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Television and SHORT-WAVE WORLD

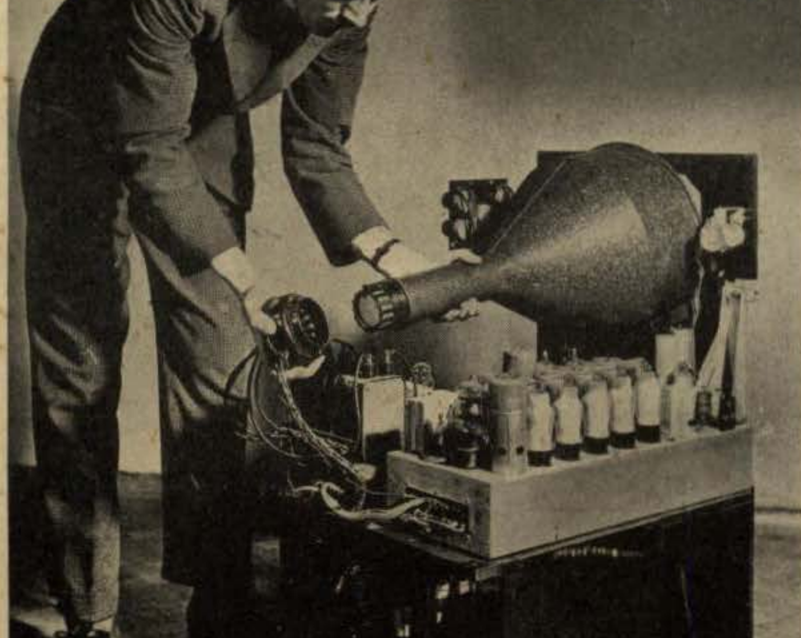
1/- MONTHLY

JANUARY, 1937

No. 107. Vol. x.

G.E.C. ENGINEER EXPLAINS

ELECTRONIC TELEVISION IN SIMPLE LANGUAGE



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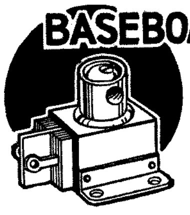

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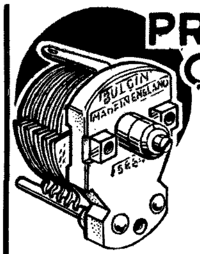

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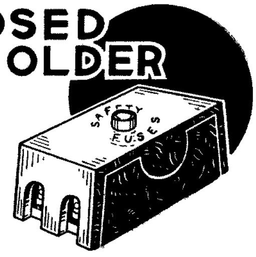

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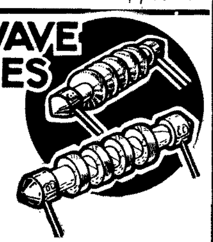

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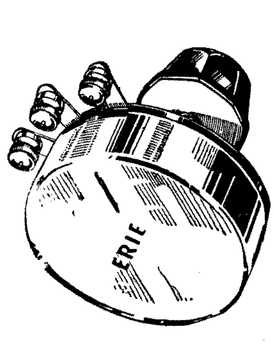

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No. 107 VOL. X JANUARY, 1937.

TELEVISION and SHORT-WAVE WORLD

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COMMENT OF THE MONTH

Things To Come

WILL our readers mark and keep for reference the information given below. Possibly it may not be necessary to turn back to it for two or three years, but on the other hand, before the year is out it may prove to have been intelligent and informed anticipation.

The success of purely electrical systems of television in which there are no mechanical moving parts has been such during the past year as to put the mechanical systems somewhat into the shade. There are many keen students and followers of the art who regret this, particularly, of course, the home constructor who feels, rightly or wrongly, that the mechanical system offers him better opportunities than the electrical systems.

There are many people who think that mechanical systems are impracticable for high-definition television, in other words that they have had their day. But is a new day coming?

From a long conversation which we had this month with a manufacturer who is thoroughly conversant with American practice, and has toured Europe with the single object of discovering the present state of the television art, we must conclude that there are some big surprises in store, and that both on the Continent and in the United States, and very probably here in Great Britain, there are mechanical and mechanical-cum-electrical systems which one day will put up a fierce competition with the purely electrical systems. Our informant, whose experience is such that his opinions are worthy of all consideration, tells us that there is on the way a mechanical system lacking nothing in definition and capable of giving a wall-size picture with, to use his own words, "light to spare."

We repeat, mark this statement and file it for reference.

