BRIGHTER TELEVISION PICTURES (p. 394)

Television and SHORT-WAVE WORLD

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JULY, 1937
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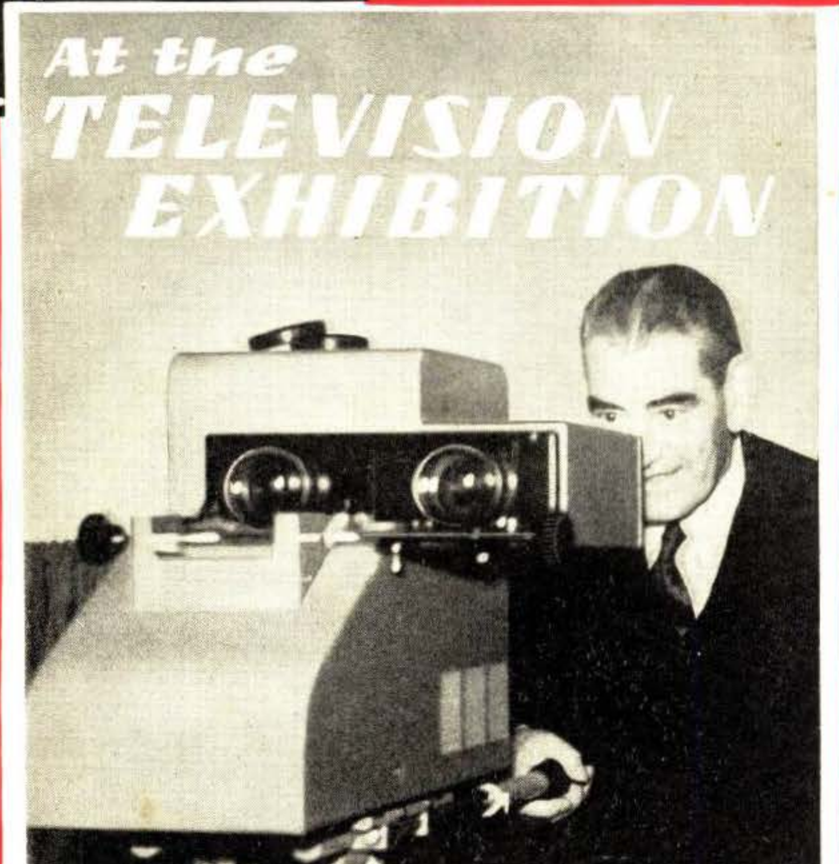

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SHORT WAVES

SELF-CONTAINED 3-VALVER

10-WATT PORTABLE TRANSMITTER

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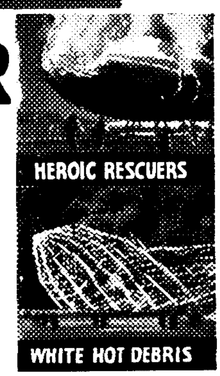
THE FIRST TELEVISION JOURNAL IN THE WORLD

HINDENBURG DISASTER



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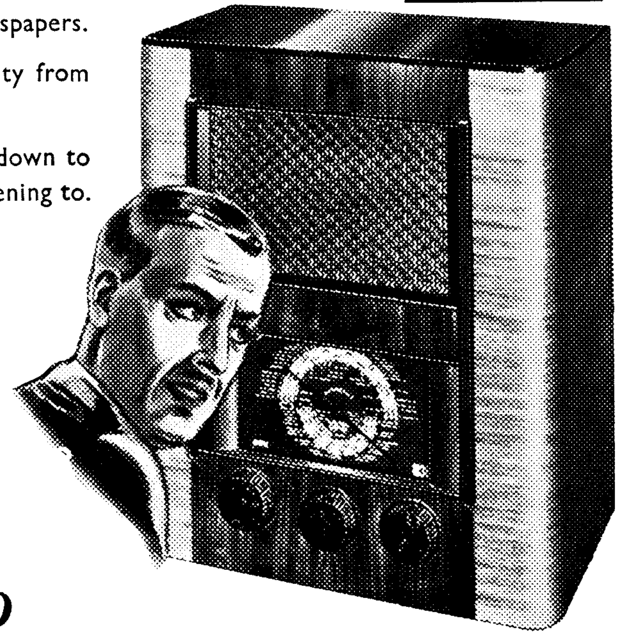

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No. 113 VOL. X JULY, 1937.

TELEVISION and SHORT-WAVE WORLD

Special Features

TELEVISION AND SHORT-WAVE WORLD

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COMMENT OF THE MONTH

The Television Exhibition

IF television is to become popular it is essential that the general public should be made aware of the vast strides that have been made and that they should realise that here is a new form of entertainment within the reach of many. Despite the publicity that television has received during the past few months it is quite evident that there is still a large section of the public who are not aware of its possibilities and limitations, and we suggest, therefore, that our readers would be doing television a real service by inducing their friends to visit the exhibition at the Science Museum so that they can see for themselves what an advanced stage has been reached. The exhibition is free and it is open at convenient times.

We have heard the criticism that there is much at this exhibition that the average person cannot understand, and that the many details are bewildering, a criticism which is doubtless true, but a fact which does not in any way detract from the value of the exhibition except that it may lead some people to think that television is such a complicated matter that the proper operation of a receiver requires expert knowledge. That this is not the case needs no stressing so far as our readers are concerned, but this impression undoubtedly exists in the public mind, and we make the further suggestion that our readers should do what they can to dispel the idea.

Of the ultimate future of television there can be no doubt. At the opening ceremony of the exhibition, Lord Selsdon said, "British television was ahead of the rest of the world. England was the only country where the public could receive a regular programme in their own homes." And Sir Noel Asbridge, Chief Engineer of the B.B.C., gave it as his opinion that the establishment of a service which would cover the whole of the populated areas of this country was not an improbability. How soon this latter will be an accomplished fact depends largely upon public interest.

No one who saw the Radiolympia demonstrations last year can fail to appreciate that since then very great progress has been made, and it is significant that we have not heard any adverse criticism regarding the quality of picture that is now being obtained. Also it is gratifying to know that the veil of secrecy that has hitherto been over television has at last been removed; the sooner the public knows all about it, the sooner will it be disposed to buy receivers.

The organisers of the Exhibition are to be congratulated upon getting together a most representative show, and for the first time giving the public an opportunity of seeing television as it really is to-day.

OUR COVER PICTURE.

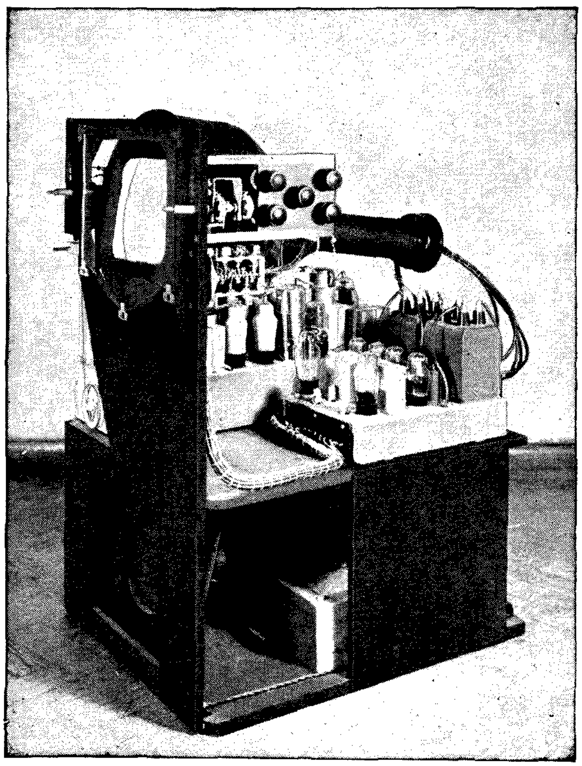
The photograph on the cover of this issue shows Lord Selsdon, Chairman of the Television Advisory Committee, inspecting the Emitron camera on the occasion of the opening of the Science Museum Television Exhibition.

SIMPLE WIRELESS PRACTICE IN TELEVISION RECEIVERS

RADIO AND TELEVISION RECEIVERS ARE VERY SIMILAR

This article explains how closely allied are the ordinary wireless receiver and the television receiver and how identical principles are employed almost throughout

MOST people have a good knowledge of the construction and working principles of an ordinary wireless receiver but the television receiver is a mystery. They know that it employs wireless principles and that the construction appears to follow wire-



The chassis of the G.E.C. television receiver showing the sound and vision receiver beneath the cathode-ray tube.

less practice, but it is not clear to them how these principles and the components used are employed to produce a picture of something happening a number of miles away. The cathode-ray tube also is a device with which they have had no experience, and then again there are many new terms used which in themselves do not convey much information to the unitiated.

The Radio Parallel

Now there is one very simple way to obtain a general idea of the make-up and functioning of a cathode-ray television receiver and this is to find a parallel in ordinary wireless receiver practice. Actually the similarity is so great that with but one exception we can find a parallel throughout the entire apparatus, this exception being the arrangement provided for keeping the received picture in step, or synchronism, with the transmitter scanning.

Before proceeding further it will be as well to see of what a complete television receiver consists. First of all we have the sound receiver. Secondly we have

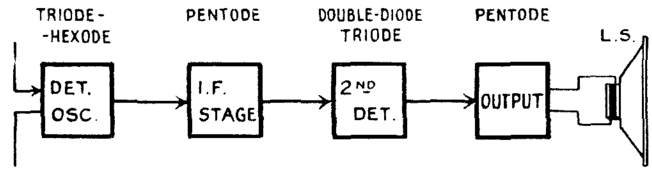


Fig. 1.—Schematic diagram showing the stages of the sound receiver.

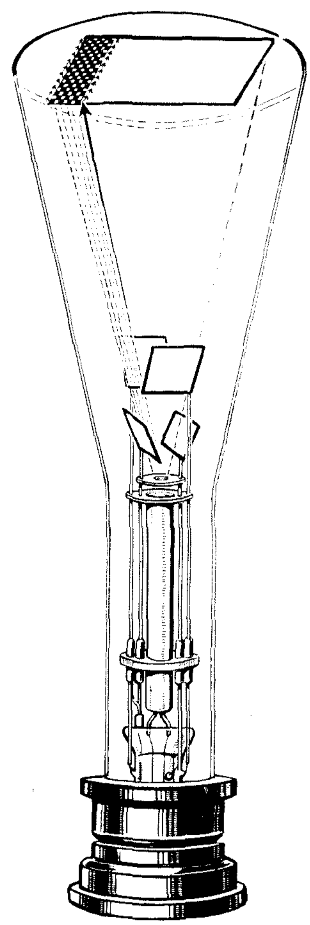
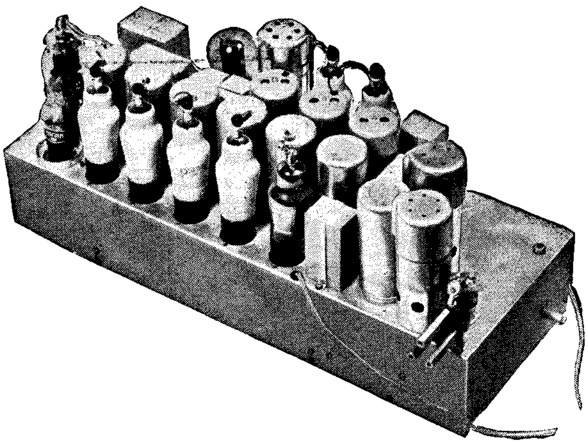


Fig. 2.—Diagram showing the scanning motion of the cathode beam.

the vision receiver. These, of course, must be supplied with filament current and high-tension as is the case with ordinary receivers so for these we have a power pack which is the equivalent of the low and high tension supply unit in the case of an ordinary receiver. It

THE UNITS OF A CATHODE-RAY RECEIVER

is a convenience to supply filament current and high tension to both vision and sound receivers from the same unit, though, of course, it is not essential, and it would be quite in order to treat both receivers as separ-



The sound and vision chass of the G.E.C. receiver showing aerial connection at the front and single tuning adjustment in the right foreground.

ate units. Additionally there is the cathode-ray tube and the high and low tension supplies for this and, finally, the time base unit for producing the scan with its necessary high and low tension supplies.

As the sound receiver is the counterpart of any normal short-wave receiver, this need not be dealt with beyond saying that it must conform to ordinary short-wave receiver practice. As selectivity is not of importance a super-het receiver is generally used with a low wavelength I.F. stage that gives broad tuning with a corresponding decrease in volume. This makes it simple to tune in the 7-metre signals and does away with the need for superfine tuning as with an ordinary short-wave set. Fig. 1 shows a typical arrangement schematically.

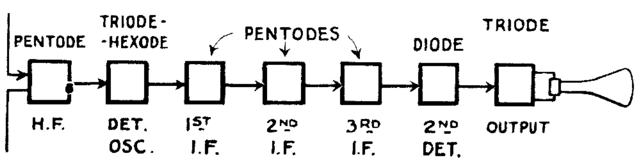


Fig. 3.—Schematic diagram showing the stages in a vision receiver.

Some confusion may arise because of the terms used to indicate the various units. The complete instrument is generally spoken of as a television receiver, but included in the make-up of this are two ordinary receivers, one for sound and one for vision, so perhaps it will be better to term the latter a vision signal receiver in order to avoid any confusion. A vision signal receiver is simply a multi-valve radio set plus a cathode-ray tube, which latter we may regard as taking the place of the loudspeaker in an ordinary wireless set, but with the difference that the cathode-ray tube must be provided with power supplies.

Before proceeding to consider the vision receiver it will be as well to get a mental picture of the cathode-ray tube and the method in which it functions (Fig. 2). With this again we have an ordinary wireless parallel in the valve. The valve has a cathode which gives off electrons which are attracted to the anode, their rate of passage being governed by the grid. The chief differences between the valve and the cathode-ray tube is that in the case of the latter, the electrons instead of passing from the cathode to the anode in a sort of cloud, as is the case of the valve, are compressed into a jet formation and instead of finishing on the anode are caused to pass through a hole in the centre and strike a specially prepared screen at the far end of the glass envelope which fluoresces under their impact. Actually there is more than one anode, the object being the attainment of sufficient velocity of the electrons to enable them to travel the comparatively long distance to the end of the tube.

It will be clear, therefore, that as the action of the cathode-ray tube so nearly approximates that of the valve it will be necessary to provide it with the requisite power supplies, that is there must be current for the tube heater, and high-tension supplies for the anodes. As the distance which the electrons have to travel is considerable, the latter must be high, usually of the order of three or four thousand volts, and this calls for a special power pack, or in ordinary wireless parlance a high-tension unit.

Briefly, then, the cathode-ray tube is a valve-like device capable of producing a fine stream or jet of electrons which reveal their presence as a bright spot of light by striking a specially prepared screen. Moreover, like the valve, the intensity of the electron stream can be varied and with it the brightness of the light spot. There is one other important difference and this is the provision of two pairs of deflector plates which by the application of suitable potentials on them cause the beam to travel across the screen and so trace out a line of light. The generation and variation of these potentials calls for another unit and its associated power supplies and this is the only one which has no parallel in ordinary wireless practice. This unit is called the time base and is peculiar to cathode-ray tube operation.

The Units Employed

We can now sum up the various units that are necessary for the assembly of a complete cathode-ray television receiver and these are as follows:

- Sound receiver } and associated low- and high-tension supplies.
- Vision receiver }
- Cathode-ray tube and necessary low- and high-tension supplies.
- Time base and necessary low- and high-tension supplies.

As a matter of convenience these units need not be separate and it is common practice to combine some of the power packs, and also the sound and vision receivers are often built on one chassis. They may, however, be regarded as the essential units of a cathode-ray television receiver.

There are two types of vision signal receiver—the straight set and the super-het—the latter being the more usual type and this type only need be considered

THE CONSTRUCTION OF THE VISION RECEIVER

for the purposes of this explanation. (Fig. 3.) The vision receiver conforms to normal practice and there is no more difficulty in its construction than there is in an ordinary short-wave receiver, though it is essential to employ suitable components. It may, and usually does, consist of a straightforward super-het. circuit. As, however, television signals occupy a very wide band width of nearly half a metre, or more accurately 2,000,000 cycles, the tuning has to be very broad otherwise the picture loses definition.

How the Vision Receiver Functions

To get this broad tuning the intermediate-frequency stages are designed to work on a wavelength of 15-20 metres, as compared with 2,000 to 3,000 metres on a normal broadcast set. Also as the transformers are shunted with resistances, still further to broaden the tuning, the gain per stage is quite low. This means several I.F. stages in order to obtain the gain normally obtained with one I.F. stage when operated at a higher wavelength.

Although a vision signal receiver normally has three I.F. stages it does not follow that such a receiver is difficult to construct. It should be remembered that the gain from these three stages is less than the gain from one normal I.F. stage, so that the problem of instability does not arise if the receiver is built to a proper design.

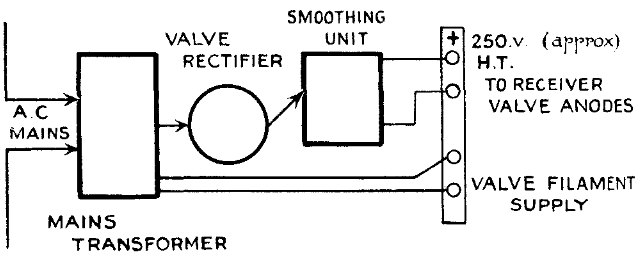


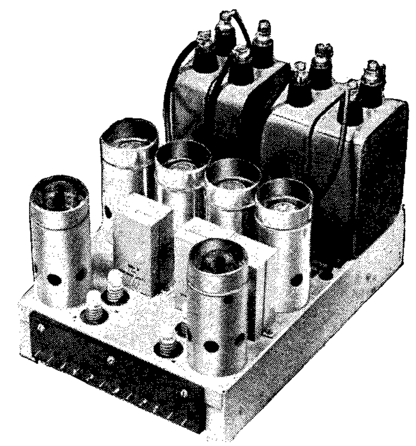
Fig. 4.—Units supplying high- and low-tension to the valves of the vision and sound receivers.

Still further to increase the gain, which is naturally low owing to the use of broadly tuned circuits, a vision receiver includes an amplifying stage at speech frequencies in front of the first detector. Actually the aerial feeds into a pentode H.F. stage which, of course, amplifies at speech frequency, that is 6½ metres, and feeds the slightly amplified signal into a detector stage which normally consists of a double valve of the triode-hexode type. The triode portion is an oscillator used in a normal circuit converting the signal into one at about 15 to 20 metres so that there is a slight increase in gain. This, of course, is the normal super-het principle.

After passing through three broadly tuned I.F. stages, and increasing in amplitude in each stage, the signal is rectified by a diode second detector before being fed into a normal low-frequency amplifier and ultimately to the cathode-ray tube.

It will be clear that, fundamentally, the circuit of this vision receiver is exactly the same as for a conventional short-wave super-het receiver except that there are more valves and the tuning is flat. Its construction entirely follows normal practice.

In the sound receiver the second detector is a diode which is included in a double-diode triode valve so as to give increased gain from the diode circuit. If, however, a double-diode triode were used in the vision circuit, the inter-



The G.E.C. double time base showing valves, condensers and neon limiters.

electrode capacity between the triode electrodes and across the base would form a small-capacity fixed condenser and when shunted across the circuit the higher frequencies would be accentuated, and nullify the effect of the broadly tuned I.F. circuits. For example, an I.F. amplifier that will pass frequencies of up to 2,000,000 cycles will have these frequencies decreased to as low as 1,000,000 cycles merely by the capacity in a badly designed triode amplifier. Also a triode detector, or multi-electrode detector, will have the same effect because the inherent capacity always forms a condenser, so decreasing the band width. For that reason a diode valve is invariably used in a vision receiver as a second detector as its shunt capacity is negligible.

As the output from the diode is so small, it is neces-

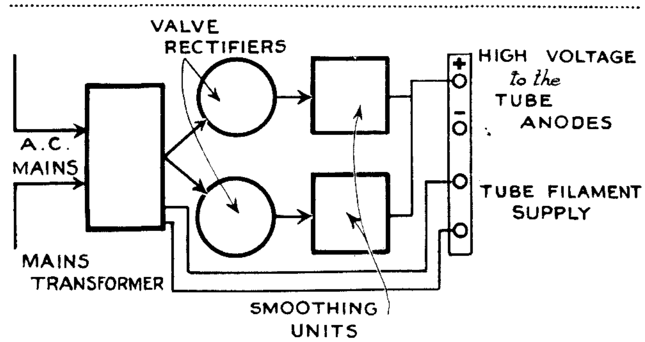


Fig. 5.—Units supplying high and low tension to the cathode-ray tube.

sary to amplify it by means of a triode or pentode valve of low inter-electrode capacity and arranged so that the grid connections are at the top of the bulb, again to reduce capacity. Though the low-frequency amplifier stage may appear complicated, the circuit is identical with a conventional L.F. amplifier except that these precautions have to be taken.

We can now consider the power pack for feeding the

THE COMPLETE SCHEME OF A TELEVISION RECEIVER

anodes and the filaments of the sound and vision receivers. This, as will be clear from Fig. 4, consists of a mains transformer giving high and low tension; a rectifier, usually a full-wave valve, and a smoothing unit made up of a choke and two high-capacity condensers. These are wired up absolutely the same as in the case of a standard radio set; the output is usually 250 volts

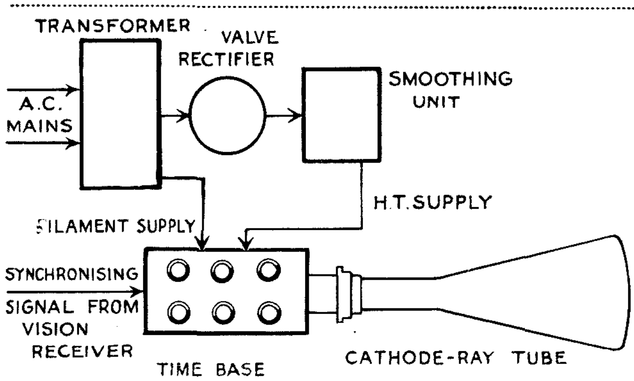
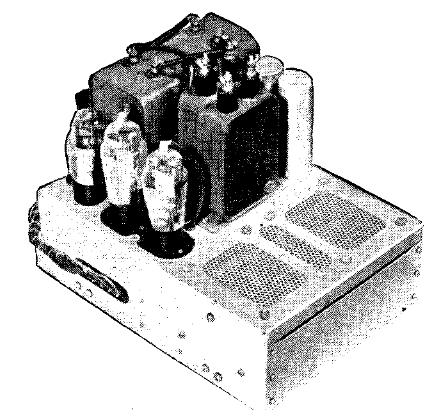


Fig. 6.—Time base and synchronising arrangements with associated high- and low-tension supply.

at 60 to 100 m/A. and suitable filament windings to feed the valves in the two receivers.

As mentioned previously a power pack has also to be provided to supply the high voltage and filament current for the cathode-ray tube. The high-tension is of the order of 3,000 to 4,000 volts, but its provision again follows conventional radio practice. The tube power pack consists of a mains transformer, with very high insulation between windings, two valve rectifiers and two smoothing units. Two rectifiers are needed owing to the fact that at high voltages mercury-vapour valves are used with a wide gap between electrodes to prevent arcing. These are half-wave valves and the design of the unit are practically the same as in the smaller power pack. Two smoothing units are included



A typical power pack for supplying high- and low-tension.

because every trace of mains ripple must be smoothed out otherwise its presence will be revealed on the cathode-ray tube and the picture marred. Fundamentally, as Fig. 5 shows, the circuit is quite straightforward and except that one or two special precautions must be taken to prevent breakdown owing to the high voltage employed there is no difficulty at all in the construction of such a unit. The condensers are, of course, of a special kind to withstand the high voltage, while

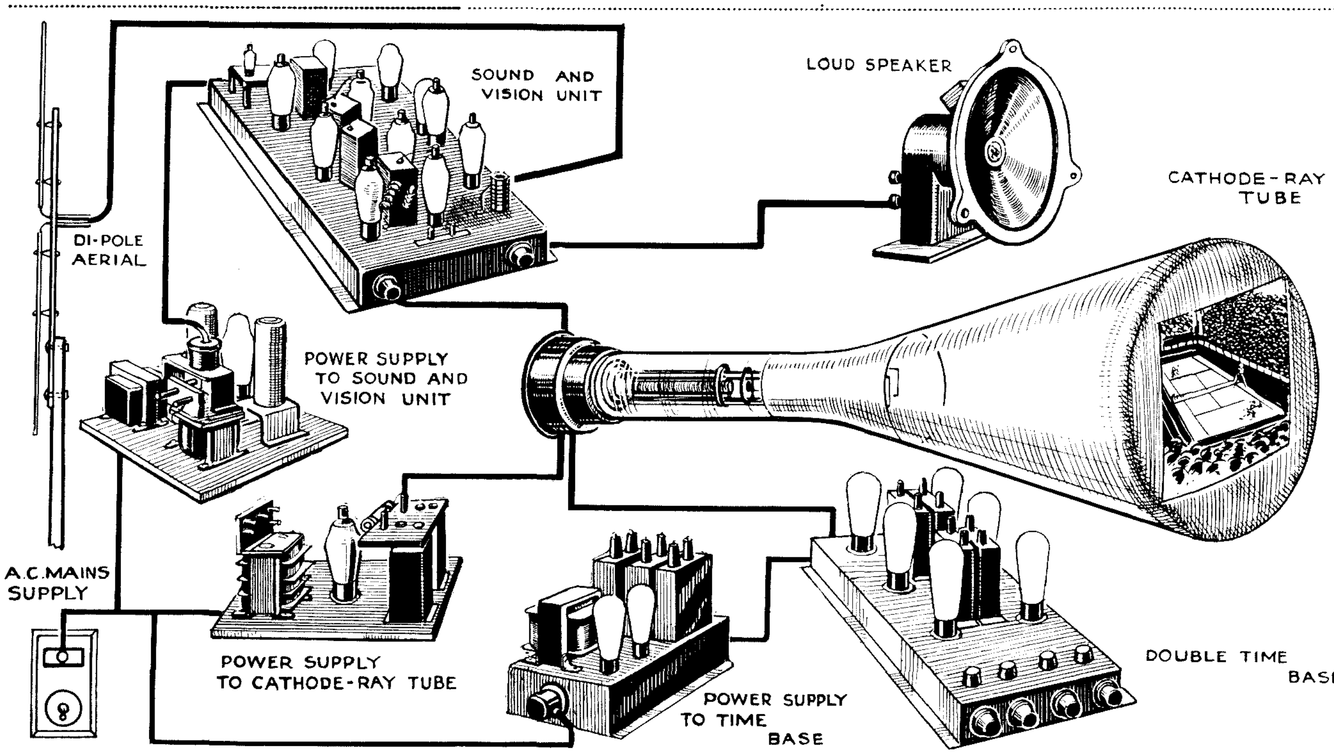


Fig. 7.—The complete arrangement of a cathode-ray receiver shown schematically.

the chokes must have very good insulation between the windings and the iron core.

It is essential with mercury-vapour valves that the heater must be warm before the high-tension is applied. As the heater takes 60 seconds to heat up a thermal delay switch is connected either in series with the H.T. supply or in some part of the circuit to break the H.T. to the rectifier valve anodes. This thermal delay switch is made up in a valve and consists of a heater and two dissimilar metals. These two metals when heated slowly expand and make contact; by varying the voltage on the heater the contact time can be delayed from 20 seconds up to 2 minutes.

The final item is the time base. The construction of this unit again follows radio practice though it has no counterpart in the ordinary wireless set. The time base is nothing more or less than a resistance-coupled network using as a rule six valves. These valves are of special types, but are just as simple to connect and no more trouble in operation than the normal power valve. The function of the time base is to provide a regular sequence of potentials to the deflector plates of the cathode-ray tube in order to produce the correct scanning motion of the electron beam.

The maintenance of this scanning motion in strict accordance with that at the transmitter is dealt with at length in another article in this issue and it will suffice to say here that the synchronising signal which is transmitted at the same time as the vision signal is picked up by the vison receiver, filtered out after the second detector, and applied to the time base where it provides just the requisite amount of check to correct any inaccuracies of scanning speed produced in the latter.

As the time base employs valves it also, of course, needs a suitable power supply and this again is a unit similar to that supplying high- and low-tension for the sound and vision receivers. The whole scheme is outlined in Fig. 6.

From what has been said it will be apparent that there is no more difficulty in the construction of a complete television receiver than there is in an ordinary wireless set, if we except a few special precautions which must be taken with certain parts where high voltages are employed. Admittedly the work is greater, for there are a number of units, but the fact that the units are complete in themselves and simple to couple together actually makes the task more easy than would be the case were the whole built up as one complete piece of apparatus as the entire circuit diagram appears to indicate. Fig. 7 shows a typical assembly of the whole of the units which are employed in a complete television receiver.

SOUND BROADCASTING AND TELEVISION

By Harry R. Lubcke.

Director of Television—Don Lee Broadcasting System, U.S.A.

Arising out of a suggestion which we made recently that television could be linked to sound broadcasting to a greater extent than at present we have received the following views of Mr. Harry R. Lubcke, Director of the Don Lee Broadcasting System, U.S.A.

SINCE September 1, 1936, radio broadcasting station KHJ, Los Angeles, California, has been used as a television sound outlet for the Don Lee television station W6XAO. Operating in the centre of the usual broadcast band, television sound programmes have been periodically made a part of the KHJ schedule. On several occasions the sound has been extended to the Mutual Network of California, consisting of ten stations.

The service was inaugurated with a 20-minute programme for the benefit of a joint meeting of the Institute of Radio Engineers and the American Institute of Electrical Engineers, which was held in the auditorium of the Don Lee Building. The guests, who numbered 350, adjourned to a receiving location 3¾ miles from the transmitters, there to witness reception on 45,000 kilocycles from station W6XAO, and the accompanying sound on 900 kilocycles (333 metres) from station KHJ.

Since that time combined programmes have been radiated regularly, usually weekly, at various hours of the day and night in order to test their suitability. In all, twenty-seven joint programmes have been transmitted, each starting and ending within a few seconds of a specified time, according to regular broadcast practice. Thus far, not one second of programme time has been lost on account of technical or other difficulties. Of the various hours chosen the later evening hours appear to be the most suitable—somewhere between 8.30 and 9.30 p.m.

A certain portion of the public receive both vision and sound of these programmes, having provided themselves with television receivers, constructional details of which have been provided by the Don Lee organisation.

The sound programmes are further available to all persons having an ordinary radio receiver within the area served by the broadcasting stations; from two to four million people depend upon the network. The reaction of the usual auditor, tuning in a programme for the first time, is that something unusual is going on. The various items of narration or dialogue, with sound effects, are presented in a manner different from that used in sound broadcasting alone.

Many persons who are only able to hear the sound take much interest in visualising what is taking place on the television screen. News items, often broadcast, give a sufficiently clear impression in the sound phase to put over the meaning, but create inferences that stimulate the imagination if the auditor be in such a mood.

Persons with an interest in television are frequent listeners, finding a certain satisfaction in witnessing part of a television programme, at least. Critical auditors, or those desiring a purely musical programme, as a dance band or chamber music, are not listeners. To be enjoyed, the television sound programme must be given definite attention. Purely musical programmes are often made the background for other activities as is well known, and this cannot be done with television, either sight or sound.

BRIGHTER AND BIGGER PICTURES WITH THE G.E.C. RECEIVER

By THE EDITOR.

The larger tube is accommodated by increasing the size of the hole in the mask.

FROM time to time during the past few months I have recorded my experiences with the G.E.C. Model BT3701 television and all-wave radio receiver. So far as the actual receiver has been concerned there has been practically nothing to record for its functioning has always been so consistent and the reproduction so good that it appeared to leave nothing to be desired. I can again repeat, that throughout this period it has never required the attention of the service engineers and it has not showed the slightest sign of falling off in any way whatever. Synchronism has been perfect and nothing short of some very violent interference would ever disturb it. These facts speak well for the design and the quality of components that are used.

A New Tube Development

However, the G.E.C. have not been content to rest on their laurels and recently I was somewhat surprised to receive a suggestion from the G.E.C. Service Department that the tube be changed for one that would give " larger and brighter " pictures. Increase of picture size with any receiver is a desideratum, but it has been usual to associate increased brightness with lack of contrast. The G.E.C., however, have produced a new cathode-ray tube with which whatever the amount of brightness the contrast does not suffer in the slightest, and the net result is that an intensely bright picture is available with full contrast.

The brightness and clarity of the image on this new tube is really amazing and although no measurements have been made the brightness appears to compare with the average cinema picture. Perhaps the following rough observations will convey some idea: in ordinary bright daylight the picture can be clearly seen: in diffused light, as for example when the window is covered with a light curtain, the programme can be watched in comfort: in a properly darkened room the illumination from the tube is sufficient to allow a paper to be read practically anywhere in the room.

The G.E.C. receiver has always had a reputation for very good definition and now with the added brightness and contrast this makes it possible to view the picture from any point in an ordinary sized room; also the fact that there is no necessity to block out any stray light is a great convenience during the light evenings.

This new tube is larger than the old one, the actual picture size being 10 ins. by 8 ins. It is easily adaptable to existing receivers and the G.E.C. are making the conversion free of charge. No alteration to the cabinet is necessary except the fitting of a larger mask. The fact that the G.E.C. are making the conversion free of charge is a comforting assurance that purchasers of their receivers will be treated generously in the matters of service and any new developments. I understand that this new tube is a development of the special laboratory which the G.E.C. maintains for research in luminescence and its applications. As is well known many uses for luminescent materials are being made for ordinary lighting purposes.

The consensus of opinion of viewers who have seen the new tube in operation is that the results are amazing and that the pictures closely approach cinema quality, both as regards brightness and detail. The G.E.C. are to be congratulated on this new development.

Book Review

Electrolytic Condensers, Their Properties, Design and Practical Uses, by Philip R. Coursey, B.Sc., M.I.E.E., F.Inst.P. The fact that this book is the work of Philip R. Coursey, Technical Director of The Dubilier Condenser Co., is a sufficient guarantee that it is authoritative. The author deals first with general theory and the origin and development of electrolytic condensers. Chapters are devoted to testing methods and apparatus, and the practical construction of the two types, aqueous and non-aqueous, are dealt with at length. Later chapters deal with the characteristics and applications of electrolytic condensers. We believe this to be the first time that so much information on the subject of electrolytic condensers has been presented, both from the theoretical and practical points of view, in such a detailed manner. The book is published by Chapman & Hall, and the price is 10s. 6d.

