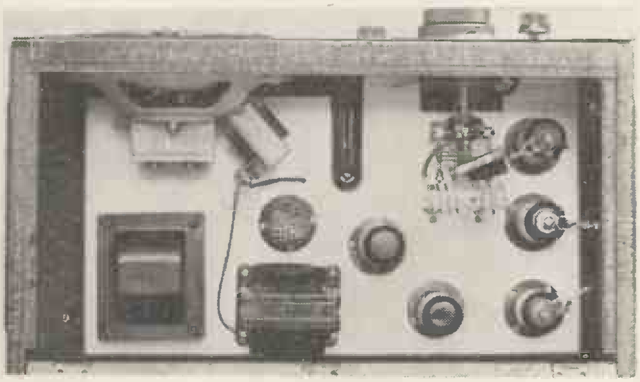
Coil Ranges

L1, the grid coil, can be permanently fixed into position as it is of the interchangeable type, and by using several coils enables the receiver to cover from 3 to 10 metres. L2, incidentally, is a 3-turn aerial coupling coil which is not changed, for it provides approximately the correct coupling for the entire wavelength coverage of the receiver.

It is important, however, that the gap between coils is correct. But this point is easily taken care of owing to the fact that if the bases are fixed so that the edges touch, it so happens that the coupling will be correct. A 3-turn coil covers approximately 3 to 4.5 metres; a 4-turn coil from 4 to 6 metres; a 6-turn coil 6 to 8 metres; and an 8-turn coil 8 to 10 metres. We have found on the 10-metre band a slight increase in gain can be obtained by utilising a larger coupling coil of 4 turns, but this depends very much on the length of aerial used.

Metal Valves

Metal valves are used throughout. In the detector-oscillator division is a 6J7 pentode, which has a fixed grid base, and a very high amplification factor. It is followed by two 6K7's, triple grid amplifiers of slightly lower amplification factor, but an increased slope. The second detector, a 6C5, is a conventional triode, while the 6F6 output pentode is similar to the British conventional high-gain pentode. A novelty is the metal valve rectifier, a 5Z4, which gives an output of 125 m/A. at 400 volts, so that in this circuit it is being well under-run.



This plan view gives a good idea of the layout of the components. Particularly notice the arrangement of the mains transformer, output transformer and smoothing choke.

The Circuit

Several readers have queried the fundamental principle of this resistance-coupled super-het receiver. It is appreciated that this type of set is ideal for ultra-short wave reception and has proved most efficient in America, where it is the standard receiver for DX reception.

The 6J7 is a conventional autodyne detector obtaining oscillation by virtue of the cathode coil, L3, which is a high-frequency choke. The values of resistors and condensers in the I.F. stages are chosen so that they are correct only to by-pass the intermediate frequencies. The coupling condensers and resistances are too small in value to pass audio frequency. Phone stations will be interested to know that the response curve of the amplifier is quite broad and will handle a number of lightly modulated self-excited oscillators.

Extreme screening is not necessary owing to the layout and the use of metal valves; while it is very difficult to make the receiver unstable. The oscillator control should be adjusted so that the circuit is barely oscillating, and never should it be allowed to squegger. Gain is controlled by R7, and even at maximum the I.F. stages should not go into oscillation. R8, a 500-ohm resistor, applies a continuous

(*Continued on page* 512)

The valves shown in this illustration are from left to right, rectifier, output pentode, second detector, two I.F. amplifiers and the first detector next to the panel.

Programmes for Short-wave Listeners

By A. C. Weston

TRANSMISSIONS from three Australian stations are being well received in this country. These stations, Sydney, Melbourne and Perth, are on the air at the following times.

Sydney, VK2ME, on 31.28 metres, radiates from 5 to 7 a.m. and 9.30 a.m.

The National Barn Dance programme on Saturday through N.B.C. Blue network introduces LaValle Carter and his bride Verne Hassell.

to 1.30 p.m. on Sundays, and from 3.30 p.m. to 5.30 p.m., also on the same day.

Melbourne, on a slightly different wavelength of 31.5 metres, transmits from 9 a.m. to 12 mid-day, Monday to Saturday. On 31.28 metres also is Perth, VK6ME, but this station only transmits on week-days between 11 a.m. and 1 p.m. These times are all Greenwich Mean Time.

Coming closer home, I notice that there are some good programmes from the Philip's station PHOHI, from Eindhoven. The wavelength used by these stations are 16.88, 25.57, 19.71 and 31.28 metres. The interesting programmes are far too numerous to mention, but transmissions can be heard from 12.25 to 3.25 and 7 p.m. to 8 p.m. on Sundays, and from 1.25 p.m. to 3 p.m. on week-days. These times are all G.M.T.

Russian programmes for August consist primarily of talks in English, although Soviet music is transmitted every Wednesday on 25 metres at 9 p.m. G.M.T. Listeners to Moscow should tune in any evening between 9 p.m. and midnight, but the majority of the programmes will consist of talks of the following nature. On August 1, talk entitled "The U.S.S.R. in the Struggle for Peace." On the 13th, the "Bolsheviks at the North Pole." The 19th, a review of international events; 22nd, "Football in the Soviet Union," and on the 27th "A Visit to Ivanovo, the Soviet Manchester." It seems that most of these Soviet transmissions consist of talks, but even so, they will probably be interesting, if only to give an indication as to the Soviet opinion regarding foreign affairs.

Star-station for August will be Boundbrook relaying N.B.C. programmes and using a highly directional aerial beam on Europe.

August 1, brings Music Hall on the Air at 5.30 p.m., Musical Favourites at 6.30 p.m., and Magic Key of R.C.A. at 7 p.m., through Pittsburgh. At 11.15 the same evening, film star Frank Morgan and guest artistes have 15 minutes, to be followed by Ernest Gilland his California Concert Orchestra a little later at 11.45. High light for Monday through Pittsburgh is the West View Park Orchestra at 9.45 p.m. Tuesday brings Lucille and Lanny at 10 p.m., and Easy Aces at midnight, while Francia White, the prima donna who broadcasts from the N.B.C. studios in Hollywood, can be heard at 2.30 a.m. Continental Varieties for half-an-hour is a very good programme for Wednesdays through Pittsburgh, while the Caballeros are continuing their 15 minutes every Thursday through August at 8.45 p.m. Listen to the Alka-Seltza programme in the National Barn Dance at 2 a.m. each Saturday night, for the star performers are Lavalle Carter and Verne Hassell.

The serial, Girl Alone, has as its star Betty Winkler, who can be heard over N.B.C. Red network daily, except Saturday and Sunday, at 5 p.m. She takes the part of Patricia Rogers.

WLW, through its short-wave outlet W8XAL in Cincinnati, transmits the Court of Human Relations at 10.30 p.m. each Sunday evening. A unique programme entitled "For Men Only," is transmitted at 12.30 a.m. each Monday night. Vocal Varieties at 11.15 p.m. is broadcast on Tuesdays and Thursdays, while Robert L. Ripley and guest artistes, is scheduled for 2 a.m. on Friday nights.

W2XAD introduces a new item entitled "Tapestry of Melodie," which is relayed from Cleveland each Sunday at 8 p.m. It follows the ever-popular Thatcher Colt mysteries. I notice that Jack Benny and Mary Livingston are off the air for the time being, and their 30 minutes on Sunday night at midnight has been taken by the Jello Summer Show, which is relayed from Hollywood.

Words and music is a new listing for 6.30 p.m. each Monday evening, while the Three X Sisters are still carrying on their daily programme at 11.35 p.m. "Science in the News" is an interesting feature at 11 p.m. on August 3, while the "Adventures of Dari Dan" are relayed from Chicago at 10.15 each evening. This short playlet is well worth hearing. I always make a point of listening to Barry McKinley for the short time he is allotted. I notice he has another 15 minutes at 11.15 p.m. on August 6.

The Top Hatters, relayed from Philadelphia at 11 p.m., and the Spanish revue, "El Chico," is scheduled for midnight on Saturday, August 7. These two programmes are supreme in their class. I would very much like to be up early in the morning to hear Jimmie Lunceford and Fletcher Henderson. For those who are interested in early morning listening, these two artists are scheduled for 4.35 a.m. and 5.35 a.m. on August 1.

A directional beam is now in general use from Boundbrook on 16.87 metres between 5 p.m. and 8 p.m. each day. This means that the signal strength in this country is almost twice that which it normally is when the aerial is beamed on Central and South America. This station operates from 2 p.m. with an omni-directional aerial.

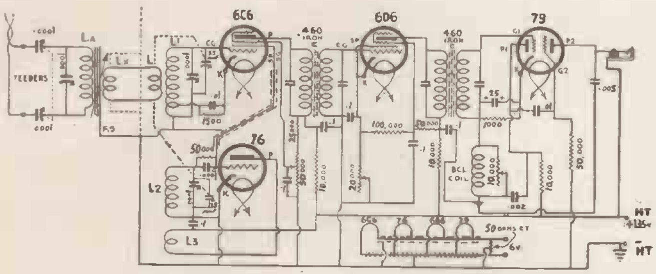
Francia White is relayed from Hollywood and takes part in Fred Astaire's Tuesday broadcasts over the N.B.C. Red network.

The Short-wave Radio World

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

An Ideal Amateur Super-het

IN a recent issue of the Australian publication, *The Sydney Bulletin*, is an interesting design for an amateur super-het receiver built by Don B. Knock, VK2NO. It is easily constructed, is comparatively inexpensive, and gives a remarkable performance considering that only four valves are used. It is claimed that the receiver is almost ideal as regards signal to noise ratio.



This is the circuit of the Ideal amateur super-het so popular in Australia. Full coil details are given in this page.

Owing to the use of 6-volt low-consumption valves, the receiver can be used on either batteries or A.C. supply, working equally well in either way. However, as would be expected, the output from the A.C. supply is higher owing to the extra voltage.

A special super-het circuit is used that gives a better performance than many multi-valve super-hets. Iron-cored intermediate-frequency transformers of 460 kc., are essential, and the designer states that substitution of air-cored transformers will decrease the efficiency.

In order to obtain maximum gain from the first detector, regeneration has been introduced. A 6C6 valve is used as a detector with a triode type 76 as an oscillator.

I.F. amplification is provided by a 6D6, while a 79 performs the functions of second detector with oscillation control for C.W. working, and L.F. amplifier for phone use.

It is interesting to note that plug-in coils are suggested, these coils being wound to cover the amateur band with the best possible L-C ratio. The aerial coupling unit is not essential, but is well worth the slight extra trouble in tuning. However, tests can be made by twisting a few turns of the aerial lead around the grid lead of the 6C6.

The I.F. transformers are Aladdin type A100 which are litz wound on dust iron cores. There are several agents in this country who can supply these transformers. One or two features should also be noted. The primary circuit in the I.F.'s are decoupled by 10,000-ohm resistors and .1-mfd. condensers. This is essential owing to the high gain, and if the decoupling is omitted instability is noticed at maximum gain.

Instead of using a separate B.F.O. valve, regeneration is included in the 79 cathode by merely fitting in series a coil wound for the broadcast range. This is shunted by a 10,000-ohm potentiometer to control the amount of oscillation. To change from phone to C.W. reception the operator has merely to advance the potentiometer until the triode section on the 79 goes into oscillation.

If the receiver is run from the A.C. mains it is advisable to screen the heater leads in copper braid, otherwise slight hum level is noticed at maximum gain.

The receiver is suitable for use down to 10 metres, and the coil dimensions are as above. In every case the coil formers are the standard low-loss 1½ ins. diameter type.

Wavelength	L1 Detector.	L2 Oscillator.	L3 Oscillator Plate.
80 Metres.	40 turns No. 20 D.S.C., spaced to cover 1¾ in. tap at ¾ turn.	33 turns No. 20 D.S.C., spaced to cover 1¾ in.	8 turns No. 24 E, close-wound 1-16 in. from L2.
40 Metres.	12 turns No. 20 D.S.C., spaced to cover 1½ in. tap at ½ turn.	11 turns No. 20 D.S.C., spaced to cover 1¼ in.	5 turns No. 24 E, spaced ¼ in. from L2.
20 Metres.	5 turns No. 20 D.S.C., spaced to cover ⅞ in. tap at at one-third turn.	5 turns No. 20 D.S.C., spaced to cover ⅞ in.	3 turns No. 20 D.S.C., spaced ½ in. from L2.
10 Metres.	3½ turns No. 20 D.S.C., spaced to cover 1 in. tap at one-third turn.	3½ turns No. 20 D.S.C., spaced to cover 1 in.	2½ turns No. 20 D.S.C., ¼ in. from L2 and spaced 1-16 in. between turns.

A Neon Code Practice Oscillator

Much more interest in short-wave reception can be had if listeners were able to understand the hundreds of messages sent in morse code that are so easily picked up on the simplest of receivers. Low power stations are able to transmit more signals all over the world and messages from ships, news bulletins and distress signals can all be understood and appreciated once the morse code has been mastered.

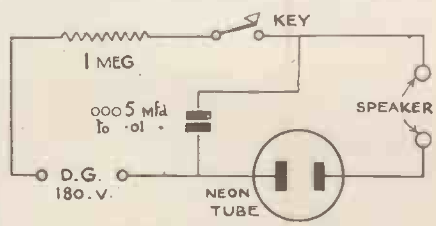
In *Short-wave and Television* for June is described a simple practice set which provides quite a loud signal and enables the operator to practise morse code until he is able to receive signals at quite high speed. The unit when used with a magnetic type of loudspeaker is quite satisfactory, although headphones are to be recommended. The circuit is self-explanatory as there is a minimum of components required. The condenser has a varying value depending on the pitch of the note required. The limits are .0005-mfd. to .01-mfd., but a good average is .002-mfd. If the supply voltage is less than 180 the resistance of 1 megohm should be decreased in value.

We suggest that constructors use one of the simple indicator type of neon bulbs, but before it is put into use the limiting resistance in the base must be removed, otherwise the circuit will not oscillate. There is no possibility of interference being caused to neighbouring receivers, but occasionally when high voltage is used sparks become heavy at the key contact which can be picked up over a few yards. To prevent this spark, connect a resistance and condenser in series across the key to act as a filter. Suitable values are 500 ohms and .002-mfd.