The First Home-constructed Receiver

WE direct our readers' attention to the extract from a letter regarding our Guaranteed Cathode-ray Receiver which appears on page 30 of this issue. If proof were needed of the ability of the amateur to construct his own receiver here it is; the results that our correspondent is getting he describes as "nothing short of a miracle" and his remarks amply bear out our guarantee that, properly constructed, the receiver will give a very fine performance.

In this issue a complete summary of the construction details is given which will be helpful if considered in conjunction with the detailed information already published. This section concludes the constructional details, but in future issues these will be amplified and information given on adjustment, operation and any modifications which may, in the course of the rigorous testing which the receiver is undergoing, seem desirable.

ELECTRONIC TELEVISION

A PRACTICAL OUTLINE IN SIMPLE TERMS

By G. C. MARRIS,* B.Sc., M.I.E.E, of the G.E.C. Research Dept.

We wish to acknowledge our indebtness to Mr. Marris in allowing us to publish this paper read before The Joint Meeting of the Association of Supervising Engineers and The Institution of Engineers in Charge and also to the G.E.C. for placing at our disposal the illustrations accompanying the article and the many courtesies received from them during its preparation for publication.

THE first problem that arises in television is that of "scanning"; in other words, that of translating the picture, point by point, into an electrical current.

The retina of the human eye contains some millions

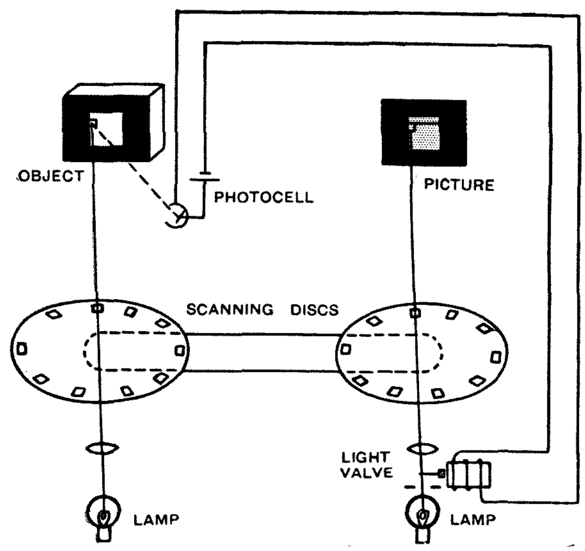


Fig. 1.—*Diagram showing the elementary principle of television.*

of minute cones, each sensitive to light, and capable of conveying a separate message by a separate nerve to the brain. To give the brain a picture it is not necessary to excite all those cones simultaneously. If that were the case television would be impossible, because one could not provide millions of wires or radio links between the picture to be sent and the eye of the distant beholder, each wire responsible for one bit of the picture.

Fortunately each cone has, so to speak, a memory lasting about 1/25 of a second, and practical television consists in using that period of 1/25 of a second for the transmitter to look separately at minute areas of the picture one after another in regular sequence. As it does so it sends an electrical impulse by wire or radio to the receiver. This electric current impulse is converted, according to its strength, into a spot of light in the receiver which has auxiliary apparatus, called a "time base," to direct the spot to the same part of the picture that the transmitter is viewing at the moment.

In a 1/25 second or less, then, the whole picture is transmitted once and the process starts again. By this time the scene may have changed, but it is known from the experience of the cinema, which works with pictures changed every 1/24 second, that a satisfactory appearance of continuity is thus obtained. With this elementary explanation of the general idea we can proceed to discuss the technical devices used and problems that have been overcome.

The Photo-electric Cell

In the chain of apparatus, starting with transmission, the first item is the device for converting the brightness of each picture point into an electric current proportional to the brightness. For this purpose the now well known photoelectric cell is used. It is extremely simple. It consists of an evacuated glass bulb with an internal mirror-like deposit of potassium or caesium metal, and a metal plate supported in the centre. It is connected to a high-tension battery, and when light falls on the internal surface electrons are released from it; in other words a current flows and the magnitude of the current depends on the brightness of the light. It may be called, therefore, one element of an electric eye.

Its limitation for television purposes is in its lack of sensitivity; a candle, a foot away from a normal cell might give 1/3 of a microampere (10 microamperes per lumen). Recent developments of so-called secon-

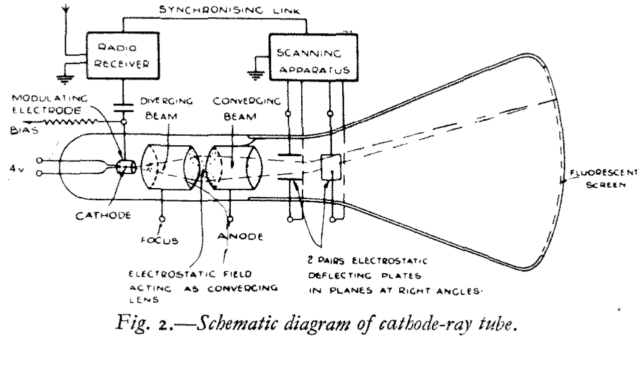


Fig. 2.—*Schematic diagram of cathode-ray tube.*

**The photograph on the cover of this issue is not that of Mr. Marris, the author of this article.*

THE ELEMENTS OF TELEVISION

dary-emission photocells have been very useful for television, giving a sensitivity 4 or 5 times greater.