THE SCIENCE MUSEUM TELEVISION EXHIBITION

DEMONSTRATIONS OF ELECTRONIC AND OPTICAL-MECHANICAL RECEIVERS AT THE SCIENCE MUSEUM, SOUTH KENSINGTON

OPEN TO THE PUBLIC,
JUNE 11TH, 1937—SEPTEMBER, 1937
ADMISSION FREE

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Sundays, 2.30—6
August Bank Holiday, 10—8

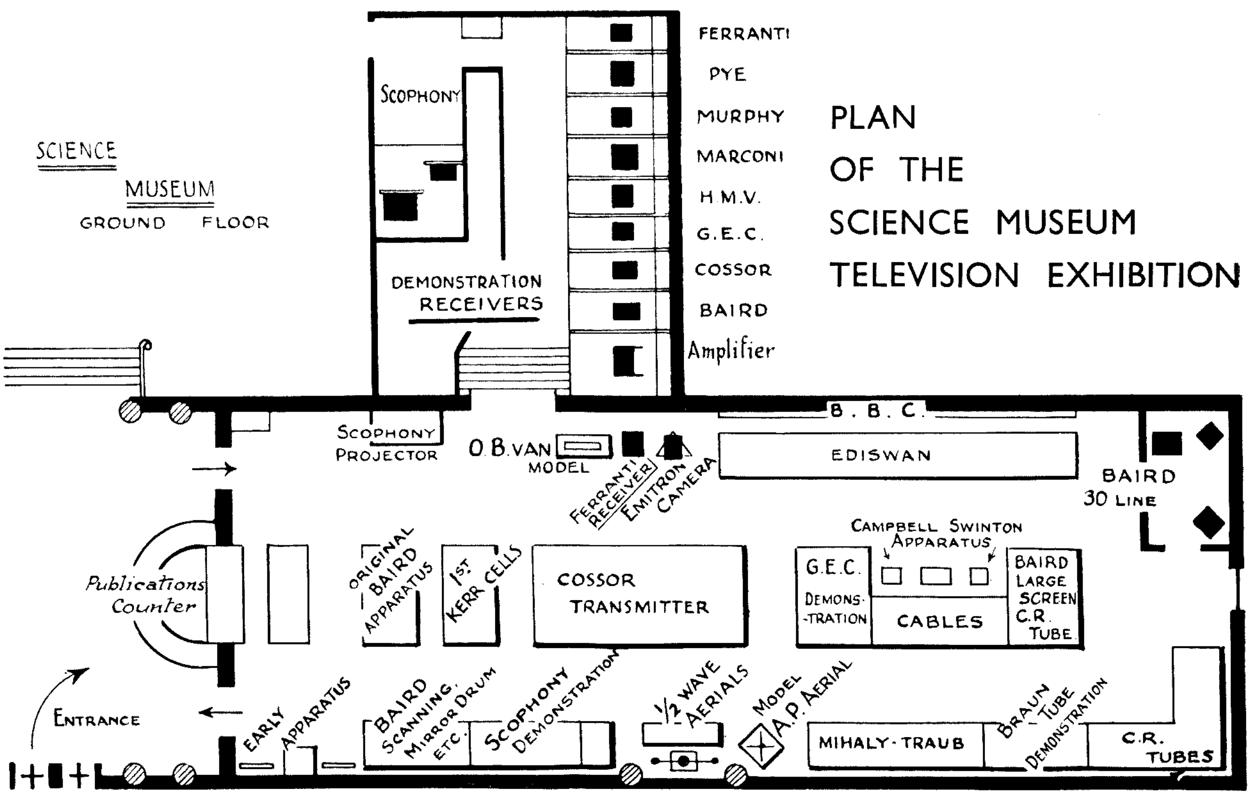
THE Television Exhibition that opened at the Science Museum, South Kensington, is the first to be held in this country on such a scale. Its purpose is to enable the general public to appreciate the amount of development that has taken place and to show historically how the present high standard has been reached. The exhibition, which is of a very comprehensive nature, is largely due to the efforts of G. R. M. Garratt, M.A., of the Science Museum.

The Exhibition is comprised of two sections, one of which contains exhibits of historical and scientific character and the other demonstration receivers of the types which are at present on the market. The interest is increased by the fact that these receivers are shown in operation for the greater part of the time that the Exhibition is open. During the periods when transmissions are being made from the Alexandra Palace the receivers are operated by the signals received from there, and at other times they are operated from a local transmitter which has been installed (and can be seen working) in the Central Hall by A. C. Cossor, Ltd. For the operation of the Scophony receivers special radio transmissions are being put out from the Scophony laboratories at Camden Hill, Kensington.

All the prominent names associated with television development are represented—Baird, Cossor, Ferranti, G.E.C., H.M.V., Marconi-E.M.I., Mihaly-Traub, Murphy, Pye and Scophony and as will be seen from the plan view of the Exhibition reproduced on this page most of these concerns have demonstration receivers which are being shown in operation. Incidentally, the arrangement of these receivers is liable to variation.

Baird Apparatus

Amongst the exhibits in the main hall modern and



PLAN OF THE SCIENCE MUSEUM TELEVISION EXHIBITION

THE BAIRD EXHIBITS

historical Baird apparatus is prominent. Of particular interest is the Baird electron camera, which consists of an evacuated glass cylinder at one end of which is a circular cathode having a uniform light sensitive surface. The functioning of this camera is as follows: An optical image of the scene to be televised is focused by a lens on to this cathode. This produces an electron image, the electron density at every point corresponding to the variations of light and shade in the original scene. By an ingenious combination of electro-static and electro-magnetic fields, the electron image is drawn forward to the target plane and scanned over the aperture. The electrons passing into the aperture constitute the original picture dissection signal and this is amplified by the multiplier integral with the tube itself. The resultant output constitutes the camera signal for feeding to the amplifier of the picture signal chain.

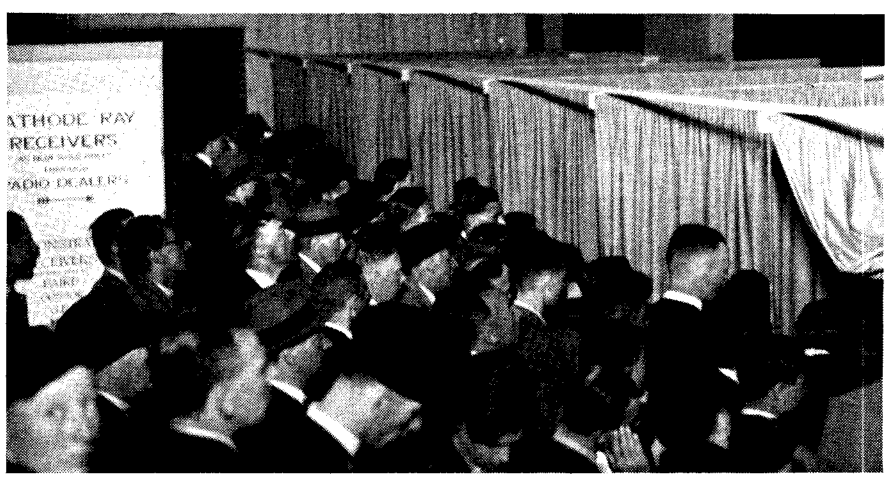
Electron multiplier photo-electric cells are also shown by the Baird Company. For the purpose of illustrating the action of this device, the electron permeable grid type is shown. The incident light on the cathode releases the primary electrons and by pressing a button the passage of a single electron can be traced. At the first grid secondaries are released so that three electrons pass from this first grid for the initial striking one. At the second grid, the same multiplication process takes place, and the three entry electrons become nine emerging electrons. At the end of the electron-multiplier photo-electric cell, a collector plate passes the electrons to the output circuit.

An interesting exhibit is the Baird Projection Cathode-ray Tube for obtaining large pictures. This is a small cathode-ray tube producing an exceedingly bright picture, which can be projected on to a remote screen. The resultant picture is several times larger than is possible by direct or indirect viewing on a cathode-ray tube. The associated scanning and focusing equipment together with the vision radio chassis, are similar to that used in a standard television receiver, but the operating voltage of the tube is higher. A receiver with a small screen is exhibited, this showing an unmodulated scanning field.

This photograph gives a general idea of the exhibits in the main hall. In the foreground are models of the Scophony light control, the beam convertor and the split focus system. Controls are provided outside the cases and visitors can test the actions of these devices by operating these, the results appearing on screens within the cases.

Another Baird exhibit is the magnetically-operated "Cathovisor" cathode-ray tube. The electrons emitted from the indirectly-heated cathode are accelerated towards the screen through an aperture in the specially shaped anode to which a high voltage is applied. This electron beam, as it emerges from the orifice, is then focused through the medium of a solenoid coil surrounding the glass neck. A direct current passed through this coil, produces a magnetic field which causes the electron beam, when it reaches the screen, to evidence itself as a sharp-edged but minute area of bright light.

Line scanning is brought about by saw-toothed shaped current pulses being fed into the pair of air core



The interest which is being evinced in the demonstration receivers is evident from this picture which shows the crowd outside the special viewing booths which contain eight different makes of receivers. Although this section of the exhibition is not in total darkness the pictures are clearly visible.

THE COSSOR LOCAL TRANSMITTER

coils seated on the glass neck, while an iron-cored electro-magnet gives the necessary frame scanning when fed with similar shaped currents, but at a much lower frequency.

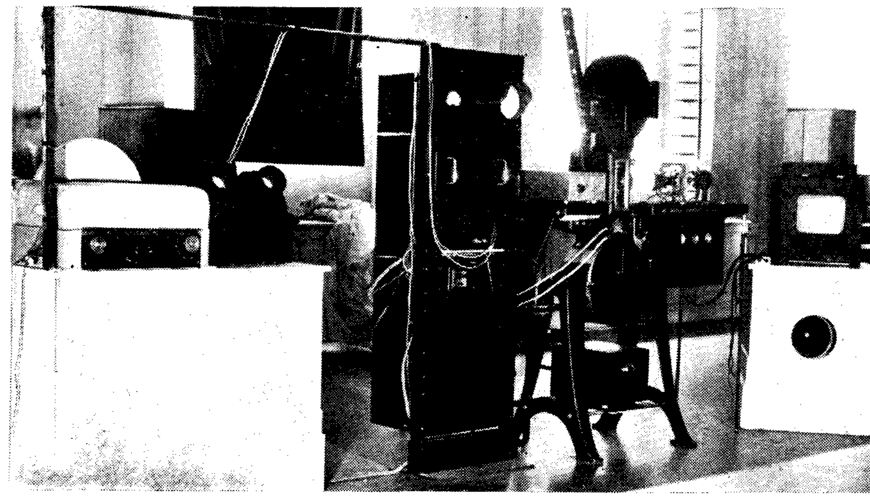
The combination of these magnetic fields produces a rectangular shaped scanning field and by allowing the incoming television signals to modulate the intensity of the scanning spot, a received television picture is produced on the screen.

A small room has been provided in the main hall for a demonstration of the Baird 30-line transmitting and receiving apparatus as used by the B.B.C. from August, 1932, to September, 1935. This is shown transmitting a dummy head. A revolving mirror-drum causes a spot of light to trace out a scanning field of 30 vertical lines $12\frac{1}{2}$ times per second. The light reflected every instant from the person or object within this scanning field is picked up by banks of photo-electric cells where the light variations corresponding to the light and shade of the transmitted picture are converted to equivalent voltage variations. After amplification, these television signals are fed to the mirror-drum receiver where they modulate a beam of light through the medium of a grid cell. A revolving mirror-drum traces this modulated light beam over a translucent screen so that when transmitter and receiver are synchronised, the picture observed is a coarse light replica of the scene at the transmitting end. This exhibit provides an interesting comparison with the results obtained with the modern receivers in the demonstration theatre.

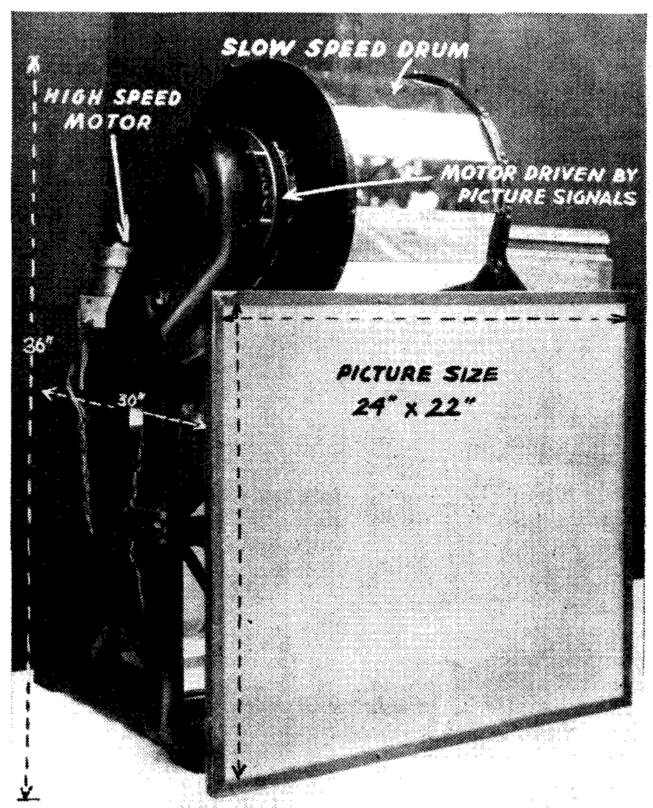
Associated with this apparatus is a grid cell for light modulation and a duplicate of this is shown separately. One of the earliest light controls suitable for use in conjunction with mechanically reconstituted pictures was the Kerr cell and the Baird grid cell unit is an example of a commercialised form. It consists of a special holder housing the sets of polarising prisms, hermetically sealed cell, condenser lens and projection lamp. The cell itself, as shown by the exhibit, is built up from a set of very thin interleaved electrodes being designed to operate at a polarising voltage of approximately 400 volts, while the signal voltage for full modulation is 125/150 volts.

The Cossor Transmitter

The most important piece of apparatus in the main hall is the Cossor television film transmitter which has been installed for the purpose of supplying signals to the demonstration receivers during the periods when the Alexandra Palace transmitter is not in operation. This transmitter represents perhaps the most complete development of the cathode-ray tube scanning method. The issues involved here are not at all straightforward,



This photograph shows the Cossor transmitter, which is used to provide sound and vision signals from film during such times as the Alexandra Palace transmitter is not in operation. All this apparatus is within a glass surround. On the left is the synchronising gear which consists of an apertured disc. On the right is a monitor receiver for checking the output to the receivers in the demonstration theatre.

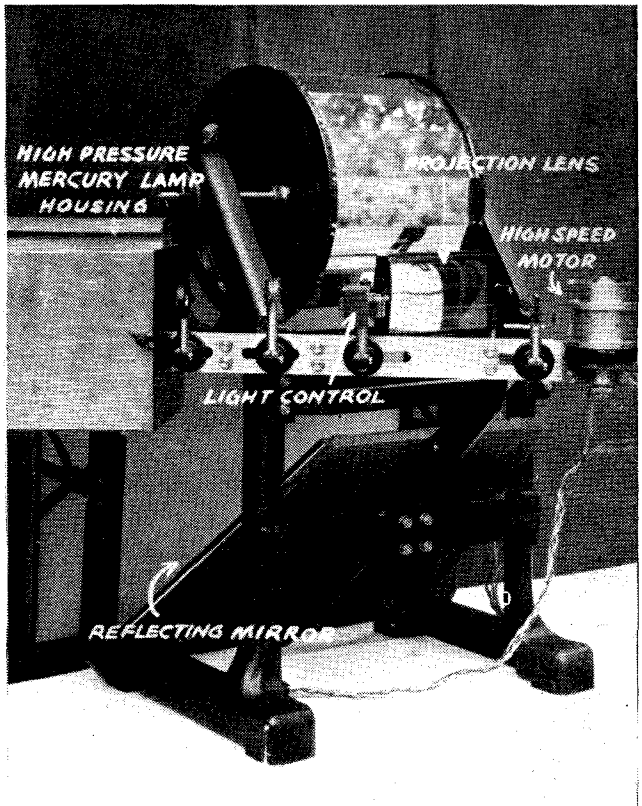


A view of the chassis of the Scophony home receiver which can be contained in a cube approximately 30 inches square.

EDISWAN AND G.E.C.

and the complicated problems arising from the screen time constant questions have been successfully solved.

With the use of cathode-ray tube scanning, the system is, of course, highly flexible. In this transmitter a choice is provided of five different line numbers—405, 315, 243, 187, 121, with a choice of sequential or interlaced scanning in all cases. For the first time, an immediate comparison can be made between interlaced and sequential scanning for any given number of lines, and such comparisons are most striking.



Rear view of the Scophony receiver showing the optical arrangements and light control.

The transmitter also illustrates the use of simple time base circuits to derive special forms of synchronising pulse. The wave form of the transmitter, inclusive of picture and synchronising intelligence, is continuously monitored on two oscillographs which can be seen near the transmitter..

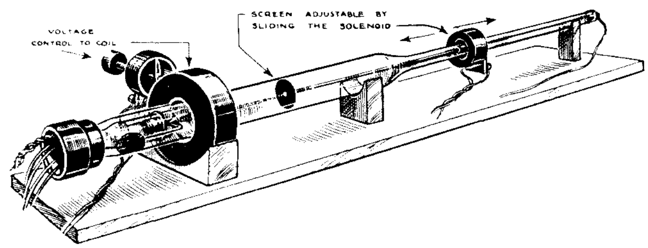
Cossor television transmitting and receiving tubes are also being exhibited in addition to the Cossor television receiver, which is shown in operation in the demonstration theatre.

Ediswan Cathode-ray Tubes

Ediswan show a cathode-ray tube connected to two time-base generators which cause the electron beam to travel in vertical and horizontal directions respectively. The number of lines produced depends on the relative frequencies of the two oscillators and can be varied by altering the resistance. At the end of each line and each frame, the time-base generators automatically return the beam to the starting point.

The motion of the electron beam may be synchronised with that of the transmitter by means of a synchronising signal which actuates the scanning oscillators at the correct instant for the start of each line.

Another interesting exhibit by this firm is a tube illustrating the principles of magnetic focusing. Opposite the " gun " of the tube a small screen is mounted on a tube attached to a soft iron core. By means of an external solenoid the core, and hence the screen, can be moved to any distance from the focusing coil. The effect of varying the current through the latter can then be observed and the focal length of the system demonstrated.

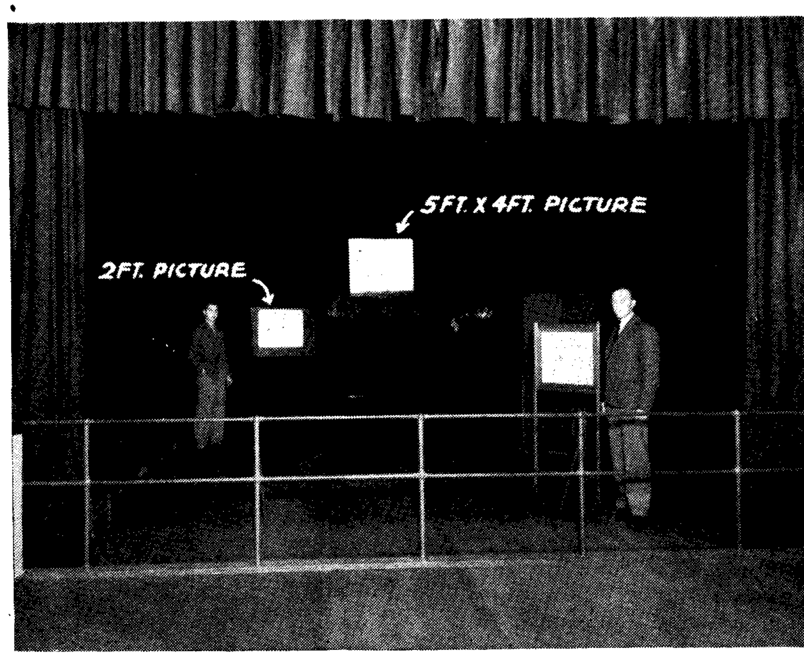


Ediswan model illustrating magnetic focusing.

The G.E.C. Exhibit

The G.E.C. show an ingenious working model of the cathode-ray tube of a television receiver. This model,

(*Continued on page* 419)



The Scophony demonstration theatre in which two receivers are shown in operation, one giving a picture 5 ft. by 4 ft. and the other 24 inches by 22 inches.

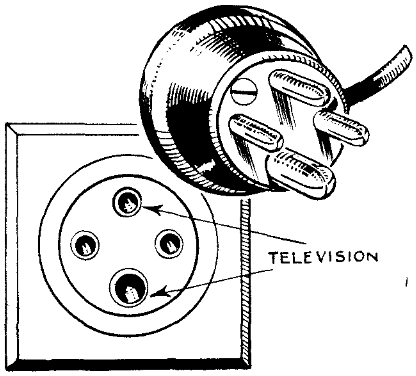
TELEVISION RELAYS FOR MODERN FLATS

FIRST PUBLISHED DETAILS of a "TELEVISION-ON-TAP" SYSTEM

IN our issue of April we illustrated a scheme showing how multiple television might be made available to a number of wards in a hospital or other similar institution. The scheme was suggested as a perfectly feasible proposition, and in following up this subject

Arlington House, Piccadilly, which is equipped with a television relay system.

we are now able to review a system of television relay which is in being in a very large block of flats in London; this particular case—at Arlington House, Piccadilly. The system is really a recent development of the radio relay systems for flats, etc., which is a special feature of Radio Furniture and Fittings, Ltd., of 73 Sloane Avenue, Chelsea, S.W.3, a company already noted for its work in relaying radio programmes, and for the attractive design and installation of suitable receivers, loudspeakers, electric clocks, etc.

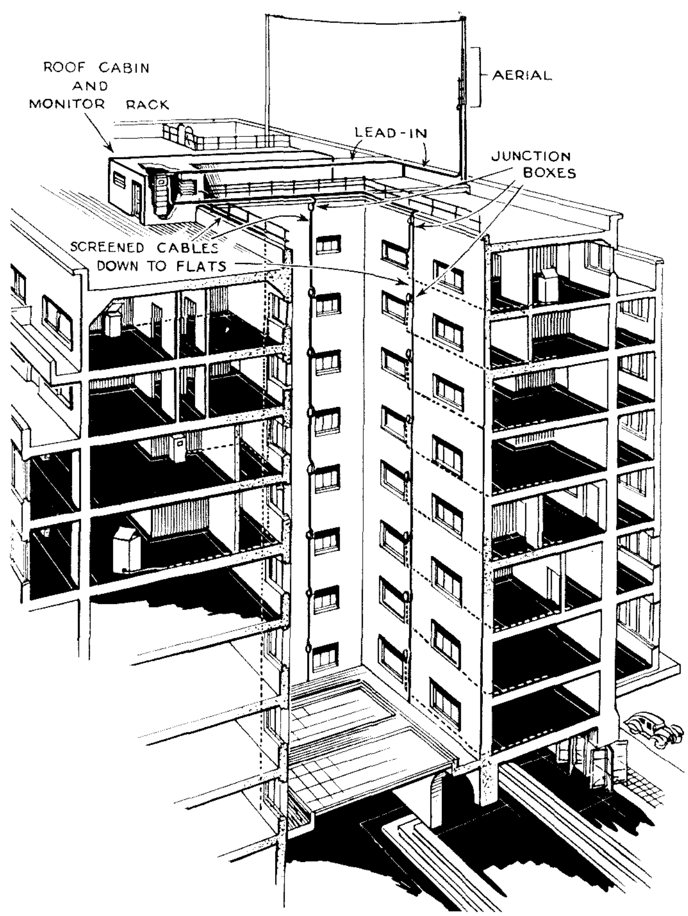


Special wall plug for television and radio relay systems.

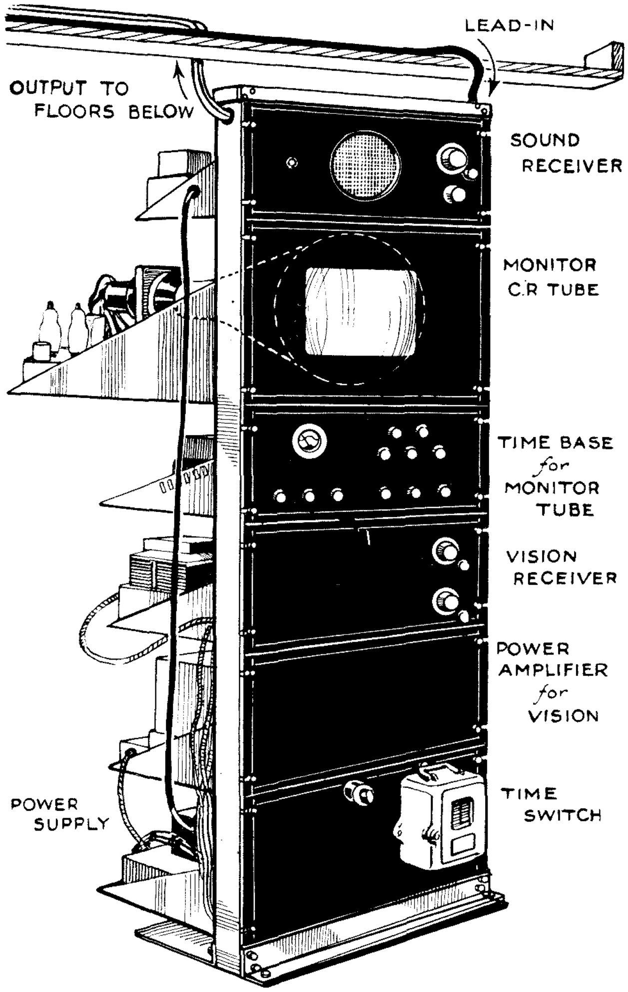
In the case of television their method is to house a master receiver on the roof of the building, isolated from all interference and to feed amplified vision and sound signals down to any number of modified viewing instruments in the various flats. To some extent the system is analogous to radio relays to any number of loudspeakers; it should be clearly understood, however, that this is in no way a system of aerial extension which in some respects is not so good, chiefly by reason of the susceptibility to interference from the variety of electrical apparatus in such buildings as modern flats. Such a method would also involve the use of complete receivers at each point and the tuning of these individually, whereas in the system under review the receivers are only fitted with a switch, light intensity control and sound volume control.

The master receiver is housed in a concrete cabin on the roof of the building, some 100 ft. above the street level; it receives the Alexandra Palace signals on a special aerial mounted on one of the masts of the radio relay aerial, the lead-in being ½-in. concentric cable run for convenience parallel with the radio leads.

The cabin contains other apparatus, including the



Sectional view of Arlington House showing the aerials, roof cabin and cables connecting to flats.



Drawing showing construction of master receiver situated in roof cabin

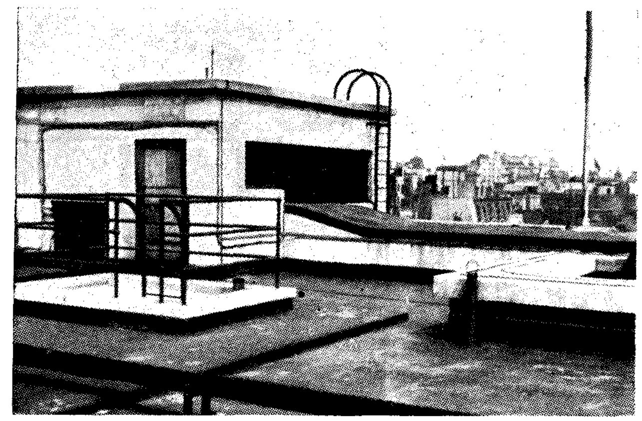
electric motors which drive the ventilation fans and these do not interfere with reception although they are only a few feet away.

The various units of this monitor receiver are indicated in our illustration; the clock switch operates at a few minutes to 3 o'clock and 9 o'clock, the receiver comes to life and the supply is available at all points in the building without any personal attention from the staff. An engineer visits the apparatus about once a fortnight for general inspection, otherwise, it remains untouched—indeed, locked up.

From the master receiver the supply is by screened, twin cable, in vertical runs down the central well of the building to various metal junction boxes, one of which is provided for each reception point; these boxes contain in addition to the connectors (of both radio and television) a resistance network by which impedance of the lines can be balanced, thus preventing any one point getting excess signal values and the consequent starving of other points.

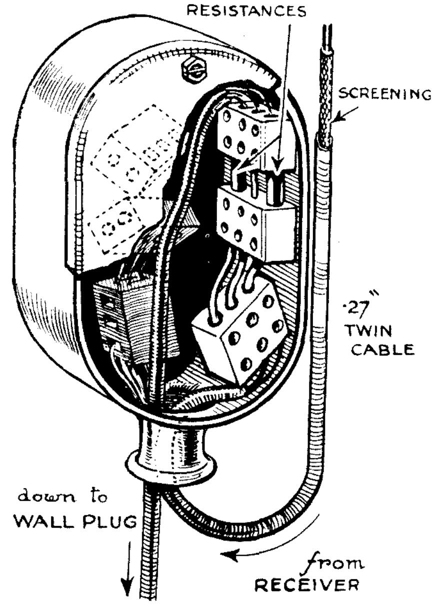
Inside the building the wiring is continued with similar cable to 4-pin plugs (usually on the skirting) at convenient points in each flat; two of the pins are for television, the other two being connected to the radio relay system. In Arlington House the wiring was installed after the building was completed, and is external, but in other cases where the installation will be made during erection of the building, the wiring will be run in metal tubing in the walls with consequent shorter lengths.

The receivers in use are not, of course, complete instruments as ordinarily used. Internally they comprise the C.R. tube and power pack, the time base and its power pack, and the loudspeaker; neither vision nor sound receivers are needed here, of course, as there is the "master" receiver on the roof.



View on the roof of Arlington House showing the master receiver cabin.

The operation and control of these receivers is simplicity itself and a number are now in the hands of persons without the slightest technical knowledge. Several different makes of receiver specially adapted for the different conditions are in use. The results obtained are exceptionally good; interference is nil and the scheme appears to function excellently.



A junction box is provided in each flat which contains the connectors and resistances for television and radio relay.

There are other buildings equipped for television in Berkeley Square district and Roehampton, and already the number of tenants who have taken advantage of the scheme is considerable.

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WORLD PIONEERS & MANUFACTURERS OF ALL TYPES OF TELEVISION EQUIPMENT

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The Baird Receiver, Model T.5, is the finest set offered to the public. Although costing only 55 guineas it provides a brilliant black and white picture larger than that obtainable on any make of receiver now marketed. Among the factors contributing to the set's performance, are simple operation, wide angle of vision, high fidelity sound and excellent picture detail.

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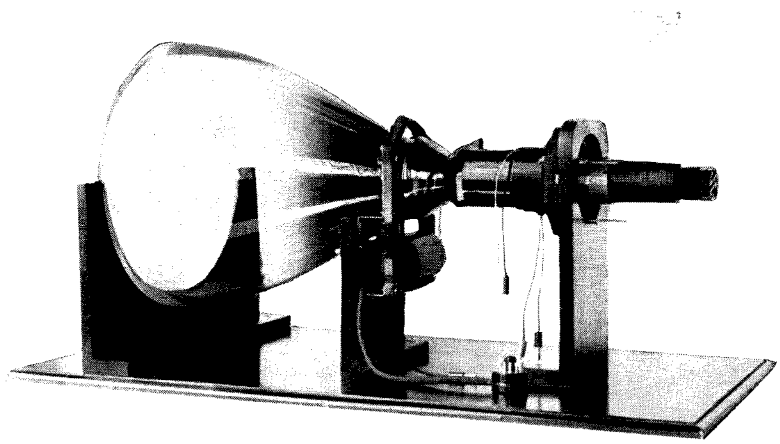

" CATHOVISOR " CATHODE RAY TUBE Type 15 MWI Complete with Electromagnetic Scanning and Focusing Equipment.

BAIRD MULTIPLIER P.E. CELLS

Baird Multiplier Photo Electric Cells are made in two main types. The first has a small cathode of 15 sq. cms. for use with a concentrated light beam, while the second has a large cathode of 250 sq. cms. for diffuse light.

The Baird Multiplier has a chain of electron permeable grid stages and current gain factors of the order of 100,000 can be obtained. Cathode sensitivity is approximately 30 microamperes per lumen and the good spectral response enables the cells to be used for infra red detection and infra red signal amplification. Details on application.

BAIRD CATHODE RAY TUBES

TECHNICAL DATA

TYPE 15 MWI.

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.

GENERAL

The Baird Cathode Ray Tube, type 15 MWI, 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.

All " Cathovisor " Cathode Ray Tubes are completely electromagnetic in operation, a feature of outstanding advantage. Furthermore, not only is the electrode system extremely simple and robust, but due to the special form of cathode employed, a high intensity cathode ray beam is produced which results in a very brilliant picture.

The ideal tube for really large television pictures—12 in. by 10 in.—without distortion.

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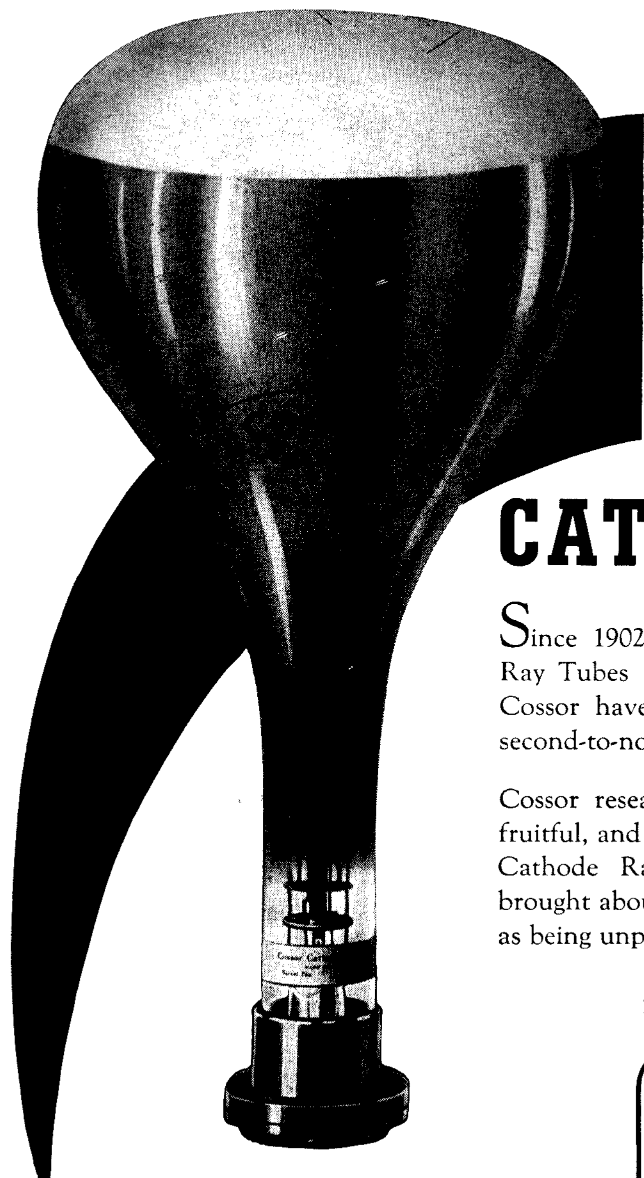
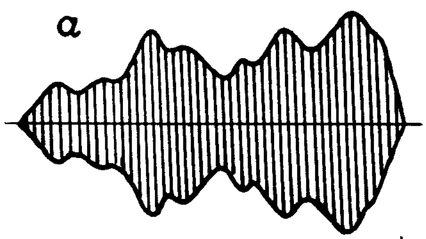


THE ABC OF SYNCHRONISING

In this article G. Parr summarises the various types of synchronising signal which have been used and explains the differences between each type.

THE synchronising signal is a vital part of the television transmission because there is at present no means of making two systems keep in exact step, any more than two clocks can keep time with absolute precision. The clock analogy is very useful in considering the question of synchronism and we can develop it a little further.



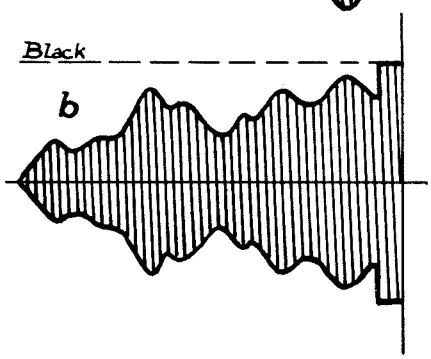


Fig. 1a.—A modulated carrier wave in which black corresponds to full amplitude.
Fig. 1b.—The same carrier with the addition of a synchronising pulse at the end of the line.

Suppose a house were equipped with mains driven clocks in every room. For practical purposes they can be considered as keeping correct time, but in reality they probably differ between themselves by two or three seconds. Any given minute hand will perform one revolution of the dial in an hour, but will not necessarily be in exact space relationship with that of another clock. The clocks will be *isochronous*, that is run at the same speed over long or short intervals of time, but they will not necessarily be *synchronous* or move in exact step with one another.

To ensure synchronous running we could arrange a time signal to be applied to the mechanism at the end of each hour so that the clock which was a few seconds out in timing would be corrected and its hand moved to coincide with that of the other. If we assume that the mechanism is sluggish it is possible that it might alternately run fast or slow by a fraction of a second and in that case an hourly time signal would not be sufficient to keep it in synchronism throughout the whole time. The signal would then have to be applied at ten-minute intervals to be more effective, and to continue to the extreme, we might, in order to ensure perfect synchronism, apply a time signal at the end of each ten seconds or even less.