A Sensitive Current Measuring Instrument

In the current issue of *Review of Scientific Instruments* appears an interesting article dealing with the application of valves and gaseous tubes. Of these an improved valve microammeter is particularly interesting for those who require to make measurements of low values of current.

The main parts of this valve meter are a high resistance input circuit, a direct current amplifier of high gain, which is highly stabilised through the use of regenerative feed-back, a large condenser in shunt with the output circuit in order to prevent oscillation, and

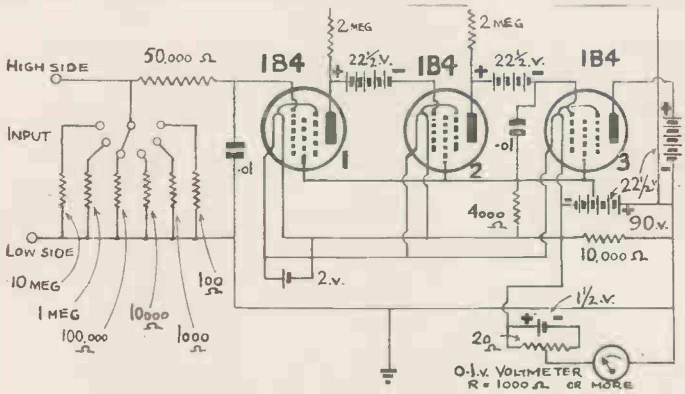


Beginners will find this neon-oscillator very useful when learning morse code.

For the Long-distance Listener

a meter in the output circuit of the amplifier in order to measure the current in the high impedance input circuit.

The theoretical circuit shows the arrangement embodying a battery-operated valve in a meter circuit having a full scale of from 10^{-8} to 10^{-2} ampere. The various current scales are obtained through the use of resistors in the input or grid circuits of the first valve. By using a wide range of input resistors the device becomes an ammeter with a correspondingly wide range.



Sensitive measuring instruments of this kind are essential in an up-to-date laboratory. It has numerous applications.

Any tendency for the amplifier to oscillate is prevented by the capacity resistance series network shown shunted across the grid circuit of the output valve. An odd number of valves must be used in the amplifier in order that the feed-back to the grid circuit of the first valve is of the correct polarity. If the amplifier output circuit is so designed that its saturated output is insufficient to damage the output meter burn-outs can be eliminated.

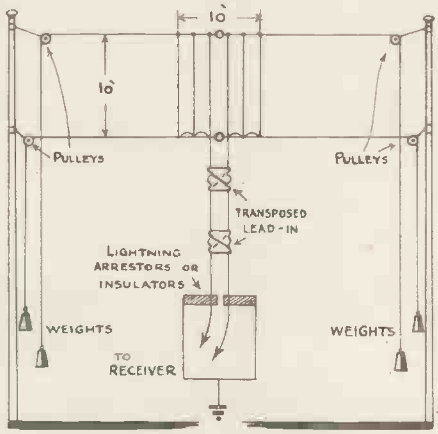
A Noise-reducing Aerial

If all amateurs were to pay as much attention to their receiving aerials as they do to other parts of their equipment then results would be much more satisfactory. One of the biggest problems confronting amateurs situated in large towns is how to reduce noise level caused by local electrical plant without decreasing to any appreciable extent signal strength.

An aerial which does very much to help to cut out man-made static is reviewed in the Australian paper, *The Australasian Radio World*. The aerial can be slung between two poles or between one pole and a chimney-pot providing that the lower wires are at least 15 ft. from the ground.

If necessary the length and number of wires can be increased when ample space is available. Also as the insulators at top and bottom of the grid are slipped on the rope or wire before the aerial is erected, it is advisable to add extra insulators so that ultimately the number of wires can be increased without difficulty.

Transposition blocks should be spaced not more than 2 ft. apart and can be of the conventional Eddystone type. The idea of weights make sure that the aerial is always taut and allows for variations that are caused in wet weather. This aerial has an excellent signal to noise ratio and can be strongly recommended to those who are in local trouble when using highly efficient receivers.



Listening amateurs will appreciate the design of this noise-reducing aerial. It is particularly effective with local interference and is suitable for modification.

A Novel Beat-frequency Oscillator

After reception of morse code signals has been mastered many operators are keen to increase the efficiency or suitability of their receivers for C.W. reception. By introducing an oscillation into the second detector of a superhet receiver, the oscillation can be made to beat up the incoming signal so that it is increased in strength very considerably. It brings out the carrier wave as an audio whistle, so enabling the tuning to be made much sharper.

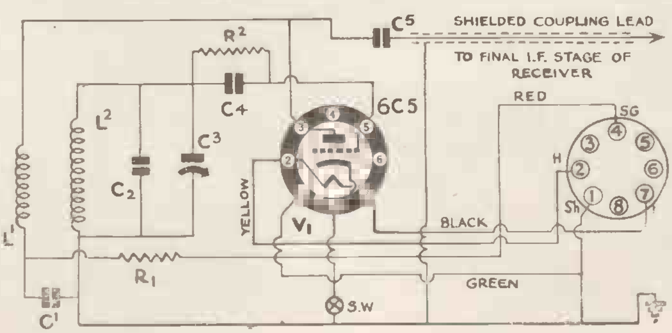
With the standard straight receiver C.W. signals are received much more easily when the circuit is made to oscillate. This idea cannot be added very easily to a multi-valve super-het receiver unless a unit of the kind to be described is used. This unit is intended for connection to commercial receivers. It is wired up in a similar way to the conventional H.F. adaptors and is wired so that it can be connected to the valve socket of a 6F6 output pentode.

This enables filament and anode voltage to be obtained to feed the 6C5 used in the oscillator. The coil is the secondary of a standard I.F. transformer which is loosely coupled to the grid lead of the I.F. amplifier in the main receiver.

On weak signals very light coupling is required, otherwise sensitivity is reduced. As would be expected, a strong signal needs closer coupling which can be arranged very simply by making condenser C5 a variable one. Condensers C1 and C2 are both pre-set, while C3 is of the midget variable type. Component values are approximately as follows:—

- L1, L2 Oscillator coil.
- R1 30,000 ohms.
- R2 10,000 ohms.
- C1 .01-mfd.
- C2 .0001-mfd.
- C3 .00003-mfd.
- C4 .00025-mfd.
- C5 4-10-mmfd.

The B.F.O. can be built in a small, 6 ins. by 6 ins., metal box and in many cases fitted inside the cabinet of a commercial receiver. If the switch is connected externally then the oscillator can be brought into circuit as required.



Amateurs interested in C.W. reception, but who are confined to the use of commercial broadcast receivers will appreciate this beat-frequency oscillator which can be made up as a separate unit with self-contained tuning circuit.

The Magic Eye— Many Practical Applications

Most modern receivers include the Magic Eye visual tuner which was originally designed by the R.C.A. Company. This tuner has many other practical applications of interest to the experimenter. The information in this article was supplied by courtesy of Messrs R. C. A., Harrison, N.J.

THE visual indicator valves known as the R.C.A. 6E5 or British Mazda type AC/ME orginally designed for tuning indicators in receivers, both have characteristics which make them suitable for use in many types of

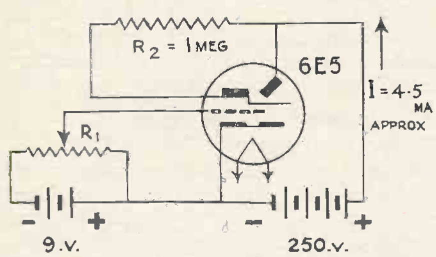


Fig. 1.—The basic circuit of the tuning indicator.

electronic devices where an *indication* of voltage or current, maxima or minima, is desired.

In addition to indications of maxima or minima, the tuning indicator can be utilised for quantitative measurements in devices which require calibration or which operate on the voltage balancing principle of the slide-back valve voltmeter.

The 6E5 essentially consists of a high-mu triode above which is located a cone-shape fluorescent target and a blade-like ray-control electrode; the latter is internally connected to the triode anode. The simple circuit in Fig. 1 illustrates the operation of the indicator. With zero bias on the triode grid the fluorescent pattern caused by electrons striking the coated target have a shadow sector of about 100 degrees as shown in Fig. 2. The electronic shadow is cast on the target because the ray-control electrode is at negative potential with respect to the target; the bias on the ray-control is caused by the IR drop across the anode resistor R2 when triode-anode current exists.

When the triode grid-bias is changed from zero to a negative value by means of R1 the triode-anode current decreases, the voltage drop across R2 decreases, the ray-control electrode becomes less negative with respect to the target, and the shadow sector closes to a smaller angle. With 6 or 8 volts of negative bias on the triode grid all anode current through R2 is cut off and the shadow sector is reduced to a narrow, dark line, as illustrated by the second part of Fig. 2. Slightly more bias on the triode grid may cause the pattern completely to close or even to over-close; in the latter case the dark line may change into a narrow luminous line having greater brightness than the remainder of the pattern.

A Voltage Indicator

Because the variations of the fluorescent pattern on the target are controlled by the negative bias on the triode grid, it is apparent that the 6E5 is a voltage indicating device which draws substantially no power and can be used across high-impedance circuits with little or no loading effect. The actual variations of shadow angle, anode current and target current with respect to grid voltage, are shown in the average control characteristics in Fig. 3.

The Indicator in a Valve Voltmeter

One of the most useful applications of the 6E5 is that of balance indicator in a

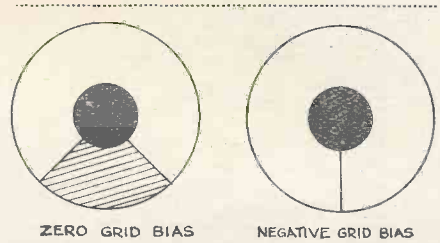


Fig. 2.—The patterns obtained on the indicator as explained in the text.

slide-back type valve voltmeter. An instrument of this type having a voltage range of 200 volts is shown in Fig. 4. Refer to this circuit and assume that the input terminals A and B are shorted and that the movable arm of slide-back potentiometer R7 is at the positive voltage end of its range, at which setting d-c voltmeter V will read zero. The anode current of the triode-connected input-coupling valve (6J7, 6C6, 57 or Acorn 954) is practically cut off due to the biasing action of the 2-megohm cathode resistor, R1.

As it requires approximately −14 volts to obtain approximate cut-off of the 6J7 anode current, the cathode end of R1 is at a potential of positive 14 volts with respect to the lower, or negative, end of R6. The zero setting potentiometer R5 is next adjusted so that the potential of the 6E5 cathode is approximately 21 volts positive with respect to the negative end of R6. This 21 volts in series opposition to the 14 volt drop across R1 places a net voltage of -7 volts on the grid of the 6E5 with respect to its own cathode. So the pattern on the target will close to a narrow dark line which is the correct initial setting for all valve voltmeter measurements.

If the test prods are applied across any d-c or peak a-c voltage of suitable value—0.5 to 200 volts—which it is desired to measure, the anode current flowing through R1 will increase by an amount substantially proportional to the d-c or *peak* a-c voltage applied. The action is similar to that of a diode-rectifier except that practically no power is drawn by the negative-grid input circuit. In the case of a-c voltages rectification occurs on the positive half cycle and the large condenser C1—shunted across R1—holds the d-c voltage developed across R1 at practically the peak value of the a-c wave.

Because of the 2-megohm circuit across which it is shunted, condenser C1 must be of a *high quality, low-leakage* type; a good paper condenser is satisfactory. The capacity value of C1 depends on the lowest frequency a-c voltage that might be measured. A value of

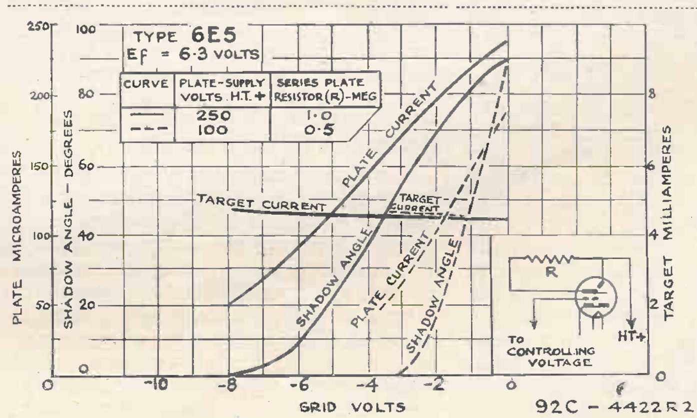


Fig. 3.—Average control characteristics.

A Valve Voltmeter :: Testing

4-mfd. is suitable for frequencies of 50 cycles per second or higher. In the case of d-c voltages, terminal A of the valve voltmeter is always connected to the positive side of the input voltage.

meter reading of 0.6 and 1.75 volts respectively. This percentage error is naturally smaller for larger values of a-c voltage, so that the higher a-c readings are quite accurate.

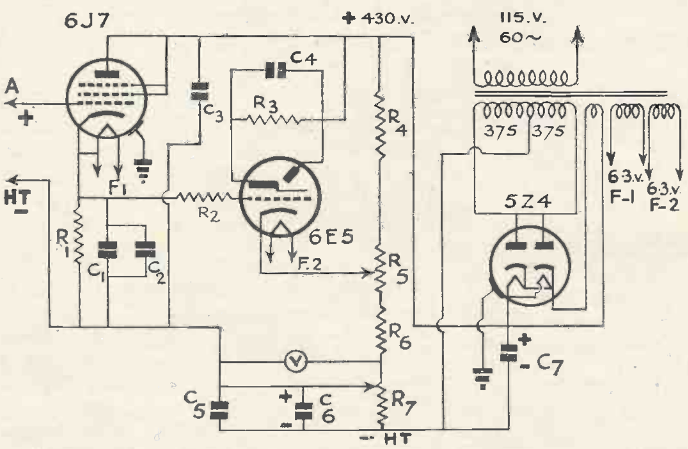


Fig. 4.—This meter has a range of 200 volts.

To complete the explanation of the valve voltmeter operation, assume that a d-c voltage of 10 volts is applied to the input terminals. The IR drop across R1 will be 14 plus 10, or 24 volts. This places a voltage of 24-21, or plus 3 volts on the grid of the 6E5, causing the shadow sector to open. The slide-back control R7 then has to be moved forward towards its negative end until voltmeter, V, indicates 10 volts before the original -7 volts of bias is again restored to the grid of the 6E5. So when the voltage introduced into the circuit by R7 is adjusted just to cancel the unknown input voltage, the pattern of the 6E5 is then functioning as a voltage-balance indicator.