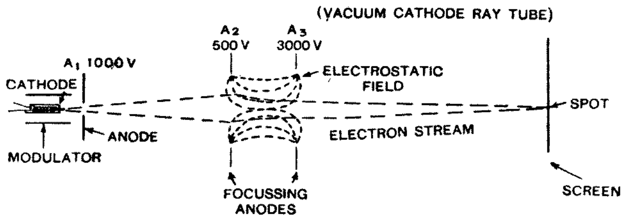


Fig. 3.—Electrostatic focusing of the cathode-ray beam.

Principle of Scanning

Scanning is simple in theory but difficult in practice.

If we look at a page of print and move the point of a pencil under the lines, we are making the pencil move in the way characteristic of television scanning; a steady movement along a line, a quick snap back and slightly downwards to the next line, and so on to the end of the page. We shall have scanned the page in so many lines, say 40, in perhaps one minute; that is, in television language, 40-line definition, and one picture frame per minute.

The muscles that move the pencil correspond to the television time base, or synchronised disc, and it will be clear that there are two motions at right angles, one along the lines, pretty fast, one down the page much slower with a quick flick back after each line, and after each page. It will be clear also that if we make the motion of the pencil a little slantwise, the downwards movement can be a steady one tilll the end of the page is reached. This is what is done.

We must have, therefore, a high-frequency scan and a low-frequency scan. For 400 lines the first is 10,000 periods per second, and the low-frequency 50 periods for interlaced pictures. The speed of travel of the spot across a receiver screen is therefore about 2 miles a second in the horizontal direction.

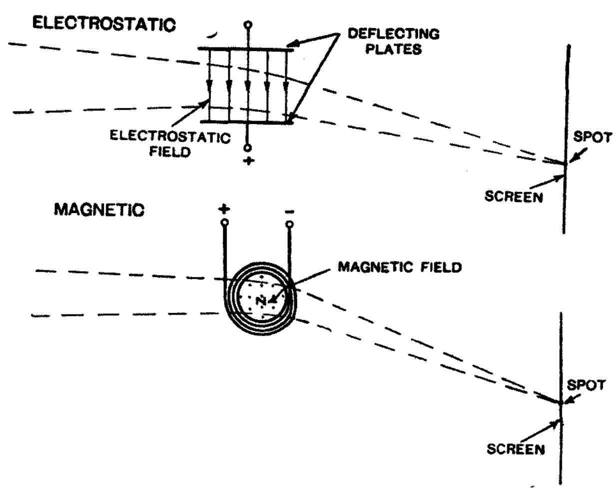


Fig. 4.—Diagrams showing the two methods of deflecting the cathode beam.

Scanning by Disc

Scanning by disc, invented by Nipkow in 1884, has been developed rapidly in the last three or four years, and is one practicable way of obtaining high definition.

A disc much larger than the picture is rotated in front of it. The disc has small holes near the edge arranged in a spiral. The picture is illuminated as brightly as possible, and the light reflected from it passes through the hole which is opposite the picture at the moment, and is focused on the photo-cell.

The holes are so arranged that the first passes across the top line of the picture, looking at a strip as wide as the diameter of the hole, and when it gets to the end the second hole starts again at the beginning, but being on a spiral is one line lower. For 400-line definition the hole must be so small that its diameter is 1/400 of the length of the picture, and there must be 400 holes coming into place one below the other in turn. The photo-cell then looks only at a spot 1/160,000 of the picture area at once, and sends a current corresponding to the brightness of that spot. Since the picture must be viewed 25 times a second to preserve continuity we may have 25 × 160,000 current variations per second, or a vision frequency as it is called of 2 million complete periods per second, if every spot of the picture is of different brightness from the next.