The necessity for applying a time signal would not detract from the qualities of the clock as a time-keeper—it is purely a question of the degree of precision required in the running as compared with the running of a similar clock elsewhere.

Now in television we have the necessity for precision running of the highest order. We are receiving signals which unless they are assembled in the right order and at the exact moment will produce an unintelligible blur on the receiving screen and the only method of ensuring exact synchronism between the two mechanisms (which have not even the advantage of being connected by a wire to a common supply) is to provide a time signal at as frequent an interval as possible.

Applying the Synchronising Signal

We have two definite points in the production of the picture at which the signal can be applied to the best advantage—the beginning or ending of each line can be signalled and the start or finish of each complete picture. A signal at the end of each line would ensure that each line was ended at the correct moment even though it might not keep step throughout the line period. Each line is, so to speak, given a fresh chance. Similarly with each picture—whatever slipping may occur in the previous one we are assured of a fresh start for the new one coming.

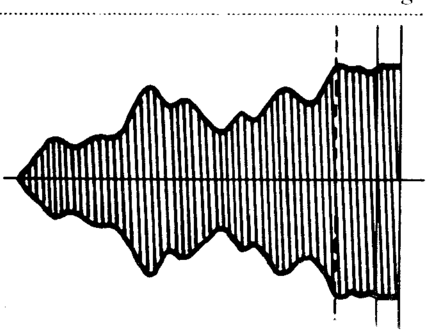


Fig. 2.—If a black part occurs in the picture before the pulse it causes the synchronising to be irregular.

In the days of mechanical reproduction of pictures by the mirror drum or disc the provision of two separate signals was not necessary since the number of lines per picture was automatically limited by the holes in the disc or the mirrors on the drum.

If, therefore, we ensured synchronism at the end of each line the picture could be relied on to keep step. Returning to the clock analogy for the moment, the hour hand is geared to the minute hand, and if the minute hand is kept synchronous the hour hand will automatically keep in synchronism.

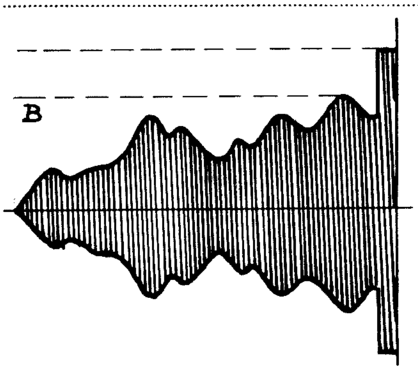


Fig. 3.—The method of distinguishing between signal and synchronising pulse used in the French system.

The problem in the low-definition system was therefore to provide a signal at the completion of each line, which should be of sufficient amplitude to correct fast or slow running of the rotating mechanism. To see how this was done we must consider the nature of the signal itself.

The low-definition signal was radiated on the lines of the standard broadcast sound system in which the sound signal modulates the strength of the carrier wave. Full amplitude of sound modulates the carrier to zero and during the silent intervals the carrier rose to its full height. In a corresponding way, full picture brightness modulated the carrier to zero and absence of light from the scene corresponded to the unmodulated carrier (Fig. 1a). A certain portion of the time of each line was then set aside during which no light was transmitted and the full strength of carrier so obtained was used to provide the energy for synchronising.

This is shown at the end of the line signal in Fig. 1b, and in practice was done by masking off a portion of the scene by a black bar across the bottom of the scanning aperture. Each line therefore terminated in a "black" impulse. Although this system was effective in that it provided ample energy for synchronising it had one drawback. If the scene was such that a considerable portion of black appeared at the bottom of the picture the black picture impulse became confused with the "end of line" impulse and the synchronising signal acted too soon. This is shown in Fig. 2 in which the line signal shows a long black portion before the actual occurrence of the synchronising pulse. The receiving mechanism can therefore be "tripped" at any part between the dotted line and the end of the line instead of at the correct instant shown.

An obvious improvement in avoiding this trouble is that shown in Fig. 3 in which the amplitude of the synchronising pulse is made higher than that of the maximum picture signal during any portion of the line. This means that the carrier is always modulated to a certain depth even by a "black" impulse (shown by the dotted line marked "B") and there is thus no possibility of the black being confused with the synchronising pulse. This system is in use in the Barthelemy television system radiated from the Eiffel Tower, the signal being in the form of a very sharp peak of maximum energy occuring at the end of each line and each picture.*

The Modern Method

A different method altogether of distinguishing between the synchronising and picture impulses is that used by Marconi-E.M.I. in the B.B.C. transmissions. In this system the synchronising pulse is made in the opposite "sense" to that of the picture pulses and any circuit which is correctly wired to respond to the picture impulse is unaffected by the synchronising pulse and vice versa. This is done by completely reversing the modulation system so that white corresponds to a maximum amplitude of carrier and full modulation is given by the black impulses.

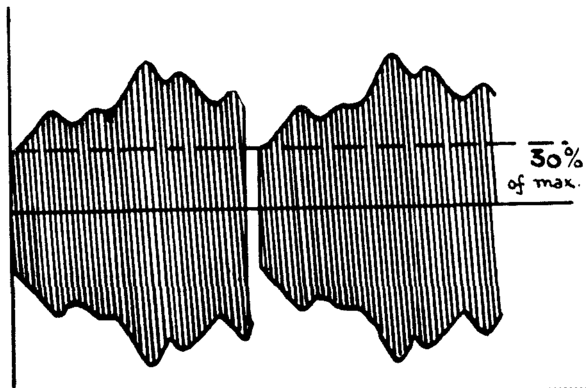


Fig. 4.—The present signal radiated by the B.B.C. in which the carrier drops to zero to provide the synch. impulse.

Full modulation in this system does not imply that the carrier is reduced to zero amplitude as it would be in the case of sound broadcasting, but the depth of modulation is restricted to a definite percentage of the maximum carrier amplitude. This has been set at 30 per cent. of the maximum and the complete line signal then appears as in Fig. 4. It will be seen that the fluctuations in carrier amplitude for a given line all lie between the dotted limits shown, the highest peak corresponding to full brilliance.

At the end of each line a pause in the signal occurs during which the carrier ceases altogether and it is an absence of impulse rather than a positive "kick" which operates the timing of the receiver circuit.

The meaning of the opposite "sense" of the pulse is clearer if we consider the line drawn through the 30 per cent. modulation in Fig. 4 as a zero line from which potentials can be reckoned. If our reproducer (which is in most cases a cathode-ray tube) is adjusted so that there is no brightness on the screen at this arbitrary zero line, an increase in signal can be considered as reducing the grid bias of the tube and increasing the brightness of the screen.

On the other hand, a further reduction of signal will increase the grid bias still further and produce no effect on the tube. Now so far as the scanning circuit and its valves are concerned the opposite takes place. For the same arbitrary zero line the synchronising pulse can be made to decrease the bias of the valves and trip the timing impulse while the picture signal proper produces no effect.

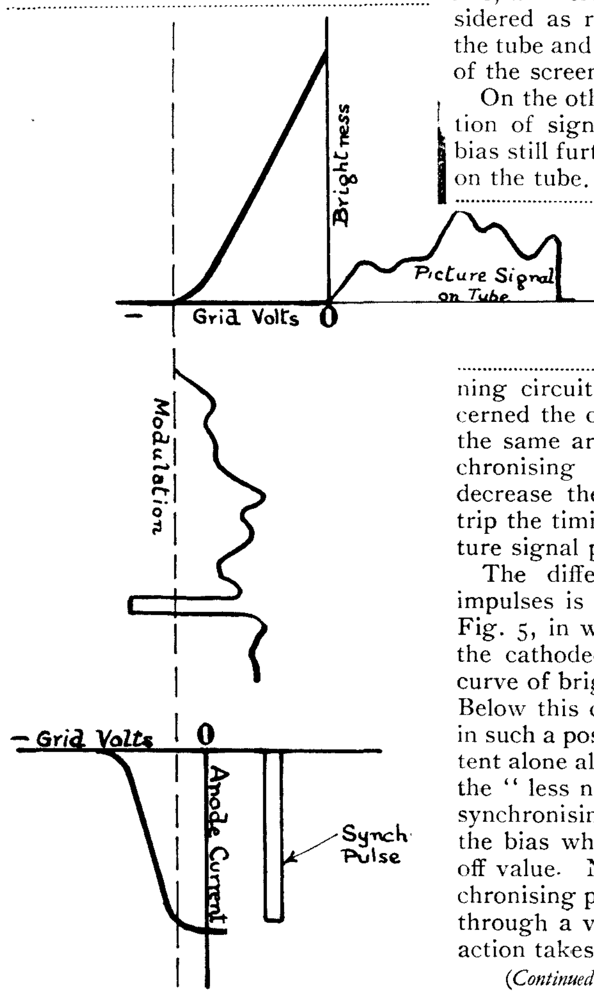


Fig. 5.—How the picture signal is separated from the synch. pulse. At the top the signal is applied to the tube characteristic as shown, while the separating valve characteristic (bottom) only passes the synch. pulse.

The difference between the two impulses is shown in the diagram of Fig. 5, in which the characteristic of the cathode-ray tube is shown as a curve of brightness against grid bias. Below this curve the signal is shown in such a position that the picture content alone alters the bias of the tube in the "less negative" direction. The synchronising pulse merely increases the bias which is already at the cut-off value. Now we separate the synchronising pulse by passing the signal through a valve in which the reverse action takes place.

(Continued in first column of next page)

* See the issue for July 1936, p. 401.

Scannings and Reflections

TELEVISING WIMBLEDON TENNIS

THE televising of play on the centre court at Wimbledon was one of the most successful broadcasts to date. The important part, however, was not so much the technical success of this broadcast, but the manner in which it was carried out. Three vans, forming between them a complete television station, broadcast directly from Wimbledon to Alexandra Palace without the need of the expensive co-axial cable.

If anything the transmissions were more successful than that of the Coronation, and they show that in the future transmissions can be made from almost any part of London or within an area of 10 to 15 miles of Alexandra Palace. No longer will the television camera be restricted to the range of the co-axial cable.

This development will make a very big difference to future television programmes, for their scope can be greatly increased and producers should be able to create programmes of a more interesting and novel type than in the past when they were restricted to studio shows. The television vans are complete with transmitter, operating on a wavelength of approximately 3½ metres and special beam aerials were erected for the occasion.

At the commencement of the tests the B.B.C. said that the experimental nature of this attempt could not be too strongly emphasised as it is the first occasion on which use has been made of the radio link, and much will depend on the quality of the signal picked up at Alexandra Palace from the mobile television unit at Wimbledon.

Telephoto lenses were used when lighting conditions permitted, and rapid and frequent " panning " was avoided, the intention being to give a more stable picture by concentrating on the play first at one end of the court and then at the other.

TELEVISION RESEARCH WORKERS

Probably the majority of television research workers come from the ranks of radio engineers, but, of course, there are many specialised branches of the subject which require specialised knowledge, as for instance, optics and chemistry. There are many problems in the latter subject relating to television which still remain to be solved, as, for example, those relating to fluorescence and the production of intense light sources. All the research laboratories now have specialists who devote their time to the solution of problems within their own particular sphere. The highly skilled artisan who is capable of precision work is also finding an outlet for his skill.

EIFFEL TOWER PREPARATIONS

Recently there has been a great deal of activity in the small hours of the morning at the foot of the Eiffel Tower where a band of engineers has been engaged in the work of hoisting up a length of special television cable to the summit of the tower. The manipulation of such an enormous length was by no means easy, as can be judged from the dimensions: diameter 15 cm., length 405 metres, and weight 30 kilogrammes per metre, or more than 12 tons in all. The cable has been specially made in Germany and can carry 30 kilowatts of H.F. power at 50 megacycles.

INSURING CATHODE-RAY TUBES

It is now possible to insure cathode-ray tubes used in television receivers irrespective of type or make. The terms and premiums are as follows:

For limited cover against loss or damage by fire, explosion of boilers, gas explosion, lightning, burglary, housebreaking, theft and accidental breakage by external agency, but *excluding* earthquake, war, invasion, riot, strike, civil commotion, wear and tear, gradual deterioration, use of tube contrary to the makers' directions, loss or damage caused by over-running, excessive pressure, short circuiting and/or any damage caused directly or indirectly by the application of an electrical energy.

Rate—5 per cent. of maker's catalogue price.

For loss or damage by any accident or misfortune other than war, riot, etc., and loss or damage arising through wear and tear or gradual deterioration, or the use of any tubes contrary to the maker's instructions.

"THE A B C OF SYNCHRONISING"

(*Continued from preceding page*)

The pulse gives a momentary increase in anode current which is handed on to the scanning circuit while the picture signal does not affect it.

Two more points: The cathode-ray tube as a reproducer has no equivalent of the mechanical interlock that we saw in the case of the disc receiver and it is, therefore, necessary to provide both a pulse at the end of each line and each picture. These are similar in shape except that the latter is slightly longer in duration and is repeated several times and its action in the scanning circuit is similar to that of the line impulse.

Secondly, the fact that the scanning lines are interlaced requires a slight variation in the line impulses depending on where the timing has to operate. As we know the picture is scanned twice, the first scanning producing the odd lines and the second the even. To make these lines fall in their correct place the line which finishes the " odd " frame is abruptly cut off half-way along its length and the synchronising pulse for the picture starts to pull the scanning circuit into step for the second half of the total scanning lines.

The whole secret of interlacing depends on the accuracy with which these synchronising pulses are applied to the scanning circuit and great care is required in designing the circuit so that they are not lost or distorted.

MORE SCANNINGS . . . .

Rate—15 per cent. of the maker's catalogue price.

The above rates are to cover the tubes in television sets only in fixed situations, that is, the private dwelling of the owner or hire purchaser.

Incidentally, it is interesting to note that since one or two accidents have happened to the Iconoscope cameras at the Alexandra Palace the B.B.C. have taken the precaution of insuring these against accidental damage.

NEW B.B.C. GOVERNOR

Mr. Charles Howard Goulden Millis, D.S.O., M.C., has been appointed Vice-Chairman and Governor of the British Broadcasting Corporation for a period of five years.

Mr. Millis succeeds Mr. Harold Brown, the late Vice-Chairman, who retired at the end of last year on completing his five years' term of office as a Governor of the Corporation. Mr. Millis' appointment brings the number of Governors up to seven, as recommended by the Broadcasting Committee. Mr. Millis, who is 43 years of age, is a partner in the banking firm of Baring Brothers & Co.

TELEVISION IN THE PROVINCES

Although no decisions have been made regarding the inauguration of television in provincial centres, suitable arrangements allowing for its installation are being borne in mind in the schemes which are being planned for new relay and broadcasting stations that are projected.

SPONSORED TELEVISION IN U.S.A.

Consideration is now being given in the United States to the appropriateness of television for advertising purposes. That it will be developed for this purpose is quite evident and the Television Director of the Don Lee Broadcasting System recently stated that: "It has every opportunity of becoming the most intimate and perhaps the most pleasurable contact between advertisers and the public. I envisage, along with interesting eye-and-ear entertainment, the presentation of the commercial message with a theme-picture, a theme-song and a single word, rather than the multi-worded commercial announcements in use to-day. Television programmes will be available only a few hours per day, at first. The concept of the "nightly performance" will follow. Later, television will be as continuously available as is radio to-day."

AN INTERNATIONAL TELEVISION CONGRESS

We understand from the French wireless journal, *Le Haut Parleur*, that an international congress has been organised in connection with the 1937 Paris Exhibition, having for its object the discussion of all radio subjects. A separate section is devoted to television and discussions will take place on July 8, 9 and 10.

The principal question which will receive attention is that of what immediate improvements can be made in television and what facilities there are to effect them. The technical aspect is already being considered in France by the Minister of Posts and Telegraphs and at the end of this month the French standard will have been tentatively settled in order that the commercial interests may proceed with development.

Le Haut Parleur invites suggestions and comments, particularly in connection with such questions as:

(1) The ideal proportion of films to direct scenes in the programme.
(2) The most favoured time for transmissions to be sent out.

TELEVISION AT THE ZOOLOGICAL SOCIETY'S RECEPTION

Two Maharajahs, four Sultans, a Zulu Chief, and about five hundred other distinguished guests, saw television for the first time at the Zoological Society's reception on May 28. By arrangements with the Society, Marconiphone installed two television receivers in the new Studio of Animal Art.

AMATEUR STATIONS FOR COMMUNICATION PURPOSES

Amateur stations operating on the 80- and 160-metre bands are to be co-opted into a national organisation to operate their stations in time of national emergency. The plan calls for two stations in all main towns to be able to cover an area of 50 miles.

These stations will have to operate from a power supply other than the normal supply mains, for in case of a complete breakdown they will have to maintain normal communications. The usefulness of these amateur stations was fully demonstrated in America during the Pittsburgh floods, and to a lesser extent during the recent floods in the Fen country. This National Emergency Network will have its full dress rehearsal early this month, when some idea as to its effectiveness will be ascertained.

SIGNALS FROM THE NORTH POLE

Broadcasts can now be picked up from the U.S.S.R. station situated at the North Pole. This station, operated by members of the U.S.S.R. Polar Expedition, has the call sign Radio Upol and operates on 20, 40 and 75 metres with a station call of RAEM, and an input of 70 watts. It will be interesting to see which country will be the first to receive the news bulletins and weather reports sent out from this station.

TELEVISING CRICKET MATCHES

As the three new B.B.C. television vans are equipped with telephoto lenses it will soon be possible for viewers to see transmissions of outdoor events such as motor racing, athletics and cricket matches. Tests have already been made and a successful transmission was made of a cricket match so that it is not unlikely that transmissions from Lords will follow quickly on the Wimbledon broadcast.

THE CENOTAPH PLAN

For the first time the ceremony at the Cenotaph on November 11 is to be televised. The telephoto camera will again be brought into use, so that viewers should be able to witness yet another successful broadcast of an outstanding event. It is this type of broadcast which will popularise the television receiver rather than the repeated transmission of musical and variety shows.

THE POLLSMOOR GRAND PRIX

Five-metre transceivers proved their use when six short-wave stations were in continuous operation during the Grand Prix Motor Race held at Pollsmoor, South Africa. Two of the transmitters were used to communicate from the time-keepers' tables opposite the grandstand to the pits, while four were in use by traffic control authorities. An aeroplane, also equipped with a 5-metre transmitter

. . . . AND MORE REFLECTIONS

and receiver, kept an eye on traffic congestion and was able to talk to the police department and advise them as to the best way of relieving congestion.

PYE RADIO AND TELEVISION

At the eighth ordinary general meeting of Pye Radio, Ltd., Sir Thomas A. Polson, K.B.E., C.M.G., F.D., chairman of the company, outlined the company's policy as regards television development. Sir Thomas said: " Our policy with regard to the development of television, although conservative, has kept us well abreast of current practice. Our research department and our factory are well equipped to meet the growing demand. We are already in production with limited quantities of Pye Teleceivers, and they are capable of reproducing an excellent picture. The models on the market have been well received and I think I can say, without being unduly optimistic, that the prospects for this section of our business are very encouraging. It is the intention of your directors that the name " Pye " shall be just as significant in the field of television as it has always been in the field of radio sound."

LONG DISTANCES ON ULTRA-SHORT WAVES

Generally speaking, record breaking on wavelengths below 10 metres is confined to the winter months, for although, for example, 5-metre stations do extremely well during summer months, extremely long distances are not bridged. Despite this, however, some interesting work has been put in by British and American amateur stations who are able to span the Atlantic reasonably well, but so far they have not been able to work one another.

However, the 7-metre television signals are being picked up very consistently in Cape Town by Mr. C. G. J. Angilley, using very simple equipment. His reception of the Alexandra Palace transmissions are perhaps the farthest on record yet to be confirmed.

BIG SCREEN TELEVISION

The film world is taking a keen interest in the Scophony big screen television demonstrations at the television exhibition being held at the Science Museum, South Kensington. Pictures 5 ft. by 4 ft. have been shown, so illustrating the possibility of the Scophony system as far as the cinema industry is concerned. Cinema interests have expressed the opinion that a slight improvement in the picture definition and the omission of flicker will enable Scophony to produce a picture suitable for the average cinema.

PICTURES RECEIVED AT 6,000 MILES

Pictures have actually been received a distance of 6,000 miles from Alexandra Palace, in Cape Town. A home-built vision receiver was used embodying the R.C.A. 6-in. tube, and satisfactory pictures were seen, but synchronising was poor. This reception has been reliably confirmed and apparently, according to reports, the feat can be repeated. Mr. C. J. G. Angilley, the Cape Town ultra short-wave experimenter, is confident that pictures can be received in Cape Town with good definition and synchronising providing he erects suitable aerials and employs a sensitive receiver.

Mr. Angilley is at present in this country and it is reported that he is contemplating the purchase of a number of British television receivers.

R.M.A. OFFICIAL SCHEDULES

The R.M.A. have added to their official schedules many items including television receivers, cathode-ray tubes and holders, barretters and indicators of all kinds. This means that Regulation 8 of the R.M.A. by-laws dealing with the prohibition of goods of foreign manufacture will apply to all these television components.

PUPPET ORCHESTRAS

On July 3 and 10 a puppet orchestra is being televised in the afternoon programmes. This puppet show is the joint creation of Jan Bussell, one of the producers at Ally Pally, and his wife, Ann Hogarth, who have made all the small figures, measuring 15 ins. in height, miniature stage, scenery and dresses. There are five players in the puppet orchestra and they will be worked by three operators on an invisible rostrum.

ZOO ANIMALS TO BE TELEVISED

On Friday, July 2, Dr. G. M. Vevers, F.Z.S., M.R.C.S., L.R.C.P., Superintendent of the Zoological Society of London, is going to give a talk on the animals in the London Zoo. He is going to bring in front of the television camera, tortoises, parrots, and marmosets. This type of transmission seems to be very popular, for, from time to time, monkeys and chimpanzees have been televised with great success.

SUN-SPOTS AND THE SHORT-WAVES

The period of maximum sun-spot activity reaches peak point towards the end of 1938, but already its effect is being noticed on reception of stations below 30 metres. At the present time listeners are experiencing a very bad period for short-wave reception, which is likely to continue for some little time.

During the past few weeks it has been almost impossible regularly to receive some of the 20-metre amateur stations or to hear the popular short-wave broadcasters at anything like their normal strength. One prominent short-wave expert gave as his opinion that the continued bad conditions would adversely affect the sales of all-wave receivers unless the efficiency of the receivers was tremendously increased to counteract the reception conditions. Fortunately some of the American broadcasters are now using higher power and special beam aerials, which has helped in a way to counteract what would otherwise be an unusually bad time for the short-wave listener.

It is hoped that short-wave conditions will reach a peak for good reception about 1942, although one cannot forecast just what may happen quite so far ahead.

MORE TELEVISION FROM WIMBLEDON

The more recent transmissions from Wimbledon have proved so good that in the opinion of many experts there is little to choose between the television screen and the average news-reel, except that the latter does not last so long.

Definition is now so good that small details could be recognised; when Miss Mary Hardwick laced her shoes the lacing was clearly noticed. The match between Miss Marble and Miss Hardwicke could be clearly followed.

THE THEORY OF LUMINESCENCE

This article is an abstract from a paper read before the Royal Society of Arts by J. T. Randall, M.Sc., of the G.E.C. Research Laboratories. The Paper was entitled Luminescence and Its Applications and is published fully in the journal of the Royal Society of Arts. In view of the continuous development of screens for cathode-ray tubes this section of the paper is of particular interest.

MANY substances exist, a few of them in nature, that are capable of transforming the energy of ultra-violet radiations and cathode-rays, for example, into radiations detectable by the eye. This is the study of luminescence, and it is seen that it is only a special branch of the transformation of "invisible" energy into "visible" energy.

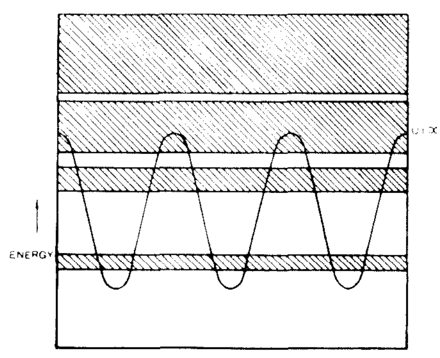


Fig. 1.—Possible energies (indicated by hatching) for an electron moving in a simple periodic field.

Sometimes the substances that effect this transformation are referred to as "fluorescent," sometimes as "phosphorescent" and less frequently as "luminescent."

The terms fluorescence and phosphorescence are frequently used vaguely in a synonymous manner. When ultra-violet radiation of a given wave-length falls on certain classes of matter, visible radiations are emitted and continue to be emitted so long as the ultra-violet falls on them. This effect is referred to as fluorescence.

We have long been familiar with the excitation of the spectra of single more or less isolated gas atoms such as, for example, are obtained in a low-pressure gas-discharge. We know that, to speak in the older and more familiar descriptive language, that an electron is raised up from a lower energy level to a higher one, and that the process of dropping back results in the return to a lower energy condition and the consequent emission of energy.

To come now to the case of fluorescent solids involving impurity atoms, we see at once that the process of light emission must involve the absorption of energy in the first place, and to this slight extent the processes are similar to those of the individual atoms. Except in the case of organic compounds we must realise that there are very few substances in which individual molecules can be distinguished. Solid bodies are, in general, a continuous array of closely packed atoms in which we cannot distinguish one molecule more than another; it is only correct perhaps to refer to the whole crystal as a molecule. Instead, therefore, of dealing with single atoms or molecules we have, in considering the reasons for the existence of these particular fluorescent bodies, to deal with the properties of hosts of atoms; with, in fact, the whole crystal lattice.

From the present point of view we may regard a crystal as a very large number of negative and positive electrical charges at fixed distances apart. This regular arrangement is only another way of saying that there is a regularly varying electrical field within the crystal. If the crystal was for simplicity a single row of atoms, the field would vary in some very definite way. We now come to a very interesting point. If we calculate the possible energies that a single negative charge of electricity may have in such an electric field, we find that they are not continuous. This can be seen from the comparatively simple example of Fig. 1, where the field U(x) is of a sinusoidal type. Possible energies which the electron may have in this field are separated by forbidden bands, and the electron can only have energies represented by the shaded portions. As the possible energies increase and we move to the top of the diagram, the forbidden bands get narrow, but they never disappear. These remarks apply to a real crystal in three dimensions, only, of course, in a more complicated way. Each atomic plane in the crystal has its own set of energy levels. The important point about these levels is that they belong to the crystal as a whole; they are not "atomic" levels. For the problem of fluorescence we need only consider the uppermost energy bands. It is known for the substances we are interested in that the top band is empty; that is to say, there are no electrons of these energies. The band below this is a "forbidden" one, and the bottom band is full of electrons. Suppose now that ultra-violet light falls on a crystal with bands as in Fig. 2 (i). If the forbidden band is wide, nothing will happen. If, however, it is sufficiently narrow, electrons will jump from a to b. When these electrons return from b to a, we get fluorescent emission. This would represent the case of a pure substance, and it is possible that the fluorescence of the platinocyanides can be explained in this way. Usually, however, the band f is too wide for this to happen. If the width of this band is greater than the difference in quantal energy between blue light and red light, the chance of an electron jumping from a to b is very small.

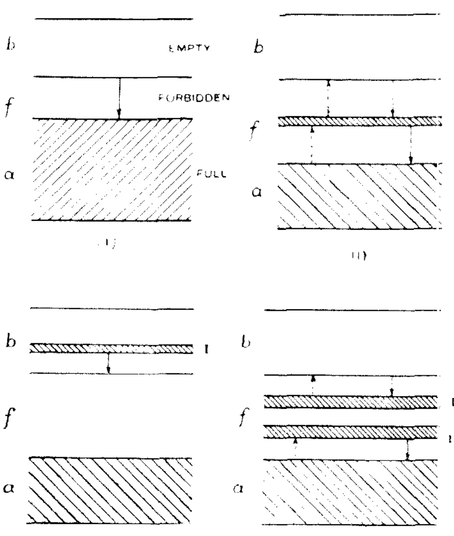


Fig. 2.—Electronic energy bands in fluorescent solids. The downward pointing arrows indicate transitions leading to fluorescence emission and the shaded bands marked I, I_1 and I_2 are new levels introduced by impurities.

Suppose now an impurity is incorporated in the material. The impurity atoms will set up new localised energy levels, but their position in the crystal will be so far apart that they will not affect the energies of the main "lattice" levels. If the nature

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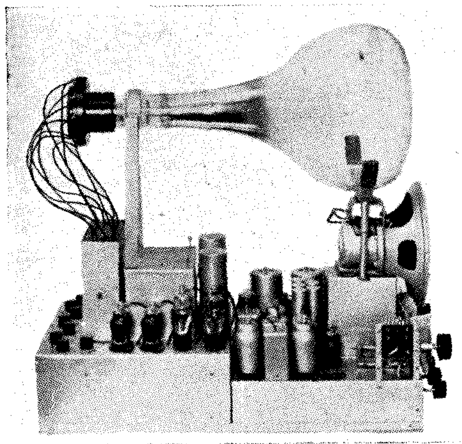


The units of the Chauvierre receiver.

A FRENCH TELEVISION RECEIVER

FROM THE LABORATORIES OF MARC CHAUVIERRE

The following is a brief description of the television receiver developed in the laboratory of M. Marc Chauvierre, using a Cossor 12in. cathode-ray tube. The designer claims that the receiver can be adapted for any type of future transmission and the conversion is covered by guarantee.

As will be seen from the photograph, the Chauvierre receiver comprises two separate chassis placed end to end and fastened to a common angle strip. The total area of the whole chassis is approximately 24 ins. by 12 ins., and the separation into two units facilitates wiring and adjustment.

The tube is mounted horizontally above the chassis and supported on two cradles as shown. Behind the tube are the two H.T. supply units, one of 3,500 volts for the tube and the other of 1,000 volts for the time base. The latter is of the thyratron type with a push-pull stage and the line screen shows no trace of trapezium distortion.

The front chassis carries the vision receiver and an all-wave receiver, both of which are fed from a common H.T. unit. The vision receiver covers a range of 6 to 10 m. and the sound has three ranges: 18-50 m.; 200-560 m.; and 1,000-2,000 m. and is of the conventional type with variable selectivity. Special precautions are taken to avoid interference from the line-frequency time base.

In the actual model shown the vision receiver is adjusted for the 180-line Barthelemy transmission and comprises a frequency changer, steep-slope I.F. amplifier, pentode detector, and two video stages. The total number of valves in the set is 18.

Although the design of the amplifier follows standard practice, exceedingly good results are obtained by careful attention to circuit characteristics and appropriate compensation in each stage. The I.F. stages are fixed frequency and are not fitted with trimmers.

An original feature in the receiver is the method of separating the synchronising signal—the receiver does not use either a phase reverser or amplitude filter, but the circuit has its time constants carefully selected to conform to the received signal. Phase reversal is effected magnetically and the picture is held perfectly steady provided that the signal-to-synchronising signal ratio is maintained.

Another interesting feature of the receiver is the H.T. transformer which is of a special construction with a negligible stray field. This avoids the use of a shield round the tube and considerably reduces the price.

The receiver was designed with a view to easy adaptation to any type of transmission, e.g., 400 lines interlaced, positive modulation, independent line and picture synchronising, etc., and for the purpose two extra sockets have been provided in the chassis.

The controls are as follows: Sound receiver:—tuning, volume, wave-change switch, and selectivity. Vision receiver:—tuning and modulation intensity—six controls in all.

The remaining pre-set controls are concerned with the focusing and time-base speed.

The whole receiver is mounted in a cabinet 65 cms. high by 70 cms. deep and 35 cms. across, the size of the picture being 17 by 20 cms.

Valves used: Type 80, 2 Mazda thyratron type T100*, 4 Philips' valves type EL.2, for the time base.

EZ.4—EK.2—EF.5—EBC.3—EL.3 in the sound receiver.

EK.2—3 special type 4673 in the vision receiver.

The I.F. transformers were specially designed and wound in M. Chauvierre's laboratory.

The receiver is sold under a guarantee that it will be converted to any type of transmission radiated in the future.

* French "Mazda"—Ed.

"The Theory of Luminescence"

(*Continued from previous page.*)

of the impurity atoms are such as to put the new localised levels somewhere in band f we see that the impurity has added a new rung to the ladder. When ultra-violet radiation now falls on the crystal, it is possible for the electrons to jump from a to I and from I to b (Fig. 2—ii). When the electrons fall back, we have fluorescence emission.

Many possibilities with regard to the position of the impurity bands can arise, and two of them are shown in (iii) and (iv). The exact conditions under which emission takes place and the probable details of the spectrum depend to a large extent on the nature of the impurity and whether it is free to give up or absorb electrons.

It is easy to see, however, that the general ideas provide an adequate qualitative explanation of the width of the spectrum bands and also of phosphorescence. The impurity levels are of finite width, and each plane or direction in the crystal has its own levels; as a consequence the individual contributions to the spectrum overlap and broad bands, in general, result. With regard to phosphorescence the impurity levels are few and far between; consequently, once the electrons are raised to the higher level, appreciable time is taken for them to find appropriate levels to which they may return.

The burden of these ideas is this: theoretical physics has at last provided us with a framework on which we may now build; so far it is only a framework, but there are strong reasons for believing that it is one built on solid foundations.

METAL RECTIFIERS FOR TELEVISION

We give below details of some useful applications of the metal-type rectifier in television circuits. It will be seen that in some respects these offer certain definite advantages over the valve rectifier.

METAL rectifiers have a considerable number of applications in television receivers and in some cases offer definite advantages over the valve rectifier, which would be used for a corresponding purpose. Below we give a brief summary of the principal uses to which the metal rectifier can be put in television circuits. The Westinghouse Brake and Signal Co., Ltd., of 82 York Road, King's Cross, London, N.1, will be pleased to supply any further technical information that may be required.

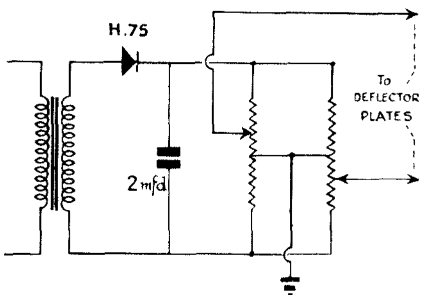


Fig. 1.—H.T. supply to picture shift circuit employing a metal rectifier

H.T. Supply to Vision Receivers

The current consumption of the present design of vision receiver varies from about 200 volts at 40 milliamps, to 230 volts at 50 milliamps., and for these outputs the use of rectifiers style H.T.12 and H.T.9 in the voltage-doubler circuit will be very suitable.

D.C. Output.	Rectifier.	V.D. Condensers.	A.C. Input (approx.).
200 V. 30 to 40 mA.	H.T.12	4+4	140 volts, 120 mA.
230 V. 50 mA.	H.T.9	4+4	180 volts, 170 mA.

The great advantage of this arrangement is that the use of the voltage-doubler circuit limits the output current of the rectifier, and accidental short circuits, which are particularly liable during experimental work, can do no damage to the rectifier or transformer.

H.T. Supply to Sound Receivers

H.T. consumption for the sound receiver is normally of the order of 250 volts at 50 milliamps., and for this output the H.T.9 rectifier used in the voltage-doubler circuit with two 4 mfd. condensers can be recommended. The A.C. input for the above-mentioned output would be approximately 200 volts at 170 mA. This rectifier is, however, quite suitable for a maximum output of 300 volts at 60 milliamps., in which case, the input would require to be increased to 200 mA. at 240 volts.

The advantages of the voltage-doubler circuit also apply here, and either of these rectifiers are suitable for the average hard valve time base.

H.T. Supply to Time Base

The requirements of thyratron tube time-base circuits vary from about 900 volts at 14 milliamps. to 1,000 volts at 18 milliamps. For the latter output two H.T.9 rectifiers connected in series, and used in the voltage-doubler circuit, will be found excellent. The voltage-doubling condensers should each be 2 mfd. 750 volts working, and the A.C. input 460 volts.