The use of a protected resistor, R2, in the grid circuit of the 6E5 is important because any input voltage exceeding 7 volts will drive the grid of the 6E5 positive. The IR drop across R2 developed by the 6E5 grid current automatically biases the valve so that the grid current cannot reach a value high enough to be harmful.

Accuracy of the Valve Voltmeter

In general the accuracy of this type of instrument depends upon the care with which the fluorescent pattern is adjusted before and after the unknown voltage is applied as well as upon the accuracy of the d-c voltmeter V. D-c voltages between 25 and 200 volts can be read to 1 volt or better, depending on the readability of the voltage scale on V. Between 0.5 and 10 d-c volts the accuracy is plus or minus 0.1 to 0.2 volts. A-c voltages will give readings which are in error by a fairly constant value of 0.8 to 1.3 volts on the low side of the correct value. This error is apparently due to the reaction of the negative half cycle on the static value of the 6J7 anode current. For example a peak a-c voltage of 1.4 and 2.8 volts gave a

The error on low a-c voltages is not disturbing as the instrument can readily be calibrated for these voltages by means of a variable a-c source of known voltage. The calibration can be made

APPLICATIONS OF THE VISUAL TUNER

1—Tuning Indicator
2—Valve Voltmeter
3—Negative Peak Over-Modulation Indicator
4—Tuning Indicator in Non-A.V.C. Receivers
5—A Null Indicator
6—Modulation Meter
7—Anode Voltage Measurements in R.C. Coupled Circuits
8—Ripple Voltage in Radio Receivers
9—Peak Anode Current of Mercury Vapour Rectifiers
10—Audio Frequency Output Meter
11—Stage Gain Meter
12—For Measuring Transformer Ratios
13—A.V.C. Voltage Measurement
14—I.F. Transformer Alignment

in terms of either or peak values. It is important to remember, however, that the voltage indicated by V is invariably of terms of either d-c or *peak* a-c. If the a-c input voltage has reasonably good wave form the peak a-c readings can easily be changed to values by multiplying them by the factor 0.707.

Other Valve Voltmeter Considerations

A voltage calibration of slide-back potentiometer R7 can be made if it is desired to eliminate d-c voltmeter V from the circuit. This arrangement will not, of course, provide as good accuracy as with a d-c voltmeter having several voltage scales. If mandy measurements are to be made in the low voltage range of 1-10 volts a 500 ohm potentiometer should be placed in series with R7 as shown in Fig. 5. A single-pole double-throw switch is required to change from the 10 to the 200 volt range. The switch must be thrown to the low-voltage scale and the 500-ohm potentiometer adjusted to zero in order to make the initial zero setting with R5, even when a voltage higher than 10 volts is to be measured; the switch is thrown back to the 200 volt scale after the zero setting is made with R5.

The mounting of the input valve is quite important. Where RF voltages are to be measured the capacitance of the input circuit must be kept as low as possible. The well-known "goose-neck" probe construction is recommended for this reason. If very many R.F. measurements are contemplated a 954 acorn valve connected as a triode should be used in place of the 6J7 for the loading introduced by the 954 is relatively small.

Application of the 6E5 Valve Voltmeter

Because the valve voltmeter described has a considerable voltage range, does not draw any current, and can be used across a high-impedance and high-frequency circuits, it has a multitude of uses.

The A.V.C. circuit of a refractory super-het receiver can easily be checked. Prod A is connected to the cathode of one of the controlled R.F. or I.F. stages and prod B to the earth side of the R.F. or I.F. transformer secondary. The A.V.C. bias variation can be accurately measured either on a signal or with a test oscillator. The 6E5 will at the same time serve as a resonance indicator or as an alignment meter because the A.V.C. voltage varies as the different circuits are adjusted.

Valve screen and anode voltages can be checked with precision even though a very large series resistance is included in the circuit. The true anode voltage at the anode end of a resistance-coupled low-frequency amplifier can quickly be determined even if the anode load has a value of 500,000 ohms. If the L.F. valve is correctly biased the voltage at the anode will usually be about one-half of the supply voltage.

The operation of radio frequency or I.F. stages can be roughly checked by measurement of the R.F. voltage across the transformer secondary. The test lead from prod A should be short and have a

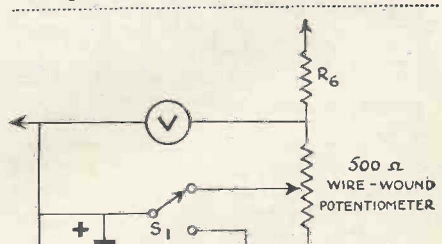


Fig. 5.—A slide-back valve voltmeter for low voltage readings.

Watts Output :: L.F. Gain :: Modulation

minute capacitance to earth. The 6J7 may, even with very short input leads, place a capacity load of 5 to 10 mmfd. across the transformer; this will detune the circuit under test.

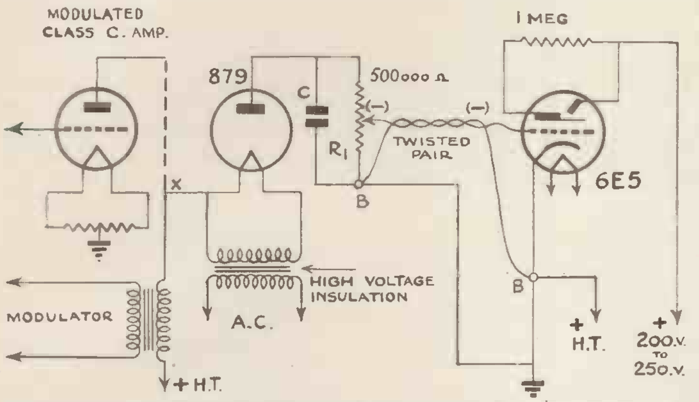


Fig. 6.—A negative peak over-modulation meter.

Where an output meter is needed for low-frequency the test prod can be applied to almost any part of the low-frequency circuit. If it is necessary to separate an L.F. voltage from a d-c voltage, in such application a 0.1 mfd. blocking condenser and a 1.5 megohm grid leak can be employed at the input to the valve voltmeter. In addition to serving as an L.F. output meter the valve voltmeter can be used to measure the peak a-c driving voltage applied to the grid of the L.F. valve.

L.F. Gain

The gain of the low-frequency stages can also be measured. A known *peak* L.F. voltage such as a 50 cycle source shunted by a known voltage divider is applied to the grid of the L.F. valve under test. The peak a-c voltage across the anode load is next measured; this value divided by the known input voltage gives the voltage gain of the stage at the particular test frequency employed.

Transformer Ratios

Determination of transformer ratio is also a simple test. A suitable a-c voltage is applied to any winding and that voltage measured. The voltage of any other winding can also be measured and a ratio of the two peak voltages is substantially that of the two windings.

Speech Output in Watts

Power output from an audio power amplifier can be determined with the aid of a valve voltmeter and a little arithmetic. A test signal of, for example, 1,000 cycles from an audio oscillator having a reasonably good waveform is applied to the audio system at any convenient stage.

A pure resistance load of the correct resistance and wattage is shunted across the primary of the audio output transformer. A value of 7,000 ohms for example is required in the case of a single 47 pentode. The secondary load of the output transformer is disconnected and the test signal increased until its peak value at the grid of the output valve or at one grid in a push-pull stage, is the maximum permissible for the stage under test. For a power valve operating in Class A or Class AB the peak signal should not cause d-c grid current to flow. The peak a-c voltage across the anode load

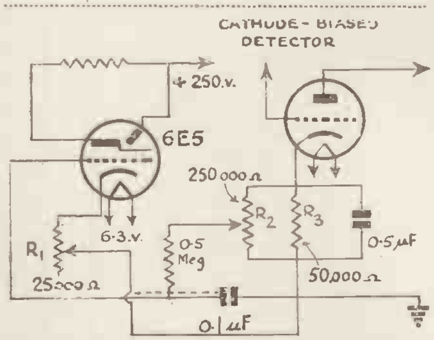


Fig. 7.—A tuning indicator for non-A.V.C. receivers.

resistor is then measured. Taking again the 47 as an example, the measured peak output voltage (E_{pk}) is 186 volts. Changing this to an r.m.s. value for power calculations, we obtain E_{rms} = (0.707) (186) = 132 volts. From the relation $P = E_{rms}^2/R$ we find that $P = (132)^2/7{,}000 = 2.5$ watts to the power output.

Peak Anode Current Checks

Peak anode current of a mercury vapour rectifier can be measured as a check on the correct operation of the rectifier valve. A 100-ohm or other suitable value resistance is joined in series with the negative H.T. lead of the rectifier between the transformer and the filter system. The valve voltmeter measures the peak d-c voltage developed across the resistance, the rectifier being operated under normal load. Ohms Law gives the peak d-c anode current in the circuit, $I_{pk} = E_{pk}/R$.

Hum Level

The ripple voltage of a high voltage rectifier can readily be checked if there is sufficient ripple voltage to measure. (0.5 or more). A d-c blocking condenser and leak input circuit must be used for the valve voltmeter with, of course, a condenser of necessary high-voltage rating. The peak ripple voltage is measured across the filtered output of the supply in the usual manner for measuring small a-c voltages.

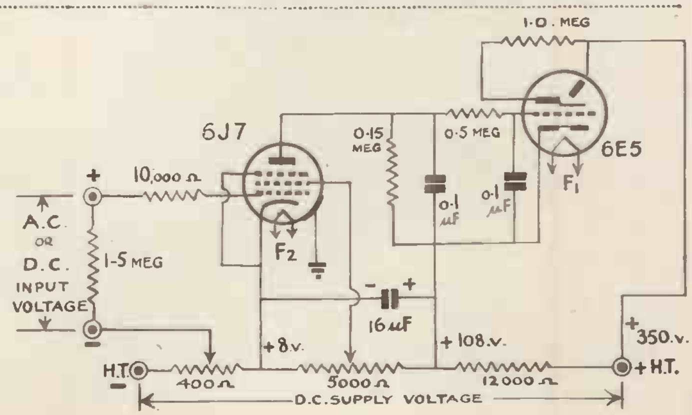
Transmitter

Transmitting amateurs will appreciate the many uses to which a valve voltmeter can be put in adjusting the various stages of a transmitter. It may be used as an ultra-sensitive neutralising indicator merely by employing it as an R.F. output meter across all or a portion of the anode tank circuit of the stage being neutralised. The voltage measured will be at a minimum when the point of best neutralising is determined. Test prod B should be placed at the R.F. voltage node on the tank coil, for this input terminal has a lower impedance to earth at high frequencies than terminal A.

Modulation Meter

As a modulation meter the valve voltmeter will measure the percentage of

Fig. 8.—A voltage minima indicator for bridge circuits.



For Bridge Circuits :: Over Modulation

modulation with good accuracy, provided the modulation is symmetrical and the carrier is not subject to appreciable shift. A small amount of R.F. voltage picked up at the modulated R.F. stage and transferred to the valve voltmeter through a low-impedance line is measured. Assume that this voltage with no modulation on the carrier is 10 volts. At 50 per cent. modulation the valve voltmeter will read 15 volts; at 100 per cent. modulation it will read 20 volts, that is twice the non-modulated value. Only positive modulation peaks can be indicated by this method.

Over Modulation

As an over-modulation indicator the valve voltmeter can be operated in a somewhat different manner. Slide-back potentiometer R7 is adjusted *just to cancel* the non-modulated carrier voltage and the d-c voltmeter reading noted. R7 is then adjusted so that V reads about 95 per cent. higher than the first setting. This over-biases the 6E5 and over-closes the pattern.

When the pattern begins to open slightly as the carrier is modulated the positive modulation peaks are beginning to exceed the 95 per cent. modulation point. The only disadvantage of this arrangement is that the indicator does not show the effect of carrier shift or of over-modulation on the negative modulation peaks. It is the negative modulation peaks which create maximum interference when they reach carrier cut-off point owing to the resultant flattening of the modulation carrier on one side.

A Negative Peak Over-modulation Indicator

Another application of the 6E5 not involving the valve voltmeter is shown in Fig. 6. Here the electron ray tube is used in conjunction with a higher voltage half-wave valve rectifier. This arrangement operates as a negative peak over-modulation indicator in the following way. When the a-c modulating voltage at point X swings positive the rectifier does not pass current because its filament is at a positive potential in respect to its anode. When the modulated voltage swings negative at the point X the rectifier still fails to pass current until the negative audio frequency peak *exceeds* the d-c anode voltage applied to the Class C modulated R.F. amplifier.

When this does occur, causing carrier cut-off, the instantaneous voltage at X is negative in respect to the anode of the rectifier and the latter then passes a rectified d-c current through the load resistor R1. This current, causing a d-c voltage drop across R1, negatively biases the grid of the 6E5. The pattern of the 6E5 therefore shuts when the negative audio frequency peaks are great enough to cause carrier cut-off. This happens irrespective of possible carrier shift.

It is apparent that this device is exceedingly sensitive to the slightest negative peak over-modulation insomuch as only 7 volts are required completely to close the indicator.

Sensitivity can be controlled by potentiometer R1 in Fig. 6 which regulates the amount of excess modulating voltage applied as bias to the 6E5. The size of condenser C controls the speed with which the tuner reopens after an excessive modulation peak has passed.

An Indicator in Non-A.V.C. Receivers

It is, of course, well-known that the Magic Eye is ordinarily used in receivers employing automatic volume control with a diode-detector. The electron ray tube can also be used in a receiver having neither A.V.C. nor a diode-detector. The alternative arrangement is suitable for tuned radio frequency or super-het receivers employing a cathode-resistor-bias-detector, as shown in Fig. 7. Potentiometer R2 is set at the detector cathod potential. This places a positive voltage, equal to the no signal bias of the detector, on the grid of the 6E5, opening the "eye." Cathode resistor R1 in the 6E5 circuit is then adjusted *just to close* the "eye" to a narrow line.

When an R.F. signal is tuned in the anode current of the detector rises, the voltage drop across R2 and R3 increases, and the 6E5 pattern slightly opens. At the point of correct tuning the pattern will have opened to a maximum; detuning the receiver will cause it to close again. The 6E5 thus acts as a visual tuning indicator, but operates exactly backward with respect to its usual pattern movement. The backward operation of the "eye," however, is not objectionable—the larger the shadow the better the tuning.