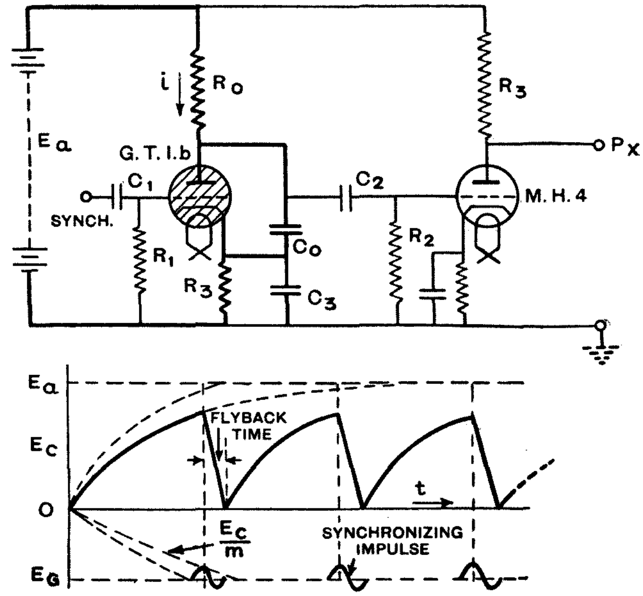


Fig. 5.—Time base circuit using gas-filled relay and (below) the saw-toothed wave form produced.

Fig. 1 show in symbolic fashion a complete television system. The current from the photo-cell varies the light from a lamp which shines on to a screen. Between lamp and screen is a similar disc of spiral holes, which rotates in exact synchronism with the first, so that a point of the screen is illuminated corresponding to that which the photo-cell is viewing at the moment. Such a method of reception was the basis of the old Baird 30-line television. It is impracticable for high definition because of the mechanical difficulties of the

HOW THE CATHODE-RAY TUBE WORKS

discs, and the impossibility of getting enough controlled light.

Before describing the cathode-ray tube, which is the modern alternative, it must be explained that if such a disc is used to transmit from a film, the holes need not be in a spiral, as the downward scan can be provided by steadily winding the film through.

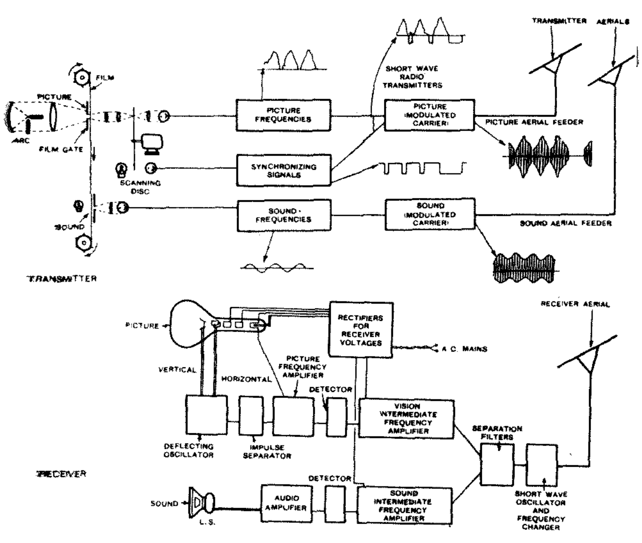


Fig. 6.—Schematic diagram of complete television system employing a disc transmitter and cathode-ray tube receiver.

The Cathode-ray Tube

Everyone is aware that there exist phosphorescent or luminescent materials such as are used on luminous watch faces. Certain of these substances, notably zinc sulphide and calcium silicate, give an intense light if they are bombarded by high-speed electrons. In the cathode-ray tube a beam or ray of these electrons is produced and caused to bombard luminescent powder deposited on the large, almost flat, end of a big flask shape bulb which is highly evacuated. (See Fig. 2.)

In order to use this idea for television it is necessary for the electron beam to be small enough to make on the screen a bright point, of size corresponding to the size of the point seen by the transmitting photo-cell.

Then the electrons must be accelerated with sufficient voltage to get the spot bright, and their number must be varied according to whether any spot of the picture is dark or bright. Finally the beam must be made to strike in turn every portion of the screen. That is, the beam must be made to scan the picture, line by line, as did the pencil in our illustration of the perusal of a printed page; and then start all over again, in exact synchronism with the transmitter disc or other scanning device.