The advantages of the voltage-doubler circuit are even more marked at this voltage, as the transformer can be wound for a very much lower voltage than if valve rectification were used, and this results in a smaller and cheaper transformer. The elimination of the high voltage secondary winding also has an important bearing on the question of safety from shock, and this is particularly important in home-constructed apparatus. A further advantage is great stability of output, since vibration and sudden draughts will not affect the D.C. voltage, and this results in freedom from drift, and reliable operation of the time base.

Supply to Picture Shift Circuit

An output of about 250 volts at 4 milliamps. is usually required for this purpose, and a suitable rectifier is the H.75, which may be used in the half-wave circuit as shown by Fig. 1.

For this output, an input voltage of approximately 230 volts 8 milliamps. r.m.s. will be required. The rectifier is, of course, quite small, and takes up very little space. It can be supported by reasonably heavy wiring, or, if this is not convenient, a small clip is quite sufficient. The rectifier is capable of a maximum output of 10 milliamps.

H.T. Supply to Cathode-ray Tube

Cathode-ray tube requirements vary from 3,000 volts at 0.75 milliamp. to 4,000 volts at 0.75 milliamp. "J" type rectifiers are quite suitable for these outputs as shown below:—

D.C. Output.	Rectifier.	V.D. Condensers.	A.C. Input (approx.).
3,000 V. 0.75 mA.	2 units J.176	0.5+0.5 (2,000 V.).	1,200 – 1,300 volts.
4,000 V. 0.75 mA.	4 units J.125	0.5+0.5 (3,000 V.).	1,600 – 1,700 volts.

The advantages of cheapened transformer construction and greater safety from breakdown and shock are again very marked when dealing with the high voltages required for the tube anode supply. The automatic protection afforded against damage by short circuits, mentioned above, also applies in this case, and in addition, full wave rectification is obtained. The "J" type rectifier

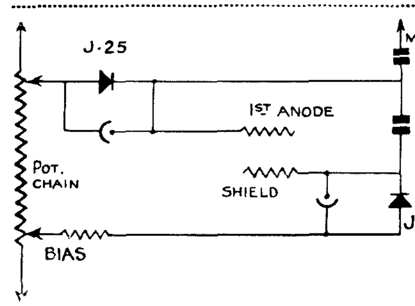


Fig. 2.—Double Modulation circuit employing metal rectifiers

(*Continued at foot of next page*)

THE MURPHY TELEVISION RECEIVER

It is interesting to note that Murphy Radio, Ltd., have entered the television field. Their receiver is described in this article.

MURPHY RADIO, LTD., have now entered the television field, and a model of their first receiver was demonstrated at the Science Museum Exhibition. The Murphy A42V receiver is designed for the television transmissions of the Alexandra Palace station, together with the accompanying sound. It is a television receiver only. The set operates from A.C. mains of the standard voltages, 200 to 250 volts, and 50 cycles, the consumption being 200 watts.

Reception is, of course, by the cathode-ray method. A twelve-inch tube is employed, which is mounted in the cabinet at an angle considerably less than the vertical. The image is viewed in a mirror carried in the lid of the cabinet, which by virtue of the sloping of the tube, opens to an angle greater than the usual 45°, thereby increasing the angle of vision in the vertical plane. This feature permits of the use of a low and compact cabinet. An aluminised mirror is employed giving high efficiency and absence of secondary reflection effects. The colour of the picture is black and white.

The front and sides of the cabinet are veneered with Bombay rosewood. The outside edges of the top are veneered with quilted mahogany, surrounding a large leather-covered frame which forms the picture-surround and also the back-plate for the control knobs. A rectangular mask of black felt encloses the picture, and the cathode-ray tube is protected by a sheet of plate glass. The lid is in black pearwood with white inlaid lines and white handle. The speaker aperture is covered with copper wire mesh.

The Murphy A42V Television Receiver.

The receiver employs the supersonic heterodyne principle with a common frequency changer for sound and vision. A signal-frequency amplifier precedes the frequency changer, amplifying both sound and vision signals, which are separated in the anode circuit of the frequency changer. Four vision and two sound intermediate frequency stages are used, the band width of the latter being of ample width to take up any frequency drift occurring in the oscillator. The vision intermediate-frequency circuits employ high frequency pentodes of very high slope, and have an overall band width of 4 megacycles. Both sidebands of the vision signal are thereby amplified, ensuring the maximum signal to noise ratio in the receiver.

The time-base circuits each contain three valves, electrostatic deflection being used in the cathode-ray tube. Four valves are used in the filter circuits which separate the synchronising impulses from the picture signals and from each other, a special circuit arrangement producing a very sharp frame-synchronising impulse to ensure steady interlacing.

The power pack delivers current at 5,000, 1,200 and 250 volts for the operation of the cathode-ray tube, time base and radio receiver respectively. A neon-stabilised supply at 125 volts is also provided for certain of the receiver valves.

The receiver contains a total of 27 valves of which six are of the "midget" type. The aerial is of the half-wave type and is connected to the receiver by means of concentric cable.

"Metal Rectifiers for Television"

(*Continued from preceding page*)

units are capable of a maximum output of 2 milliamps.

Restoration of D.C. Component

The circuit, Fig. 2, presents a particular application where the use of metal rectifiers shows a marked saving in space and increase of safety. It is understood that this circuit is the subject of a patent application, but this need not prevent its use experimentally.

As the present tendency is to earth the tube anode, the use of diode rectifiers in the positions shown necessitates highly insulated heater windings. It will be seen that the above circuit provides double modulation and restores the D.C. component of the picture signal which is normally lost when V.F. amplification is used.

Book Reviews

Television Up to Date, by R. W. Hutchinson, M.Sc. (University Tutorial Press Ltd.). This book is a revised edition of one of the same title originally published in 1935. There has, of course, been considerable development since then and the author has therefore devoted approximately two-thirds of the present edition to modern practice. In its present form it deals with early methods and apparatus sufficiently fully to enable the student to obtain a thorough grasp of the principles involved, and then gives a clear exposition in simple language of modern high-definition television. The treatment is necessarily somewhat brief as the author covers a great deal of ground, but it is sufficient to enable anyone to obtain a sound knowledge of the principles involved. The price of the book is 2s. 6d.

THE TELEVISION SOCIETY

THE SECOND KERR MEMORIAL LECTURE

ON May 19, at the Royal Institution, Prof. J. T. MacGregor-Morris delivered the second Kerr Memorial Lecture to a large audience of members of the Television Society and their friends.

The chair was taken by R. A. Watson-Watt, Esq., who is well-known for his work on the application of the cathode-ray tube to the study of the ionosphere, and the subject: "The History and Development of the Cathode-ray Tube," was one in which Prof. MacGregor-Morris himself had played an important part.

Early Experiments

One of the first experiments performed at the lecture was one which Prof. Morris had carried out in 1896 under the direction of Prof. (now Sir Ambrose) Fleming in which a magnetic field was applied to a Crooke's tube in order to reduce the potential required to produce the discharge. The lecturer also found that the field due to the coil had a focusing effect on the cathode-rays—a principle which was subsequently developed by other workers and applied to later types of cathode-ray tube.

Another early experiment which was tried in Prof. Morris' laboratory was that of using a hot cathode, and the witnesses to this were Mr. Warren, of the Experimental Department at Woolwich, and Mr. Frank Murphy.

Prof. MacGregor Morris said: "When one is surveying the field of research of the cathode-ray tube one has to pay a high tribute to the manufacturers and experimenters who have provided means of producing a really high vacuum. The degree of vacuum in Faraday's time was nothing in comparison with that given by modern technique. Then a vacuum of 1/1,000th atmosphere was considered good, but nowadays we think nothing of going down to 10/1,000ths of an atmosphere."

After describing the development of the tube to the present day, the lecturer then showed slides illustrating special types of tube and some of the work which has been done in high voltage and insulator testing. A small 40 kV transformer was used to demonstrate the corona on a transmission line and the loss which accompanied it. Another interesting experiment was the effect of ultra-high frequencies on the sensitivity of the tube and to demonstrate this the lecturer used a 300 mC. magnetron oscillator.

In concluding, Prof. MacGregor-Morris paid a tribute to the work done by Mr. Watson Watt and his colleagues of the Radio Research Board and suggested that a new layer in the ionosphere should be associated with one of them in name. He also acknowledged the help that he had received from his assistant Mr. Grisdale, and the staff of the R.I. in the preparation of the experiments.

Mr. Watson Watt in a witty speech returned the thanks of the meeting to the lecturer for the trouble he had taken in organising such an instructive and interesting paper, and the meeting closed after the Rev. E. Goodchild had acknowledged the kindness of the Chairman in sparing time from his numerous engagements for presiding.

A full report of the lecture will appear in the Journal of the Television Society in due course.

[An article on the history of the tube appeared in the issue for February, p. 85.—ED.]

Book Review

Fundamentals of Vacuum Tubes. A. V. Eastman. (McGraw-Hill Co. 438 pp., 364 figs. in text, 20 tables).

The high reputation of the McGraw-Hill Company in the technical publishing world is maintained by the latest addition to their list. "Fundamentals of Vacuum Tubes" is a comprehensive book covering all the various applications of thermionics and includes the latest types of gas-filled tubes and photo-cells in addition to the all-metal valves of the R.C.A. and acorn tubes.

The chapter headings give an idea of the wide field covered and include: Oxide-coated and thoriated tungsten cathodes; laws governing emission; rectifier circuits; mercury arc rectifiers; reversed feed-back amplifiers; screen-grid thyratrons; ignitrons; Class B and C amplification; magnetrons; beam power tubes, etc. At the end of the book there is an appendix giving the Fourier analysis of periodic functions with examples of its applications to the analysis of complex waveforms. This is perhaps the most abstruse mathematical reasoning in the book, as for the most part the treatment of the theory is delightfully simple and easy to follow.

The author points out that no attempt has been made to deal with the circuits in which the valves are used although sufficient "skeleton" circuits are described to enable the theory of operation to be fully understood. In most cases reference is made to lengthier articles in which the subject is dealt with by a specialist.

It is with regard to these references that the first criticism of the book arises. The Proceedings of the I.R.E. are quoted with such frequency as to suggest that the author had no other reference work available. This must obviously not be the case, but the value of the book as a standard work of reference for students would be increased if the existence of other equally authoritative publications were acknowledged.

It must be remembered that the book was written in America for American radio engineering students, but the usefulness of such a complete work is in no way diminished by the examples confined to American valve practice.

The theory of thermionic valves is fundamental, and British readers will derive as much information from it as if it had been written in this country. In fact, with the rapidly growing popularity of American valves in this country a book of this type should find a ready and well-deserved sale among radio students.

TELEVISION AND SHORT-WAVE WORLD

PROJECTION WITH CATHODE-RAY TUBES

AN ACCOUNT OF SOME RECENT ITALIAN DEVELOPMENTS BY THE SAFAR COMPANY

By A. Castellani.

The following is an account of experiments in cathode-ray projection by S.A.F.A.R., the Italian Radio Company, which has been responsible for the development of television in Italy. Signor Castellani will be remembered as the author of several papers and inventions in television and allied subjects.

IN this article it is proposed to discuss the dependence of the dimensions of the picture on the size of the cathode-ray tube and how it can be eliminated.

The improvements in the cathode-ray tube which have been made in nearly every country have practically

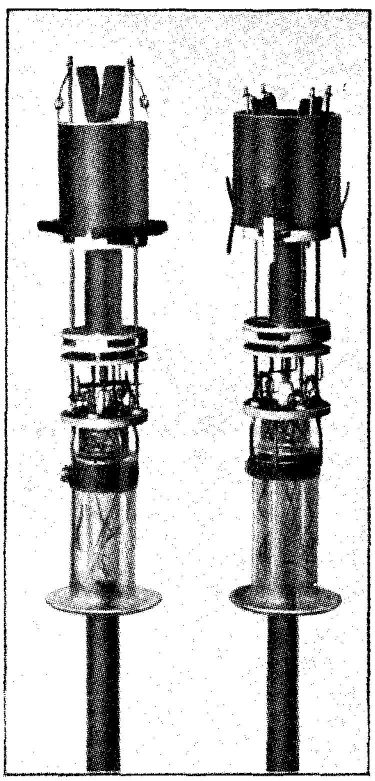


Fig. 1 Electrode structure of SAFAR tube, 1934 type.

reached finality in a tube lasting for some 2,000 hours and reproducing a picture of adequate sharpness measuring 240 mm. square. It is not surprising that those who have endeavoured to improve on these results have not met with success from the commercial point of view, since apart from the technical difficulties the larger cathode-ray tubes have proved costly and dangerous to handle.

With the exception of von Ardenne, very little seems to have been done by investigators on the possibility of using smaller tubes for projecting the picture, but recently the Telefunken laboratories have pro-

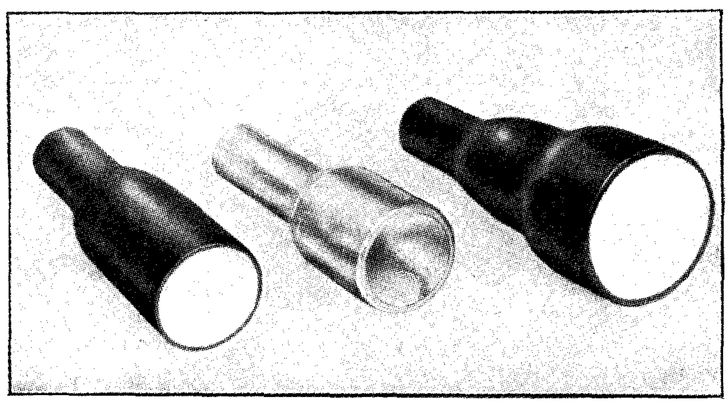


Fig. 2. Three types of bulb for projection tubes—metal, quartz and ceramic.

duced a hard glass projection tube which has given satisfactory results.

Some little time after this the Safar Company attacked the problem and produced cathode-ray tubes in metal envelopes, the first patent being taken out in February, 1934.

The first tests were conducted with metal bulbs and a screen of hard glass. The construction of such bulbs took time, since the material had to be found for making a satisfactory joint between the bulb and screen. It may be noted that the joining of metal to glass in the case of a power triode is a simpler operation since it only involves joining two co-axial cylinders and not the fusion of a cylinder to a flanged end. This difficulty was eventually overcome by the use of special furnaces and glass, the strain produced by the fusion being removed in the subsequent optical machining operations.

A piece of hard glass is joined to the end of the metal tube to act as an intermediary between the stem and the bulb itself and the stem is sealed in by means of the usual machine.

The electrode mount was the normal Safar 1934 pattern (Fig. 1) with the final anode omitted, the place of this being taken by the metal bulb.

The following conclusions were

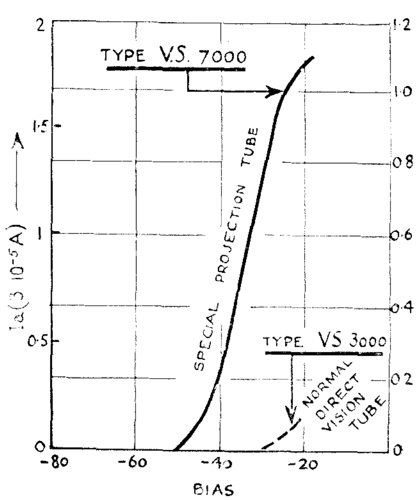


Fig. 3. Characteristics of projection tube.

arrived at as a result of the preliminary tests:

Owing to the high insulation between the final anode and the remaining parts of the system (breakdown voltage 200,000) it was possible to apply a high anode potential and thus obtain a very high degree of luminosity corresponding to a cathode current of several milliamperes. (The luminous intensity of a picture 200 mm. square on a standard tube is about 0.2 Hefner candles per sq. cm., corresponding to an anode current of .05 milliampere.

The possibility of applying both electrostatic and electromagnetic deflection was investigated, but the latter was found to be limited to the picture scan since the higher frequency saw-tooth became distorted, possibly owing to eddy currents in the bulb.

Projection Tubes

To compensate for the use of the metal bulb and its relative cost, the possibility of using smaller bulbs was investigated (60 mm. by 250 mm. long) and projecting the picture to the dimensions given above (300 mm. square).

In the early types of tube, however, the anode voltage could not be raised above 12,000 with an anode current of 0.6 mA., since at the higher voltages the screen became discoloured by overheating. The screen material used at that time was a mixture of zinc and cadmium sulphides. Comparative tests showed that the compound deteriorated at about 250° under the anode voltage mentioned, and that the darkening of the screen also depended on the binder which became unstable at temperatures exceeding 300°. The trouble with the binder was first eliminated by varying its composition and the method of application and attention was then turned to the preparation of fluorescent substances which would be stable at high temperatures.

A suitable mixture of synthetic silicate and specially prepared sulphate was eventually found which gave satisfactory results at a temperature of 750°, an ample margin for safety.

At the same time it was realised that the mass production of metal tubes was expensive and only justified by production on a very large scale. Experiments on other bulb materials were therefore made, with a view to their production on a moderate scale, and among these materials quartz and porcelain were found to give excellent results.

In both these insulators the anode can be obtained by silvering the interior of the bulb, and from the point of view of production the insulated bulb has several advantages, notably in the ease with which it can be refilamented.

The ceramic bulb (Fig. 2) can be produced for a standard anode voltage of 7,000, which can be raised to 12,000 in the latest type allowing a system of double metallisation (inside and outside coatings, electrically connected) in the bulb.

At 7,000 volts it is possible to obtain pictures of 300 mm. square equal in size and clarity to those obtained from the best direct vision tube. The characteristics are shown in Fig. 3. The electrode construction is of the 1935 type sealed in with a flux of special glass between the porcelain and the stem. The use of porcelain in the construction of the tube electrode system makes a more rigid structure and tends to minimise the aberrations which are so frequently found in high-voltage tubes.

The life of the latest tube is guaranteed for 3,000 hours at 7,000 volts and 2,000 hours at 12,000 volts. It is hoped to describe the application of these tubes in a future article.

The Exhibition Handbook

In connection with the Television Exhibition at the Science Museum a handbook has been prepared by Mr. G. M. Garratt, M.A., assisted by members of the Exhibition Committee. This handbook is in no sense a guide to, or catalogue of the exhibits; its purpose is to present to those who have but a scanty knowledge of television an outline of the principles involved in the various systems which are demonstrated.

The contents of the book include the history of television, photo-electricity, picture dissection and synthesis by scanning, light control, cathode-ray tubes and electron cameras, details of the Alexandra Palace transmitter, descriptions of receivers and information on television aerials.

Although the handbook is necessarily somewhat technical it should prove of great use to visitors who have little knowledge of television and enable them to take an increased interest in the exhibits, which are demonstrated. Copies will be on sale at the Science Museum, or may be obtianed from the publishers, H.M. Stationery Office, Adastral House, Kingsway, price 6d. (by post, 7d.), or through any bookseller.

Surplus Television Apparatus

H. E. Sanders & Co., of 4 Gray's Inn Road, London, W.C., have for disposal a large quantity of surplus television and short-wave experimental apparatus, and are offering to readers of this Journal components at very low prices.

Among the apparatus are high-voltage condensers, valves A.C. and D.C., mains-dropping resistances, chassis, new cadmium plated at 1s. 6d., loudspeakers, new permanent-magnet at 7s. 6d., partly assembled television chassis at 2s. 6d., mechanical scanning apparatus, etc. Lists will be sent on receipt of a postcard or callers may personally select what they require.

Mullard Cathode-ray Tubes

The price of the Mullard cathode-ray tube, type E.40-G3, has been reduced from £4 15s. to £3 10s. The E.40-G3 is a precision tube of 3-in. screen diameter, operating on 500 volts. Its wide field of utility has led to an increasing demand, enabling large-scale production to be undertaken with consequent decrease of cost.

The I.S.W.C.

All short wave enthusiasts should become members of the International Short Wave Club. Membership costs 5s. per year and begins from the month of joining. A specimen copy of the Club's magazine will be sent to any reader. Meetings are held in several of the largest towns where the members are able to meet others who are also interested in short wave radio. Lectures and demonstrations are given, and visits arranged to places of interest. The London Chapter meets every Friday evening, 8 p.m., at 80 Theobalds Road, W.C.1. The Brighton Chapter every Wednesday evening, at 100 Cromwell Road, Hove, and the Guernsey Chapter every Tuesday evening, at 5 Well Road, St. Peter Port.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

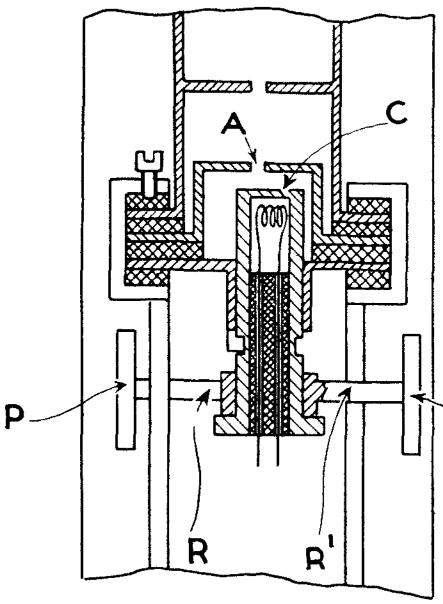
Specially Compiled for this Journal

Patentees:- H. P. Barasch :: M. von Ardenne :: The General Electric Co. Ltd. and D. C. Espley :: The British Thomson-Houston Co. Ltd. :: H. W. W. Warren and W. J. Scott Baird Television Ltd. and J. R. H. Forman :: Marconi's Wireless Telegraph Co. Ltd.

Prolonging Life of Cathode-ray Tubes

(Patent No. 462,243.)

AN indirectly-heated cathode is mounted so that it can be moved relatively to the other electrodes of a cathode-ray tube. The object is to change the "working point" of the emissive surface from time to time, so as to lengthen the effective life of the cathode, and therefore of the tube.



Construction of cathode-ray tube with rotatable cathode in order to change the operative part of the cathode surface. Patent No. 462,243.

As shown in the figure the cathode C is carried on a support which is provided with two extending arms R, R1 fitted with magnetic end-pieces P, P1. A horseshoe magnet is then applied, from outside the tube, to rotate the cathode as a whole relatively to the aperture A through which the main electrode stream passes. In this way when one part of the cathode surface has lost its emissivity a fresh part can be brought into play.—*H. P. Barasch*

Preventing Distortion

(Patent No. 462,275.)

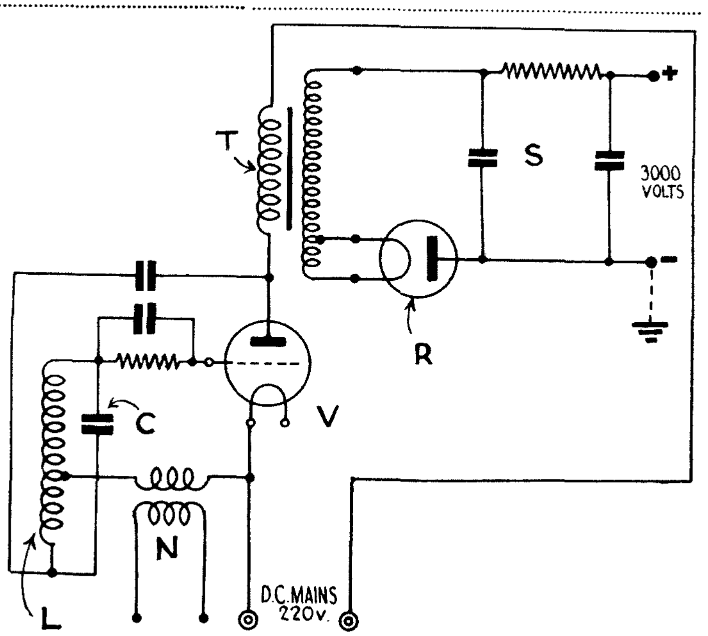
Distortion in a cathode-ray tube receiver is sometimes caused by external fields of force which stray into the space between the pairs of deflecting plates used for scanning. According to the invention the edges of the plates are connected together by a layer of high-resistance material of the order of 5 megohms. This converts both pairs of deflecting electrodes into open-ended "boxes," which give free passage to the electron stream, but prevent any stray fields of force from entering at the side.—*M. von Ardenne.*

Supplying D.C. Voltages to a C.R. Tube

(Patent No. 462,488.)

The figure shows a method of deriving D.C. voltages—of the order 1,000 to 3,000 volts—from a 220-volt D.C. mains supply, to energise the electrodes of a cathode-ray tube. The mains voltage is first applied to a back-coupled valve V which produces continuous oscillations in a tuned circuit L.C. These oscillations are then fed to a rectifier valve R through a step-up transformer T, and the resulting D.C. voltage is fed through a smoothing circuit S to the electrodes of the cathode-ray tube.

The frequency of the valve generator V is stabilised by feeding into the grid circuit, as shown at N, a voltage derived from the transmitted synchronising signals.. This prevents any interference effects, due to im-



Method of deriving voltages from a 220-volt mains supply to energise the electrodes of a cathode-ray tube. Patent No. 462,488.

perfect smoothing of the output from the rectifier R, from showing themselves in the picture.—*The General Electric Co., Ltd.,* and *D. C. Espley.*

Metal C.R. Tube

(Patent No. 462,600.)

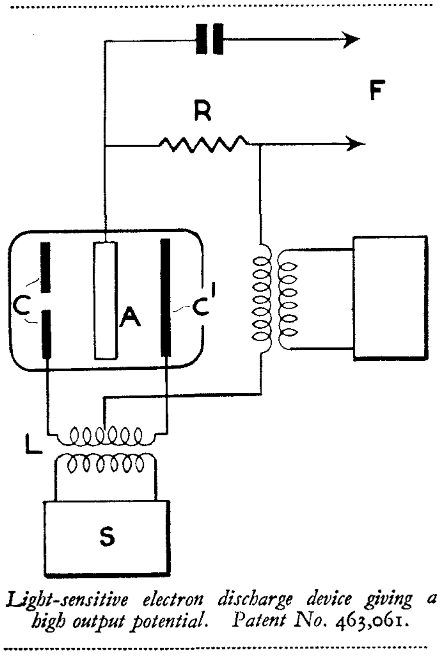
To reduce the risk of a highly-evacuated cathode-ray tube collapsing under the strain of external air-pressure, the body of the tube is made of metal, and the fluorescent screen is deposited upon an end-piece of glass. The glass is connected to the tube through an intermediate piece of metal having the same coefficient of expansion as glass. It is fixed to the glass at one end, and welded to the metal body at the other end.

Another advantage of using a metal casing is that a breakable soldered or brazed joint can be made at the lower end of the tube so as to allow a new cathode to be inserted when the first has lost its emissivity, thereby prolonging the life of the tube.—*The British Thomson-Houston Co., Ltd., H. W. W. Warren,* and *W. J. Scott.*

Electron Multipliers

(Patent No. 463,061.)

Two light-sensitive " cold " cathodes C, C1 are branched across a coil



Light-sensitive electron discharge device giving a high output potential. Patent No. 463,061.

L, which is fed from a high-frequency source S so that the cathodes carry alternating potentials. A ring-shaped anode A is located between them and is fed from a low-frequency source F.

When light enters the tube through the central aperture in the cathode C, it first falls on the cathode C1 and liberates electrons, which are attracted back towards the cathode C, as the latter becomes positive, the ring-anode A allowing them free passage.

Secondary electrons are produced at the cathode C, and, as the potentials reverse, these are urged towards the cathode C1. The process is continued, whilst the electron stream rapidly increases in strength. After a certain interval, the anode A is thrown positive, and so collects a current which is proportional to the intensity of the light first entering the tube. This is used to produce an amplified signal voltage across the resistance R.—*Baird Television, Ltd.,* and *J. R. H. Forman.*

Voltage Supply for C.R. Tubes

(Patent No. 463,253.)

Part of the scanning-voltage applied to the deflecting-coils of a cathode-ray tube is rectified, and is then applied to the anode of the tube. The deflecting coils are shunted by a variable resistance in series with a diode rectifier and a condenser. The diode is so arranged that it is non-conducting during the deflection stroke, but comes into operation as a rectifier during the idle or " flyback" stroke. The D.C. output from the rectifier goes to charge up the series condenser. The latter is shunted by a potentiometer resistance, from which a tapping is taken to the anode.—*Marconi's Wireless Telegraph Co., Ltd.*

Summary of Other Television Patents

(Patent No. 462,110.)

Correcting for " uneven brightness " of the picture produced in a cathode-ray television transmitter.—*E. L. C. White.*

(Patent No. 462,247.)

Means for ensuring correct " contrast " values of light and shade in television.—*A. J. Brown* and *Baird Television, Ltd.*

(Patent No. 462,330.)

Television receiver in which a bank or checkerboard of small lamps is controlled by a number of light-sensitive cells.—*Marconi's Wireless Telegraph Co., Ltd.,* and *R. J. Kemp.*

(Patent No. 462,550.)

Television transmitting systems using electron tubes of the " image-dissector " or " Iconoscope " type. —*H. Miller.*

(Patent No. 462,683.)

Cylindrical shield for surrounding the magnetic focusing-coil of a cathode-ray tube.—*A. H. Gilbert, L. R. Merdler,* and *Baird Television, Ltd.*

(Patent No. 462,684.)

Deflecting coil with adjustable pole-pieces for eliminating stray fields in a cathode-ray tube.—*A. H. Gilbert, L. R. Merdler* and *Baird Television, Ltd.*

(Patent No. 462,877.)

System for televising pictures simultaneously, without the use of scanning apparatus.—*Standard Telephones and Cables, Ltd.*

(Patent No. 462,929.

Television system in which all the " peak " values of the transmitted signal are brought to a constant value.—*Radio Akt. D. S. Loewe.*

Three New Cossor Valves

Three new valves, including two particularly suitable for use in television receivers, have just been released by A. C. Cossor, Ltd. The first is the M.V.S./PEN.B, a variable-mu screened pentode for high-frequency or intermediate-frequency amplification. Owing to a high impedance, providing it is used with the correct anode load, high gain, coupled with good selectivity, is obtainable.

Fitted with a 7-pin base it has the conventional B.V.A. basing with the control grid to the top cap and the suppressor grid brought out to an external contact. The mutual conductance of this valve is 3.0 ma/V, and it has variable-mu characteristics.

The M.S./PEN.B, similar to the previous valve, has a fixed grid base and a maximum slope of 3 5 ma/V. It makes an ideal grid detector with a .0001-mfd. condenser and 1 megohm leak with a .5 megohm series screen resistance, and a .1 megohm external anode impedance. The maximum gain is approximately 100 times with an input of .25 volts.

Both the previous valves are of the indirectly-heated cathode type with 4-volt 1-amp. heaters, but a third valve designated the 202 S.T.H. has a 20-volt .2-amp. heater. This valve is an indirectly-heated triode-hexode for use in AC/DC super-het receivers. It is ideal for use on short-waves, since by separating the two sections of the valve, degenerative effects between them are avoided.

The hexode section has variable-mu characteristics so that it can be embodied in normal A.V.C. circuits. The heterodyne voltage for maximum conversion conductance is 8 volts r.m s. with a conversion conductance of 0.6 mA/V. Full details regarding these valves can be obtained from the manufacturers, Messrs. A. C. Cossor, Ltd., Cossor House, Highbury Grove, N.5.

TELEVISION AND SHORT-WAVE WORLD

STUDIO & SCREEN

A MONTHLY CAUSERIE on Television Personalities and Topics

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

THE temporary cessation of television transmissions from Alexandra Palace for three weeks beginning July 26 will provide a well-earned rest for the B.B.C.'s staff. A few already have enjoyed their annual holidays, such as Peter Bax, who has just returned from the Riviera; but the majority at the

Aulikki Rantawara, Finnish singer, who recently made her television debut.

Palace are planning to make this period their annual respite and certainly no better time of the year could have been chosen.

Gerald Cock, the popular television chief, will be having his first holiday for three years, but I have been unable to find out where he is going. D. H. Munro, the energetic productions manager, no doubt will repair to his native Aberdeenshire mountains, and most likely go there by road overnight. This overnight travelling, by the way, is quite a habit with Mr. Munro. On one celebrated occasion of which I have heard tell, this human dynamo left London late at night in a Ford car and was home in Aberdeenshire for breakfast on the following morning. He travelled absolutely non-stop all the way.

Elizabeth Cowell, charming hostess announcer, is, I learn, off to Denmark to spend her three weeks' vacation.

"I'm going to forget all about television and dance bands—in fact, about everything," she said.

But not long after somebody discovered that Henry Hall is going to play from a Danish station during her stay in the country! You cannot escape from radio these days.

I have not heard where Jasmine Bligh is going to for her holiday, but wherever it may be of course she will take "Gay" with her. "Gay," as readers know, is her wonderful little dog, who made his television début a few weeks ago. Somebody asked me in a whisper the other day how long it will be before Elizabeth Cowell brings a kitten up to the studio to keep "Gay" company. I wonder.

* * *

Leslie Mitchell, the peripatetic announcer, provided something for everyone to talk about for a long time as a result of his recent daring adventure with the fire escapes. Regular televiewers will recall that a few Saturdays ago he took charge of an O.B. designed to show the history of fire engines and their associated equipment during the last 150 years. As a grand climax Leslie himself mounted the latest type of fire escape. This took place before a record crowd in the park.

Before anyone, including Leslie himself, quite knew what had happened, he was shot up 100 feet into the air. The ladder is of the telescopic variety and the sight of it shooting out made a remarkable picture. Leslie was strapped in, of course, so there was no fear of him falling off, and after reaching the aforesaid dizzy height—which, by the way, is well above the tower itself at Ally Pally—he was

Sylvia Welling, the well-known stage and concert soprano, who appeared in "Regatta," the television revue transmitted on Saturday, June 12.

able to give his impressions via a microphone which ascended with him.

On reaching the top he bravely admitted to "feeling rather sick." He was "not used to such heights." Then he was half lowered into a position where he could be seen by another television camera.

Well done, Leslie! This was a

A new photograph of Irene Prador who is now starring in many television programmes.

stout effort and provided a real thrill of a picture. Leslie Mitchell is the Peter Pan of television—the boy who never grows up, but certainly goes up!

* * *

No startling changes, I hear, are to be made in the studios at Ally Pally during the holiday. So far as I can gather there is going to be a general clear up, and that is all.

Apart from the holidays the important topic of conversation at the moment is what is going to happen about television at this year's Radiolympia—Britain's great annual radio exhibition, which this year will be from August 26 to September 4.

It is now no secret that the B.B.C. is all out to make this winter a "television winter," and although continuous publicity during the year has been doing a lot to popularise this new form of entertainment, undoubtedly Radiolympia provides the one unexcelled opportunity to focus the attention of the general public upon recent developments in television in a really big way. Last year, visitors to the television booths could not help having mixed feelings. On the one hand, we all felt the greatest admiration for the B.B.C. and R.M.A. alike for the wonderful way in which almost at the last moment a show was put on. The new service was hardly ready and the regular programmes had not begun, yet thousands of people were enabled to get a first glimmer of what this new wonderful science soon might mean.

But it is a moot question whether the whole thing proved to be a real service to the progress of television. Long queues of visitors were formed, waiting to pass through the booths, and they were necessarily kept moving most of the time when they got inside, with the result that most people just saw a few minutes of television which obviously could not be typical of what programmes as a whole were like at that time.

From the point of view of publicising television effectively and giving a great fillip to public interest, it is imperative that the television arrangements at Radiolympia this year should be really adequate.

* * *

At the B.B.C. end, the matter has already been given very close consideration and skeleton programmes already prepared. The definite scheme of these programmes has been worked out on the assumption that visitors to the booths at Radiolympia will be able to enjoy an uninterrupted view of the programme for 15 minutes, during which time several short but thoroughly representative items will be televised.

There will be the usual film programme from 11.30 a..m. to 12.30 p.m., but the special Radiolympia transmissions will be 4 p.m. to 5 p.m. and 9 p.m. to 10 p.m.