If a very strong signal develops so much voltage across R3 that the pattern fully opens and loses its indicating value the arm of R2 should be moved towards earth. R1 must then also be re-adjusted for a closed pattern under no signal conditions.

A Zero Indicator

A more unusual application of the 6E5 is that of a null or voltage minima indicator for bridge circuits. Fig. 8 indicates such a device including a 6J7 signal amplifier. The input terminals of the null indicator should be connected across the balance points in the bridge circuit. Either an a-c or d-c voltage may be used across the bridge circuit as far as the null indicator is concerned.

The 6J7 is operated as a d-c amplifier with an adjustable grid-bias supply provided by the 400 ohms potentiometer in the bleeder circuit. The grid-bias and screen voltage controls are adjusted under no signal conditions so that the anode current is almost cut-off. The screen voltage is important as regards the sensitivity of the 6J7 on small a-c signals. A small amount of no signal current flowing through the anode resistor of the 6J7 will produce about 3 or 4 volts of negative bias on the grid of the 6E5 through the 0.5 megohm filter resistance. This bias voltage will cause the 6E5 pattern to close about half-way.

The AC/ME cathode-ray tuning indicator is fitted with a 7-pin base and designed for horizontal mounting.

If a small d-c or a-c voltage appears across the input terminals, as is the case when the bridge circuit is unbalanced, the anode current of the 6J7 increases so placing more bias on the 6E5 grid and closing the pattern to a narrow line. As the balance control on the bridge is adjusted to a point on either side of the correcting nodal point, the "eye" may keep entirely shut. At the nodal point it will open to the same maximum angle at which it rests under no signal conditions. The nodal point can be accurately determined by noting the position of the balance control on the bridge at the two points, one on each side of the nodal point at which the "eye" just closes to a narrow line. The nodal point can then be found on the balance control half-way between the two points mentioned. The sensitivity of the indicator is estimated to be about 10 millivolts.

The 10,000 ohms protective resistance in the 6J7 grid circuit is essential. In case a relatively large voltage appears across the input terminals, this resistor will prevent excessive d-c grid current due to the extra d-c bias automatically applied to the grid of the 6J7.

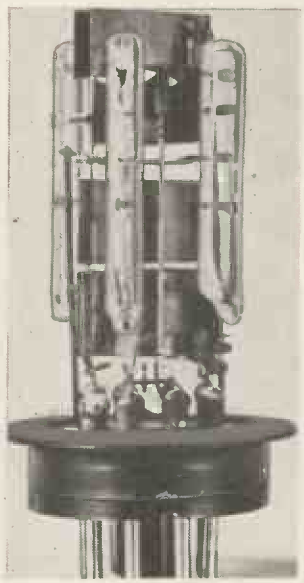
A Miniature Cathode-ray Oscilloscope

Linear Time Base Attachment

By G. Parr

THE linear time base forms a separate unit from the oscilloscope but is connected to it by a short length of 4-core cable which carries the H.T. and L.T. supplies from the rectifier. The separate unit also incorporates a single stage of amplification which can be used in conjunction with either the vertical or horizontal plates of the tube for magnifying low inputs.

A front view showing the controls of the linear time base.



The R.C.A.913 C.R. tube having a screen of 1 in.

The unit is mounted in a " Magnum " steel box measuring 6½ in. cube. These can be obtained from Webb's Radio of Soho Street, or from the makers, Messrs. Burne Jones, and are valuable for assembling all sorts of minor accessory circuits for the C.R. equipment and other jobs. The box should be disassembled and two adjacent sides marked out according to the diagram of Fig. 1. The hole on the left is for the fixing of a Bulgin 4-pin valveholder to take the H.T. and L.T. connections. The right hand side, which will be in the front of the box is drilled with three 3/8ths clearing holes for potentiometers and one 1/4 in. hole (marked) for the multi-contact switch. The holes below are for three sockets which should be slightly different from each other to avoid confusion. The actual dimensions of these holes is determined by the type of socket used. A baseboard 6 in. square is also required.

Circuit

The time base is of the standard condenser thyratron type, the output being taken through a valve amplifier as shown in the circuit diagram of Fig. 2. The connection to the grid of the amplifier is made through one of the plugs and sockets in the front panel, so that the time base can be disconnected when it is required to use the amplifier by itself.

Variation in speed of the sweep is made by adjusting the variable resistance R_3 in conjunction with the selector switch controlling the charging condensers. These are not shown in detail in the circuit diagram, but are given in the list of components and are connected one to each of the contacts of the switch, the highest capacity on the left.

The time base is synchronised to the input wave by means of the potentiometer and condenser R_1 and C_1. The degree of " locking " varies considerably with the frequency of the applied wave, owing to the variation in the impedance of the condensers and to reduce the effect on the higher frequencies a smaller series condenser has been included between the synchronising socket and the resistance. This condenser is connected across the switch contacts of the resistance switch so that it is short circuited before the slider is moved over the resistance.

Alternatively, this extra condenser can be omitted and a plain potentiometer used instead.

The bias for the thyratron is obtained from the common bias resistance R_8 in the pentode cathode circuit and this is by-passed by a 25 mfd. condenser C_8.

Layout

A diagram of the layout of the baseboard is not given as it can be varied without introducing complications. It is advisable, however, to undertake the wiring in a certain definite order as some leads are difficult to solder after the components are in place. The two baseboard valveholders are screwed

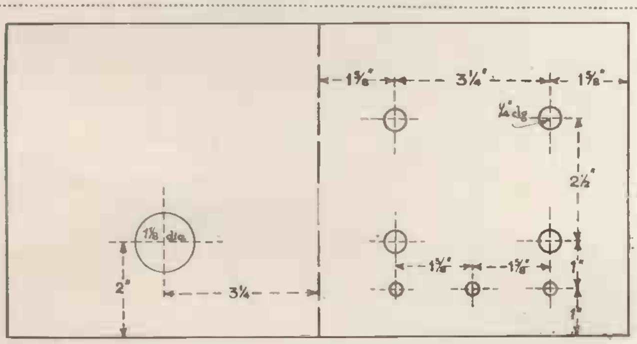


Fig. 1. Drilling dimensions showing the side of the cabinet to the left and the face to the right.

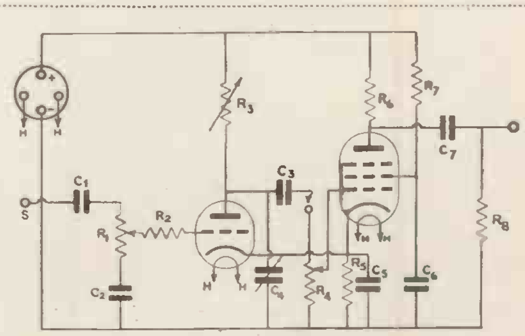
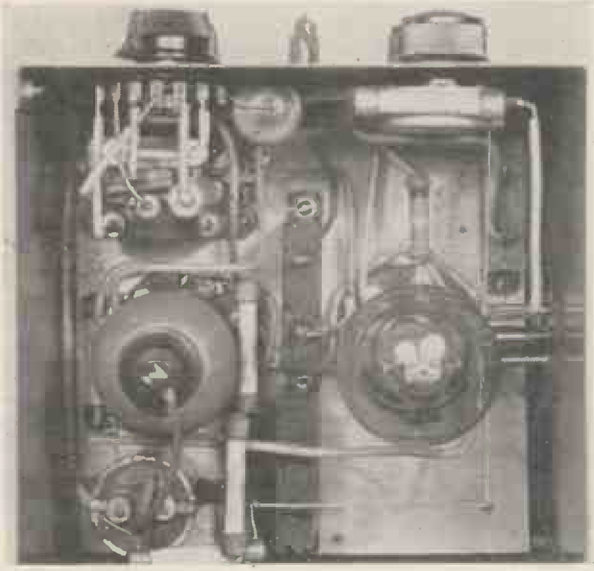


Fig. 2. The circuit diagram of the linear time base attachment.

Testing :: Final Construction

down in the centre of the baseboard, room being left between them for the screen decoupling condenser C_6 and the thyratron coupling condenser C_3. The fixed condensers associated with the multi-contact switch are mounted just below it on the board. The resistances can be hung in the wiring. Before fitting the baseboard into place, solder three leads to the sockets in the bottom of the front panel as these will be difficult to get at after the baseboard is screwed down. To complete the wiring, the whole box is disassembled and the baseboard and sides carrying the components fastened into place. The remaining sides can be fitted after everything has been finished and the set tested. The four-pin valve socket for the input leads should be fixed to the side of the box before it is fastened down.



Components are laid out in this way. This plan view shows the two valves, a T31 and an ACVP1 with their associated resistance and condenser networks.

The fixing of the variable resistances is as follows: Looking at the front of the box, top left is R_3 the speed control. Below it is the synchronising potentiometer R_1.

Below this is the plug for the synch. connection. In the centre is the plug and socket connection for the input to the valve amplifier, and to the right we have the condenser switch at the top of the panel, the amplifier input potentiometer below and the output socket below that. This socket should match the one already on the unit to avoid confusion. The wiring for the synchronising should be completed first as this is difficult to do after other leads have been put into place. When wiring up the input socket, use the anode pin for the H.T. + and the grid pin for the H.T.—, the filament pins being for the L.T.

For attaching the unit to the existing C.R. tube box a similar 4-pin socket will be required. To fit this, remove one side of the box opposite to that which has the mains input socket and cut a 1 1/8 in. hole 2 in. down from the top edge in line with the 4 mfd. condenser (see layout in last month's issue).

It is essential to use a Bulgin 4-pin socket for this as the contacts are sufficiently short to clear the condenser case; the centre contact can be removed if a 5-pin socket is used. Be careful to take the H.T. + connection to the amplifier H.T. and not to the tube. The L.T. supply is taken from the amplifier socket in the tube compartment.

Testing

Switch on the C.R. unit and check that the H.T. is at the anode of the valve amplifier in the time base. With the valve in, the anode current should be between 3 and 5 mA, but this figure depends on the type of valve used. Join the socket on the right (output) to the socket on the unit which is connected to the horizontal plate, withdrawing the 150 v. A.C. plug for the purpose. Join the earth terminals, and a line should appear on the screen of the tube. If the time-base stops altogether as the speed is decreased, the bias on the thyratron may be too high, and the 1,000 ohm bias resistance can be split into two of 750 and 250 ohms, the thyratron bias being obtained from the tapping between them. This should not, however, be necessary with the values specified.

When a waveform is applied to the vertical plates, the linearity can be adjusted by the amplifier input. It will be found that the trace is slightly off centre at low amplitudes, which is inevitable with the method of connection of the plates in the tube. As the input to the amplifier from the time-base is increased the wave will broaden on the screen and one or two good traces will be seen. The effect of synchronising can now be tried, the synch. socket being connected to the input wave. Remember that the synch. potentiometer will impose an additional load on the circuit and may distort the wave. As the potentiometer is turned the "locking" of the wave may increase to such an extent that the time base itself is distorted. This can be seen on the screen by the turning over of the end of the trace.

If the time base is non-linear at certain speeds it is permissible to increase the resistance of the grid circuit of the amplifier to reduce the loading on the thyratron and condenser. A series resistance of 1 megohm in the top end of the potentiometer is sufficient, but this will at the same time reduce the available input to the valve when used as a plain amplifier. If it is required to use the valve alone, withdraw the centre plug from the socket and plug in the input under test.

The amplitude of the trace on the screen is then controlled by the grid potentiometer in the usual way. The values of condenser and leak are sufficient for the range of audio frequencies, but if R.F. is to be used, a choke should be connected in the anode circuit of the amplifier to give a boost to the higher frequencies.

Components for
A MINIATURE CATHODE-RAY OSCILLOSCOPE.
Linear Time Base Attachment.

CABINET.
1—Steel box 6½ ins. cube (Burne-Jones).

CONDENSERS, FIXED.
1—.01-mfd. type 50 (C1) (T.C.C.).
1—.001-mfd. type 50 (C2) (T.C.C.).
1—.25-mfd. type 84 (C3) (T.C.C.).
7—Condensers on switch as under (C4):
.25-mfd. tubular (Bulgin).
.1-mfd. tubular (Bulgin).
.05-mfd. tubular (Bulgin).
.01-mfd. type 50 (T.C.C.).
.005-mfd. type M (T.C.C.).
.001-mfd. type M (T.C.C.).
.0005-mfd. type M (T.C.C.).
1—25-mfd. 25 volt type 3016 (C5) (Dubilier).
1—.25-mfd. type 84 (C6) (T.C.C.).
1—.1-mfd. type 84 (C7) (T.C.C.).

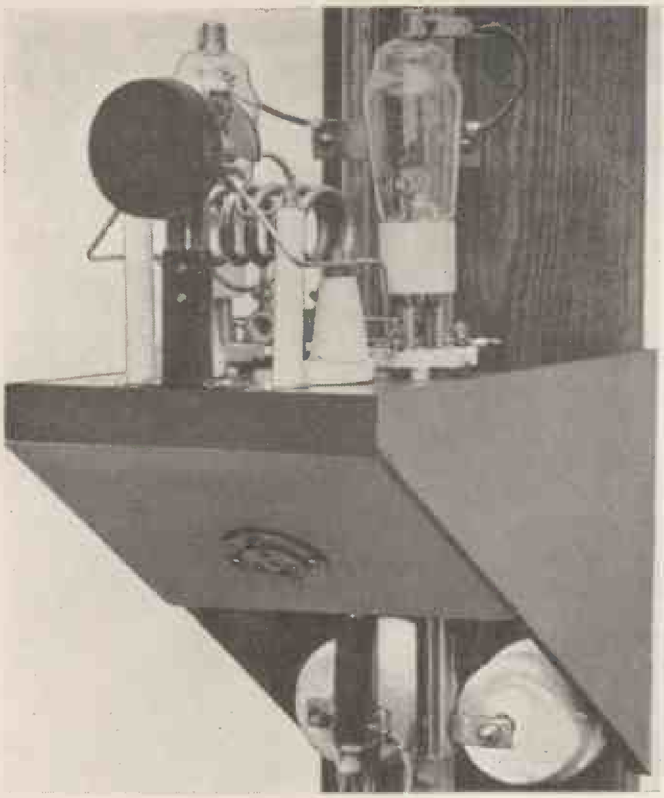
HOLDERS, VALVE.
1—7-pin baseboard mounting holder (Bulgin).
1—5-pin baseboard mounting holder (Bulgin).
1—5-pin chassis mounting holder, type VI, less terminals (Clix).