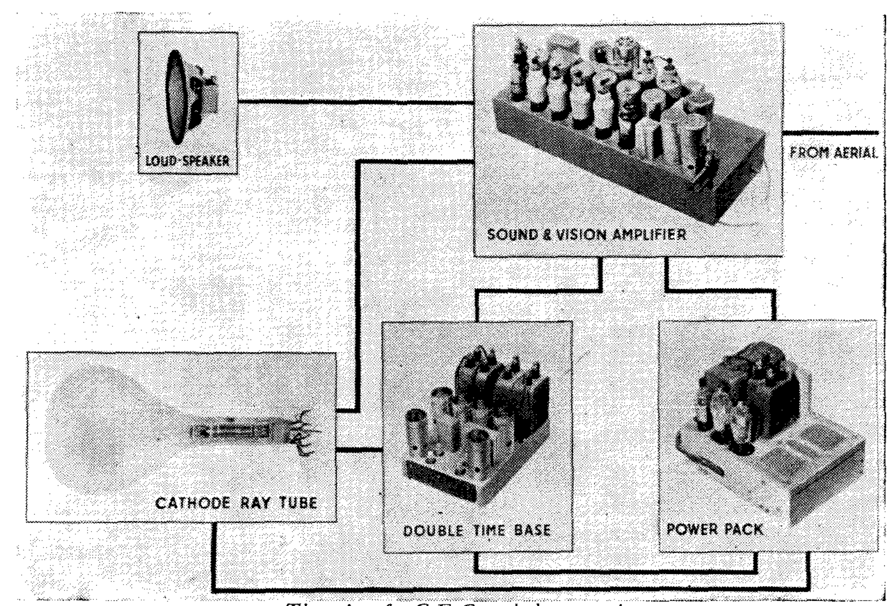
In modern cathode-ray tubes for television, these requirements have been achieved with a great deal of success.

The electrons are produced from a hot cathode just as in a valve. The number that escape towards the screen is controlled by a thin metal cylinder, known, in honour of its inventor, as the Wehnelt cylinder, which acts like the grid of a valve. To it is applied the photo-cell current, after being radiated by the transmitter, and amplified and detected by the receiver, so that, in effect, the photo-cell current, by varying the output of electrons, varies the brightness of the received spot at that moment.

The electrons are accelerated in the direction of the screen by the cylinders and disc A1, A2, A3 (Fig. 3), to which positive voltages of, say, 1,000, 500 and 3,000 are applied, and the arrangement is such that a narrow beam is formed.

After leaving this portion of the electrode system, often called the gun, the beam passes between metal deflector plates. Since electrons are charges of electricity they can be deflected by sufficient voltages, say, about 1,000 volts, applied to these metal plates. One pair of plates deflects the beam rapidly sideways for the high-frequency scan, the other more slowly for the low-frequency scan. The deflecting voltages are produced by the receiver time bases described below. The ray can also be deflected by a magnetic field (see Fig. 4).

One type of electron optical lens is formed by two discs with a hole in the middle through which the beam passes. The first disc is at 500 volts and the second 3,000 volts. There will be an electrostatic field between them as indicated by the dotted lines, the direction of force on an electron being from left to right. An electron, on reaching the field near the 500-volt plate, will receive an impulse causing it to move inwards along the line of force; when it gets near the 3,000-volt plate



The units of a G.E.C. cathode-ray receiver.

HOW THE CATHODE BEAM IS DEFLECTED

it will receive an equal outward impulse, but by this time it will have speeded up enormously, say, from 7,000 to 18,000 miles per second, therefore the outward impulse has little effect, and it proceeds on its new path converging to form a spot with all the others. An alternative method of focusing is by a magnetic field.

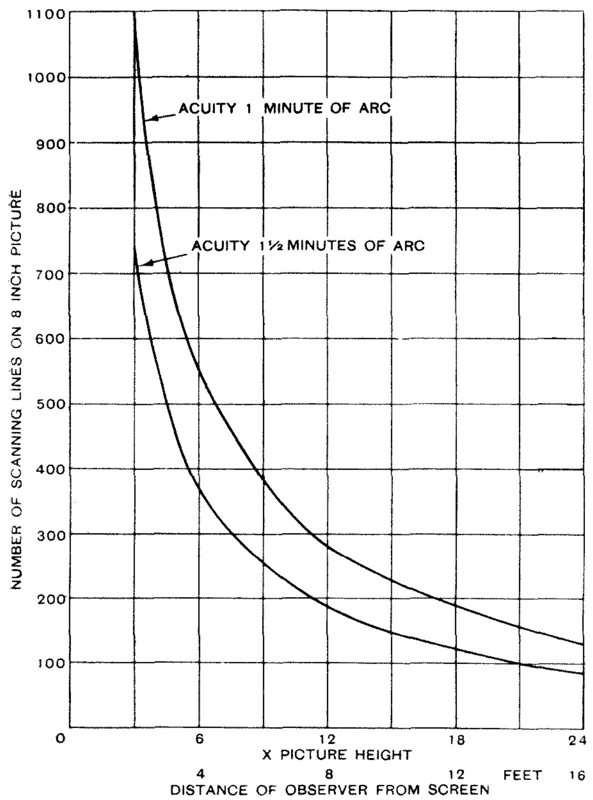


Fig. 7.—Curves showing suitable viewing distances.