I am told that these two latter transmissions each will consist of three separate programmes to the hour, with an interval of 5 minutes in between.

The type of programme will be as follows:—

Five minutes, say, golf, this being a typical O.B.

Five minutes, popular comedian, such as, for instance, Leonard Henry.

Five minutes' music, say, syncopated pianist, such as Billy Mayerl. Then follows an interval of five minutes which it is expected will be occupied by people filing out and the new audience taking seats. Thereafter a second similar programme of 15 minutes' duration will be broadcast, and so on.

Anne Twigg—the first girl to be televised with her head under her arm! She took the part of Anne Boleyn in the television burlesque of Henry VIII surrounded by the jeering ghosts of his wives.

It seems to me that these programmes will be very suitable for the purpose, but the important question is what number of people will be able to enjoy these programmes in an uninterrupted manner. I think everyone will recognise that it is most important that the audience should be allowed to remain and witness the whole of one of the six 15-minute programmes per day in comparative comfort, because if they are moved on, as happened last year, and individuals only see a small portion of the transmission which is unrepresentative of the television programmes as a whole, the inevitable result, I am afraid, will be damaging rather than helpful.

Les Allen, the dance band vocalist, who makes first television appearance on July 1.

At the time of writing these notes, no definite information is available as to the facilities to be offered at Radiolympia, but I understand that about 12 booths at least will be in service. If we assume that 30 people can be seated in comfort in each booth, about 180 people could be accommodated in one booth for the six programmes in one day.

This would mean that few more than 2,000 people would be able to see the programmes each day, but if we assume that the hour of film transmission in the morning also will be used for demonstration purposes, 3,000 visitors per day.

My purpose in making this little calculation is to point out that unless much more comprehensive arrangements are made than at present are spoken of, one of two things will happen: either only a tiny percentage of the visitors to Radiolympia will be able to see the television transmissions, or the general public will not be able to see a whole programme through because, as last year, of the pressure of others waiting.

I have no doubt that the R.M.A. officials are intending to cope with this difficult situation, and will do so with their customary efficiency. But it seems to me that the only solution is instead of having, say, 12 seats, one in each booth, each manufacturer should be invited to demonstrate simultaneously with four receivers, making close on 50 in all. This would immediately multiply the number of people who could see the programmes at once.

It has also been suggested that instead of transmitting special programmes to Radiolympia for two hours only during the run of the Exhibition, the B.B.C. should extend the programme time. The official reply to this is that any such extension would impose too great a strain upon the staff at Alexandra Palace, and is quite out of the question. It is not practicable to increase the staff at a moment's notice, as it is with other types of work, so that it looks as if the solution of this problem, whatever it may be, will have to be found at the Radiolympia end.

One thing is certain: television has now become such an important factor in the radio world that every visitor to the Exhibition should have the opportunity to see this new wonder and be convinced of its entertainment value. It is up to the Exhibition officials to ensure this.

THE TELEVISION EXHIBITION (Continued from page 398)

which can be operated by visitors, shows how the invisible electric "cathode-ray" beam is shot from a "gun" and is focused so as to build up the television picture on a screen inside the end of the large glass bulb of the cathode-ray tube. Cleverly arranged devices are used to show in slow motion the movements of the scanning beam which normally travels towards the screen at the amazing speed of 70 million miles per hour.

Alongside the model an actual cathode-ray tube is mounted as in a television receiver. The controls, arranged for operation by the public, are "ganged" to the model as well as to the real tube.

Alterations of currents and voltages to the tube electrodes can be observed on a number of meters at the same time as the consequent effects on the screen, whilst the model displays the same effects pictorially.

Other interesting G.E.C. exhibits in addition to their standard television receiver, which is demonstrated, include a number of vacuum-type photo-cells, showing the stages in the development of the latest type cell designed for television purposes. Among them are several thick-film cathode cells which were the only type available prior to 1929. The remaining cells all incorporate the modern thin-film caesium cathode, a far-reaching discovery which was first developed and applied in this country by the G.E.C.

The latest advances in photo-cell design are represented by the secondary emission cell, and the electron multiplier. The G.E.C. are exhibiting an example of the former which is now commercially available, and also an electron multiplier which is arranged with coatings of a fluorescent material on its plates to demonstrate to the public its method of operation.

Marconi-E.M.I.

In addition to a display of cathode-ray tubes, Marconi-E.M.I. show several pieces of apparatus which are in actual use at the Alexandra Palace. There is, for example, an Emitron camera and visitors are able to see how by means of a secondary lens which by operating in unison with the actual electron camera lens the operator can keep the image being televised focused and in the correct position.

The very fine model of the television outside broadcast van is another very interesting exhibit of Marconi-E.M.I. This has the roof partly removed and its construction can be seen to the smallest detail. This firm have also provided a model of the system of television proposed by Campbell Swinton in 1911 and which was described in our June issue.

The Mihaly-Traub System

The I.M.K. Syndicate are showing a number of exhibits in connection with the development of the Mihaly-Traub system.

On view is an original Mihaly type of receiver, using a complete circle of stationary mirrors in conjunction with a single rotating mirror, and designed for 90-line definition. Another model which is being shown is the 180-line Mihaly-Traub receiver using 20 stationary mirrors and a 9-sided polygon. This receiver is extremely neat and compact, and was designed to give a picture 6 ins. by 8 ins. In addition to these two receivers a number of polygonal line multiplier drums are shown indicating the reduction in size that has been made in this moving part during the last four years. The early drums were about 4 ins. in diameter and 8 ins. high; the present drums are about 1 in. in diameter and ½ in. high. A number of stationary mirrors rings are also exhibited, showing the reduction in the number of stationary mirrors and in the size thereof. Older models used 20 or even 30 stationary mirrors, the modern 405-line receiver uses only five stationary mirrors, which are extremely small, and are of an improved construction, which avoids any necessity for adjustment.

In another section of the exhibition a number of experimental Kerr cells are shown, indicating the development of these, starting with a rather crude form of multi-plate cells and ending with a low capacity 2-gap cell of very simple construction.

Scophony Large-screen Television

For the first time Scophony have publicly revealed some of their optical-mechanical secrets, and in the main hall are shown models of their supersonic light valve, the split focus system and the beam convertor. These are in glass cases and are constructed so that they can be operated by visitors and the principles demonstrated.

Of very special interest is the Scophony demonstration of large-screen television, particularly as this is the first time that the general public have had any opportunity of seeing the work of the Scophony laboratories. Two receivers are shown in operation at certain times in the special demonstration theatre—one giving a picture 5 ft. by 4 ft., and the other (the home receiver) providing a picture approximately 2 ft. by 1 ft. 10 ins. Both these receivers are being operated from a special transmission from the Scophony laboratories at Kensington with a picture frequency of 25 and a line frequency of 240.

The 5-ft. by 4-ft. picture is rear projected by apparatus using the Scophony supersonic light control which in this particular case uses 80 picture elements simultaneously, and the split focus.

The apparatus uses as a light source a high-intensity arc consuming 100 amps., this being of the standard cinema type. The first scanner is a high speed polygon 5 cm. in diameter and only 3 mm. wide. This rotates from a synchronous motor at 18,000 revs. per minute. The second scanner is a low-speed drum employing 20 mirrors and rotating at a speed to give the 25 pictures per second.

The total number of valves used for this receiver is 12. Sound is received with a separate receiver incorporating four valves on a separate channel.

The 2-ft. receiver uses an identical optical lay-out, the only difference being the sizes of light source and low-speed scanner drum. The light source used is a small microscope arc consuming 500 watts or a high-intensity mercury lamp which has been specially developed in the Scophony laboratories giving nearly twice the light of the arc but consuming approximately 300 watts. The same radio receiver employed to drive the big screen projector is used to drive the 2 ft. home receiver.

Our Readers' Views

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

The Guaranteed Receiver

SIR,

I think you may be interested to hear of the excellent results I am obtaining with a television receiver constructed from a kit supplied by the Mervyn Sound & Vision Co., Ltd.

The definition is extremely good and synchronisation is effected without difficulty.

The Mervyn people have given any advice necessary and my thanks are due to them and to you for publishing this excellent design.

W. KEITH HILL (G2VT) (Croydon).

SIR,

I have completed the construction of your Guaranteed Television Set, and must say how delighted I am with the results I have obtained. I get a good bold picture, using an indoor aerial. I thank you for making it possible for the amateur to produce such a fine set.

W. BIRKINGER (North Finchley).

The Beginner's Transmitter

SIR,

I should like to take this opportunity of thanking you for the design of a very satisfactory and remarkable short-wave transmitter. I have had some very fine reports from other stations regarding [illegible] QRK on 40 metres. [illegible] days I have contacted [illegible] out exception [illegible] QSA5 with very good [illegible] quality. Twenty of these stations were Scottish, 11 French, 3 Danish, 9 Belgian, 4 Dutch, and 5 Irish.

FRANK LUCIE (G8NA).

[The Beginner's Transmitter was fully described in the April, 1937, issue of TELEVISION AND SHORT-WAVE WORLD.—ED.]

Television Transmissions from Alexandra Palace

SIR,

I have, during the last few weeks, been receiving the television sound signals very weakly. On Saturday, April 3, I carried my set to the top of the downs here, about 300 ft. above sea level and with an aerial about six feet long and two feet off the ground, I received the sound signals at R8 QSA5 and listened to the whole of the programme from 4 to 4.15 p.m. No interference of any sort was experienced and the signals were extremely clear. My receiver is of the straight-det. 2 L.F. type.

At my house I have an aerial 25 ft. high at the house end and 6 ft. high at the other, and 40 ft. long, pointing N.E. at the 6 ft. end at approximately sea level. The signals received on this aerial with the same receiver rarely reached R5. (This aerial is, of course, screened by the South Downs, which lie to the north.

N. D. MATTOCK (Shoreham-by-Sea).

Eiffel Tower 7-metre Transmissions

SIR,

You may remember receiving a report from me last October regarding receptio[illegible]lexandra Palace. My reason [illegible] is to repor[illegible] 7 metres. [illegible] band a signal at R7 was tuned in, and a lady and gentleman were reciting short verses alternately in French, music followed between each verse; this continued for about five minutes. I then switched off to adjust the aerial coupling condenser, but when I switched on again the station had closed down and was not heard again. The aerial used is verti[illegible] and 10 feet in length with lead[illegible] at the top. The set is a detector coupled by a 4-1 transformer to a L.F. valve and reception on earphones. As I have not heard this station before [illegible] you think it was caused by freak conditions or did I hear the end of the evening broadcast. I also heard the Berlin television station last August for about half-an-hour one evening, but did not hear it again, they were then broadcasting a variety concert to an audience, which could be heard applauding the artists.

J. TAYLOR (Isle of Wight).

> **OUR POLICY**
> *The Development of TELEVISION*

Palace Transmissions at 120 Miles

SIR,

I feel I must write to thank you and your contributor, Mr. O. J. Russell, for the excellent article in the recent issue of TELEVISION AND SHORT WAVE WORLD, in which a super-regenerative receiver was described.

I have built this receiver at very small cost, and am carrying out exhaustive tests with it.

Using it with 1 L.F. stage I enjoy loudspeaker reception of the Alexandra Palace sound transmissions. I am, I believe, about 120 miles from the transmitter.

Although, as [illegible], at this time of the year the 10-metre band is "dead," I have received several local "Hams" on 5 metres and I find that the rig is stable and easy to handle on all bands even down to 3 metres, on which wavelength it oscillates fine.

I might add that I am using this receiver to investigate (on behalf of my employers, Norwich Relays, Ltd.), the strength here, with various aerial systems, of Alexandra Palace.

ALAN H. CUTBUSH (Norwich).

Superspeed Flux-cored Solder

WE have received for test a sample of a new flux-cored solder which has been specially produced for electrical and radio work. The makers are Superfluxes, Ltd., of Aintree Road, Perivale, Greenford, Middlesex, and they [illegible]im for this solder: (a) extreme speed and thoroughness in working, and (b) complete freedom from dry and corrosive joints. The solder is a cored tin-lead alloy made in all the usual proportions from 65 T./35 L., down to 20 T./80 L., and in all gauges from 3 s.w.g. down to 21 s.w.g. The 60/40 alloy in 14 s.w.g. is the particular quality and size most called for in radio work and the sample which we tested appeared to be very easy to use and the joints were quite sound without any indication of "dryness."

Superfluxes also market a special flux for electrical work, known as "Purpose" flux, for use where a flux separate from the solder is preferred. A test of this showed that it also was quick in action and enabled a sound joint to be made. It is approved by the Air Ministry whose tests have shown it to be non-corrosive.

A 10-watt Portable Transmitter

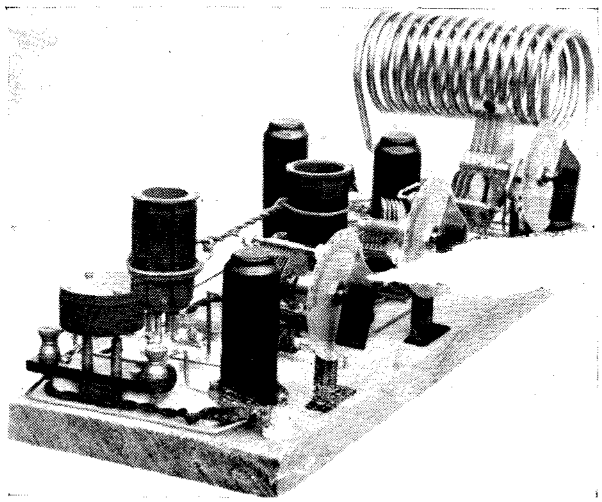
By KENNETH JOWERS

This portable equipment can be run entirely from a 6-volt accumulator, and although rated for 10 watts input, will provide a maximum of 15 watts with full modulation. We believe that it will be ideal for amateur portable use, while many beginners would be advised to consider this equipment in view of its simplicity and easy construction.

THIS portable transmitter has been built as simply as possible, and designed to handle a maximum of 15 watts input with full modulation. The entire equipment obtains high-tension from a vibrator which is in turn powered by a 6-volt accumulator.

One very often hears of the difficulties experienced by amateurs in building portable apparatus, not so much in the design, but with the layout and construction. To this end the equipment was built bread-board fashion with the minimum of loose connections and wired with 12-gauge copper wire.

Although the original design was for 40-metre working, the apparatus lends itself for use on any of the lower-frequency amateur bands by interchanging coils and crystal.



Three tw... needed, ...ted on ad- ... atals ... despite their ... cost

Three Units

The apparatus is constructed in three sections, these being transmitter, modulator and combined power packs. First of all consider the transmitter, the circuit being shown here. It will be noticed that American valves are used, and it is not recommended that any deviation from these be made. These valves, of the metal type, are very robust, have a comparatively low filament consumption, and run from a 6-volt accumulator.

As a crystal oscillator, a 6C5 triode is used in the conventional circuit, but with link coupling between anode and the following grid stage. It is suggested that a 7-mc., that is 40-metre crystal, be used, and this is connected directly between grid of the 6C5 and the common earth line. Bias is obtained by means of a 10,000-ohm resistor in parallel with the crystal and this need only be of the 1-watt type.

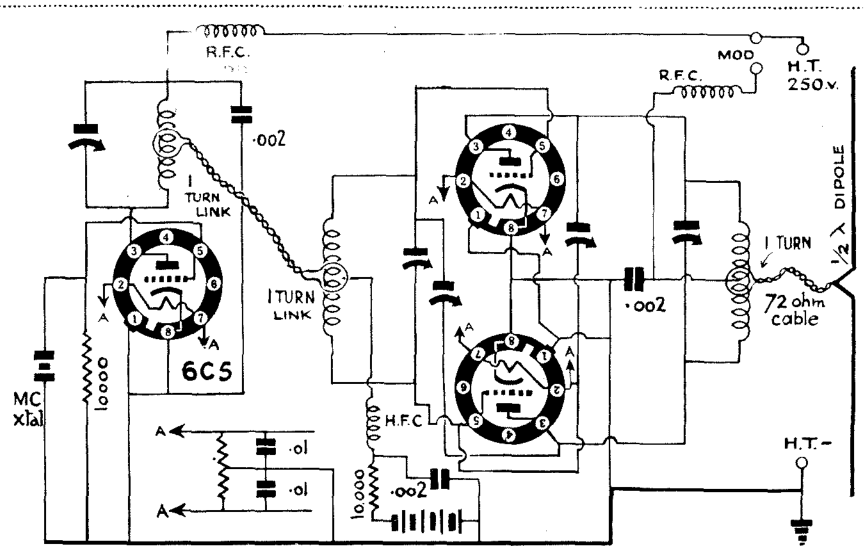
A rather large condenser is needed to tune the anode circuit of the crystal oscillator. This is rather bad practice, but in the circumstances is permissible for it does not call for accurately wound coils, while extreme sensitivity is not necessary from the crystal stage in this particular circuit owing to the high sensitivity of the driven 6D5's. The crystal oscillator anode coil has to be home constructed and for this a 4-pin plug-in former is required that is already threaded. Constructional data on this coil will be given later.

Suitable Chokes

It is important to use an efficient R.F. choke in this stage, so for this reason a Bulgin type SW68 was chosen and connected in the wiring between H.T. positive and the H.T. side of the C.O. anode coil. In view of the low voltage employed throughout this transmitter it was not considered desirable to have a split-stator condenser in the C.O. stage. The only material advantage would be that the by-pass condenser could be omitted, but in view of the low cost of this component it was found better to use a straight condenser and by-pass condenser. Actually the C.O. tuning condenser is a special Eddystone component having a maximum capacity of .000192-mfd.

With portable equipment of this kind it is essential that it be carefully wired, so that should any of the leads be unduly long even though 12-gauge wire is used, support them off the baseboard by a wood-screw to prevent movement.

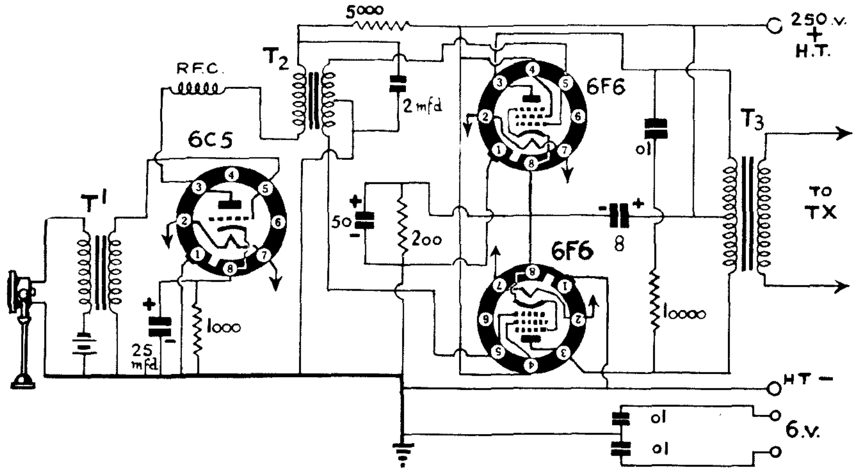
Consider the push-pull power amplifier stage using two 6D5's in a straightforward neutralising circuit. The grids are tuned with the coil again home constructed on a 7-pin plug-in former plus a 40-mfd. condenser. The exact centre of the coil is tapped and through



Here is the complete circuit for the transmitter. It consists of a triode crystal oscillator link coupled to two neutralised triodes in push-pull.

The Coils :: Constructing The Transmitter

this point bias is applied to the grids of the output valves. In series with the grid return is a high-frequency choke followed by a 10,000-ohm 3-watt resistance which supplies a percentage of the bias required, and also a bias battery. The 10,000-ohm resistance and bias battery are shunted by a .002-mfd. condenser.



The modulator is very similar to the transmitter, consisting of a triode amplifier and two pentodes in Class A push-pull. Approximately 8 watts output can be obtained.

Copper-tube Coil

The only bulky coil is in the P.A. anode circuit and this is constructed of copper tubing and mounted on beehive stand-off insulators. Actually in the original transmitter the coil was silver-plated, but this is not really necessary in equipment of this kind. The effect of the silver-plating only shows up on high power and when a number of similar coils are employed.

A double-spaced .0001-mfd. condenser parallel tunes the tank coil and the reasons for using this type of condenser in preference to a split stator are the same as explained for the crystal oscillator stage.

At this point make a mental note that a common earth bar is fixed right down the centre of the baseboard and to this all earthy returns are made. It is rather important that this be remembered for it materially helps in producing a stable transmitter and one that can be easily neutralised.

Talking about neutralising, the system employed for push-pull is rather different from that used for a single-ended amplifier. Instead of the neutralising condenser being connected from grid to the H.T. side of the anode coil, the condensers are connected from the anode of one valve to the grid of the other. Actually with the 6D5's 8-mmfd. condensers are needed, but as there are none of these available a 20-mmfd. condenser is employed in each section and used with almost maximum capacity. An alternative arrangement is to remove all but one rotor and two stator plates, as this makes neutralising even more simple.

Many amateurs are inclined to neglect the aerial with portable equipment and to use at the best of times a simple tapped on arrangement. With this equipment a di-pole has been used that does not need any feeder tuning condensers and is easy to erect. Full details will be found in the operating data.

Precautions to Take

One or two points should be considered before the transmitter is constructed. First of all the adjustable brackets are not entirely suitable as supplied by the makers for use with the simple tuning dial specified. Two round-head bolts are supplied with the brackets and these foul the dial if it is mounted flush. So before fitting either bush-off the dial from the bracket or substitute counter-sunk bolts for the round-head bolts supplied.

Arrange for all the components to be mounted so that the interconnecting leads are as short as possible, while those components, which are mounted in the wiring should be anchored where necessary to wood-screws into the baseboard.

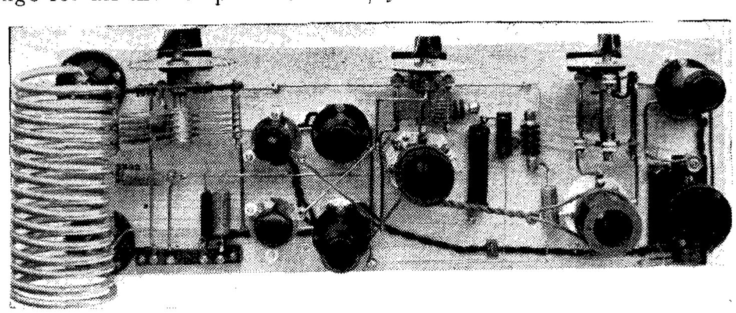
It will be appreciated from the theoretical circuit that the crystal oscillator and power amplifier circuits are quite separate until the link coupling is included. This is quite a useful feature for it enables stages to be checked individually without having to disconnect permanent wiring.

The Modulator

That is sufficient for the time being about the transmitter, so here are some details regarding its associated modulator. Actually the modulator caused more trouble in design than the transmitter. Not from any technical aspect, but from the fact that the power supply was so limited and that an audio output of 7.5 watts was essential for a 15-watt input. However, the difficulty was overcome in rather a simple way. Here, again, American valves had to be used for they were the only ones that would give the output with the voltage available.

First of all a carbon microphone of the single or double button type is advisable. Actually, in the original circuit, a single button was used, but for those who can obtain a double button type from Raymart, certainly do so, for the output is very much greater with better quality than with the single button type.

The microphone is fed into the grid of a 6C5 metal triode through a multi-ratio midget microphone transformer. The correct ratio has to be found by experiment and is usually about 1-30. A 1,000-ohm resistor in the cathode of the 6C5 shunted by a 25-mfd. condenser provides the correct amount of bias, but this value again is subject to experiment for it depends solely on the characteristics of the 6C5. For guidance, however, the anode current flow in this circuit should be limited to 5 mA.



A good idea of the layout of the components can be obtained from this plan view. A crystal stage is on the extreme right, which is link coupled to a pair of valves to the left.

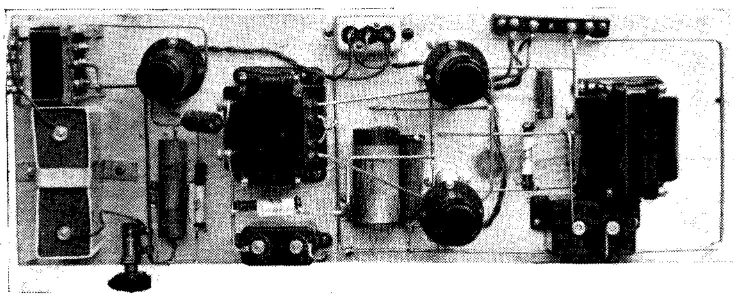
For a coupling transformer a Ferranti AF5C is employed. Despite the fact that this is rather heavy the quality

Modulation :: Vibrators Energised From L.T.

and efficiency is so much better than when miniature units are used that it was considered essential to use it.

In the primary a 5,000-ohm resistance with a 2-mfd. by-pass condenser was found to provide ample decoupling without reducing the voltage to too low a level. Throughout the design of this amplifier the fact that 250 volts at 60 mA. was the maximum available had always to be borne in mind.

The modulators are pentodes of the 6F6 metal type with the screens connected directly to high-tension positive. This point is important for if the voltage is reduced, the audio output drops very quickly. Bias for these valves is obtained through the current flow across a common 200-ohm resistor. A 50-mfd. capacity shunting the resistor is essential, otherwise there is noticeable bass attenuation.



All connections are made with heavy gauge wire, for with portable work nothing must come loose. The layout of the components can be seen from this illustration.

Tone Correction

Top note response is automatically corrected by means of the 10,000-ohm resistor in series with a .01-mfd. condenser connected from anode to anode of the 6F6's. The only other point in the anode circuits is that the centre tap to the output transformer is by-passed to cathode by an 8-mfd. condenser.

The output transformer, T3, is the Ferranti OPM1 split primary with a 1-1 ratio. The secondary of this transformer is connected in series with the H.T. supply to the transmitter as indicated in the circuit.

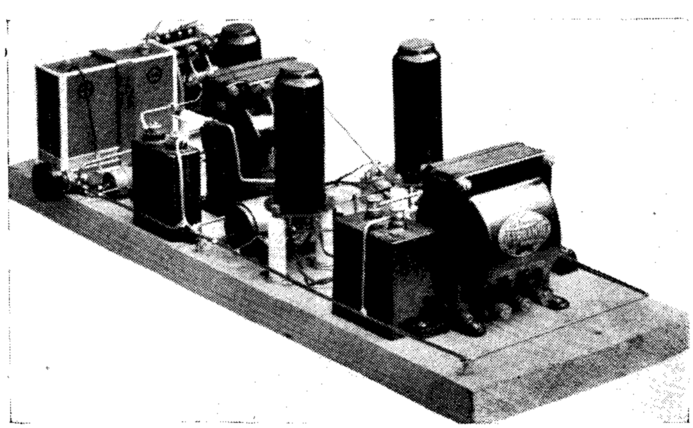
As with the transmitter, the modulator is mounted on an inch plank and wired with 12-gauge wire. In this way it is very robust, will stand any amount of mishandling, and only has four external battery leads and two contacts feeding the modulation into the transmitter.

There should not be any need to experiment with the value of cathode-bias resistor in the 6F6 circuit, but it should be checked and if necessary adjusted to give a total anode current of 50 mA. for the two valves.

In such circumstances the maximum audio output is in the region of 8 watts, which is very good indeed for such a simple amplifier and low voltage.

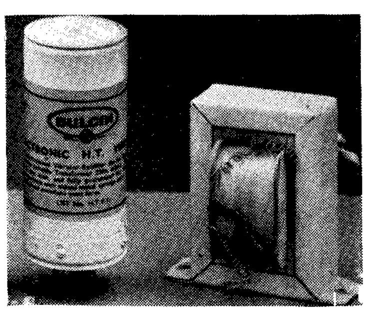
Power Supply

In any case this transmitter could not have been designed without the use of the new Bulgin vibrator converter units, which are about the cheapest components of their kind we have so far tried. The transformer and vibrator are shown in the illustration. The vibrator is fed from a 6-volt accumulator and gives an A.C. output of 4 volts. This voltage is fed into the primary of a conventional transformer and is stepped up to 250 volts.



On the right of this illustration can be seen the output transformer, the secondary of which is connected to the transmitter. The two 6F6 pentode valves are operated in push-pull and mounted on stand-off insulators, owing to the fact that no baseboard type octal valveholders are available.

An output of 15 watts is available from the vibrators so giving 250 volts at 60 mA., or lower voltage and a higher current as required. The vibrator is similar in appearance to an electrolytic condenser, but is fitted with a special 5-pin valve-holder type base. Precautions have to be taken to prevent interference due to arcing contacts, so that a comprehensive filter circuit has been embodied.



These two units, the vibrator converter on the left, and step-up transformer on the right, provide 250 volts at 60 M/a with an input of 6 volts only.

To give some idea as to the effectiveness of the filter, the three-valve battery receiver described in the June issue can be used side-by-side with the vibrator without picking up interference. The circuit on p. 422 shows the power pack, of which two are required, one for the transmitter and one for the modulator. Both power packs are fed from the same accumulator, but a separate accumulator is recommended for feeding the filaments of all valves.

The MT5 transformer, which steps up the low-voltage A.C. to 250 volts is supplied with long leads. The primary has one plain wire, one with a red spot, and a twisted pair. The secondary has a centre tap of green wire and the outers of the secondary yellow and blue. Sufficient smoothing can be obtained with one high-inductance choke plus two 8-mfd. condensers.

Again, as with the previous units, both power packs are mounted on a 20-in. by 1-in. board, so that ultimately the three units can be bolted together and fitted with a carrying handle at each end. It is not convenient to wire up the power packs with 12-gauge wire so single flex is used throughout.

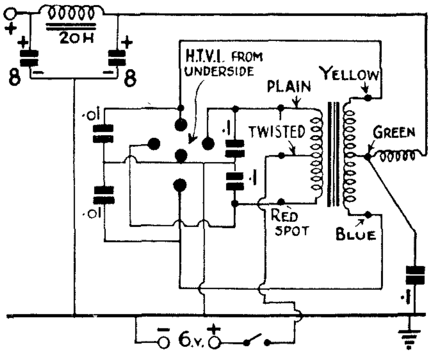
In case readers should query our not using a Class B amplifier so as to obtain a high-audio output with the minimum amount of trouble, the reason can be found in the power supply. Unless the anode current flow is steady the voltage from the vibrator will not remain constant, so making Class B operation out of question. Also owing to the limited supply it is not feasible to fit the conventional buffers to take up variations in current flow.

Link Coupling :: Tuning :: The Licence

The previous details should make it easy for all constructors to build these three units, but here is some more information on operating. First of all the transmitter.

The oscillator coil is made up of 20 turns of 22 gauge wire spaced according to the threads on the former. The following grid coil is made up of 26 turns of the same gauge wire but centre tapped.

The link coupling is not wound in the same manner. A single turn of flexible wire is wound around both the H.T. end of the oscillator coil and the centre of the grid coil and connected together by twin lamp flex.



Two of these units are needed to drive the complete transmitter; one for the modulator and one for the oscillators.

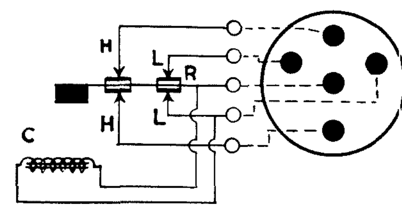
With voltage applied to the oscillator, but omitted from the output valve, tune the oscillator circuit to give maximum light in a looped lamp circuit or minimum current in a milliammeter temporarily connected in series with the H.T. supply. Then tune the grid circuit of the 6D5 to give maximum light in a loop lamp and adjust the link in the C.O. circuit both for coupling and number of turns. The number of turns in the grid circuit should also be varied in order to obtain maximum light. For those who have a low-reading milliammeter available, connect this in series with the bias supply to the 6D5's and adjust the crystal oscillator and P.A. grid circuit to give maximum grid current reading. This should be of the order of 10 mA., when the high-tension is omitted from the P.A. stage.

After these adjustments have been made, disconnect the H.T. from the crystal oscillator—the quickest way to do this is to pull out the coil and apply H.T. to the 6D5's. This will cause a certain anode current flow, so grid bias should be increased until this current flow drops to zero. Reconnect high-tension voltage to the crystal oscillator, after which an anode current of about 50 mA. will flow in the anode circuit of the output valves.

Quickly tune the .0001-mfd. condenser across the tank circuit until the anode current drops to as low a value as possible. For guidance, unless the anode current drops to 5 mA. from 50, the stage is not working efficiently.

Neutralising is rather important. With the transmitter tuned up, disconnect H.T. from the 6D5's and couple up a single turn loop lamp to the tank coil. If the circuit is unneutralised the lamp will light up, in which case, the neutralising condensers should be adjusted until this light disappears.

For an aerial use a di-pole of half-wavelength, that is 66 ft. long and 40 metres, coupled to the transmitter tank coil by a length of 72-ohm Belling-Lee cable terminated in a single-turn coil.



The Bulgin H.T. vibrator is made up internally in this way. The multi-contacts explain the need for so many buffer condensers.

With the anode current of the output valve reduced to 5 mA., the single turn coil should be pushed inside the tank coil until the current rises to 50 mA. The transmitter is then all ready for operation.

Before connecting the modulator to the transmitter, connect a high-resistance speaker across the secondary of the T3 and check for quality and output. There should not be any possibility of hum being introduced, particularly if the power pack is at a short distance from the transmitter. On the other hand, when all three units are mounted together any hum that may be noticed can be removed by rotating transformers T1, T2 and T3 until it is cancelled out. After these tests have been made the secondary of T3 should be connected in series with the H.T. supply to the 6D5's after the H.F. choke, as indicated in the theoretical circuit.

It will be noticed that buffer condensers have been incorporated across all heaters with a buffer resistance across the heaters of the valves in the transmitter. The idea of this is to enable the apparatus to be used from a power supply on A.C. mains, for it is not intended that the transmitter be used solely for portable work. Owing to its simplicity, low cost and easy construction, it is ideal for the beginner.

It should be remembered that before this apparatus is constructed a permit must be obtained from the Post Office and it is suggested that constructors, not so licensed, should write to the Engineer-in-Chief, Radio Division, General Post Office, Armour House, Aldersgate Street, E.C.1.

Components for
A 10-WATT PORTABLE TRANSMITTER.

BASEBOARD.
1—20 in. by 6 in. by ½ in. deal plank.
CHOKES, HIGH FREQUENCY.
3—Type SW68 (Bulgin).
COIL FORMS.
2—4-pin threaded type CT4 (Raymart).
1—Type 6T6 (Raymant).
CONDENSERS, FIXED.
3—.002-mfd. type 620 (Dubilier).
2—.01-mfd. type 4421/E (Dubilier).
CONDENSERS, VARIABLE.
1—942/180 (Eddystone).
1—Type 900/40 (Eddystone).
2—Type 900/20 (Eddystone).
1—Type 979 (Eddystone).
CRYSTAL.
1—7 mc. standard type mounted (Q.C.C.).
DIALS.
3—Type 1027 (Eddystone).
FEEDER WIRE.
1—Length 72-ohm cable (Belling-Lee).
HOLDERS, VALVE.
3—8-pin octal (Clix).
1—4-pin type 949 (Eddystone).
1—5-pin type 950 (Eddystone).
RESISTANCES, FIXED.
1—10,000-ohm 1-watt (Erie).
1—10,000-ohm 3-watt (Erie).
1—30-ohm humdinger (Claude-Lyons).
SUNDRIES.
4—Coils Quickwyre (Bulgin).
2—Insulated terminal blocks type SW47 (Bulgin).
2—Stand-off insulators type SG (Raymart).
6—Stand-off insulators type 1019 (Eddystone).
3—Adjustable brackets type 1007 (Eddystone).
VALVES.
1—6C5 (Premier Supply Stores).
2—6D5 (Premier Supply Stores).

MODULATOR SECTION.