PLUGS, SOCKETS, ETC.
3—Insulated plugs and sockets, type 1015 (Belling-Lee).

RESISTANCES, FIXED AND VARIABLE.
1—2-megohm potentiometer with switch (R1) (Bulgin).
1—20,000-ohms ½ watt (R2) (Bulgin).
1—.5-megohm variable and one .25-megohm fixed (Dubilier). (R3)
1—2-megohm variable type B (R4) (Dubilier).
1—1,000-ohms ½ watt (R5) (Bulgin).
1—100,000-ohms 1 watt (R6) (Bulgin).
1—200,000 ohms 1 watt (R7) (Bulgin).
1—2-megohm ½ watt (R8) (Bulgin).

SWITCH.
1—7-point (Kabi).

VALVES.
1—T31 (Mazda).
1—ACVP1 (Mazda) or AC/S2/Pen.



This illustration shows quite clearly the layout of the transmitter components in respect to the grid lines.

A Long Line 5-metre Transmitter

This transmitter is inexpensive to build, but is decidedly more satisfactory than the conventional push-pull oscillator. It uses battery operated valves, and was designed by G2HK.

BEING keenly interested in ultra-short wave work and most dissatisfied with the results obtained with a self-excited oscillator, I have been building numerous experimental transmitters to try and find a design which would give good frequency stability coupled with high output without going to too high a cost.

For various reasons, mainly space, the long-line anode and grid transmitter could not be utilised, while the usual arrangement with long-lines in one circuit was not convenient.

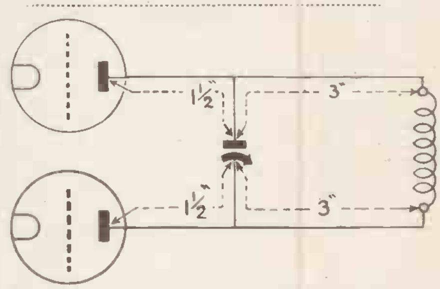
Practical Considerations

Crystal control, even with double valves of the 6A6 type, meant higher cost and multiplicity of stages, with far too many components for my liking. Realising that at least one circuit would have to employ resonant lines, I forgot for a moment the technical aspect and devoted a considerable amount of time to the practical side. By this I mean finding a layout that would give maximum efficiency, but at the same time would not take up too much benchroom. Ultimately I hit upon an arrangement that suits my purpose in every way, and as my radio room is similar to that used by many other amateur transmitters, the idea should be generally useful.

Examine the illustration showing the entire transmitter, for then the following details will be more simply understood. The whole equipment is mounted on a 48 ins. plank with a block of wood fixed crossways at each end. The idea of this was not so that connecting wires could be mounted under the plank, but so that the whole could be hung on the wall. The transmitter has the top edge hooked on to a picture rail, so that the amount of room-space taken is negligible. Actually I had a space on the wall where this apparatus could hang quite nicely, and as the power supply was interconnected by means of a 4-pin socket the modulator and other etcetras could be in any convenient spot. Also, to everybody's surprise, the fact that the grid lines were so close to the wall did not cause any appreciable losses.

Low Loss

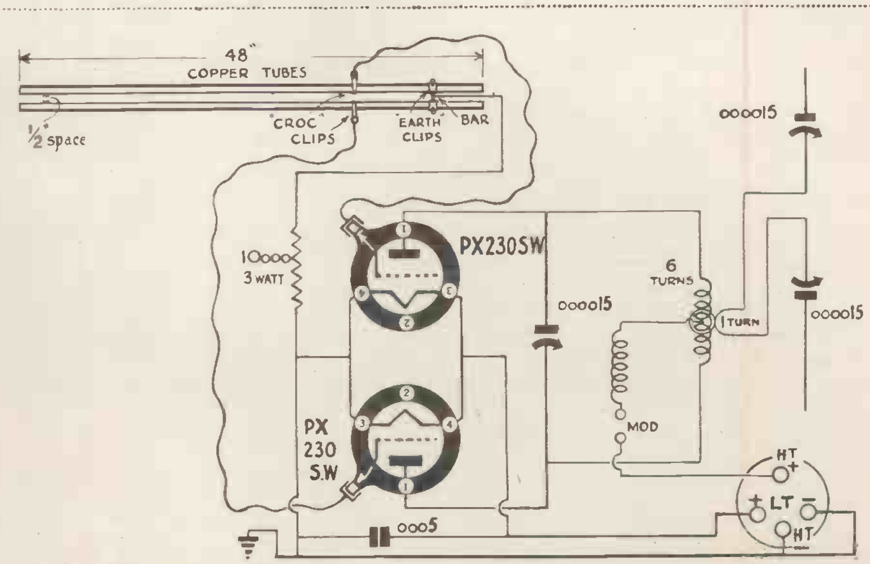
As I did not want to use high power any DX results could only be obtained by maximum efficiency. I have found



Providing the anode leads are to the length shown the transmitter will tune approximately to the 5-metre amateur band.

in the past that it is the simplest thing in the world to hook up a 5-metre transmitter with a 2 or 3 turn tank coil and appear to obtain fairly good results. However, by decreasing losses and reducing capacity wherever possible, a much larger tank coil could be used giving an unbelievable increase in R.F. output.

However, all these points will be dealt with later. First of all examine the complete circuit. The most important items are the two grid lines which were made up from two lengths of



This is the complete circuit showing how the grid lines are interconnected in the circuit.

Tube Mounting :: Special Valves

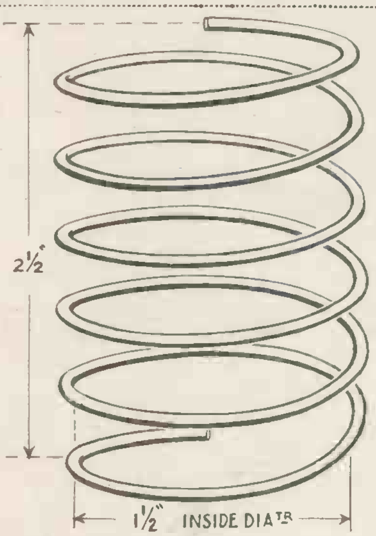
48 ins. copper tube, ½ in. diameter and approximately 1/16 gauge walls. This copper tube is very scarce at the moment, but I have found a reliable source of supply for this and all sorts of copper from the Midland Tube and Metal Company, New House, Hatton Garden.

Originally these two lines were mounted on home-made stand-off insulators, although the conventional beehive insulators are quite satisfactory.

Some difficulty was experienced in accurately drilling fixing holes through the ½ in. hard drawn copper tubes, while some of the beehive insulators had too short a shank to pass through the tube and to allow sufficient threading to take the wing nut on the top. This trouble, however, was overcome quite simply.

Mounting the Tubes

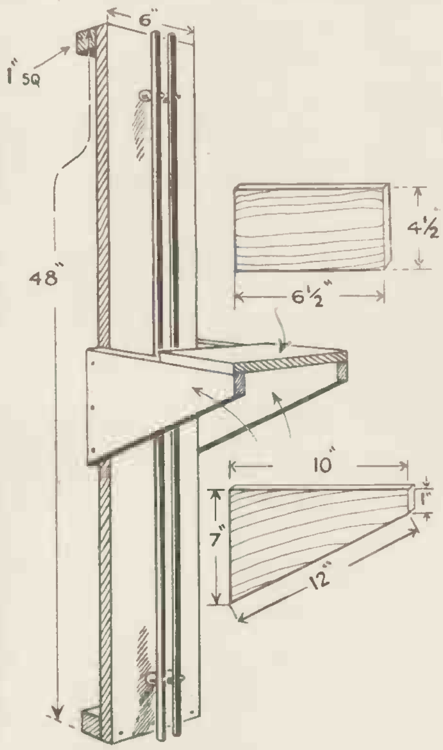
Four strips of brass were obtained and cut to approximately 1 in. by ¼ in. and soldered to the copper tube. The brass was drilled and this was then fixed to the beehive insulators. For those who, however, wish to make their own stand-offs, I suggest that you follow the idea shown in the photographs. Porcelain ceiling roses can be obtained for about 2d. each, and these should be fitted with a length of O.B.A. brass studding. A large nut should be soldered to one end inside the rose, while the other side is



The anode coil is most important. Here are the dimensions using 12 gauge wire.

locked by the usual nut. This makes quite a nice stand-off, while the studding can be of almost any length to suit individual requirements. In fact, a 4 ft. length of studding mounted in this way makes quite a good 5-metre receiving aerial.

Four of these insulators are required and they should be mounted so that the copper tubes are absolutely rigid and spaced ½ in. apart. Connecting the grid leads was the next problem, for crocodile clips were out of the question, and it was not an easy matter to solder the



The complete chassis is made up of several sections having sizes as indicated.

flexible wire to the tubes in the correct spot.

To overcome this, earth clips were used and arranged so that they were adjustable over a limited area. Actually these clips can clearly be seen in the illustrations.

Two more earth clips are needed at the earthy end of the tube and must be connected together by a short length of very heavy gauge wire. Actually a length of aerial wire of the 7/22 variety is most satisfactory.

The centre point of this shorting link is then connected to earth via a 10,000 ohm 3-watt resistance. While on the topic of the resonant lines, it would be advisable to give the correct positions for the clips as found with the original transmitter. First of all, the tubes are 48 ins. long and are mounted with the earthy ends to the bottom. The shorting bar is fixed approximately 7 ins. up from the bottom end, while there is a gap of 10 ins. between the shorting bar and the grid clips.

A Special Chassis

Next comes the chassis for the actual transmitter itself. As can be seen from the illustrations, this consists of four pieces of wood mounted at right angles to the copper tubing and screwed to the sides of the plank. The top face of this chassis takes the valves, and other components, whie a gap is left to allow for the copper tubes. Just how this is connected can be seen from the close-up view of the transmitter. Components should be mounted as shown, but arrange them as compactly as possible and make sure that the connecting leads in the anode circuit are of the following dimensions.

The lead from the anode of the valve-holder to the rotor plates of the tuning condenser is 1½ ins., while the lead from the stator plates to the other anode contact is of the same length. Two leads must then be taken from the tuning condenser to the extreme ends of the anode coil, and these leads have a total length of 3 ins. each.

Build the anode coil to the dimensions shown in the illustration, for this is most important. The coil consists of six complete turns of copper tube wound to a total length of 2½ ins. with an internal diameter of 1½ ins. The coil is then tapped in its exact centre and the high-frequency choke soldered straight on to the coil. Incidentally, the average soldering iron finds it a bit difficult to heat up a copper tube tank coil, so it is a good plan to solder on the high-frequency choke by a large bit of iron before the coil is fixed into place. Also notice that the entire transmitter with the exception of two flexible leads is wired with 12 gauge.

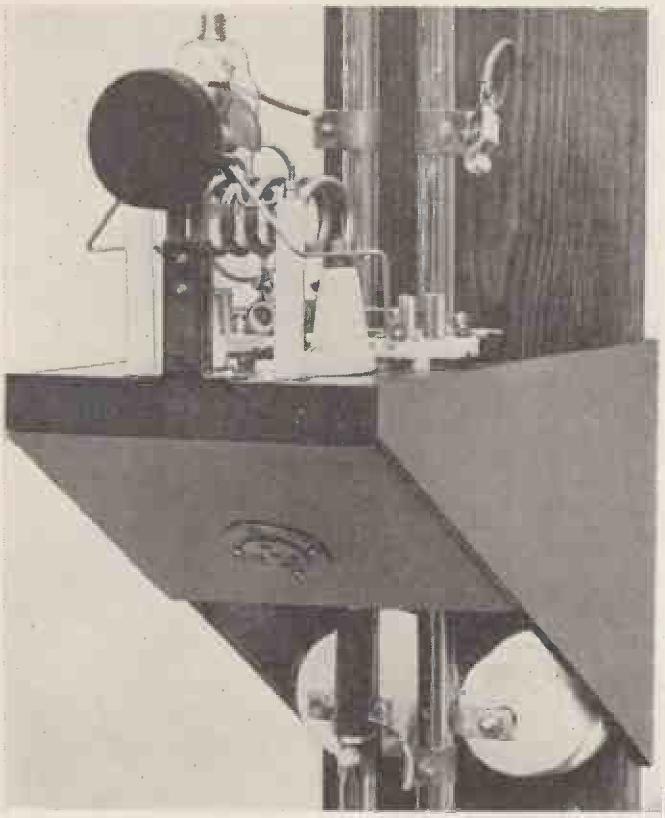
Highly-efficient Valves

Stray capacity in this circuit is reduced to an absolute minimum, but the whole arrangement is completely upset

Components for A LONG-LINE 5-METRE TRANSMITTER.

CHASSIS.
1—Deal plank 48 in. by 6 in. by 1 in.
CHOKE, HIGH FREQUENCY.
1—Type 1022 (Eddystone).
CONDENSERS, FIXED.
1—.0005-mfd. type 690W (Dubilier).
CONDENSERS, VARIABLE.
1—Type NC15 (Raymart).
2—Type VC15X (Raymart).
COPPER TUBES.
2—Lengths 48 in. by ½ in. 16 gauge copper. (Midland Tube and Metal Co.).
DIAL.
1—1026 (Eddystone).
HOLDERS, VALVE.
2—4-pin type 949 (Eddystone).
1—4-pin less terminals type V1 (Clix).
PLUGS, TERMINALS.
2—Insulated plug tops, type 1156 (Belling-Lee).
1—4-way plug, type P9 (Bulgin).
RESISTANCE, FIXED.
1—10,000-ohm type 3 watt (Erie).
SUNDRIES.
6—Beehive insulators (Raymart).
1—lb. 12-gauge copper wire (Premier Supply Stores).
1—Collapsible 5-metre aerial, type 1038 (Eddystone).
VALVES.
2—PX230SW (Hivac).