Here we touch on the real problems of cathode-ray tube research. To form the perfect spot, to deflect it without changing its shape or brightness, and to change its brightness without changing its position or size, and to make it still brighter—these are the difficulties.

The fine pictures obtained are a proof of the success with which the work has so far been attended, but there is still more to be done, and in the G.E.C. Research Departments we have many devices for accurately tracing electrostatic fields, and for obtaining cross sections of a spot. The diagram of the perfect spot should be a rectangle.

Brightness

The cathode-ray tube has already *exceeded the brightness of the average home cinema screen.* This is in part due to research carried out on the fluorescent powders of which the screen is composed. The zinc and calcium salts used require to be of extreme purity with exceedingly minute, but accurate, amounts, perhaps 1/1,000 of one per cent. of added metallic salts.

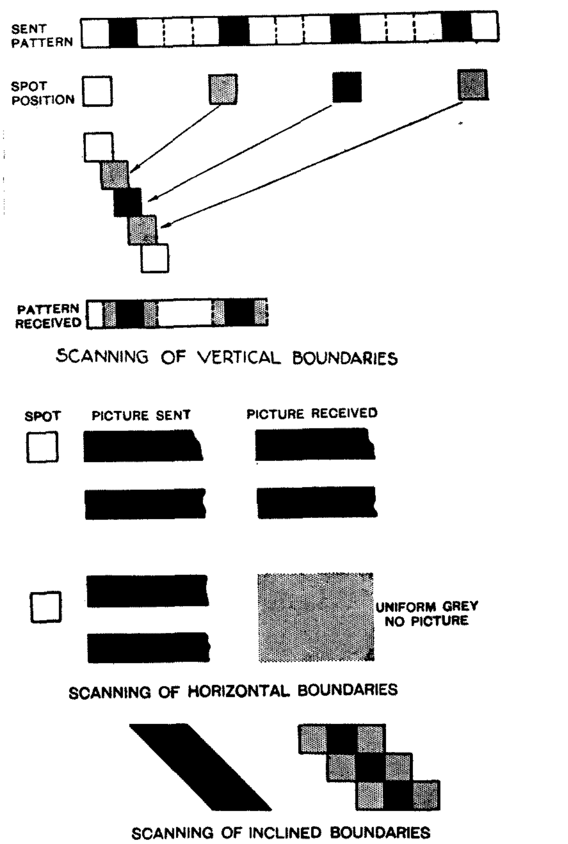
Time Base Circuits

Many of the electrical circuits of a television receiver can be called elaborations of broadcast receiver technique, but the time base circuits are something quite new.

The method is to generate a voltage rising as linearly as possible to its maximum in the necessary time, e.g., to 1,000 volts in 1/10,000 of a second for the horizontal scan of a typical electrostatically deflected tube. Thus the beam is steadily deflected from beginning to end of a line. Some trigger device must be incorporated so that at the end of this period the voltage returns to zero, as nearly as possible instantaneously. This discharge period is called the " fly-back."

The rising voltage is readily obtained by charging a condenser through a resistance, and the type of relay known as a gas-discharge relay is a very convenient trigger. It resembles in some ways a triode valve, but instead of a vacuum is filled with vapour such as mercury, or for television purposes, where high frequencies are involved, with rare gases such as neon and argon.

With these two devices the necessary linear rise and rapid flyback can be obtained, giving the so-called " saw-tooth " wave form, repeating itself with extreme accuracy of timing. But the wave must be not only kept at the same frequency as the transmitter;



Figs. 8. and 9.—Diagrams showing the cause of aperture distortion.

THE COMPLETE TELEVISION SYSTEM

it must be actually in step so that each line and picture begins in the right place. To achieve this a locking, or synchronising signal is sent out by the transmitter at the end of each line and each picture. This signal is received, and filtered out by the receiver and keeps the time base in step. Here again the gas-filled relay proves its value, for it can be run a little too slow, and the synchronising signal applied to its grid will hurry it up each time.

Exactly how these operations are accomplished will be apparent by following the diagram (Fig. 5).