BASEBOARD.
1—20 in. by 6 in. by ½ in. deal plank.
CHOKE, HIGH FREQUENCY.
1—Type SW68 (Bulgin).
CONDENSERS, FIXED.
1—2-mfd. type BB (Dubilier).
3—.01-mfd. type 4421/E (Dubilier).
1—8-mfd. type 0281 (Dubilier).
1—25-mfd. type 3016 (Dubilier).
1—50-mfd. type 3004 (Dubilier).
HOLDERS, VALVE.
3—8-pin octal (Clix).
MICROPHONE.
1—Type double button DBM (Raymart).
RESISTANCES, FIXED.
1—1,000-ohm 1-watt (Erie).
1—5,000-ohm 1-watt (Erie).
1—10,000-ohm 1-watt (Erie).
1—200-ohm 3-watt (Erie).
SUNDRIES.
2—Coils Quickwyre (Bulgin).
2—Dozen 6 B.A. round-head wood screws.
2—Insulated terminal blocks type SW47 (Bulgin).
TRANSFORMERS, LOW FREQUENCY.
1—AF6 (Ferranti).
1—OPM1 (Ferranti).
TRANSFORMER, MICROPHONE.
1—Midget type LF35 (Bulgin).
VALVES.
1—6C5 (Premier Supply Stores).
2—6F6 (Premier Supply Stores).

POWER SUPPLY.

BASEBOARD.
1—20 in. by 6 in. by ½ in. deal plank.
CHOKES, HIGH FREQUENCY.
2—Type HF9S (Bulgin).
CHOKES, LOW FREQUENCY.
2—Type LF14S (Bulgin).
CONDENSERS, FIXED.
2—8 × 8 type 0288 (Dubilier).
6—.01-mfd. type 4421/E (Dubilier).
6—.1-mfd. type 4423/S (Dubilier).
CONVERTERS.
2—Vibrator type HTV1 (Bulgin).
SUNDRIES.
1—Coil Quickwyre (Bulgin).
2—Terminal blocks type SW47 (Bulgin).
TRANSFORMERS.
2—Type MT5 (Bulgin).

A Miniature Cathode-ray Oscilloscope

We present this miniature oscilloscope, designed by G. Parr, for the keen amateur and experimenter who realises the uses to which it can be put. The instrument is more complete and flexible than the average oscilloscope of this kind.

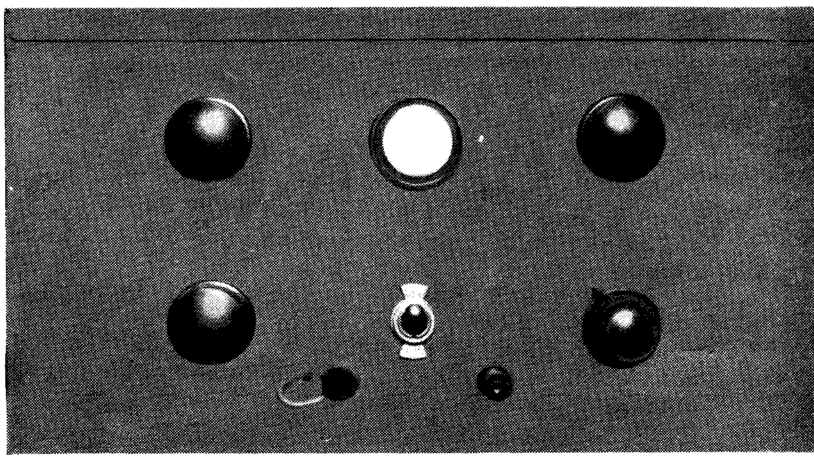
THE new R.C.A. 913 cathode-ray tube with a 1 in. screen diameter is now available in this country and with its aid a remarkably neat miniature test equipment can be constructed at a very reasonable figure. The voltage required for exciting the tube is moderate and the whole circuit can be accommodated in a box less than 1 foot long. The sensitivity of the tube is sufficient to enable it to be used direct for monitoring transmitter circuits, while the addition of a single stage of amplification before the deflector plate gives a reasonable amplitude at low inputs such as would be obtained from a grid signal input.

The following apparatus has been designed with a view to providing the advantages of the cathode-ray tube as a test indicator combined with the most economical circuit.

Certain elaborations are possible, however, and room has been left in the box to provide for additions at a later date.

The Circuit

The circuit for the tube has been based on that recommended by the R.C.A. with the exception of the linear time base. If a 50-cycle sweep is obtained from the mains it will be found adequate for most A.F. waveform investigations and a considerable saving in components and valves results. British valves have been used wherever possible, but there is no objection to the use of equivalent



The panel view is quite symmetrical, the 1-in. tube being mounted as shown.

types of American valves if they are available. The windings on the transformer will have to be modified accordingly and attention has been drawn to this point in the specification for the latter.

The whole of the supply is taken from one transformer specially made to the specification given in the panel. Note the method by which the H.T. for the amplifier V3 and the H.T. for the tube are both obtained from a common secondary winding. The maximum rating of the tube is 500 V H.T., but 300 will be adequate for work in subdued daylight and has the advantage of giving increased sensitivity.

V1 is the amplifier H.T. rectifier and can be of the standard type, say, Mazda UU.3, but a Type 80 can be used if available. V2 is the 1-V rectifier, and the heater of this valve is connected to the same winding as that of the tube itself.

The amplifier V3 is of the screened pentode type and can be either an AC/S2.Pen or the American equivalent 6J7. A low-capacity changeover switch connects the input to the plate to the grid of this valve or direct to the plate.

The timing sweep is provided by a separate winding of 150 volts which is sufficient to carry the beam well off the screen on either side. The central portion of the sweep is thus substantially linear. Normally, owing to the return of the beam being at the same speed as the sweep, a wave would be traced twice on the screen and appear as a series of loops, but this is overcome by applying a small voltage to the grid of the tube and

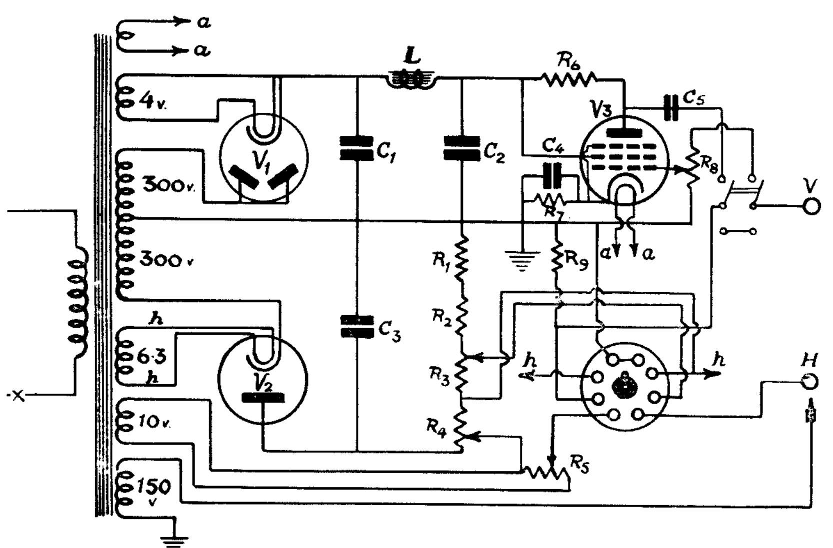


Fig. 1.—This is the complete circuit showing the power supply and the tube time base.

The Layout :: Complete Smoothing

cutting off the beam on the return travel. This is done by connecting a potentiometer in series with the grid lead and applying about 10 volts A.C. to it as shown. The tapping on the 8+8 mfd. condenser is a close fit in the box and the height of the bracket on which it is screwed must not be more than enough to clear the leads from the baseboard. The socket for the 1-V rectifier is usually of the chassis type as the baseboard type is difficult to obtain, and it will therefore have to be held off the baseboard by four drilled rods of ebonite or paxolin long enough to allow the sockets to clear.

Before screwing down the components, prepare and drill the screen which runs across the box. The drawing for this is shown in Fig. 2, the dotted rectangle representing the Bulgin 5-way group board. The socket for the tube is mounted in the centre and the holes for mounting it should be slotted as shown to allow of aligning the tube after it is fitted in. The operating instructions, say, "The 913 is based so that trace given on the screen by deflecting plates D1 and D2 is parallel, to the line joining pins Nos. 3 and 7." This

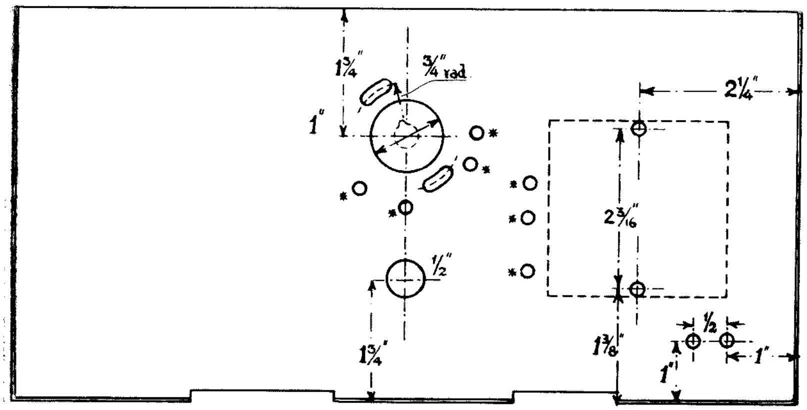


Fig. 2.—These are the dimensions for the screen which is fitted across the box.

potentiometer R5 can be adjusted when the equipment is tested. The focusing control is the potentiometer R3 connected to the first anode of the tube and the brightness is controlled by the bias potentiometer R4. R8 is also brought out to the front panel and serves to vary the input to the amplifier stage.

The resistance of this is 2 meg. and this should be borne in mind as it represents the effective load of the tube plates on the external circuit. Note that the heater of V3 is supplied from a separate winding marked a a, and this should be specified according to the type of valve used.

Before the layout of the components is commenced, one or two auxiliary pieces will have to be made. These are the brackets for holding the electrolytic condensers. The

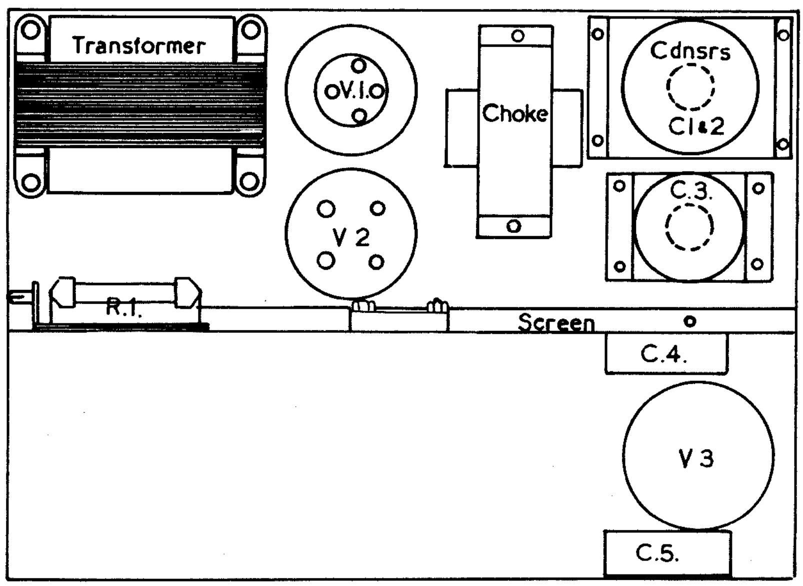


Fig. 3.—Components are laid out in this manner in order to keep wiring as neat as possible.

Components for
A MINIATURE CATHODE-RAY OSCILLOSCOPE

CABINET AND CHASSIS.
1—Steel cabinet, 11 in. by 8 in. by 6 in., with centre partition 11 in. by 5½ in. (Burne-Jones).
1—¾-in. wooden baseboard 11 in. by 8 in.
CONDENSERS, FIXED.
2—Electrolytic 8 mfd. type 0821 (Dubilier).
1—.5-mfd. type 4426 (Dubilier).
1—.25-mfd. type 690W (Dubilier).
1—4-mfd. Type 2921 (Dubilier)
CHOKES, LOW FREQUENCY.
1—Type LF34S (Bulgin).
KNOBS.
4—Special knobs (Webbs Radio).
HOLDERS, FUSE.
1—Single pole type F17 (Bulgin).
HOLDERS, VALVE.
1—4-pin baseboard type 949 (Eddystone).
3—Octal (Clix).
PLUGS, TERMINALS, ETC.
2—Sockets and plugs type 1015 (Belling-Lee).
1—Mains plug and socket type 1099 (Belling-Lee).
1—Terminal type B marked Earth (Belling-Lee).
RESISTANCES, FIXED.
1—1,000-ohm type 1 watt (Erie).
1—60,000-ohm type 1 watt (Erie).
1—40,000-ohm type 1 watt (Erie).
1—50,000-ohm type 1 watt (Erie).
1—100,000-ohm type 1 watt (Erie).
1—2-megohm type ½ watt (Erie).
RESISTANCES, VARIABLE.
1—1,000-ohm type B (Dubilier).
2—10,000-ohm type B (Dubilier).
1—25,000-ohm type B (Dubilier).
1—2-megohm type B (Dubilier).
SUNDRIES.
1—5-way group board type C31 (Bulgin).
1—Dozen 6 B.A. nuts, bolts and washers.
SWITCHES.
1—Type S8OT (Bulgin).
1—Type 1-22 (Wright & Weaire).
TRANSFORMER, MAINS.
1—Special to specification (Premier Supply Stores).
VALVES.
1—V914 (Mazda).
1—6J7 (Eves Radio).
1—1-v (Eves Radio).
1—C.R. tube RCA913 (Eves Radio).

position is when the key is pointing upwards as shown. Below the tube socket is a clearing hole for the potentiometer R5. The holes marked with an asterisk are for leads and need not be critical.

Before going further, check that the hole in the screen is in line with the hole in the front of the box for the tube.

When fitting the socket in it is advisable to interpose a mica disc between the contacts and the screen in the case of porcelain sockets as it will be found that the contacts are

A 1-inch Screen :: Low Voltages

sufficiently moveable to touch the metal. The two holes in the right-

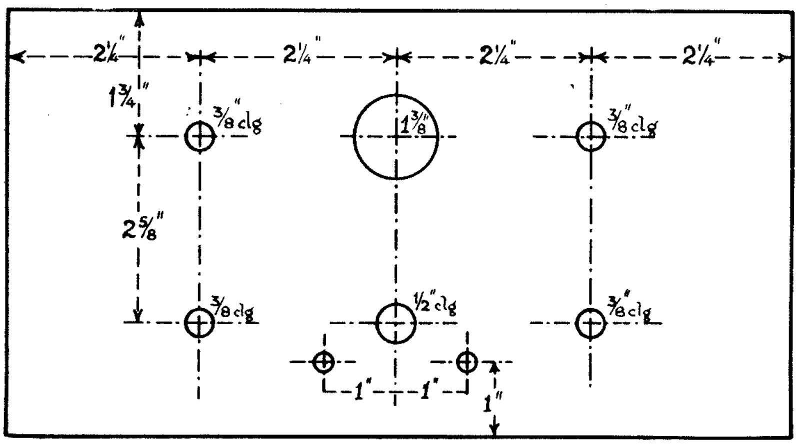


Fig. 4.—The box is drilled with several holes, the exact dimensions being as above.

hand corner are for the mains plug, and in fixing this care must be taken that the prongs do not project beyond the edge of the baseboard or it will not fit in the box without trouble. A slotted hole is cut in the side of the box to correspond with the position of the plug.

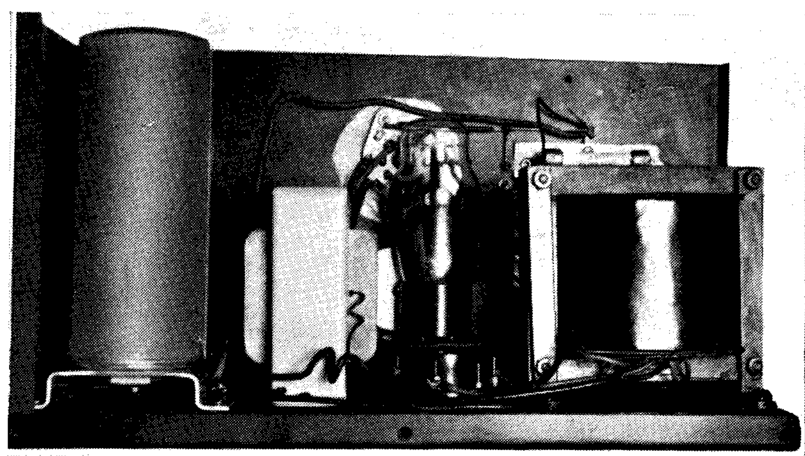
Do not screw the screen on the baseboard until a greater part of the wiring has been done, and now proceed to the fixing of the components.

These are shown in position in the drawing of Fig. 3 which is almost self-explanatory. The screen is fixed with its flange turned towards the back of the board as indicated. The position of the mains plug is shown at the left of the board, and the fuse can be screwed down between the transformer and the screen, or in any other convenient position.

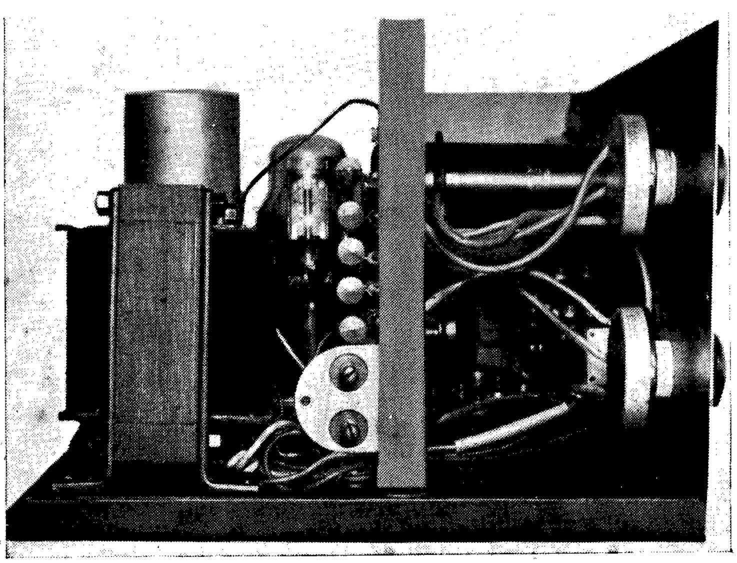
Fig. 4 shows the drilling of the front of the box for those who do not purchase the finished article. The holes at the bottom front are for the Belling-Lee sockets which are deliberately made of different types to avoid confusion.

A small hole should be drilled at the left-hand socket to allow a lead to be pushed through from the 150 volts winding, and this should be connected to the shrouded plug.

Nearly all the wiring should be done before the screen is fitted in place as it will be difficult to finish some of the joints with it screwed down. The whole of the rectifier wiring can be done and the connections from the resistance chain to the tube socket with the exception of these to the variable resistances. The amplifier can be wired complete except the lead from the change-over switch and potentiometer. When the screen is ready to be fitted, cut two slots from the bottom edge to clear the wires already in place. These slots are indicated in the drawing of Fig. 2. The screen should be earthed to the



The mains transformer and special electrolytic condenser can be seen in this illustration.



Resistances are mounted on a group board, while the tube can be seen mounted horizontally.

transformer core when finally in place. The earth terminal can be screwed into the box at the back or in any convenient place on the front panel.

To provide sufficient support for the tube the clearance hole in the box has been made as small as possible, and it will not be possible to insert the tube after the screen and baseboard are in place. The easiest method is to slip the tube through the hole in the box and allow it to rest loosely there while the baseboard is eased into place with the screen.

The tube can then be guided back in its socket. At no time should direct pressure to be put on the glass.

The resistances in the front panel and the switch are the last to be wired and care must be taken that the leads

(*Continued on page* 444)

Programmes for Short-wave Listeners

By A. C. Weston

Bad reception conditions have been accidentally counteracted by the fact that American short-wave stations are now using higher power and directional aerials. Listeners should make a point of hearing some of these programmes during July, which can be heard through the regular short-wave broadcasters.

FORTUNATELY the American broadcasters have greatly increased the power of their short-wave stations, and in many cases erected aerials directional on Europe. In normal circumstances this would have had the effect of greatly increasing the signals in strength, but owing to these improvements being coincident with a very bad reception period listeners have so far not noticed very much difference.

Here are the Southernaires, the famous negro quartet, which are such consistent broadcasters.

However, it can be taken for granted that without the extra power and directonal aerials English listeners would be very badly off for reception of the American programmes. I anticipate, however, that by August conditions will have improved again—there is a tendency that way already—and then American short-wavers should be heard at a strength greater than ever before.

Boundbrook

Many of the stations have also increased their operating times by as much as two hours. For example, the General Electric station, W2XAD, at Schenectady, operating on 19.56 metres, has a new schedule and will be operating from 3 p.m. until 1 a.m. The higher wavelength counterpart of this station, W2XAF, on 31.48 metres, is still keeping to its normal schedule of 9 p.m. until 5 a.m. These two stations radiate programmes created by the National Broadcasting Company.

On Sundays during July the Boundbrook station on 16.87 metres will commence transmitting at 1 p.m., and although at this time signal strength is not very great, programmes can always be heard on a loudspeaker with any good modern all-waver. The first programme is a Melody Hour with an orchestra under the direction of Josef Honit, followed by " Coast to Coast on a Bus," or " The White Rabbit Line," featuring Milton J. Cross, at 2 p.m.

Those old favourites, the Southernaires, a negro quartet, are scheduled for 5 p.m. through this station every Sunday. This is one of the most popular features of its kind amongst American listeners, while already their fan mail is coming in from Europe.

" The Magic Key " is another old-timer that can be relied upon to provide an entertaining hour. It is scheduled for 7 p.m. every Sunday; it includes amongst other items an excellent Symphony Orchestra under the direction of N.B.C. conductor, Frank Black.

Paul Martin and his Music, relayed from San Francisco via Boundbrook, is another good feature at 9.30 p.m. on July 4. It is followed by a relay from Montreal of the Canadian Grenadier Guards Band at 11 p.m., a Golden Gate Park Band Concert, relayed from San Francisco, finishing up at midnight with Helen Traubel.

Elinor Harriot takes the part of all the extras in the Amos 'n' Andy programme. Listen to this versatile artist at midnight each evening except Sunday.

Mondays through Boundbrook bring " Rise and Shine," featuring Harry Levey's Orchestra at 12.30 p.m., and the Japanese xylophonist, Yoichi Hiraoka, at 12.45 p.m. " An Hour of Memories " by the U.S. Navy Band directed by Charles Benter is being relayed from Washington at 7.30 p.m. on July 5, while Anne Hard, the versatile journalist, has another 30 minutes at 3.30 p.m. on the same day.

Barry McKinley with Hugh Barrett and Orchestra feature in "Melody Revue " at midnight, while on the 6th and 7th at the same time Jane and Goodman Ace have 30 minutes to themselves. At 8 p.m. on Tuesdays a feature entitled " Airbreaks Variety Show " is well worth hearing. It is scheduled for 45 minutes and includes many guest artists.

A star orchestra is usually radiated at 11.5 p.m. each evening. On July 6 Meredith Wilson comes to the microphone. The following day Harry Kogen, while Bert Block, Chick Webb and Jesse Crawford, all have schedules at this time.

It is well worth while waiting up to hear Ben Bernie and all the lads at 2 a.m. each Tuesday night, for it is one of the star features of the week.

A Special Feature

Personal Column of the Air is scheduled each day for 4.15 p.m., while on July 7 at 8 p.m. the Southernaires have another 15 minutes. Mrs. Franklin D. Roosevelt makes another of her now more frequent appearances at 12.15 a.m. on Wednesday, July 7. It is claimed that she has one of the biggest American radio audiences of any similar broadcaster.

Hal Gordon can be heard most Thursdays at 6.15 p.m. His first schedule is on July 8. The programme is being relayed from New York via Boundbrook, and according to reports he is going to be a new radio star.

A new male quartet, "The Revelers," are scheduled for 11.35 p.m. on Fridays from July 9, while if you care for a selection of American orchestras, listen on Saturday, July 10, to some of the following: Harry Levey at 12.30 p.m.; Bill Krenz at 3.45 p.m.; George Hessberger at 5.30 p.m.; Jesse Crawford at 7.30 p.m.; Chick Webb at 8 p.m.; Ricardo and his Caballeros at 8.30 p.m.; Harry Kogen at 9 p.m.; Bert

When you hear a tenor voice in the Jack Benny programme every Sunday night it belongs to this new N.B.C. star, Kenny Baker.

N.B.C. and Columbia Programmes

Block at 10.30 p.m.; and Meredith Wilson at 1.30 a.m. through Boundbrook on 49.18 metres.

A selection of Baron Münchhausen's stories are being relayed from Zeesen on July 11. These are scheduled for 30 minutes and should be very interesting. I shall make a special point of comparing the German Münchhausen with the American version portrayed by Jack Pearl.

A star feature from Zeesen is a solo concert by Maria Schwamberger at 7.45 on July 26. This programme is intended for North American listeners, but should be well received in England. Incidentally Germany is collaborating with America in celebrating the Fourth of July by presenting a variegated programme of speech and music suitable for the occasion. The time is 9.30 p.m. July 4.

Two very good items should be heard through Schenectady on 19.56 metres any Sunday at 11.30 and midnight are "A Tale of To-day" and Jack Benny and Mary Livingston. The new film star Don Ameche is now being featured in a 60 minute variety programme from 1 a.m. through this station each Sunday night.

Broadcasts from the Air

Joe White, the N.B.C. tenor, is scheduled now for 6 p.m. on Monday evenings, while "Words and Music" have 30 minutes from 6.30 p.m. The American Travelogue broadcasts which originate in an aeroplane are radiated at 11.15 p.m. each Monday through this station. Various places of interest are being described from the air, and for July the following have been included: San Francisco on July 5, Saratoga Hot Springs July 12, Niagara Falls July 19, the Caves, Mammoth Carlsbad and Luray July 26, and on August 2 Yellowstone Park.

Cleo Brown is a new listing for 6 p.m. on Tuesdays, commencing on July 6.

The part of Gloria Marsh in To-day's Children every Monday on the N.B.C. Red network is taken by Gale Page. Here she is.

The Collegians have 15 minutes from 7.45 p.m. on Tuesdays, while Don Winslow of the Navy, at 10.30 p.m. on the same day is another good feature. Amos 'n' Andy are still listed for midnight every week-day and are well on the way to breaking new records for the greatest number of radio broadcasts. Chick Webb and his Orchestra are quite regular broadcasters, and his next listing is July 1 at 10 p.m. On the same day Cappy Barra's Swing Harmonicas are listed at 11.35 p.m. on Wednesdays; the Rhythmaires at 11.45 p.m. on the same day.

I notice that Vladimir Brenner has 15 minutes from 11.15 p.m. on July 1, while on the same day at 2 a.m. Rudy Vallee repeats his variety hour. The "Story of Mary Marlin" comes on the air at 5.15 p.m. on Friday, July 2, with "Words and Music" at 6.30 p.m., Barry McKinley at 11.15 p.m., Amos 'n' Andy at midnight, and finally Uncle Ezra's Radio Station at 12.15 a.m.

Dixie Debs are scheduled for 4.45 p.m. on July 3, while the Golden

Lowell Thomas does not need any introduction. Hear him every week-night at 11.45 p.m.

Melodies have 30 minutes from 7.30 p.m. followed by Walter Logan's Musicale at 8 p.m. Week-end Revue at 8.30 p.m., the Top Hatters at 11 p.m., and a Spanish Revue, "El Chico," at midnight.

Ace organist, Archer Gibson, has 15 minutes at 10 p.m. through W2XAF on July 1. Also on this day are Lanny Ross at 2 a.m. and Bing Crosby at 3 a.m. Barry McKinley has another 15 minutes from 11.15 p.m. on July 2, while Saturday Jamboree is listed for 1 a.m. on July 3.

Elinor Harriot takes the part of all the women characters in the Amos 'n' Andy programme. Included in her repertoire are the voices of Mrs. Amos Jones, the little orphan girl, Arbadella and Mrs. Kingfish. Listen to this programme through the N.B.C. Red network.

Dutch Programmes

Eindhoven on 16.88 metres is relaying a programme entitled "Our Musical Voyage" at 3.30 on July 18. There is a special broadcast from this station on 31.28 metres at 2 p.m. on July 19. An experimental programme on 19.71 is

When you hear Saturday Night Party over N.B.C. Red network listen to Donald Dickson, one of the new stars of the radio.

scheduled for 10.30 to 12 on July 20, which includes some super variety.

A popular concert from the Atlanta Hotel, Rotterdam, is scheduled for Saturday, July 24, at 3.30 p.m. The wavelength of this station is 16.88 metres. Another "Happy" programme is scheduled for 2 p.m. to 5 p.m. on July 28 on 19.71 metres. A programme from the Carlton Hotel, Amsterdam, should be worth hearing at 3.30 on July 31. This programme is on 16.88 metres.

Kenny Baker is the timid tenor in Jack Benny's broadcasts. He can be heard every Sunday at midnight over the N.B.C. Red network.

Roy Shields Encore Music is scheduled for 10 p.m. on Sunday through Pittsburgh, while Frank Morgan and guest artists are a special new feature through this station at 11.15 p.m. Gale Page can be heard over the N.B.C. Red network every Monday at 3.45 p.m., when she takes the part of Gloria Marsh in a feature entitled "To-day's Children." Lowell Thomas is another very regular broadcaster and can be heard every week-day night at 11.45 p.m., while another good listing is Jack Dempsey's fights at 2 a.m. on Mondays.

The Kidoodlers are another N.B.C. listing at 8.30 p.m. on Tuesdays, while the King's Men can also be heard at 10.45 p.m. through the same station. Vic and Sade have 30 minutes at 4.30 p.m. on Wednesdays, while another new feature is the "Ink Spots" at 8.45 p.m. A new organist is Bernie Armstrong scheduled for 12.45 a.m. on Wednesday nights.

(Continued on page 444)

Applications of the Tunograph To C.W. Transmitters

The Tunograph, introduced by Messrs. Standard Telephones & Cables, Ltd., can be utilised as a visual monitor in a transmitter. A simple circuit is described in this article.

By W. J. Purvis

ALTHOUGH the Tunograph has been used in commercial receivers for some considerable time, as far as the writer knows, its possibilities in the amateur field have by no means been fully exploited. Whilst it cannot be classed as a piece of laboratory equipment it can, in many ways, take the place of measuring instruments that are usually far beyond the reach of the average amateur; its applications are practically unlimited, ranging from a tone checker to a visual monitor. Apart from the uses outlined below it will be found that there are dozens of interesting experiments that can be performed with the tube and much practical data collected.

Construction

The construction of the tube is simplicity itself, consisting of a .6-volt heater, one anode tied internally to the first deflecting plate and a second deflecting plate; the latter brought out to the grid pin of the normal 4- or 5-pin English base. (The heater is either A.C. or D.C.) In the following examples the two anodes were coupled to their respective points by approximately two feet of ordinary lighting flex, to provide a slight coupling, and the heater should be earthed in common with the transmitter heaters. It is advisable that the tube be mounted in a box constructed of either aluminium or copper as the tube is very sensitive to magnetic influence which will distort the beam.

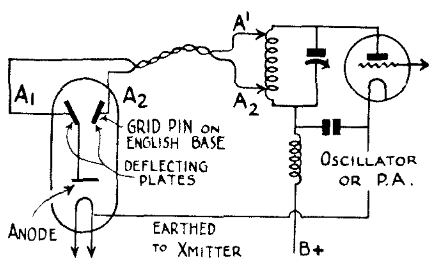
Although the rated filament voltage is .6 volt, this figure can be exceeded as the life of the tube draws short as it is virtually a current operated device and not voltage; the anode and first deflecting plate must be connected so that they are positive with respect to the second plate, when the beam will traverse the fluorescent screen from right to left.

A typical circuit is shown here; when the tube is connected across the tank coil of a crystal oscillator and the circuit is oscillating a beam should be struck in the tube. Too much attention should not be given to the nature of this beam at first as it is only to be used as a basis for comparison. With a T6 or T7 note the beam will have rather rough edges, not too clearly defined and as the tone is increased the edges will tend to sharpen.

As power is increased the beam will widen and assume a deeper contrast, but if the edges lose their clarity it shows that the increase of power is accompanied with a loss of quality. In the circuit leads A1, A2 may be tapped down the coil as desired, but up to voltages of 200 it will most probably be found necessary to utilise the whole of the coil. Above that figure a dropping resistance should be used or the leads tapped well down the coil.

It must be borne in mind that the tube is measuring the R.F. voltages developed and not the D.C. voltage. The D.C. developed across a few turns of a coil are practically nil in comparison with the amount of R.F., consequently care should be taken when first connecting up the instrument.

To prove the virtues of the instrument a T.P.T.G. was constructed and thoroughly tested with the tube to find out exactly what improvements could be made. The increase of output



This miniature cathode-ray tube can be connected very simply to a C.W. transmitter, and, as explained in the text, has numerous uses.

reached the astounding figure of 42 per cent.! It must be noted that the oscillator was constructed in a perfectly normal manner and all possible improvements had been attempted before it was "vetted" with the Tunograph; the secret lies, of course, in the fact that the Tuongraph is far more sensitive to small changes of output than an ordinary measuring instrument and therefore a large number of minor changes can be noted that amount to something worth while when taken collectively.

How It Works

The Tunograph was first connected across the anode milliameter where a considerable amount of R.F. was found; various condensers were tried to tie the anode to ground but without visible increase of efficiency and it was when the H.F. choke was changed that the R.F. across the meter dropped to a small fraction of its former value. Upon examination the choke was found to be damp internally with a consequent drop of impedance at its natural frequency. One could carry things further and carefully wind all chokes to peak exactly where desired, but it is doubtful whether or not the gain would justify the labour. It is worth noting that when the faulty choke was in circuit a fair amount of R.F. could be obtained across a resistance inserted in the positive feed in the power pack; however, as that is rather abnormal it is not worth while checking the power pack unless other cures have failed.

Results

The power of the oscillator was then pushed up to some 250 watts and the antennæ insulators checked. Whilst dry there was no sign of R.F. across them, but when they were damp a beam approximately 1.5 centimetre long appeared, thus indicating a voltage loss of approximately 24 volts. (The beam is sensitive to 16.5 volts per centimetre.) The change in the aerial ammeter reading after the insulators had been damped was not noticeable, therefore it would be worth spending a short time checking the antennæ system.

As the Tunograph draws an anode current to the order of microamps. it was decided to instal it permanently across the output stage anode milliammeter where it serves as a visual monitor. There is normally a steady beam when the drive is there and the key depressed, but as soon as one of the driver stages stops working, or for any reason slips more than a few kc. off resonance, the beam shortens rapidly or completely disappears. Consequently, if the tube is mounted within easy reach of the eye, any slight failure is instantly noted.

Much more could be said concerning the uses of the tube but any constructor will readily find countless ways in which it can be utilised.

A Radio Society in Liverpool

Short-wave readers will be interested to know that a Radio Society is being formed in Liverpool which is open to any bona-fide experimenter in either reception or transmission. Full information can be obtained from the Secretary, C. E. Cunliffe, 11 Wavertree Road, Liverpool, 7.

The Spring Callbook

Supplies of the latest edition of the Radio Amateur Callbook are now available from F. L. Postlethwaite, G5KA, 41 Kinfauns Road, Goodmayes, Ilford.

TELEVISION AND SHORT-WAVE WORLD

Test Equipment for Experimenters

Designing a Multi-range Milliammeter and Voltmeter

The test gear described in this article should be of particular interest to keen amateurs. The material has been supplied by Messrs. A. C. Cossor, Ltd., who have carried out a considerable amount of research on instruments of this kind.

ONE of the most important pieces of equipment for an amateur is a comprehensive meter to measure current flow and voltage. Unfortunately, cost is usually prohibitive and amateurs are inclined to make use of inaccurate milliameters and low-resistance voltmeters which do not give true readings.