Finding the Frequency Range



This view gives a good idea as to the construction of the transmitter. One of the valves has been omitted, showing the grid connection to the tube.

if valves of any other type are employed. I spent no considerable time in testing various low power valves before hitting on the Hivac PX230SW. This valve, although a conventional triode as regards characteristics, has the virtue of a low-loss ceramic base and a grid contact brought out to the top cap. This automatically reduces inter-electrode capacity, cuts out the losses caused by the base, and also makes the transmitter very much more simple to build. This valve has a 2 volt filament, takes .3 of an amp., and officially will handle 150 volts, but I have been using them for quite a while with 200 volts, when they give an extraordinary high R.F. output.

Manufacturers do not like me doing this sort of thing, for by over-running the valves it automatically breaks the guarantee. This point should be remembered. But, in fact at 200 volts they do not show any signs of stress and run completely cold.

Although they were originally run from a 2 volt accumulator and have their filaments wired in parallel, I have since experimented with the filaments in series and connected across a 4-volt transformer, when they give equally satisfactory results.

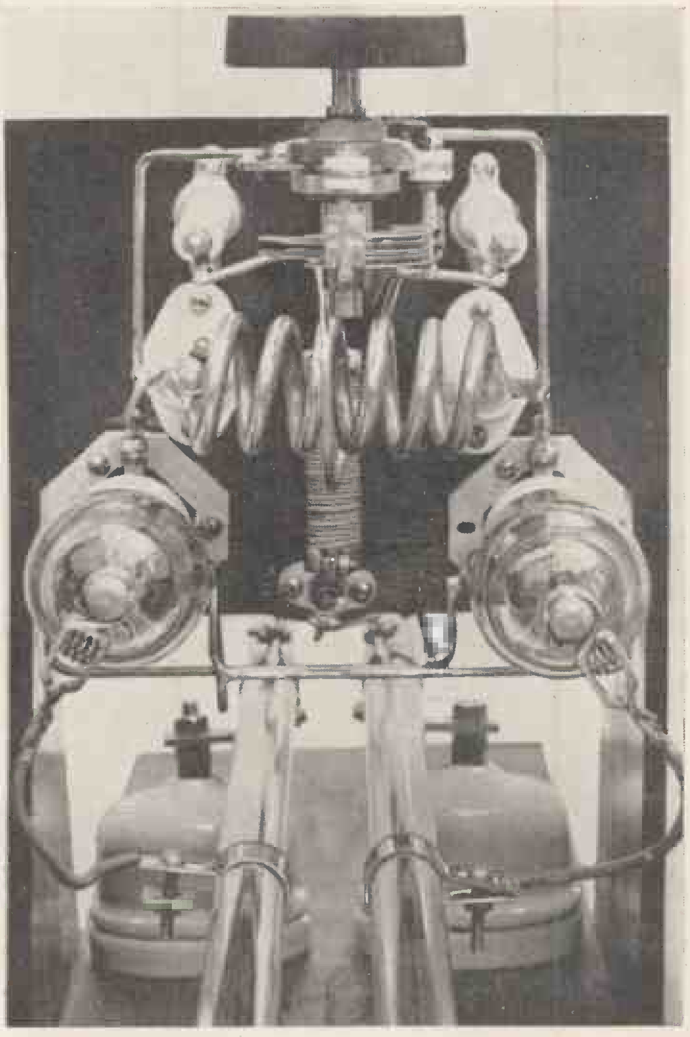
The filament leads and the connection from the high-frequency choke are taken to a 4-pin chassis mounting valve-holder which is used as a terminal point. A 4-pin socket then carries H.T., L.T. and modulation and can be situated in any convenient spot. If the valves are run at 150 volts a current of 30 M/a will be taken, which is increased to 45 M/a at 200 volts.

Coupling to the aerial is fairly critical, and if the coupling is too tight, radiation, that is effective radiation, decreases very quickly. Make a coupling coil of one turn and of 3½ ins. diameter and loosely couple this around the centre of the tank coil. Take the ends of two stand-off insulators, which can then be coupled to a di-pole or Zepp aerial.

Frequency Checking

Under these conditions the centre of the 5-metre band is towards the centre of the tuning capacity, but as variations in wiring may completely upset the tuning, a small wave-meter is a distinct asset.

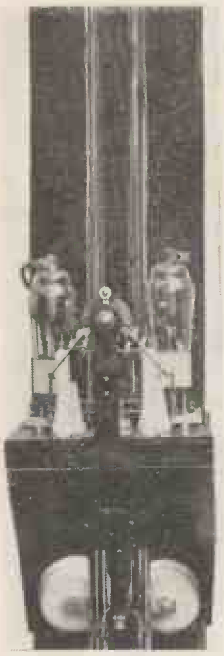
I have built up a wave-meter, the design of which is of a conventional type. It consists of a single loop of



Layout is most important, while it is essential that the components be rigid. In this illustration the tank coil can be seen mounted on two stand-off insulators with the H.F. choke between the centre tap of the coil and another insulator. The entire circuit is wired with heavy gauge wire with the exception of the grid contacts, which are flexible.

5 ins. diameter and of 9 gauge wire. It is mounted across a 15 mmfd. Raymart condenser so that the ends of the circle have to be cut to fit the condenser terminals. A Bulgin fuse-holder was taken to pieces and the metal inset soldered to the middle of the loop as shown. In this way the dimensions cannot go far wrong, and the 5-metre band then comes at 50 degrees on an Eddystone dial.

Another way to check up the frequency is to erect a half-wave aerial, less 1 ins. and to connect in the exact centre a fuse bulb. Tune the transmitter until maximum light is obtained in the bulb and then you can rest assured that the transmitter is near enough in the 5-metre band. Only 4 ft. feeders are needed with this arrangement so that a checking aerial can be erected across the radio room.



If the transmitter is constructed in this way it can be hung on the wall by means of the projections on the underside of the main chassis.

In all the illustrations I have left out the tuning dial, for this covers in the front of the transmitter, but it is advisable to use a 3 or 4 ins. dial so that the tank coil can be fairly well calibrated.

As regards the clips on the grid lines, the approximate positions for these have already been given, but it will be found that the lower the grid caps are towards the earthy end, the greater will be the stability and smoothness of oscillation. However, higher output can be obtained when the grid caps are towards the open ends, but this is not to be recommended.

Despite the low power used, the transmitter has already put up a very good performance, and when lightly modulated, can be received on a flatly tuned super-het receiver. It is therefore a distinct advance on a self excited transmitter, which, in the best of circumstances can only be received on a super-regenerator. Actually when tested on a super-het receiver. It is, therefore, a dislator produced a signal that sounded like the Post Office scrambled phone.

For Higher Power

The layout and design can be modified to use higher power or A.C. valves. In fact, experiments are being carried out with 801's and T55's, so that with the latter valves an input of 100 watts will be obtainable.

Before this transmitter is constructed a permit must be obtained from the Postmaster-General. Details about this can be obtained from the Engineer-in-Chief, Radio Section, General Post Office, Armour House, Aldersgate Street, E.C.1.

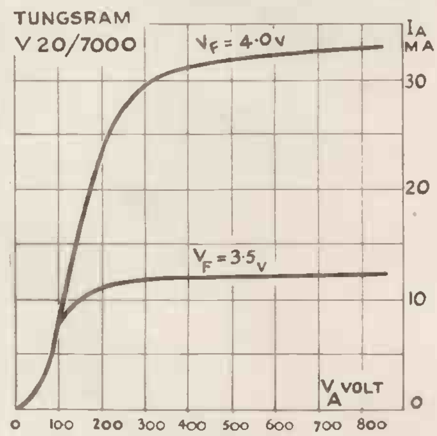
A New High-voltage Rectifying Valve

RECTIFYING valves of the mercury-vapour type which are generally used in power packs for cathode-ray tube supply suffer from the defect that the D.C. output is not easily controllable; also delayed switching is almost essential. The delayed switching complicates the circuit and increases the cost, not counting the fact that two half-wave rectifiers are generally required in conventional circuits.

A new valve which goes a long way to overcoming these defects has been introduced by the Tungsram Electric Lamp Works and designated the V20/7,000. As its title conveys, it will handle a maximum r.m.s. voltage of 7,000 with a maximum current drain of 20 m/A. The valve has a thoriated tungsten filament and as can be observed from the characteristic curve, the voltage output can be governed by varying the filament voltage. This unique feature has many uses, while the fact that a tungsten filament is embodied and that the valve is directly heated means that no delayed switching of high tension is required.

The valve is the full-wave type of conventional construction with a 4-pin base with the normal grid pin blank. It does, of course, fit the standard 4-pin valve holder. Despite the fact that a maximum inverse peak volts of 16,800 can be tolerated, the price is only 16s.

From these details it can be seen that the valve is ideal for use in cathode-ray tube H.T. supply or time base H.T. supply circuits and owing to its construction will greatly simplify the building of these circuits.



Effects of Filament Voltage Variation.

It is fitted with a filament calling for 4 volts with a current of 2.3 amperes, but this voltage is not critical. The actual variation in output with a variation of .5 volt on the filament can be seen from the curve. Suitable accurate fixed resistors for use with this valve are obtainable from Messrs. A. F. Bulgin & Co., Ltd. Full information on the V20/7,000 can be obtained from the manufacturers, The Tungsram Electric Lamp Works (Great Britain), Ltd., 82 Theobalds Road, London, W.C.1.

It appears that the presence of short waves was first noticed by Marchese Marconi as far back as 1902. He was on a voyage in the American liner, S.W. *Philadelphia,* and picked up messages on short-waves up to a distance of 2,000 miles. The most recent developments by Marconi were the centimetre waves generated at the Vatican station in 1934.

For the Beginner

By Kenneth Jowers

Aerial Coupling Circuits

The Numerous Arrangements Reviewed

This is the fourth in a series of articles explaining in a simple way the working of an amateur transmitter. The numerous aerial coupling arrangements used by amateurs are described in this article.

ONE of the most difficult problems that the amateur has to solve is what type of aerial to use for his particular requirements and location, and to a slightly lesser extent, the system of coupling that will give maximum transference from transmitter to aerial with minimum loss and maximum selectivity.

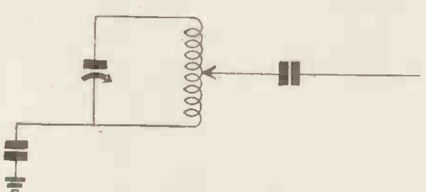


Fig. 1.—The simplest tapped on aerial coupler.

As far as I can see no two amateurs see eye to eye on the virtues of any particular aerial, for so much depends on location, and the direction of the aerial.

With coupling circuits, however, there are two or three dozen arrangements that can be used, but these when sifted out, come down to a few conventional arrangements, which give satisfactory results under almost all conditions.

Ten Arrangements

However, it is impossible accurately to make a definite claim as to one circuit being the perfect one. The best aerial circuit is the one which happens correctly to match the transmitter in use, and this depends on many points other than the design of the coupler.

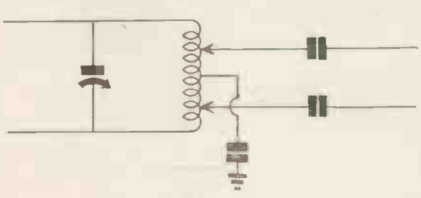


Fig. 2.—A variation of the tapped on arrangement for use with twin feeders.

Ten circuits have been chosen, all of different types, and the amateur is advised to choose the one that appears to be most suited after assimilating the various details given as to the advantages and disadvantages of the systems.

A Simple Coupler

In Fig. 1 is illustrated the simplest aerial coupler in which the coil and condenser are in the anode circuit of the final valve in the transmitter. The aerial, which is cut to a resonant length depending on the frequency of the crystal employed, is tapped on to the anode coil. The condenser in series with the feeder is not technically essential, but is to prevent D.C. voltage being applied to the feed-line which would cause a short circuit if the aerial were accidentally earthed. In this arrangement the tank circuit is tuned to resonance with the aerial removed, the feeder being tapped on at a point where maximum draw, that is, maximum anode current, is obtained with the condenser still tuned to provide maximum dip.

This arrangement is quite simple for portable work, but unless very low power is being used, is inclined to cause flat tuning and interference to local receiving sets. It is, however, used very considerably amongst some of the low-power 40 metre stations.

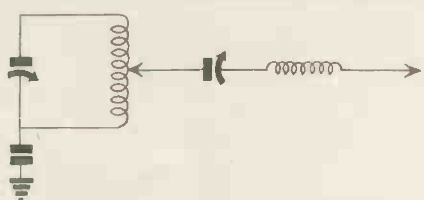


Fig. 3.—Greater efficiency can be obtained with this arrangement having a tuned feeder.

Twin Lines

A variation of this system is shown in Fig. 2, where twin feeders are used instead of the single line. The twin feeders, one of which is dead, and the other connected to the aerial in the usual Zepp manner, are tapped on to equal points either side of the centre tapping. It will be realised that in this circuit again the coil is the tank coil and that the centre tapping is connected ultimately to high-tension positive via a high-impedance choke.

The same remarks apply as to obtaining the correct tapping point. Find the spot which gives maximum draw with the tuning condenser adjusted for maximum current dip. Providing the centre tapping is electrically correct then the tapping point should be in exactly the same position either side of centre. The condenser by-passing the centre point has a value of .002-mfd. and should be suitable for withstanding the total voltage applied to the output valve.

With both of the previous circuits the efficiency of the arrangement depended very greatly on the fact that the line was untuned so had to be cut exactly to resonance. This length could not always be determined by formula as the local conditions again caused variations in total length. For example, a feeder 33 ft. long in free space would be incorrect when a section of the wire came closely parallel to the side of a house. For this reason the arrangement in Fig. 3 has much in its favour.

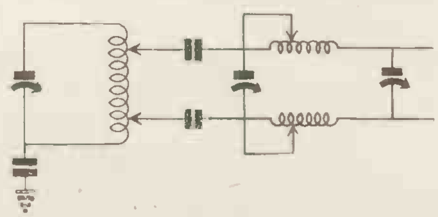


Fig. 4.—The ever-popular Collins' coupler which can be used on all bands with the exception of 160 metres. On this band a variation of the coupler has to be employed.

In this circuit a resonant coil is in series with the feeder and series tuned by a variable condenser in the manner shown. In this way the effective length of the feeder can be adjusted by varying the capacity of the series condenser, so that the aerial is completely resonating with the output circuit. The same remarks regarding poor selectivity still apply, but the system is much more efficient than those described in either Fig. 1 or Fig. 2.