The shaded valve is a gas-filled relay which is in parallel to the condenser Co. The battery or other H.T. supply Ea charges Co through resistance Ro, values of Co and Ro being chosen so that, for example, in the low-frequency time base, it takes about 1/25 second for Co to reach full volts. The charging current, flowing also through the bias resistance, R3 and smoothed by condenser C3 keeps at a steady negative

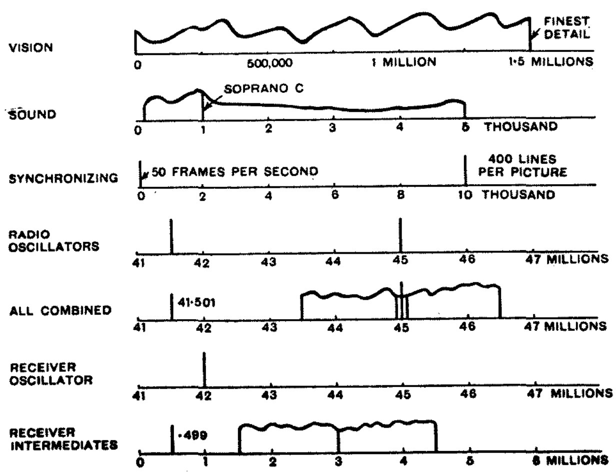


Fig. 10.—Frequencies in cycles per second used in complete sound and vision system.

potential Eg which prevents any current flowing between anode and cathode of the relay. However, the characteristics of the relay are such that when the condenser, and therefore the anode voltage, rise beyond a certain value approximately to Ea, the grid then loses control, there is an immediate and rapid flash over in the relay, the condenser is discharged, and the process starts again giving the wave form shown in the lower diagram. By making the time of charge a little too slow, as shown in the thick line, we can control the time base from the synchronising signal. This is applied to the grid of the relay and just gives the grid the extra voltage which, combined with the anode volts, is sufficient to cause the discharge.

Complete Television System

The pieces of apparatus described above, together with some devices adapted from normal broadcast receiver design, form a complete television system which is shown in outline by Fig. 6.

On the extreme left is the high efficiency carbon arc throwing an image of the film on to the holes in the rotating disc, through which the picture scanning photo-cell looks. The film also passes through the usual sound head of the talking film type where another photo-cell picks up the recorded sound.

The disc also contains a number of slits, one for each hole, which give a flash of light into the third, or synchronising photo-cell, after each line of the picture has been scanned.

Following first, the picture signal received from the picture photo-cell, it is seen to be amplified, joined by the synchronising signal, and then passed to the radio transmitter where it is converted to a 7-metre wave and radiated.

The vision signal is shown roughly triangular, plotted as amplitude vertically against time. This represents a line, white at the middle, shading to black at the edges. The synchronising signal is opposite in sign, and when added to the picture gives the wave form in modulator and radio transmitter as sketched. This is known as synchronisation by a signal " blacker than black." That is to say, the receiving screen is adjusted to be black when the picture signal is at a value above zero. The syncronising signal causes the aerial and radiated energy to drop further, actually to zero, or below the level required to give black. The longer synchronising signal is sent at the end of each picture from another photo-cell, or from 50-cycle mains.

Sound passes through amplifier and transmitter as in normal broadcast on a wavelength 41.5 megacycles.

Sound and vision each on its own wavelength are radiated and picked up by the single aerial connected to the receiver.

In the latter they may be first amplified together, and then conducted to an oscillator, more informatively called a frequency changer, which performs the combined function of separating sound and vision, and at the same time converting them to the comparatively low frequencies of three million (vision) and ½ million (sound) which are more easily handled and amplified.

Radio engineers will, of course, rcognise this as a simplified statement of the superheterodyne method. It is a method of frequency conversion by beating one frequency against another, and using resonant circuits to separate out the resulting beat frequency which, by a suitable choice of one of the oscillators, can be made appropriate to one's purpose.

Sound then pursues its course to the loud speaker as in a broadcast receiver.

The vision and synchronising signals after amplification again have their frequency changed downwards, so that they are now the original frequencies arising as the product of the picture detail multiplied by scanning speed. This process is known as demodulation, or detection, and is quite simple. After this a simple device consisting of an overloaded valve and resonant circuit separates the synchronising signals from the picture, and leads them to the time base, which they lock in step. The picture signal carries on to the con-

AN EXPLANATION OF APERTURE DISTORTION

trolling electrode on the cathode-ray tube and varies the brightness of the ray.

We must now consider what size of spot or number of lines ought to be used in television, in order to obtain a good picture. If the standard full-size cinema picture is taken as an ideal, we have to admit at once that it is beyond present-day television technique, and television engineers can only do their best.

However, it is very important to decide what this ideal quality is in terms of electrical and optical quantities, in order to see how nearly it can be achieved.

Vision

The most sensitive spot in the retina of the eye is nearly a millimetre in diameter and it consists mainly of little cones, each of which seems able to communicate with the brain and which are 0.003 mm. apart.