Multi-range meters, which are supplied by most of the high-grade instrument manufacturers, are comparatively simple to build, providing a few technical points are borne in mind.

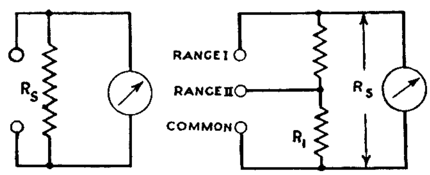


Fig. 1a. Extending the range of a milliammeter by a shunt. 1b. Another method of extending the range of a milliammeter.

All the pieces required are a single range milliammeter, a switch, and a few reels of resistance wire for the shunts and series resistances. It is proposed to deal with the problem of design in general terms rather than to describe one specific instrument. One then has all the data that is necessary to make either a simple or elaborate instrument, which easily can be adapted to fulfil any special need.

Moving-coil Meters

For the measurements usually made in radio work the moving-coil type of instrument is now almost universally used because of its numerous advantages. It is very rugged and mechanically stable, and will stand momentary overloads of several hundred per cent. without damage. Electrically it gives an open and linear scale and consumes little power from the circuit in which it is being used.

*Moreover, by the addition of a suitable metal rectifier, it can be made to read A.C. voltage and current at any audio frequency, while maintaining the same desirable characteristics that it exhibits on D.C.

When used as a milliameter the power consumption is usually specified in terms of the "millivolts drop" across the instrument, normally of the order of 75-100 millivolts. So an ammeter inserted in series with the filament of a battery valve will reduce the voltage applied to the valve by about 0.1 volt, when giving a full deflection, and proportionately if the scale reading is less than maximum.

* See pages 305, 306, May, 1937 issue.

Used as a voltmeter the power consumption is specified as the "ohms per volt," which is the total resistance of the meter on any range divided by the voltage which gives full-scale deflection on that range; in other words the current flowing through the meter on any voltage range is equal to the current rating of the instrument when used as an unshunted milliammeter. For example, a 10-milliamp. meter used on the 100-volt range will have a total resistance of 10,000 ohms; it is therefore 100 ohms/volt and when measuring a hundred volt battery will draw a current of 10 milliamps.

For radio work it is desirable that the ohms per volt should be as high as possible, and a 0-1 m/A or 0-1.5 m/A meter should be chosen wherever possible, thus giving 1,000 ohms/volt and 666 ohms/volt respectively.

An example will best show the reason for this. If the voltage on the anode of a valve is actually 100 volts, and it has in its anode circuit a decoupling resistance of 10,000 ohms, the voltage at the anode read on the 100-volt range of a 1,000 ohm/volt meter will be 95 volts, while the reading on a 100 ohm/volt meter will be 66 volts. If the measurement had been taken on the 1,000-volt range of a 1,000 ohm/volt meter, the reading would be 99.5 volts. It is important, therefore, to consider the load imposed by the meter when measuring potentials in a high resistance circuit.

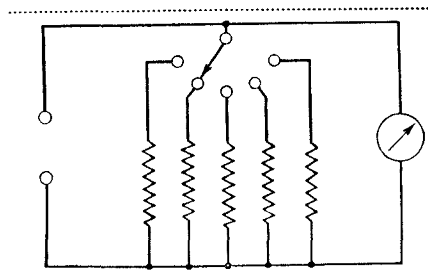


Fig. 2. If a milliammeter is shunted in this way it can cause considerable error.

The extension of the range of a milliammeter is effected in its simplest form by resistances paralleled across the meter terminals as shown in Fig. 1 (a). If n is the ratio by which the range is to be extended, then the value of shunt resistance required is $\frac{R_m}{(n-1)}$ where R_m is the resistance of the meter, since $\frac{1}{n}$th of the total current flows through the meter and the remainder through the shunt. Another method is to shunt the meter by a resistance which increases its range by say two to one, and then to tap down this resistance for the higher ranges as shown in Fig. 1 (b). The value for Rs can then be found as before, while the additional multiplying factors for the tapping points are given by $\frac{R_s}{R_1}$

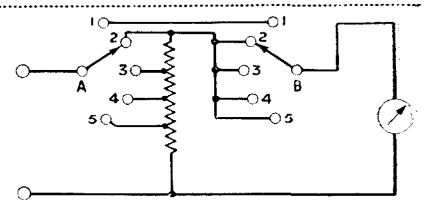


Fig. 3a. This is a more satisfactory means of switching shunts across a milliammeter.

The method of switching the shunts across the meter presents pitfalls for the unwary. It is very important that the resistance of the switch contacts should not be included in the shunt circuit which is across the meter, since on the high-current ranges this resistance will be comparable with the resistance of the shunt itself and would therefore cause considerable error.

Correct Switching

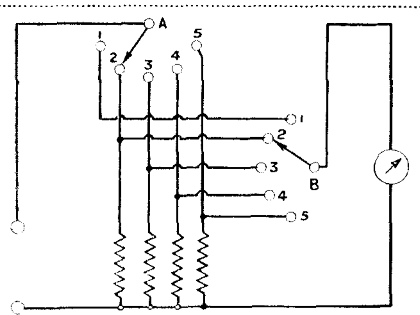
Fig. 2 shows the way the switching should not be done; Fig. 3 (a) and (b) show the correct methods. It will be seen that while switch A carries the whole current, the resistance of its contacts is not included in the meter circuit and can therefore cause no error, while the contact resistance of B is in series with the meter only, and is negligible compared with the resistance of the latter, which is of the order of 100 ohms.

Suitable two-pole switches are easily obtainable having up to twelve positions. Either the special meter switches sold by several instrument manufac-

The Right and Wrong Methods :: Construction

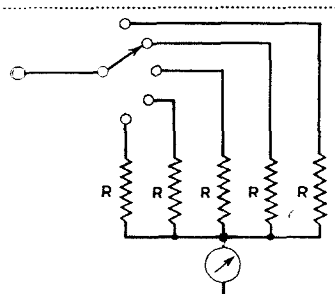
turers or the type of multi-contact switch now being used in all-wave receivers are quite satisfactory. The contacts should be of the "shorting" type, in which the rotor as it is turned does not leave one contact before making on the next. Otherwise there is a danger of the meter being overloaded when changing range while the meter is connected to an external circuit, due to the meter switch (B) making contact before the shunt switch (A).

A multi-range voltmeter is constructed by the addition of resistances in series with the milliammeter. A separate resistance can be used for each range as shown in Fig. 4 (a), or more



3b. Yet another efficient way of shunt switching.

economically a tapped resistance can be used as in Fig. 4 (b). Either arrangement is quite satisfactory. The value of series resistance required (R) is given by $R = \frac{E}{I_m} - R_m$ where E is the full scale voltage required, I_m is the full scale current of the milliammeter and Rm the resistance of the meter. Due to the high values of resistance used on the voltage ranges the contact



4a. A good method of constructing a multi-range voltmeter.

resistance of the switch can be neglected and consequently a single-pole switch only is required. Fig. 5 shows how the switching arrangements of Figs. 3 (b) and 4 (b) may be combined to form a combined voltmeter and milliammeter.

When building a multi-range milliammeter it is a good plan to increase the resistance of the meter, by means of an external series resistance, by about 25 per cent. Then should the instrument at any time be badly damaged, a new one can be fitted without having to readjust the shunts on each range; all that is necessary is to readjust the value of this series resistance, so that the total resistance of the meter circuit remains unchanged.

In order to save time when making tests it is very desirable to make the instrument easily readable on all ranges; each small division on the scale should, therefore, be made to read either 1, 2 or 5 units. So if a 0-1 m/A meter is chosen which has 50 small divisions on its scale, the various ranges should be chosen from the sequence 1-2.5-5-10-25-50-100, etc.

Building the Units

Construction of the various resistances is by no means a difficult matter. Lower values under about 5,000 ohms should be wire wound, and in this category are included all shunt resistances and series resistances for the lower voltage ranges.

Either copper wire can be used or any of the special resistance wires, such as Eureka or Nicrome, the latter having a much higher resistance for a given diameter and length of wire than has copper, so that the shunt would be less bulky. The resistance of Eureka wire is 28 times that of copper, while Nicrome has a resistance of no less than 66 times greater than copper.

Gauge.	Copper.	Ohms/yard. Eureka.	Nicrome.	Max. Current.
20	.0236	.661	1.56	1 amp.
32	.262	7.35	17.3	91 milliamps.
44	2.985	83.7	198.0	8.0 ,,

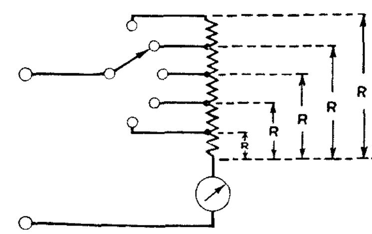
It does not follow, however, that the higher resistance wire is always the best to use, since if the length of wire is too short the shunt becomes difficult to adjust. For example, to shunt a 1 milliampere meter to read 1 amp. a shunt of 0.1-ohm is required. Wire tables show that No. 20 gauge wire will carry this current without overheating, and that the resistance of copper wire of this gauge is 23.6 ohms per 1,000 yards. This means that 12 ft. 8 in. of copper wire would be required.

With the Eureka wire, however, the length required is only 5.4 in. or 2.31 in. for Nicrome, so in this instance Eureka would be the most suitable.

When using Eureka or Nicrome it is important to remember that the shunt can only be checked accurately when cool, for quite a large current can be generated at a soldered joint by the thermo-electric effect between two metals. If this current is allowed to pass through the meter it can give rise to a considerable error.

Three gauges of wire are sufficient to wind resistances to cover most ranges in a meter for radio work, but for convenience, endeavour to use double silk covered wire. Also if the correct gauge of wire to carry the required current is not available it should be remembered that two or three strands of wire can be twisted together so as to carry two or three times the current as the case may be.

For guidance the following details should be noted. A table is given showing the resistance and maximum safe current values of three of the most useful gauges of copper, Eureka and Nicrome wire.

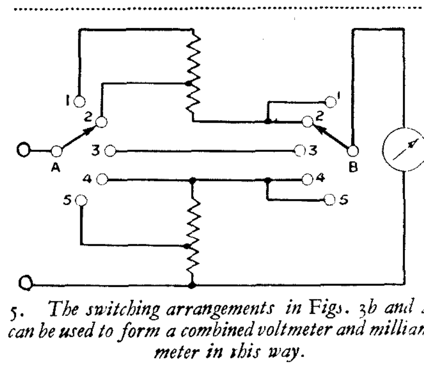


4b. This method is very economical and can be recommended.

Construct the shunts in the following way. First, calculate very approximately the resistance required and select a gauge of wire to carry the required current without overheating—the current density should not be greater than 1,000 amps. per square inch of wire diameter—then find the length of wire required and allow 10 or 15 per cent. extra for adjustments. The shunts should then be wound and adjusted, together with the same length of lead that will finally be used when it is connected to the meter.

A convenient way of winding wire thicker than 32 gauge is to wind them in bundle form. The wire should be wound bunched up on a thin piece of card about an inch in width, and then slipped off and bound up with tape.

(*Continued on page* 444)



5. The switching arrangements in Figs. 3b and 4b can be used to form a combined voltmeter and milliammeter in this way.

The receiver in a black crackle-finish cabinet of this kind assumes a typically commercial appearance.

A Self-contained Three-valve Receiver

By Kenneth Jowers.

How to construct this short-wave receiver is fully dealt with in this concluding article. A full-size blueprint is available, so that even amateurs without any knowledge of how to build a radio set will be able to receive short-wave stations without difficulty.

So as to make quite sure that no readers will have any difficulty building this three-valve receiver, here are some more purely practical notes which should be observed before construction is begun.

Several of the points have come to light after building one or two of these receivers, but if the correct procedure is observed then construction will be straightforward and snag-free.

First, Messrs. A.P.A. who supply all the metal work, have designed a cabinet with crackle-finish that is equal to any commercial article I have ever seen. The use of such a cabinet greatly improves the appearance of the receiver and is preferable to the conventional aluminium finish.

Earth Points

As, however, a black crackle-finish is much thicker than normal enamel, it is not so easy to obtain an automatic earthing point. Before mounting any of the components the cabinet must be scraped in the following places. Both holes for the bandspread condensers must be well cleaned. Also the back of the panel behind the dial light and loudspeaker jack. The aerial terminal has to be carefully insulated and bushes are supplied by the makers for this purpose, but the metal bush supplied with the earth terminal should make contact with a carefully cleaned circle on the back of the panel.

On the under side of the chassis remove the bolt which secures the dividing screen. Clean all around the hole and before replacing the washer and bolt nut fit two or three 4-B.A. soldering tags.

As the spindles of both the volume and tone control are dead there is no need to worry about hole-cleaning with these two components. But the reaction condenser has its rotor connected to earth so that unless the reverse side of the panel is cleaned where contact is made, the rotor must be independently earthed to the common bolt in the centre of the chassis.

Although large holes have been drilled so that the rotors on the band-set condensers do not make contact with the panel, slight inaccuracies in mounting can pull the condenser out of true, so that the spindle short-circuits to the chassis.

Before these two condensers are mounted, solder to the rotor plates a length of wire so that after the condenser has been mounted there is a sufficiently long lead for connection to be made to the proper point. Owing to lack of space it is impossible to make contact with the rotor plates after the condenser has been mounted.

The 6-pin coil holder can be fitted in three positions for the mounting holes are all equidistant. In order that all the connecting wires be of equal length, arrange this coil holder so that when viewed beneath terminals 4 and 6 are nearest to the left-hand corner of the chassis. Similarly with the aerial coil holder. Make quite sure that the normal grid contact is close to the front panel, for this makes for symmetrical wiring.

Transformer Connections

A colour code is used to indicate the primary and secondary on the inter-valve transformer. This component should be mounted so that the primary, wires red and green, face the back of the chassis. For guidance, grey is con-

Components for A SELF-CONTAINED THREE-VALVE RECEIVER

CABINET, PANEL, CHASSIS AND SCREEN.
1—Steel cabinet to specification (A.P.A.).
1—Steel panel to specification (A.P.A.).
1—Steel screen to specification (A.P.A.).
1—Steel chassis to specification (A.P.A.).

CHOKE, LOW FREQUENCY.
1—Type L.F.16S (Bulgin).

COILS.
1—Set type 959 six-pin (Eddystone).
1—Set type 932 four-pin (Eddystone).

CONDENSERS, FIXED.
4—.01-mfd. type tubular (Dubilier).
1—.0003-mfd. type tubular (Dubilier).
3—2-mfd. type BB (Dubilier).

CONDENSERS, VARIABLE.
2—Type 1013 (Eddystone).
2—Type 900/20 (Eddystone).
1—Type 957 (Eddystone).

DIAL.
1—Standard drive (B.T.S.).

DIAL LIGHT.
1—Type D9 (Bulgin).

HOLDERS, COIL.
1—Type 964 (Eddystone).
1—Type 1073 (Eddystone).

HOLDERS, VALVE.
2—4-pin type V5 less terminals (Clix).
1—5-pin type V5 less terminals (Clix).

RESISTANCES, FIXED.
1—1,000-ohm type ½-watt (Erie).
1—2-megohm type ½-watt (Erie).
1—500-ohm type ½-watt (Erie).
1—10,000-ohm type ½-watt (Erie).
1—20,000-ohm type ½-watt (Erie).
1—50,000-ohm type ½-watt (Erie).
1—500-ohm type 1-watt (Erie).

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

SUNDRIES.
2—Coils, screened wire (Bulgin).
2—Anode connectors type 1156 (Belling Lee).
24—6 B.A. counter-sunk bolts with nuts and washers (Bulgin).
3—yards 1 mm. flexible wire (Bulgin).
2—Coils Quick-wyre (Bulgin).
3—Wander plugs type 1276 marked HT+, HT— and HT+1 (Belling Lee).
1—Pair accumulator connectors type 1031 (Belling Lee).
2—Insulated terminals type B marked A. and E. (Belling Lee).
1—Insulated coupling piece type 1009 (Eddystone).
1—Jack type J2 (Bulgin).
1—Plug type P5 (Bulgin).
¼—lb. 22 enamelled wire (Webbs Radio).

TRANSFORMER, LOW FREQUENCY.
1—Type LF37 (Bulgin).

ACCESSORIES.

ACCUMULATOR.
1—Type PYV4 (Oldham).

BATTERY, HIGH TENSION.
1—120-volt type 13480 (Vidor).

HEAD PHONES.
1—Pair super-sensitive (Ericcson).

VALVES.
1—SG220SW (Hivac).
1—D210SW (Hivac).
1—PEN231 (Mazda).

How to Make the Most of this Receiver

nected to earth, yellow to the coupling condenser from the anode circuit, red to the grid of the output pentode, and green to the grid-bias circuit.

Valves

Owing to the grid contacts on the high-frequency and detector valves being brought out to the top cap to reduce inter-electrode and pinch capacity, some slight modification of connections has been made. For example, with the detector, the Hivac D21OSW, the grid pin at the base of the valve is blank, the remaining three pins being connected in the usual way.

With the high-frequency valve, the Hivac SG22OSW, the grid and anode contacts have been interchanged, so that the original bottom grid contact now becomes the anode, while the conventional anode pin is used for the screening grid. Arrange all valve-holders accordingly so that connecting wires are made as short as possible.

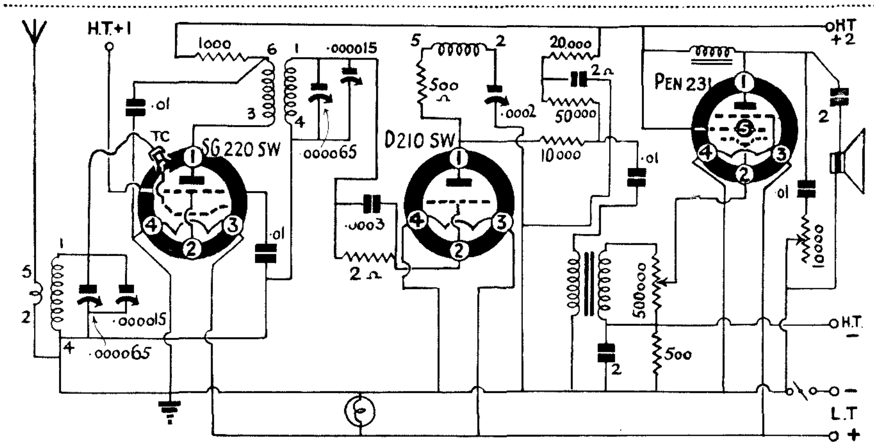
When wiring up it really will pay to have square wiring as shown in the illustration, for it makes the components so much more easy to get at, while any defects that may arise can soon be located when the wiring is in ship-shape order. The bulk of the earthy connections are made to the common earth bolt in the centre of the chassis, but there are one or two exceptions where it would mean making an extremely long negative lead. For example, the earthy side of the filament in the high-frequency stage is taken to the fixing bolt for the valve-holder, a distance of under ¾ in. By using a common earth terminal this wire will have become 3 in. in length.

Earthing the Case

Only one contact need be made to the dial light which goes to positive L.T. for negative L.T. is connected automatically via the panel. One more point in construction. The top edge of the front panel should be cleaned for its entire length with a file, and also the underside of the front of the lid. If this is not done the cabinet will not be strictly at earth potential, causing hand capacity and making the receiver quite difficult to tune.

This receiver is a reliable one, but as it tunes down to an easy 9 metres, the slightest suspicion of a bad earth contact or a loose component or faulty joint, would cause crackling and unreliable reception. So remember all these points.

Some readers have asked for some idea as to the approximate current passed by the various valves and whether there are any alternatives. The main source of query appears to be the output pentode. As this receiver is intended in the main part for portable work it is imperative that the anode current be kept as low as possible. The Pen231 is an entirely new valve of low consumption which gives a reasonably good output. However, for those who require greater volume, a Pen220 can be used without alteration. This will give approximately 200 milliwatts greater output with a current increase at maximum voltage of 2 M/a. If, however, the bias is increased from its present 2.5 volts to 4.2 volts, then the current consumption of the Pen231 and Pen220 will remain equal at 5 M/a for the anode and 1 M/a for the screen.



The numbers on the coils agree with the numbers that can be found on the base of the Eddystone coil holders. These should be strictly followed.

THE 6 WAVEBANDS COVERED

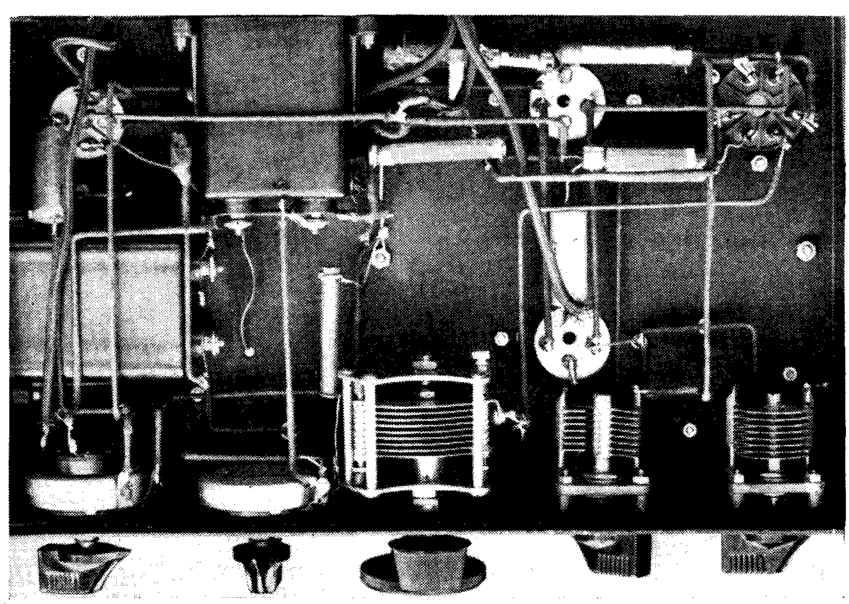
Range 1	coils BB	9-14 metres.
Range 2	coils LB	12-36 metres.
Range 3	coils Y	22-47 metres.
Range 4	coils R	41-94 metres.
Range 5	coils W	76-170 metres.
Range 6	coils P	150-325 metres.

Coils covering 260 metres to 2,000 metres are also available

Full-size Blueprint

The few days the receiver was under test several long-distance stations were picked up and worked via my transmitter on 20 metres. Conditions were bad, but amongst the stations worked were PK1ZZ, Dutch East Indies, VE2DC in Canada, and CO2JG in Cuba.

A blueprint showing point-to-point wiring at full scale is now available price 1s. The number is SW211 and can be obtained from the Blueprint Dept., TELEVISION AND SHORT-WAVE WORLD, Chansitor House, 37/38 Chancery Lane, London, W.C.2.



This illustration of the under-chassis wiring should give constructors a good idea as to the component layout.

The Short-wave Radio World

Automatic Regeneration Control

AN interesting circuit shown in Fig. 1 was found in Radio Welt, and indicates quite a useful line for experimenters to take. One of the main drawbacks to the straight regenerative receiver for short-wave listening is the difficulty experienced in keeping the receiver near to oscillation point. As operators know, the reaction control has to continually be adjusted in sympathy with wavelength covered.

Radio Welt claim to have found a system which eliminates, to a very great extent, this trouble. The arrangement consists of providing an alternative path for the feed-back in addition to the usual circuit through the reaction coil. As shown in the circuit, the resistance R represents a constant impedance shunting the reaction coil L2.

A Variable Control

As frequency is increased the reactance of coil L2 is increased, so that the feed-back current tends to pass more through R than L2. This counteracts the tendency of a reacting circuit to increase in the feed-back current as the frequency is increased. The value of R has to be found experimentally for it

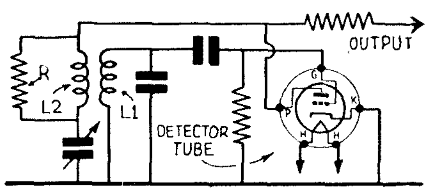


Fig. 1.—Experimenters should find this regeneration circuit of particular interest. It is suitable for use in all types of straight receivers.

varies with coils and valves. It would, of course, be possible to make R variable or pre-set, and at the same time to provide a variable action control.

The effect of compensation can be further increased by connecting a small capacity of about .0001-mfd. in series with the resistance R. This allows control to be increased to such an extent that the reaction actually falls off towards the high-frequency end of the band, a feature which has uses with screened grid detectors.

In order to make the most of this arrangement the aerial should not be allowed to damp the circuit too heavily. So to this end a small capacity condenser should always be connected in series with the feeder.

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

A Resistance-capacity Bridge

Amateurs are always interested in simple test gear. So for that reason we have taken the circuits in Fig. 2 and 3

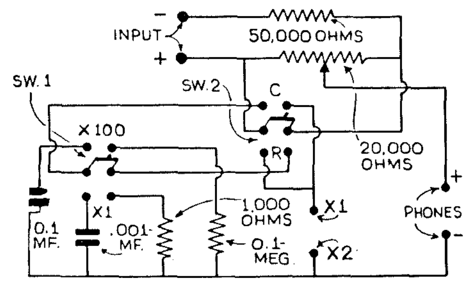


Fig. 2.—The capacity bridge.

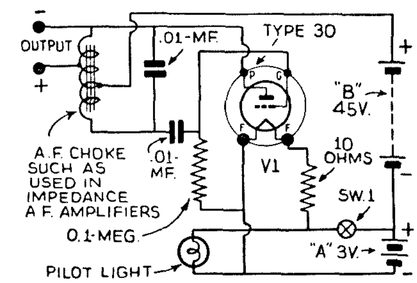


Fig. 3.—The low-frequency oscillator.

from the Belgian publication, Conseil-Radio. It shows a circuit for a capacity bridge and a low-frequency oscillator circuit. Fig. 2, showing the capacity bridge, can be simply built and is very flexible. It has two toggle switches; one for switching over from low-value resistances or condensers to components of higher values, and the other for changing the circuit from a capacity bridge to a resistance measurer.

Home-made Scales

A 20,000-ohms potentiometer callibrated by the constructor against known values of resistance and capacity, serves as the adjustable unit for balancing out the signal from the applied A.C. source. It is suggested that a paper scale be made for this potentiometer so as to increase the accuracy of the readings.

The second unit shown in Fig. 3 is for the low-frequency oscillator, which is used for supplying the necessary alternating current for the bridge. All values are given in the circuit and for those readers who wish to use a British type of valve, a type P220 will take the place of the type 30 specified.

It is suggested that the two units be made in a single screened box with a dividing screen between sections. If this box is fitted with lugs the apparatus can be mounted on a wall ready for immdiate use.

Grid Bias for the Transmitter

The high-current high-voltage bias required for the transmitter places rather an undue load on the average cheap high-tension battery. A system of obtaining bias from the mains has been developed by W8ILN and is shown in Fig. 4. This grid-bias unit is unit is suitable for fulfilling the requirements of amplifiers, modulators and doublers in high-power transmitters, while the system is both simple and economical.

Refer to the circuit and it will be seen that the high-voltage power supply section is perfectly conventional, and similar to that used in most amateur stations. The transformer T1 is fitted with a filament winding to supply the primary of transformer T2, which is a small filament transformer connected backwards, so that the usual primary becomes a secondary, supplying voltage to the half-wave rectifier; in this instance a type 84 with the anodes strapped.

The system provides an isolated and steady source of grid voltage which is not affected by variations in anode current. A further advantage is that the voltage supply to the rectifier is more

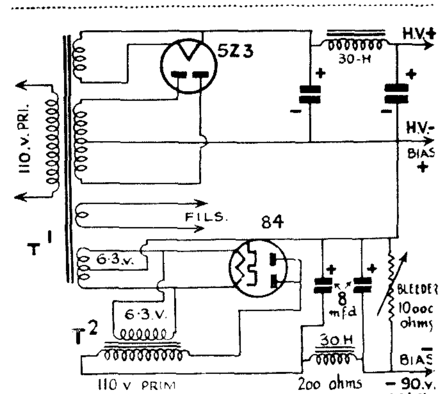


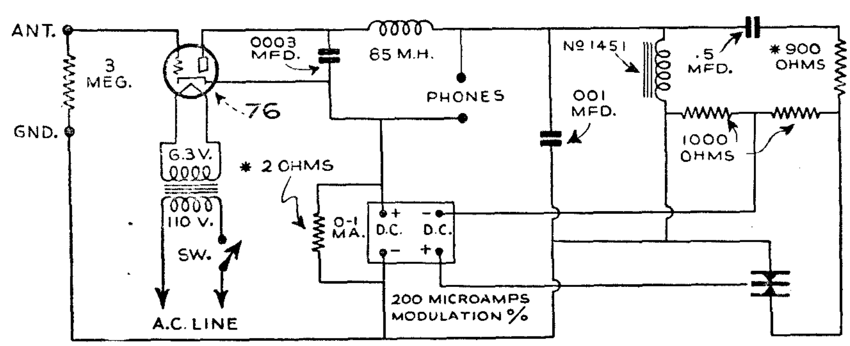
Fig. 4.—An ingenious auto-bias circuit for the transmitter.

nearly the correct value for bias supply than the usual half-wave system connected to one side of the high-voltage power transformer. Such a system gives

A Modulation Meter :: Beam Aerials

usually 400 or 500 volts, needs higher voltage filter condensers, while a percentage of the rectified voltage has to be dissipated before it can be used as a bias potential.

Up to 90 volts with 30 M/a can be obtained from this circuit, while according to the designer, it is absolutely snag-free. The American circuit shown uses a 6.3 volt to 110 volt transformer, but if this is not available a 250 volt unit will be equally satisfactory, but, of course, giving higher output. Amateurs will readily appreciate that the system is open to experiment with all types of transformer.



✱ *CALIBRATION RESISTOR—APPROX. VALUE*

Fig. 5.—Instead of guessing at percentage modulation, use this type of meter which gives accurate direct readings.

An Effective Modulation Meter

It is essential with modern transmitters with high output modulators to have some effective means of measuring the percentage of modulation. At the moment American amateurs are bound to use such equipment, and although the English amateur is not so restricted, it would be a very good idea indeed if all stations were to include a modulation meter, not only for their own benefit, but to prevent over-modulation causing unnecessary interference in the band and increased interference to broadcast listeners.

Checking Percentage

Very often amateurs take for granted that approximately 22 per cent. increase in aerial current is equal to 100 per cent. modulation. This does not always work out, while it is not easy with a similar arrangement accurately to check a lower percentage of modulation.

Under-modulation causes just about as much waste of power as over-modulation causes interference. A phone signal is no more effective than the amount of audio power available for modulation.

It will be appreciated that there is no point in driving the Class C or modulated amplifier beyond the point of providing just under 100 per cent. modulation. The effectiveness of the signal will be the same regardless of carrier power, with a given amount of audio power, providing modulation does not exceed 100 per cent.

The principal units in this meter, shown in Fig. 5, are an 0-1-milliammeter callibrated in 100 divisions, and a 200-microammeter, to indicate modulation percentage. The 0-1 milliammeter is designed as a carrier reference meter, indicating carrier shift. It also serves to adjust the signal input to the proper amount, so the modulation percentage meter will give an accurate reading.

A type 76 triode is used to rectify the power picked up from the transmitter, but a suitable English valve is the AC/HL, or with high power transmitters, an ML4. This rectified current then flows through the cathode and the carrier reference meter, which indicates the strength of the signal for the coupling used.

The Circuit

The percentage of modulation meter is electron coupled to the rectifier valve through a low-pass filter made up of an R.F. choke, a .0003-mfd. and a .001-mfd. condenser. This enables the L.F. component to pass from the rectifier and through the filter, eliminating the R.F. in this component. The L.F. component then passes through a metal rectifier which rectifies the audio wave. For operation of the meter the amount of audio wave is indicated in percentage of modulation as the monitor is adjusted to a radio frequency input on the carrier shift meter. Any audio that is superimposed on the radio frequency will be shown on the 200-microampere unit.

As the monitor is connected it will read positive peaks. To read negative peaks it is necessary to reverse the low-pass filter by changing over the A.C. connections to the metal rectifier.

The unit can be left continuously in circuit and be inductively coupled to the tank coil in the P.A. stage. It is important that the coupling coil is only in the field of the P.A. tank coil, for it must not pick up any R.F. from preceeding stages.

Full constructional details of this modulation meter designed by W2JCY can be found in *Radio News*, page 601.

A 10-metre Rotary Beam

It is not necessary to enlarge on the advantages of beam aerials, particularly when they can be made rotary. W5BZR writing in the June number of *QST* describes a most effective rotary beam aerial with reflector that can easily be constructed by English amateurs. It consists of a half-wave aerial, centre-fed through Q bars with a parabolic reflector spaced a quarter-wave from the aerial. The aerial and reflector are strung on a wooden framework fitted to a short length of piping, acting as a support. According to W5BZR, constructors will need a length of hard wood, 17 ft. long, 2 ins. square, with a hole approximately 11/16th in. in the exact centre. The hole should be suitable for passing a ¾ in. pipe, which is 27 in. long, and acts as a support.

A 600 ohm transmission line should be used to feed the Q section. The line should be terminated on two beehive insulators on the Q section, allowing for a length of slack so that the beam aerial can be rotated.

The beam can be used for transmission as well as receiving, the feeders

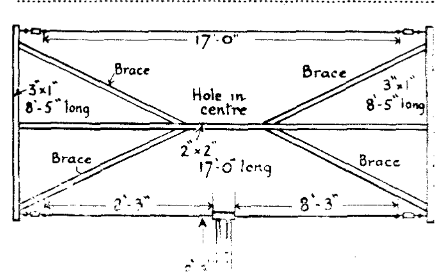


Fig. 6.—Rotary beam aerials only become practicable on 10 metres and under. Full dimensions of this aerial are given in this illustration.

being switched from one to the other by a double-pole double-throw pitch. Compared with a vertical beam of similar electrical construction the horizontal system has been found to give more complete cut-off signals in the reverse direction and in the forward direction shows a definite gain over a half-wave doublet.

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Also **6B5**, High Gain Triode, will give 15 watts per pair in Push-Pull with only 300 anode volts, **5/6** each.

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Super Quality lightweight **HEADPHONES, 3/9** pair.

A Resistance-coupled 3-10-metre Receiver

We are glad to be able to publish some details on the 5-valve ultra-short wave receiver designed by Epoch. It has many unique features

MANY readers will probably have wondered how American listening stations have been able to log so consistently the transmissions on 5 metres of G5BY and G6DH. The answer lies in the receivers used, which are invariably low-noise level, flatly tuned super-het receivers. It has now been established that these two British stations have been heard in at least four American districts, and in all parts of Europe.

Long Distances on the U.H.F.

At the present time the ultra-short wave band is most interesting in view of the fact that the optical range bogey is once and for all completely dead. In the future amateurs can expect 5-metre signals of a DX type, providing they have a suitable receiver.

We have taken particular interest in a set designed by Epoch which seems to us to be one of the most simple and effective receivers for under 10 metre reception available. It is without reservation an ideal receiver for amateur use.

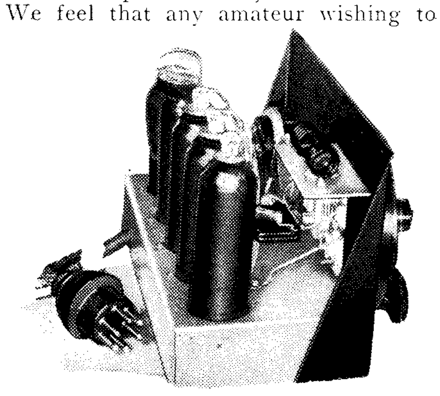
The only variable control other than tuning in the detector circuit is the variable screen voltage control R2, so that providing the inductance Ll is of the correct value the receiver is entirely fool-proof.

Two intermediate-frequency stages are employed, both using 6K7 pentodes in a resistance-capacity circuit. Admittedly the two R.C. stages do not give anything like the gain of two transformer-coupled stages, but the output is adequate, while tuning is sufficiently flat to receive some of the poor wobbling amateur signals, while at the same time troublesome I.F. trimming is obviated.