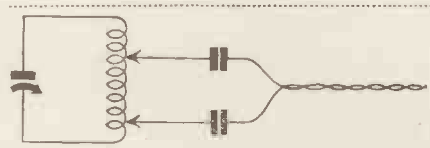


Fig. 5.—A non-resonant line of this type has much in its favour. Use low impedance cable.

Collins' Coupler

Some years ago a special matching coupler circuit was evolved by the Col-

72-ohm Cable :: The Marconi Aerial

lins Company in America, by which their transmitters could be built and ultimately matched to any type of feeder.

As would be expected, this system is very flexible for each feeder line can be broadly tuned to resonance by means of the taps on the series coils in each feeder, while parallel tuning condensers can move the effective inductance up and down. In this circuit the tank coil is again adjusted for minimum dip, after which it is left severely alone, after which the coupler is tapped on and further adjustments made to the series coils and tuning condensers to give maximum radiation as measured by hot

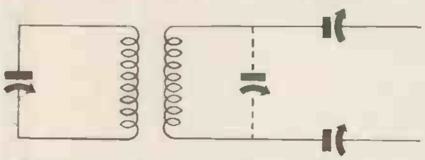


Fig. 6.—The most popular circuit used by amateurs suitable for all-band use with Zepp feeders.

wire or thermal instruments, coupled with the correct anode current draw. A modification of this circuit can be utilised for Marconi aerials, using only one coil and one tuning condenser. In such a circuit the tuning condenser nearest to the tank coil is omitted, while the remaining condenser has one side connected to the aerial end of the series coil and the rotor earthed.

Low-loss Cable

Since the introduction of low-loss cable the arrangement in Fig. 5 has become very popular. This twisted pair line is identical in operation to the circuit shown in Fig. 2, but as the twisted pair lines offer a somewhat lower impedance than the average 600-ohm cable, they are more easy to match up to the correct type of aerial than the normal Zepp lines.

The disadvantages of cheap cable, are leakage in wet and poor insulation

Fig. 7.—A particularly low-loss arrangement using 72-ohm cable.

between conductors. Also, unless a reputable cable is obtained, impedance of the line is not always to specification. A suitable cable for use in such a circuit is the low-loss Belling-Lee which is perhaps the most effective and the simplest feeder wire that the amateur can obtain.

For Zepp Feeders

The most popular coupling arrangement is the one shown in Fig. 6. This is used by a very big percentage of amateurs in this country. In this arrangement an aerial coil similar to the tank coil is connected to twin Zepp feeders through either series condensers or a parallel condenser, depending on the length of the wire and the frequency of the transmitter. The aerial coil is loosely coupled to the tank coil to obtain the correct amount of draw and the maximum amount of radiation as measured on aerial meters. This arrangement is very simple, almost fool-proof, and providing that the coupling between coils is not too tight, then selectivity will be of a reasonably high order, reducing possible interference to local listening stations.

72-ohm Cable

The introduction of the Belling-Lee low-loss cable made popular the circuit shown in Fig. 7 by which an untuned non-resonant line connects the aerial to

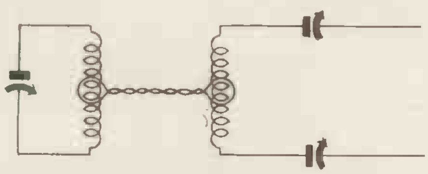


Fig. 8.—Link-coupling between transmitter and aerial coil enables the transmitter to be situated in the most convenient position.

the tank coil. The non-resonant line is terminated in a single-turn loop pushed into the centre of the tank coil.

Before the loop is coupled, the tank circuit has to be tuned for maximum current dip, that is, minimum anode current reading, after which the single loop is pushed into the tank coil until the anode current reading is correct for the valve in use.

There should not be any need to retune the tank circuit, although slight readjustments are sometimes advisable. With a 72-ohm cable of this type the line should be terminated in an aerial having an impedance of 72 ohms at the connecting point.

A variation on this scheme is shown in Fig. 8. A tank coil and aerial coil are required, the aerial coil feeding into twin wire feeders and tuned on either side by series condensers. The tank coil in the transmitter is then link coupled to the aerial coil by a length of 72-ohm cable terminating at each end in a single turn loop.

Again, with this system, before the loops are attached the tank circuit should be tuned for minimum current, after which the single loop is coupled to the cold end of the tank coil, and the centre of the aerial coil. Both series condensers in the aerial circuit have then to be adjusted to provide maximum current readings in both aerial and anode circuits. The main virtue of this arrangement is that the transmitter can be situated at a distance from the feeder wires, and placed in any convenient position in the radio room. The losses on the low-impedance cable are negligible as compared with the loss that would be experienced if a 600-ohm Zepp feeder were brought far into a

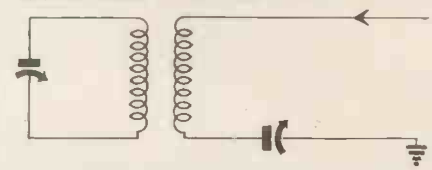


Fig. 9.—The most popular circuit for use with a Marconi aerial, particularly on 160 metres.

room. Also with this arrangement selectivity is far better than with the usual coupled coil system.

For Marconi Aerials

For those interested in 160 metre working where a Marconi aerial is invariably used, the circuit shown in Fig. 9 should be employed. The Marconi aerial, of course, consists of a resonant top length plus a similar wire about 8 ft. off the ground used as a counterpoise earth. The aerial is tapped directly on to a coupling coil of similar dimensions to the tank coil. The earthy side of the aerial coil is then connected to the counterpoise via a wide gap series tuning condenser.

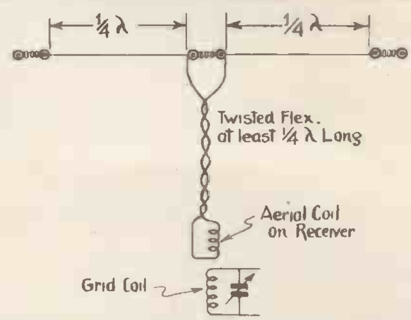


Fig. 10.—A most effective doublet with low impedance cable for reception.

This arrangement appears to be the most popular for 160 metre working.

Why a Coupler?

It would be as well just simply to explain the characteristics underlying the use of an aerial coupler. An ordinary

(Continued on page 512)

"VALVE VOLTMETERS" (Continued from page 464)

rapidly, and one doesn't want to go through the process of re-calibration too often. It is sometimes advantageous on this score to use a valve that has been in use for some time.

In Fig. 6, a switch (S) is provided so that the same meter may be used for measuring the anode battery voltage. It is not necessary that the actual value should be known, so it is not necessary (unless desired) to calibrate M with R_3 as a voltmeter. When initially calibrating, it is only necessary to note the reading on M with the switch in position 2, and to adhere to this value of anode voltage whenever the instrument is to be used for important measurements.

Care must be exercised when the instrument is first brought into use, the shunt R_4 being used across the meter whilst carrying out the initial adjustments.

Each time that the instrument is brought into use, after making the first adjustments, wait for a few minutes before using, in order to let the instrument "settle down." This is an essential precaution with all triode voltmeters, and especially this type. After the settling down period, readjust the anode voltage and backing off, if necessary.

The general characteristics of the instrument are as follows:—

The scale "law" is approximately linear at the upper end (80 per cent.), but departs considerably from linearity at the lower end (20 per cent.). The indication is not proportional to the r.m.s. value of the applied voltage in terms of which the instrument is customarily calibrated, so large errors may be encountered when measuring distorted waveforms. The input resistance may be fairly high, of the order of 2-3 megohms with the component values given in the appendix.

It is the most sensitive form of valve voltmeter, from the voltage input point of view. The instrument described would give full scale deflection with about 1 volt r.m.s. input.

One modification of this instrument dispenses with the grid leak entirely, relying upon random leakage. This results in great sensitivity and a much higher input resistance, but unless the valve is carefully chosen the instrument is not very stable.

The input capacity of this type of instrument will be between 10 and 15 micromicrofarads, unless a special low-capacity valve is used.

Appendix

In all Figures except 1a, 2, 3 and 4, M indicates an 0-1 milliammeter having a resistance of about 30 ohms.

In Figs. 2a and 2b, E.S.V. represents

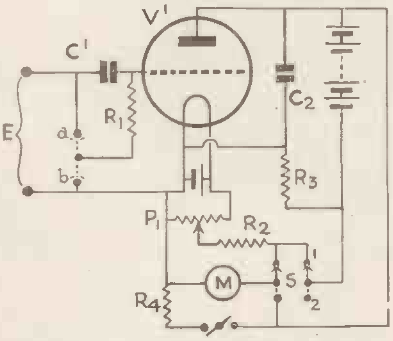


Fig. 6. Grid rectifying triode voltmeter

an electrostatic voltmeter (see text) of range either 0-300 or 0-600 volts.

The usual L.T. and H.T. "on-off" switches are not shown in the figures.

Fig. 4 represents no valve in particular, and the anode current-anode voltage curves are "idealised" to simplify the drawing.

S represents a single or double pole switch (as shown) of any convenient type.

Fig. 1.—
- V_1 = any convenient valve, if triode, anode not used. Preferably a small single diode (see text).
- C_1 = 4 mfd. good quality paper condenser.
- P_1 = value, 400-500 ohms.
- R_1 = value, 1,500 ohms, approx.

Figs. 2a and 2b.—
- V_1 = as for Fig. 1 for low-voltage (0-300 volt) instrument. For higher voltage instruments see text.
- C_1 = value, 0.1 mfd. 500 or 1,000 volt working. Preferably mica dielectric.
- R_1 = value, 1 megohm.

Fig. 5a.—
- V_1 = as for Fig. 1.
- C_1 = value, 0.1 mfd., good paper or preferably mica dielectric (e.g., Dubilier type 577).
- P_1 = as for Fig. 1.
- R_1 = value, approximately 20,000 ohms, to make M read 0-20 volts. Bias battery, standard 0-16½ volts.

Fig. 5b.—
- V_1 = Mullard PM202 or similar.
- C_1 = value, as for Fig. 5a.
- P_1 = ,, ,, ,, ,, ,,
- R_1 = ,, ,, ,, ,, ,, Bias battery, standard 0-16½ volts. Anode battery, standard 0-16½ volts.

Fig. 6.—
- V_1 = as for Fig. 5b.
- C_1 = value, 0.01 mfd., mica dielectric, T.C.C. type M, Dubilier type 670, or similar.
- R_1 = value, 5-10 megohms.
- C_2 = value, 0.1 mfd., mica dielectric (Dubilier type 577 or similar).
- P_1 = as for previous circuits.
- R_2 = value, 1,000 ohms (approx.) 1 watt type.
- R_3 = value, approx. 20,000 ohms, to make M read 0-20 volts.
- R_4 = 10-30 ohms (not critical, see text). Anode battery voltage, 16-20 volts approx.

(To be continued)

Transmissions for English Listeners

WE have received some information from the International Short-wave Club regarding a series of special transmissions in English by the Zeesen group of short-wave stations.

DJD on 25.49 metres will be on the air on Saturday, August 7, from 8.30 p.m. to 9.30 p.m., and reports are requested from English listeners. These reports should be sent to the International Short-wave Club at 100 Adam's Gardens Estate, S.E.16, from where they will be forwarded to Berlin.

This and other programmes will not be propaganda broadcasts, but programmes consisting mainly of musical items. Numerous other international broadcasts of this type are being arranged by the I.S.W.C., so that short-wave listeners are advised to get full information of future broadcasts from the secretary of this Society. Meetings are held regularly when lectures on all short-wave, television, and associated topics are given. Full information can be obtained from the European representative, Arthur E. Bear, of 100 Adam's Gardens Estate, S.E.16.

Chapters are also in existence in Manchester and Brighton, details of which can also be obtained from Mr. Bear.

The World's Most Powerful Short-wave Stations

General Electric Company's short-wave stations, W2XAD and W2XAF, located in Schenectady will shortly become the most powerful stations of their type in the world. Permission has been granted by the Federal Communications Commission for these stations to increase their power to 100 kw.

The new transmitters will be linear radio-frequency amplifiers and will provide almost twice the signal strength of the present stations. The previous strength was between 18 to 25 kw, but even so the field strength in Europe of the Schenectady stations was very high.

It is the ambition of the General Electric Co. to provide a 100 per cent. all the year round service for listeners in all parts of the world.

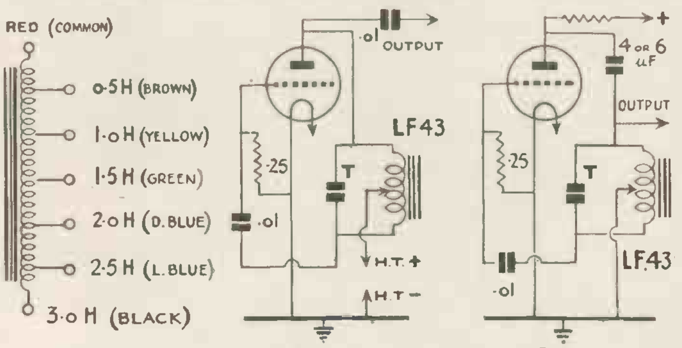
A Novel Tone-correction Circuit

MOST readers are aware of the normal tone correction circuits whereby a resistance and condenser network are connected generally in the output circuit, or where a variable condenser is connected between grid and anode of the output valve. These systems, generally speaking, attenuate the upper frequencies, but do not produce a very true correction circuit.

However, a new arrangement introduced by Messrs. A. F. Bulgin & Co., appears to be a step in the right direction, for it enables any constructor to form a filter circuit to cut off at a given frequency. The main component in this filter is a special choke having an inductance of 3 henries when measured at 1 kc., and is tapped so as to provide inductances of 0.5, 1.0, 1.5, 2.0 and 2.5 henries in addition to the total inductance value. This choke, the LF43, was specifically designed for tone correction circuits and in audio frequency oscillators is shown in Fig. 1.

In Fig. 2 is given a rejector circuit, where the condenser T is in parallel with the choke. In this way maximum voltage is given across the choke and condenser at the resonant frequency.