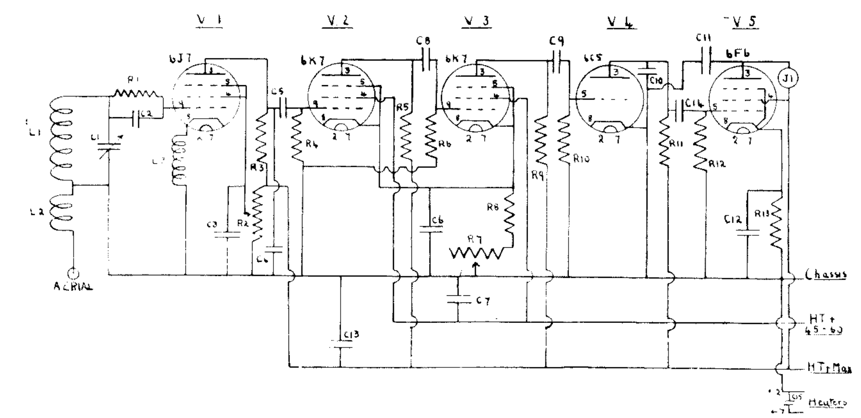
High I.F. Gain

To give some idea of the efficiency of these two stages, the designers have found it necessary to include a cathode-bias control, R7, in order to reduce gain on the stronger signals.

ing has been omitted, which gives a very good idea of its simplicity. Owing to its wide tuning coverage 5 and 10 metre amateur bands, as well as television and police bands, are all covered. We feel that any amateur wishing to experiment seriously on ultra short-waves would be well advised to consider a receiver of this nature.



Some idea as to the compactness of the receiver can be obtained from this illustration. The power pack is a separate part.



Only one tuned circuit is necessary in this receiver owing to the use of ingenious detector-oscillator circuit whereby regeneration is obtained through cathode coil L3—actually an R.F. choke.

First of all the photograph gives a very good idea as to its size, compactness and layout, but it does not convey just how efficient the receiver actually is in performance.

Considering that the receiver uses five valves, the circuit is an unusually simple one. It is shown in this page, so make a particular point of examining the arrangement. A 6J7 pentode is used as a detector oscillator, but without the usual complicated two-gang tuning circuit. L2 is a fixed aerial coupling coil, while Ll is a plug-in coil of which three are supplied, covering from approximately 3 to 10 metres. The whole secret of the circuit lies in the special R.F. choke by which regeneration is obtained, in the cathode of the 6J7.

The fourth valve is a conventional triode which is R.C. coupled to a 6F6 pentode, giving approximately 3 watts of audio output. The receiver can be run from either A.C. mains or H.T. batteries, for the filament supply is 6 volts at 1.5 amps, which can be obtained from the accumulator or mains transformer. If it is intended to use a power pack then 200 volts at 50 M/a are required.

Constructors can obtain a complete kit of parts secure in the knowledge that the receiver is as simple to build as any conventional amplifier. All valve-holders are mounted in a line with their associated condensers and resistances inter-connected by their tag ends. The first impression of the completed receiver is that half of the wir-

British Emergency Stations

PRELIMINARY tests of a National emergency network of British amateur stations is to take place in the near future.

The plan, which originated after the recent floods in the Fen country, will ultimately link up the entire country by radio, using 160-metre and 80-metre amateur transmitting stations.

It is intended to have stations situated at convenient positions and capable of covering an area of 50 miles with 100 per cent. reliability. The scheme was originated by the Scarborough amateur station, G5CU, who asks that any other amateur capable of operating on 160 and 80 metres should get in touch with him for further information.

The scheme has received very favourable consideration for in the event of an air attack or some other cause severing the normal communication channels, these amateur stations would be able to provide some sort of service.

An idea as to the value of an emergency network can be gauged from the fact that during the recent American floods when all normal means of communication were discontinued, many thousands of messages were handled by amateur stations.

In the event of a power supply failure these amateur stations would be able to carry on, for the equipment used will be independent of the normal power supply. When the scheme is complete a full list of emergency stations will be available, and it is hoped that the entire country will be completely covered.

For the Beginner
A Single-valve R.F.P. 30 Transmitter

Beginners, or those without experience of pentode valves, will find this single valve transmitter most useful. It will handle up to 30 watts input with a fair degree of efficiency.

WE have been making a number of experiments with the new medium input pentode manufactured by the 362 Valve Company, and for our experiments have used a crystal controlled single valve circuit.

This experimental apparatus was not originally intended for publication, being built in bread-board hook-up fashion, but as several amateurs have built the transmitter on similar lines with great success, we publish the unit herewith in its original form.

Beginners still appear to like bread-board hook-ups, so for that reason this simple equipment should prove popular. Despite the fact that only one valve is used, sufficient R.F. output is generated to enable us to contact a great number of European stations, both on phone and C.W. during the course of our tests.

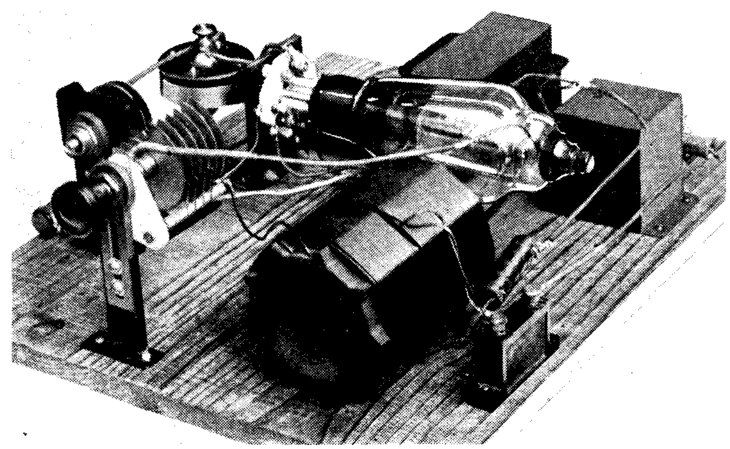
It is one of the cheapest transmitters possible to build and for those who already have a small low-frequency amplifier giving 3 to 4 watts output, the total cost will be little greater than that of an ordinary short-wave receiver.

Pentode valves are not easy to get going unless the experimenter has already had some experience of their peculiarities. However, we can safely claim that the minimum amount of trouble will be experienced with this single-valve unit, which is practically foolproof.

The basic circuit is adaptable for use on all of the amateur bands from 20 to 160 metres, but for the purpose of this description we are going to describe the transmitter on 160 metres, on which band it is at present in use.

First of all, there is no need to cramp the components in order to reduce the length of wiring unless it is going to be used solely on the higher frequencies.

Obtain a reliable crystal in a dust-proof holder that will resonate in the band required. In this case 160 metres.

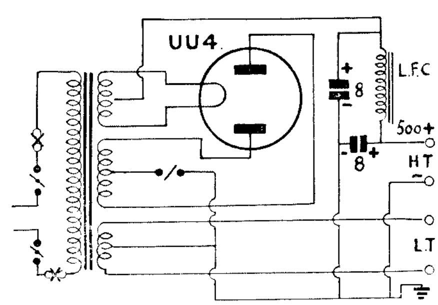


The coil shown in this illustration covers the 160 metre band, but it can be modified for use on 80, 40 or 20 metres.

This is mounted close to the grid terminal of the valve holder, as shown in the illustration. Close to it are the high-frequency choke, grid resistance and by-pass condenser.

The small neutralising condenser, which is pre-set, must be arranged so that the connection to the grid of the pentode is as short as possible.

Providing the anode coil is wound with heavy wire of at least 18 gauge, the coil will be fixed by the wiring so there is no need to mount it off the baseboard on stand-off insulators. While on the topic of coils, for 160 metres approximately 85 turns are required wound solenoid without gap on a 2 ins. former. The coil is centre tapped as shown in the theoretical circuit and is taken indirectly to high-tension positive.



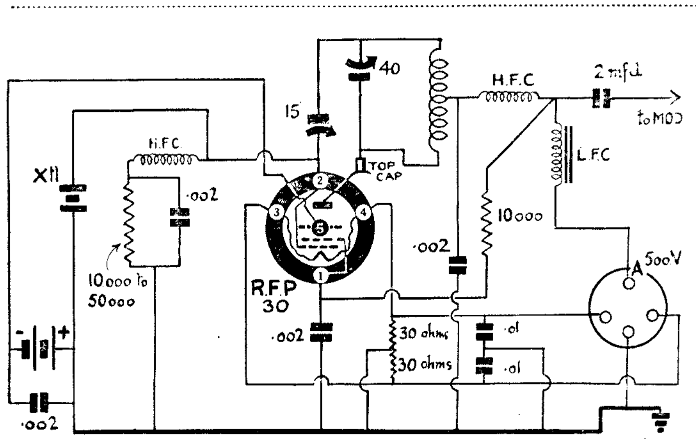
A power pack of this kind is required for the transmitter. It gives a maximum of 500 volts at 120 M/a.

This centre tapping point is by-passed to earth by a .002-mfd. condenser. In series with the feed line to the anode choke is connected a 50 M/a. low-frequency choke for modulation purposes.

In order to obtain correct and maximum modulation it is essential to modulate both screen and the anode simultaneously, so for this reason the screen is taken to H.T. positive through a resistance of 10,000 ohms and tapped on between the high-frequency choke and the low-frequency choke. In addition, the screen is by-passed to earth by a .002-mfd. condenser which is connected directly from the valve pin.

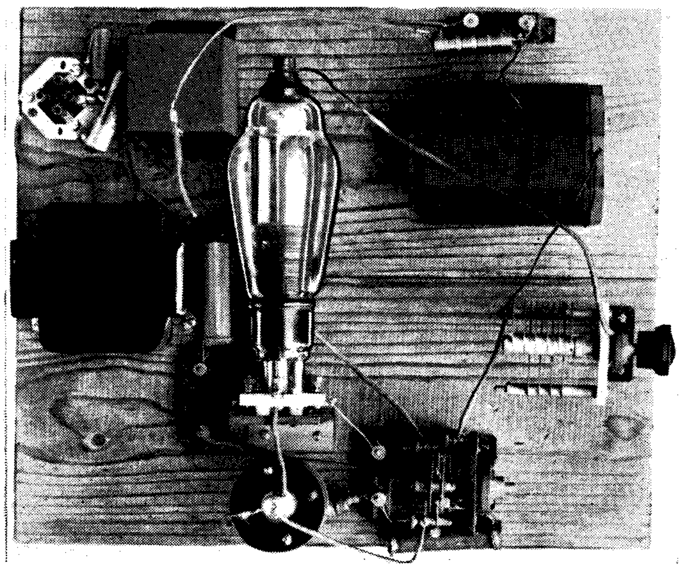
In order to simplify the wiring and to eliminate possible long leads, a 4-pin valve-holder has been mounted in the corner of the chassis and the power supply leads are terminated at this holder.

Filament leads from the valve are twisted together and taken to the normal filament pins on this valve-holder, but have shunting them two .01-mfd.



This simple circuit includes all the components as well as the modulation choke. The voltage applied should be adjusted so that the maximum input is 10 watts.

Neutralising :: Key Connections :: Wattage



If the valve is mounted in this way the bulk of the connecting leads are kept short. The valve socket in the top left corner is for the power supply.

condensers in series and one 60-ohm resistance centre tapped.

The anode lead of the valve is taken directly to the stator plates on the main tuning condenser and to one side of the tuning coil. The opposite end of the tuning coil is then connected to the rotor plates of the tuning condenser and to the remaining side of the neutralising condenser.

At this point it would be well to explain the reason for this neutralising condenser. Even beginners know that since the introduction of the pentode and screen-grid valves, there has not been the need for neutralising in radio receivers. This generally applies to transmitting apparatus, but in this particular case, unless there is slight feed-back from anode to grid, the circuit will refuse to oscillate, owing to the complete screening offered by the third grid.

In order to overcome this the neutralising condenser has been embodied and, although this is left at minimum capacity, the residual capacity of the condenser, about 6-mmfd., is sufficient to allow the circuit to oscillate.

If the transmitter is being used for phone work the third grid, that is the centre pin on the valve-holder, should be taken to earth via a small bias voltage obtainable from a miniature high-tension battery.

Bias to the control grid is obtained in the usual automatic method by means of grid current across a series grid resistor. The value of this resistor varies with the R.F.P.30 from between 10,000 and 50,000 ohms. How to obtain the correct value will be explained later.

It will be noticed from the photograph and circuit that one side of the 2-mfd. condenser in the modulation circuit is left unconnected. This blank terminal is taken to the anode of the modulator valve in the amplifier circuit, but if the transmitter is being used for C.W. then this condenser and its associated choke can be omitted.

In such circumstances it is advisable to connect the key in the suppressor or screened grid circuits, and to include across it the usual type of key click filter. It is advisable to test the transmitter with comparatively low voltage. For example, 250 volts on the anode and 200 volts on the screen will be ample to tell whether or not the apparatus is working satisfactorily, and even at this low voltage the input will be approximately 10 watts.

The wattage can be reduced and efficiency increased if the grid resistor has the correct value of between 10,000 and 50,000 ohms. Whenever possible use the highest value of resistor for it will give greater efficiency, although should there be any tendency for the valve to oscillate very roughly, it is quite permissible to reduce the value of grid resistor, even below the recommended 10,000 ohms.

All fixed condensers must be suitable for handling a voltage twice that to be used. For example, if the power supply is limited to 300 then use condensers having a working voltage of 600.

The power pack is quite straightforward, using a mains transformer giving an output of either 400 or 500 volts as required to a UU4 high vacuum rectifier. Ample smoothing is obtained with only one low-frequency choke and two 8-mfd. electrolytic condensers. The filament supply, in addition to that of 4 volts 2.5 amps. for the rectifier, should be capable of feeding 4 volts 2 amps. to the R.F.P.30.

It is quite in order to use this valve up to 50 watts, such as is done by quite a number of continental amateurs. In such circumstances, the following data and the valve characteristics will probably help.

Maximum anode voltage, 650.
Maximum anode current, 75 M/a.
Maximum anode input, 50 watts.
Maximum anode dissipation, 30 watts.
Maximum anode output, 37 watts.
Suppressor bias for C.W., 100 volts positive.
Suppressor bias phone, 100 volts negative.
Speech input, 2 watts.
Screen voltage, 400.
Screen current, 25 M/a.
Screen resistance, 10,000 ohms.
Grid bias, 25 volts negative.

Generally speaking, this valve is excellent for low power working and for the beginner who is limited to an input of 10 watts, then anode modulation is to be preferred owing to the high modulation level and high efficiency it is possible to obtain.

A suitable modulator is one having as an output valve the PP/5400 or D026 type of valve, while a pair of high slope pentodes in push-pull will also be suitable.

Constructors must obtain a Post Office permit.

Components for
A SINGLE VALVE RFP30 TRANSMITTER.

BASEBOARD.
1—Wooden, 9 in. by 9 in. by ½ in.
CHOKES, HIGH FREQUENCY.
2—Type SW68 (Bulgin).
CHOKE, LOW FREQUENCY.
1—60 M/a. type WWC1 (Sound Sales).
CONDENSERS, FIXED.
4—.002-mfd. type 620 (Dubilier).
2—.01-mfd. type 4421/E (Dubilier).
1—2-mfd. type LEG (Dubilier).
CONDENSERS, VARIABLE.
1—Type TC40 (Raymart).
—Type NC15 (Raymart).
CRYSTAL.
1—Standard type with enclosed holder (Q.C.C.).
DIAL.
1—Type 1027 (Eddystone).
HOLDERS, VALVE.
1—5-pin type 950 (Eddystone).
1—4-pin type 949 (Eddystone).
RESISTANCES, FIXED.
2—10,000-ohm 3 watt (Erie).
2—30 ohm humdingers (Claude Lyons).
SUNDRIES.
1—Aluminium screen to specification.
1—Coil Quickwyre (Bulgin).
VALVE.
1—Pentode type RFP30 (362).

POWER SUPPLY.

CHASSIS.
1—Metal, 6 in. by 6 in. by 3 in. (A.P.A.).
CHOKE, LOW FREQUENCY.
1—60 M/a. type WWC1 (Sound Sales).
CONDENSERS, FIXED.
2—8-mfd. type 0281 (Dubilier).
HOLDER, VALVE.
1—8-pin octal (Clix).
SWITCHES.
1—S80T (Bulgin).
1—S116 (Bulgin).
TRANSFORMER.
1—To specification giving 400-0-400 volts, 5 volts C.T., 4 volts C.T. (Eves Radio).
VALVE.
1—Type UU4 (Eves Radio).

"A Miniature Cathode-Ray Oscilloscope,"

(*Continued from page* 427)

from switch are kept as short and as clear as possible. Also, the leads to the deflector plates must be taken through the correct holes in the screen. This is checked by the position of the amplifier, and it will be found that the correct plate is the one nearest the anode condenser.

Testing

Withdraw the tube from its socket, and switching on, test the polarity of the H.T. voltages and the continuity of the tube resistance chain. It will be noted that a fixed resistance of 1,000 ohms has been specified in series with the grid potentiometer.

This prevents the grid being reduced to the potential of the cathode when the bias control is full off, but in some tubes it may be necessary to alter this value if too much bias is obtained.

If everything is correct, the tube should show a line on the screen when put in its holder and allowed to heat up. The line is, of course, due to the 150-volt supply to the plate, and on pulling out the left-hand plug a spot should appear. The tube should be focused on the line, however, and the controls should permit the complete cutting off of the beam and the passing right through the focus point. If the latter is not the case, the value of R1 and R2 may have to be altered.

A further article will describe one or two attachments for the unit, and will show how a linear time base can be used with the tube.

"Designing a Multi-range Milliammeter and Voltmeter"

(*Continued from page* 432).

For finer wires it is better to wind on a slotted former which can be built up with round wood washers and bakelite end cheeks bolted together. Alternately transformer bobbins from miniature type transformers are quite suitable.

For higher voltage ranges wire-wound resistances become bulky, and unless extreme accuracy is required, ordinary precision type resistances are quite satisfactory. It is most unlikely, however, that these resistances will be of the correct value for the purpose required, so that the best system is to obtain a resistance slightly lower than the value required, and to make up the difference with a home-constructed resistance. Alternately resistors of the solid type—not those in which the resistance compound is deposited on an insulator—can be filed down until the resistance is increased to the correct value.

The adjustment of the resistances to correct value is most easily done by checking the instrument against another of approximately the same range. But should this not be possible, the instrument can be calibrated over a limited portion of its original calibration.

For calibrating a milliammeter a low-voltage accumulator will give a steady source of supply and can be used. The meter should be connected in series with a suitable variable resistance across the accumulator and the resistance adjusted to give full scale deflection. The shunt is then adjusted until the meter reads half, or quarter, of its original deflection.

This procedure can be repeated to calibrate a further range, but it is not good practice to do this more than twice because the accuracy with which the meter can be set to a quarter of its full scale reading is not very high, so that the final accuracy of reading is reduced on each succeeding range.

Where another milliammeter is available for calibration purposes the two should be connected in parallel and the shunt adjusted until the two meters read the same.

A voltmeter can be calibrated in the same way. The best source of voltage for checking a voltmeter is either an H.T. accumulator or *new* H.T. battery. If a voltmeter is not available with a range as high as that as the meter to be calibrated the next best thing is to measure the voltage of the battery between its various tapping points and adjust the meter to read the total voltage. Such tests, however, call for an H.T. battery with a very low internal resistance.

"Programmes for Short-wave Listeners"

(*Continued from page* 429).

The O'Neills radiate every week-day and have been doing so now for several years. They come on the air at 4 p.m. through Pittsburgh. Make a point of hearing this programme. A special feature for July 2 is Irene Rich at 1 a.m., for this will be the first of a series of special programmes featuring film stars. Donald Dickson made his debut over the air in Saturday Night Party, and is now a regular artiste in this programme, which also includes James Melton, Tom Howard, George Shelton, and the New Yorkers Chorus, and is radiated Saturday nights at 1 a.m. over the N.B.C. Red network. When you listen each evening to Lowell Thomas keep a mental picture in front of you of the man who is the foremost newsreeler in America. His photograph is given on an earlier page.

Short-wave Stations and Wavelengths

Wave-length	Fre-quency	Call sign	Location
30.21	9930	CSW	Lisbon
30.43	9860	EAQ	Madrid
30.78	9740	COCQ	Havana
31	9680	CT1AA	Lisbon
31.01	9675	DZA	Zeesen
31.02	9670	TI4NRH	Heredia
31.06	9660	LRX	Buenos Aires
31.09	9650	YDB	Soerabaja
31.09	9650	DGU	Nauen
31.1	9645	HH3W	Port-au-Prince
31.1	9645	YNLF	Managua
31.13	9635	2RO	Rome
31.14	9630	HJ2ABD	Bucaramanga
31.19	9620	HJ1ABP	Cartagena
31.22	9615	HP5J	Panama City
31.25	9600	RAN	Moscow
31.25	9600	CB960	Santiago
31.27	9595	HBL	Geneva
31.28	9590	PCJ	Huizen
31.28	9590	VK2ME	Sydney
31.28	9590	W3XAU	Philadelphia
31.32	9580	GSC	Daventry
31.32	9580	VK3LR	Melbourne
31.34	9575	HJ2ABC	Cucuta
31.35	9570	W1XK	Springfield
31.36	9565	VUB	Bombay
31.38	9560	DJA	Berlin
31.38	9555	HJ1ABB	Barranquilla
31.45	9540	DJN	Berlin
31.45	9540	VPD2	Suva
31.46	9535	JZI	Tokio
31.48	9530	W2XAF	Schenectady
31.49	9525	ZBW3	Hongkong
31.49	9525	LKJ1	Jeloy
31.51	9520	HJ4ABH	Armenia
31.55	9510	VK3ME	Melbourne
31.55	9510	GSB	Daventry
31.57	9505	HJ1ABE	Cartagena
31.58	9500	HJU	Buenaventura
31.58	9500	PRF5	Rio de Janeiro
31.61	9490	XEFT	Vera Cruz
31.65	9480	EAH	Madrid
31.68	9470	XEDQ	Galiseo
31.78	9440	FZF6	Fort de France
31.78	9440	HC2RA	Guayaquil
31.8	9428	COCH	Havana
32.09	9350	HS8PJ	Bangkok
32.15	9330	OAX4J	Lima
32.26	9300	YNGU	Managua
32.88	9125	HAT4	Budapest
33.5	8950	HCJB	Quito
34.92	8580	YNLG	Managua
35.71	8400	HC2CW	Guayaquil
36.63	8190	XEME	Merida
37.33	8036	CNR	Rabat
37.62	7975	HC2TC	Quito
38.07	7880	JYR	Chiba-Ken
38.2	7854	HC2JSB	Guayaquil
38.47	7799	HBP	Geneva
39.74	7550	TI8WS	Punta Arenas
39.95	7510	JVP	Nazaki
40.65	7380	XECR	Mexico City
41.55	7220	HKE	Bogota
41.67	7200	YNAM	Managua
42.25	7100	FO8AA	Papeete
42.88	6996	PZH	Paramirabo
43	6976	HCETC	Quito
44.12	6800	HI7P	Ciudad Trujillo
44.26	6770	HIH	San Pedro de Macoris
44.44	6750	JVT	Tokio
44.58	6730	HI3C	La Romana
44.64	6720	PMH	Bandoeng
44.71	6710	TIEP	San Jose
45.28	6625	PRADO	Riobamba
45.74	6558	HI4D	Ciudad Trujillo
45.8	6550	XBC	Vera Cruz
47.76	6282	COHB	Sancti Spiritus
48	6243	HIN	Ciudad Trujillo
48.12	6235	HRD	La Ceiba
48.15	6230	YV1RG	Valera
48.15	6230	OAX4G	Lima
48.47	6190	HI8Q	Trujillo
48.5	6185	HI1A	Santiago
48.61	6171	XEXA	Mexico City
48.7	6160	VUZ	Colombo
48.78	6150	CSL	Lisbon
48.78	6150	CJRO	Winnipeg
48.8	6147	ZEB	Bulawayo
48.8	6147	COKG	Santiago
48.86	6140	W8XK	Pittsburgh
48.9	6135	HJ1ABB	Barranquilla
48.9	6135	HI5N	Santiago
48.94	6130	TGXA	Gautemala City
48.94	6130	COCD	Havana
48.94	6130	ZGE	Kuala Lumpur
48.94	6130	VE9HX	Halifax, N.S.
48.94	6130	LKL	Jeloy
48.98	6125		Montevideo

The Power Amplifier Stage Circuits to Use

By *Kenneth Jowers*

This is the third in a series of articles explaining in a simple way how the various stages work in an amateur transmitter.

IN the May and June issues I gave a broad outline as to the uses of the crystal oscillator and frequency doubler or frequency multiplying stages in a transmitter. It will be appreciated that these two stages in themselves constitute a complete transmitter of small output, but it is to boost this small output that a third stage is generally required.

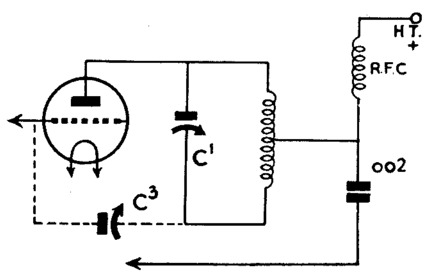


Fig. 1. Simplest radio frequency amplifier using a neutralised triode valve.

This third stage amplifies a signal at a given frequency. By that I mean that the frequency of the signal in the anode is the same as the frequency of the signal applied to the grid, but owing to the amplification, of much greater strength. For that reason the sub-amplifier or power amplifier can be taken as the same circuit with the exception that when the amplifier is used directly to feed the aerial there is usually a larger valve and higher voltage.

Triode Amplifiers

The simplest amplifier circuit is shown in Fig. 1 where a triode valve is used with an untuned grid circuit and parallel tuned anode circuit. The input from the driver stage feeds into the grid of the triode through a buffer condenser, while the output from the coil in the anode circuit is coupled to an aerial.

Condenser C1 has a fairly low capacity calling for a coil of a relatively high inductance. It is important that this ratio be observed in all amplifier circuits of this kind in order to keep the efficiency at a high level. For guidance the following condenser capacities are good average values for different frequencies.

160 metres	.00015-mfd.
80 metres	.000075-mfd.
40 metres	.00004-mfd.
20 metres	.00002-mfd.

The various other factors govern this capacity, but if these values are used beginners will find results very satisfactory. When the transmitter is being used on several wavebands employ a condenser suitable for the lowest wavelength. Condenser C3 has a low capacity of between 5 and 20 mmfd., and is used to neutralise the anode grid capacity of the power amplifier valve. Naturally this capacity will vary according to the design of the valve. Certain valves, such as the ultra-high frequency type with grid and anodes widely spaced, require only the very smallest neutralising capacity.

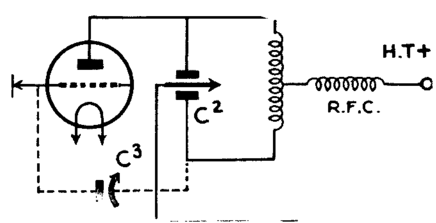


Fig. 2. A neutralised triode with split stator condenser omitting the fixed by-pass condenser.

With this circuit a by-pass condenser from the centre tap of the coil to a negative point is essential, an average value being .002-mfd. This value, if maximum efficiency is to be obtained, should decrease with a corresponding decrease of capacity in C1, but cannot always be arranged with this type of circuit.

A Balanced Circuit

In Fig. 2 a variation of the original circuit is shown.. In this hook-up the anode tuning condenser is of the split stator type having two sets of fixed plates and one common set of variable plates. The rotor plates are taken to earth and provide the correct anode by-pass capacity. As the capacity of C2 is decreased with tuning, so the capacity of the by-pass condenser is reduced in sympathy with it. For this reason the circuit in Fig. 2 is to be preferred to the arrangement shown in Fig. 1.

Pentodes

Amateurs being limited to low power

(Continued on page 447)

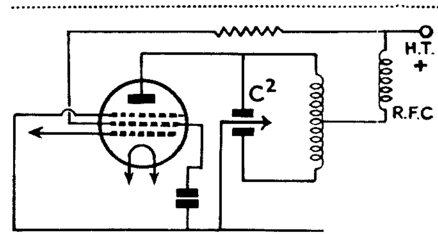


Fig. 3. Greater radio frequency output for a given input can be obtained from a pentode valve in this type of circuit.

(*Continued from page* 446)

transmitters are always keen to obtain a circuit that will give the maximum radio frequency output for the lowest possible D.C. wattage input. Assuming that the input is limited to 10 watts it will be readily appreciated that a valve having an efficiency of 50 per cent. will not be so good as one having an efficiency of 75 per cent., for the latter valve would provide 25 per cent. more radio frequency in the anode circuit. For this reason amateurs are inclined to favour the multi-electrode type of valve which with its high slope provides greater R.F. in the anode circuit for a given input than does the average triode.

The circuit for such a valve is very similar to that of the triode with the exception that owing to the inclusion of a third grid so reducing the inter-electrode capacity to a negligible quantity there is no need to use any external neutralising condenser.

This in itself is a great feature for it reduces still further the number of controls the operator has to use. A typical

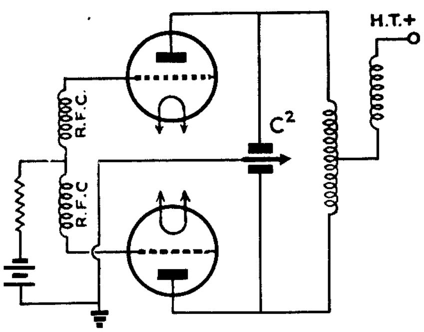


Fig. 4. Push-pull triodes are very popular, giving high output with good stability.

circuit for a pentode power amplifier is shown in Fig. 3. This circuit is suitable for all types of multi-electrode valve having three grids. This, of course, excludes valves of the 6L6 tetrode type.

Valves of the 59 type having an indirectly heated cathode can also be used in this manner for the cathode is merely tied directly to earth. The resistance in series with the screen has a value sufficient to reduce the maximum applied high-tension voltage to the value recommended by the makers. For example, an R.F.P.30 with 500 volts on the anode would need a resistance of approximately 10,000 ohms in series with the high-tension voltage and the screen. Notice also that the screen is by-passed to earth by a fixed capacity, an average value for which is .002-mfd.

With a pentode valve the same remarks apply as regards the capacity of C2 and the tapped anode coil.

Push-pull

Where wattage input is not so important push-pull triodes can be used to advantage. Generally speaking, the output from two triodes is approximately 80 per cent. greater than that of one triode when used in a balanced circuit such as illustrated in Fig. 4. Notice in this circuit that there is no tuned grid input, balance being obtained by two identical chokes connected across the grid, the centre point being taken to earth via a resistance and bias battery

Semi-auto Bias

These latter two components are not always essential for if the resistance is omitted bias can be obtained from the battery, while if the battery is omitted grid current flow across the resistance will be sufficient in many cases to bias the valve to the normal part of its curve.

However, a combination of grid leak and battery bias is most satisfactory for it reduces the size of the bias battery, and in case of accidents, there is always a certain amount of bias applied automatically across the grid resistance.

The only disadvantage of push-pull circuits is the minor one that in the majority of instances a double coupling

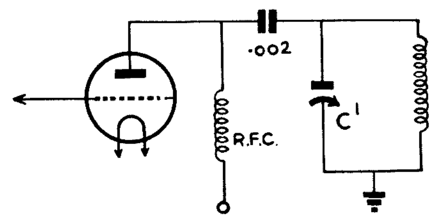


Fig. 5. This circuit prevents D.C. voltage being applied to the condenser, C1. The efficiency depends on the R.F. choke.

coil is needed accurately to couple the anode coil to the feeders. However, this can be overcome by the use of a link coupled aerial circuit or untuned lines using a single turn pick-up coil.

When high voltage is used there is a great danger of flash-over across condenser C1 or C2, and this can be overcome reasonably well by the use of a parallel tuned circuit. For example, Fig. 5 is a variation on Fig. 1. Instead of the high-tension voltage being applied to the centre point of the coil it is tapped on through a radio frequency choke.

For all intents and purposes the anode circuit is isolated as far as D.C. is concerned from the anode, so that only R.F. is in the condenser C1 and coil circuit. In one respect this is a big advantage, but in another a slight disadvantage. The efficiency of the circuit depends to a very great extent on the characteristics of the radio frequency choke, and if this is not of the correct impedance the gain in the stage decreases very quickly.

This method of supplying high-tension voltage to the anode is known as the parallel feed system because the radio frequency and D.C. anode circuits are in parallel. Providing the R.F. choke has a sufficiently high impedance at the operating frequency, so that none of the radio frequency generated by the valve can leak back to the power supply, the circuit has much to recommend it.

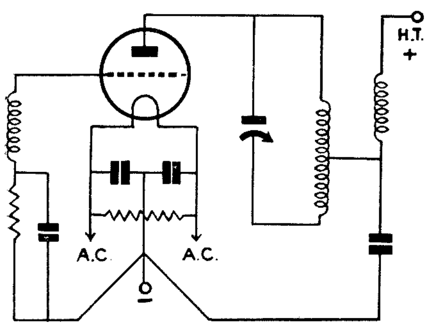


Fig. 6. To obtain smooth operation take all earth returns to a common point as shown.

A point to remember is that an inefficient R.F. choke will enable the current in the anode circuit to filter away across the choke instead of being fed into the coil circuit through the .002-mfd. condenser.

Earth Contacts

For stable operation there is one important point that must always be remembered in the design of a power amplifier, in fact, any stage of a transmitter.

Refer to Fig. 6 and notice how it has been drawn. All of the earthy returns are taken to a common point, which is the mid tap in the filament circuit. When building this stage connect the two condensers and two resistances directly across the filament terminals on the valveholder. Arrange for a common earthing point close to the centre of the two resistors and take to this the earthy sides of all condensers, etc.

Assuming there are several stages in the transmitter, this system should be employed throughout, and when the equipment has been completed the various earth points can be connected together by a heavy gauge wire. The system of anode neutralising is very well-known amongst amateurs, but for some reason or other, the grid neutralised circuit, as shown in Fig. 7 is rarely employed. This type of circuit closely follows the anode neutralising arrangement except that the neutralising voltage is obtained from an input coil and then fed to the anode of the valve. It will be noticed that with this type of circuit the grid coupling condenser is large in comparison with the valve and neutralising condenser capacities in the average circuit. But this, to my way of thinking, is rather an advantage, for it allows for more simple and accurate adjustment.

The main advantage of grid neutralising is that the whole of the anode coil in a single ended circuit is in use, so giving higher efficiency. With anode neutralising only half the anode coil is in use, so greatly reducing the impedance.

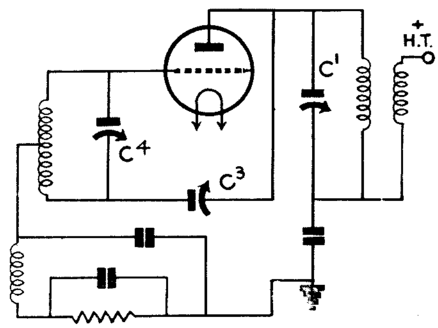


Fig. 7. A grid neutralised circuit of this kind is very effective, while the tuned circuit permits of easy coupling to the previous stage.

International Dx'ers Alliance

The London Chapter of this Society are now publishing a journal entitled "Ama-Touring." which is supplied free to members. No less than five contests are now open to British members, for which trophies and awards are being donated. The London Chapter, which has three transmitting members, holds informal monthly meetings at Chequers Restaurant, Essex Street, Strand, details of which can be obtained from the Secretary, Mr. J. Knight (2AA), 6 Fleetwood Street, N.16.

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Tottenham Short-Wave Club

This Society has recently celebrated its second anniversary and the newly-elected president is Mr. Batt.

The Society has arranged a programme of field days during the summer, while there will be a special 5-metre section. Club meetings are well attended and lectures with practical experiments in transmittings are being given by the secretary. Full information as to fees and meetings, etc., can be obtained from the Hon. Sec., 57 Pembury Road, Bruce Grove, Tottenham, N.17.

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