With the condenser in series with the choke, as in Fig. 3, an acceptor circuit is formed whereby minimum voltage is given at the resonant frequency. This latter circuit is ideal for a needle scratch filter.



Figs. 1, 2 and 3 show the tappings on the choke, a rejector circuit and an acceptor circuit.

By obtaining the correct value of inductance and capacity the filter can be made to resonate at a given frequency and it will be found that this resonant point is reasonably sharply tuned.

The following table gives the capacity and inductance required for various frequencies. For example, a 1-henry choke and a capacity of 0.025-mfd. tunes to approximately 1,000 cycles.

TABLE.

H x Mfd.		Frequency.
0.1	=	500
0.07	=	600
0.052	=	700
0.04	=	800
0.031	=	900
0.025	=	1,000
0.011	=	1,500
0.0063	=	2,000
0.0041	=	2,500
0.0028	=	3,000
0.0021	=	3,500
0.0016	=	4,000
0.00125	=	4,500
0.001	=	5,000

High values of anode current unavoidably reduce the effective inductance of the choke, but the parallel feed circuit overcomes this defect. Anode current can be fed through to the valve via a resistance which should have as high a value as possible. The feed condenser must have a large capacity of between 4 and 6 mfd., otherwise it may resonate with the choke, forming a type of series acceptor circuit. This arrangement is shown in Fig. 1.

The construction of the tapped choke is shown in Fig. 1 giving the various values of inductance and the colour coded wires.

These filter circuits can be embodied in almost any type of amplifier, but are particularly useful in radio gramophones where a variable tone corrector is not really required.

Making an Adjustable Crystal Holder

By R. C. Frost

ALTHOUGH a good adjustable quartz-crystal holder is rather an expensive component in this country, owing to the comparatively small demand for specialised transmitting equipment, a perfectly satisfactory one can be constructed at almost negligible cost. Simple tools only are required and the necessary materials consist of a few pieces of brass and ebonite, a small quantity of thick felt and one or two nuts, bolts and terminals.

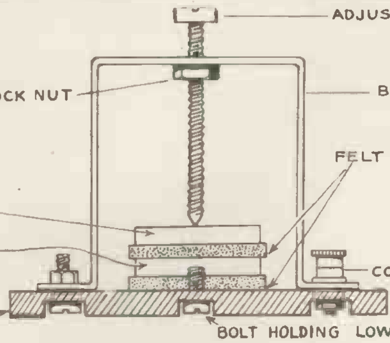
The base consists of a 3-in. square section of thick ebonite, to which is bolted a bracket for the adjusting screw. This bracket is made from a strip of ⅛ in. brass, 4½ ins. long by about ¾ in. wide, bent as shown and drilled and tapped 2 B.A. in the centre to take the adjusting screw. The bracket is fastened to the base by a terminal (which forms one contact to the holder) and a nut and bolt.

The adjusting screw consists simply of a 2 B.A. bolt, fitted with a lock-nut, which can be screwed up or down to vary the pressure on the surface of the crystal. The correct pressure is easily found by experiment and the lock-nut is then tightened up to prevent variation by vibration, etc.

In the centre of the ebonite base a hole is then drilled and countersunk to take a 4 B.A. bolt for holding the lower plate in place. A nut is run on to the bolt before the plate so that the latter can be locked in position.

Both upper and lower plates, between which the crystal will lie, consist of 1½-in. square pieces of brass, 3/16 in. thick, and must be perfectly flat on the surfaces which will make contact with the crystal. The bottom plate is drilled and tapped 4 B.A. in the centre, screwed a short way on to the bolt and locked in position by means of the nut. Care must be taken to see that the shank of the bolt does not protrude above the surface of the plate.

The bottom plate should then be loosely attached to the ebonite base and the space between plate and base should be packed fairly tightly with one or more squares of thick felt. This ensures that the plate is held fairly rigid, yet does not transmit shocks to the crystal to any extent. A connection is taken from the bolt to a terminal mounted on the ebonite base to act as the second contact to the holder.



An adjustable crystal holder is of undoubted use on the higher frequency bands. This holder can easily be made by the amateur but the instructions should be strictly followed.

Another square of thick felt is then cut, and a piece about 1/16 in. greater in diameter than the crystal is removed from its centre. This square is laid on the bottom plate and the crystal is placed in the hollow cut from it. The upper plate, identical with the bottom one except that it is not drilled in any way, is then laid over the crystal and the adjusting screw tightened.

Special Components for the Transmitting Amateurs

We were very interested in some new components offered by Galpin's Electrical Stores, of 75 Lee High Road, S.E.13. Amongst the components offered are firstly, a rotary converter with 12 volts input giving 200 volts 40 M/a. D.C. output. This converter is complete with full smoothing equipment and two high-tension tappings for 49s. 6d. This is ideal for portable use on either a transmitter or multi-valve receiver.

A transformer with the conventional primary and secondaries giving 2,000-0-2,000 volts M/a., 11 volts 2½ amperes, and 4 volts 4 amperes, is priced at £3 15s. 0d. This appears to be a very suitable unit for those interested in high power transmitting or public address equipment. Incidentally, smoothing condensers having a capacity of 4-mfd. and able to withstand the pressure of 4,000 volts are listed at 20s.

Another interesting item is an induction motor for 200/230 volts A.C. input of single phase and ⅛ horse power, has a ball-bearing movement, runs at 1,450 r.p.m. and will not cause interference to near-by radio receivers. This motor is priced at 22s. 6d.

An 0-3 milliammeter with a 3½ in. scale is available for 15s., while similar instruments reading 0-50 and 0-200 M/a. are priced at 12s. 6d.

We suggest that readers obtain some more information on the several hundred components Messrs. Galpins have for sale.

READ TELEVISION & SHORT-WAVE WORLD REGULARLY

High Power on 7 M.C.

By J. E. Hunter, G6HU

IS it not time something was done regarding the indiscriminate use of high power on the above band? Nowadays about every other station is using 50 watts, and recently I heard one say he was using 100 watts, whilst the "king of the band" is G5?? with 250 watts, but in fairness to him I must admit his visits to the 40-metre fraternity are very rare, something we certainly appreciate.

It is my firm contention that were a power limit imposed on this band the same as 1.7 mc. it would be more advantageous for all hams. Something will have to be done before long or heaven knows where we shall all end up—possibly in asylums.

I have repeatedly proved that a low power transmitter in conjunction with an efficient antenna does the job equally as well and often beter than the QRO outfit. It is a well-known fact that during a QSO it is possible to reduce the input to a very negligible percentage of the original and still get the same QRK reports. The greatest distance workable on 7 mc. under normal conditions is about 500 miles and very often less, therefore in view of this fact, is there any satisfaction gained by getting an R9 report with 50/100 watts? Apart from the fact that almost every transmitter within 20-30 kc. either side is temporarily put out of action.

As far as I am concerned, it is absolutely futile to try any QSO's on Sundays, my frequency is 7,020 kc. and if anyone doubts my statement; try listening! One recent Sunday I called 24 times and had two contacts and both went up in smoke due to QRM.

Now, what about a try at co-operation and endeavour to make the band workable and fit to carry out tests. I, personally, dare not try a test on the air or bang goes the contact.

In conclusion, I shall always be pleased to make a contact with a high power station—if he can hear me.

The Pye Teleceiver

The following details of the circuit arrangements of Pye model 4044 Teleceiver are of interest.

There are five chassis units. The vision unit incorporates eight valves. The double time base and sync. separator unit also incorporates eight valves. The valves for the line control are "hard" and for the frame control "soft" valves are used.

The sound channel feeding to the gramophone portion of the T.10 employs five valves. The T.10 broadcast chassis is the standard Pye production, five valves and rectifier.

The power pack and tube unit incorporate three rectifiers and a cathode-ray tube. Two of the rectifiers supply the 450 volts for the vision channel and time base, whilst the other supplies the 4,000 volts for the cathode-ray tube.

The line deflection is electrostatic and the frame deflection is magnetic. The tube is modulated on shield and first anode.

New Store for Short-wave Amateurs

MOST of our readers are aware of the huge stocks of components of every kind handled by G2NO, H. R. Adams, and W1JYN, Ted McElroy, who have been responsible for the American import business of Eves Radio. These two well-known amateurs have now joined an equally well-known London store of Webb's Radio, and between them they are to form the largest company in this country devoted to the requirements of amateur short-wave transmitters and short-wave listeners.

Full stocks of American receivers and complete transmitters are being carried, while almost any American component will be available on demand.

In addition, those amateurs who so badly want a multi-valve American receiver, will be interested to know that special hire purchase terms of a very easy kind will be available on transmitting and receiving equipment.

This amalgamation of two famous houses is very good news, for it ensures that constructors will no longer be held up for deliveries of components, receivers or valves. In addition, Webb's Stores, in 14 Soho Street, W., will become a meeting place for amateurs visiting London.

Full information about this merger can be found elsewhere in this issue by reference to the advertisement of Messrs. Eves Radio. Amateurs can obtain components by post or by 'phoning Gerrard 2089.

Further information on the components to be stocked by Webb's Radio will be found in our September issue.

"Aerial Coupling Circuits"

(*Continued from page* 504)

amplifier with an output valve has to have its impedance matched to that of the loudspeaker into which it feeds. Incorrect matching means poor quality, lack of volume, etc. Similarly with a transmitter, the output valve must operate into the correct load impedance for a given set of operating characteristics. If the load impedance into which the valve is fed is too high, the anode current will be low, and it will be impossible to make the valve draw the normal anode input. On the other hand, if the impedance is too low the anode current will be high, but efficiency will be low, which means that the R.F. in the feeders will be much lower than it should be for a given wattage input.

Impedance Matching

Broadly speaking, the function of the aerial coupler is to transform the impedance of the feeder lines, whatever it may be, into a value that is acceptable by the P.A. valve. Comparatively, it takes the place of the output transformer in a normal amplifying circuit. By referring to the previous nine circuits it will be seen that these couplers are segregated into groups of which the capacity and inductively coupled groups are generally used.

"An Ultra-short Wave Receiver with Metal Valves"

(*Continued from page* 487)

bias to the I.F. valve, but if there should be any traces of oscillation at maximum gain, then the value of R8 should be increased slightly with a maximum of about 750 ohms.

Resistor, R13, having a value of 500-ohms, is a good average value for cathode bias for the 6F6, but we have tried several samples of these valves and find that there is a tendency for variation in impedance. This means that the cathode bias resistor may have to be varied according to individual valves. So it is suggested that the total cathode current be checked and the bias resistor adjusted until this current is approximately 40 m/A., when the audio output will be slightly under 3 watts.

Two leads have to be taken to the dial light and unless these are kept close to the panel and out of the way of the 6J7 circuit, there is a possibility of hum being introduced. In any case, these two leads must be twisted for their total length.

On test this receiver has a very quiet background level and is particularly docile to handle. Providing R2 is correctly adjusted there is no possibility of unpleasant squeggering or over-oscillation. Stations unfortunately come in on two positions on the tuning dial, but this point can be tolerated in view of the efficiency of the receiver as regards weak signals and the absence of noise. For those who have been using a super-regenerative receiver that fails to receive very much that does not kill the quench noise, then this resistance-coupled super-het will come as a very great advantage.

The total anode current at 200 volts is 75 m/A. with a heater current of 1.9 amperes at 6.3 volts.

Southend & District Radio and Scientific Society

The Society held a very successful Direction-Finding Contest on June 27, when 23 members scoured Essex with portable receivers in an endeavour to trace a hidden transmitter, operating on a wavelength of 155.8 metres. On this occasion the transmitter was well concealed, and only one competitor—Mr. Maurice Tapson, G.6IF—succeeded in finding it, arriving only a few moments before the conclusion of the transmissions.

A series of similar events will be held during the summer months, and the Hon. Secretary, Mr. F. S. Adams, of 27 Eastern Avenue, Southend-on-Sea, will be pleased to hear from any members of other societies who would like to take part.

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INDEX TO ADVERTISERS

RADIO CLUB NOTES

Surrey Radio Contact Club

This Society has arranged a comprehensive series of lectures, while their club transmitter is in the course of construction and should shortly be on the air. Application has been made to the Radio Society of Great Britain for affiliation, and it is hoped that it will be possible to announce the acceptance at the next meeting. Full information regarding this society can be obtained from the Hon. Sec., E. E. Taylor, G5XW, "The Alhambra," Wellesley Road, West Croydon.

Southall Radio Society

The weekly meetings have been discontinued until the autumn, but a number of summer activities, including field days, direction finding contests and visits to commercial transmitting stations have been arranged. Details can be obtained from the Hon. Sec., H. F. Reeve, 26 Green Drive, Southall, Middlesex.

Components for Constructors

Constructors should remember that filament transformers for American and all types of valves are available from stock from Messrs. Premier Supply Stores, of 167 Lower Clapton Road, E.5, 50 High Street, Clapham, and 165 and 165a Fleet Street.

Short-wave components of all kinds are available, including coils, low-loss ceramic condensers, ceramic valve-holders and glass insulators. A complete list of all short-wave and television equipment can be obtained from the head office or any branches.

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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.

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362 Radio Valves

In future the 362 Valve Co. will concentrate on all types of transmitting valves, such as their now famous pentodes, and also their extensive range of rectifiers. Full information as to their current range of valves can be obtained from the manufacturers, 362 Radio Valve Co., 324/6, Liverpool Road, Highbury, N.7.

Metal Screens and Chassis

One of the problems confronting constructors is a source of supply for metal chassis, panels and screening boxes. Some excellent work has been done for us by Messrs. A.P.A. of 171C, Battersea Park Road, S.W.8. They can also supply standard relay panels and racks, and undertake all kinds of sheet metal work, turning, fitting, welding and casting, and can make to order any odd chassis or panel the constructor may require.

Constructors' Circle

F. J. Webb, "Windy Ridge," Tachbrook, Leamington; W. G. Hopcroft, 183 St. Clair Street, Sinclairtown, Kirkcaldy; R. H. Groom, 30 Grafton Road, Newport, Mon.; C. Ford, Thornlea, Deganwy Avenue, Llandudno, N. Wales; J. J. Davis, Hillside, Cold Harbour, Sherborne, Dorset; S. S. Sastry, A.M.I.R.E., Domchanch, Kodarma, E.I. Ry., Bihar, India; Percy Keneally, 83 Horton Road, Rusholme, Manchester, 14.

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