As the focal length of the eye is 22 mm. we easily calculate that the eye cannot separate objects less than 28 seconds of angle apart. Actually about one minute of angle seems nearer the fact for a normal eye. This means distinguishing 0.15 mm. at 50 cms.-distance or, say, 1/25 in. at a distance of 10 ft.

The best lenses used in taking cinema pictures will not give a perfect image of a point; the smallest element of image they can produce is about 30 thousandths of a millimetre. On standard cine film of 22 mm. by 16 mm., this corresponds to about 800-line definition, or on home cine size, about 400 line.

Fig. 7 shows the distance which an observer must be from a screen in order that each line of the number per inch indicated may subtend the given angle at his eye. For curve B, for example, if the picture is 240-line and 6 inch height, it must be viewed from 7 ft.

We are, therefore, then 14 times the height of the picture away. The situation of the best seats in picture houses suggest that this is rather too far away; a ratio of between 4:1 and 8:1 is said to be best. It is easy to be too theoretical on this subject and only practical tests can really decide.

If we go closer we shall notice the absence of detail that we are accustomed to, and it is no good enlarging the picture for we shall merely have to go further away. On the other hand, if we take the 400-line case, we can go as close at 4 ft., and then shall be more nearly in the position of a good seat.

Perfect 400-line definition would seem, therefore, a very reasonable figure, and, as mentioned above, corresponds to the definition of first-class home cinema equipment.

Limitations of Scanning

Everyone is aware that modern illustrations are reproduced in books by printing a series of dots of smaller or greater size, but always the same distance apart.

In a similar way the detail given by a television system is limited by the distance apart, and number of the holes in the disc, which determines the number of lines in the picture. In the Inconoscope, it is the size of the electron beam that is the limitation.

Figs. 8 and 9 show how this limit operates to produce what is called " aperture distortion," and is visible as loss of detail. In the first it is seen that the sharp vertical boundaries between black and white in the original picture become a little grey, because the spot is large enough to overlap the boundary, and at the critical instant of change-over is at half brightness.

If a horizontal boundary happens to occur which the spot overlaps, it disappears completely and a diagonal becomes ragged.

The smaller the spot, and therefore the greater the number of lines, the less is the amount of this particular distortion. In fact, the spot cannot distinguish in a picture any detail smaller than itself.

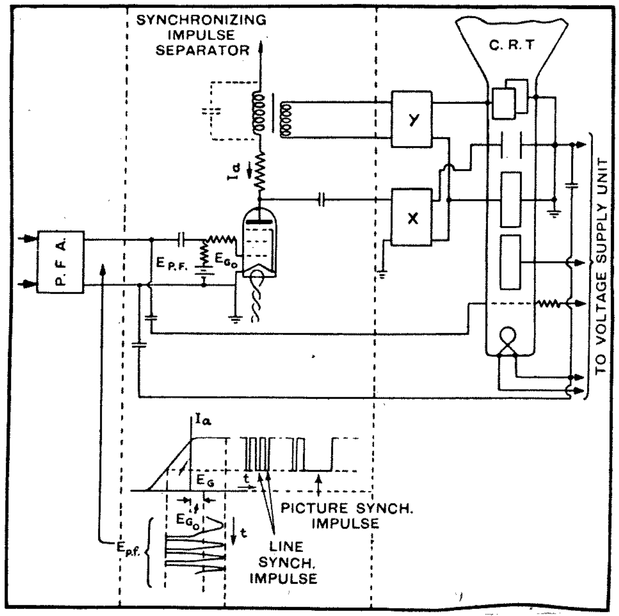


Fig. 11.—Suitable arrangements for separating the synchronising impulses from the picture signals in a receiver.

Frequency Range

We are now in a position to consider the electrical frequencies necessary in a television system. Let us choose the 400 lines; we require also to be able to distinguish 400 equal changes of detail, in the extreme case from full black to full white, along the line. The spot size must be 1/400 of a line, and since the pair " black-white " constitute a full cycle of the electric current, we find that with such a spot size the current will be changing at a maximum rate of

$$F = \frac{(\text{lines})\ 2 \text{ by pictures per sec. by width of picture}}{\text{height of picture by } 2.}$$

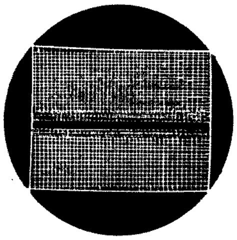
Taking the 400-line case it is seen that a maximum frequency of 2,700,000 cycles per second is required for a picture $\frac{1}{3}$ wider than it is high. This frequency is more than twice as high as that of medium wave broadcast, and explains why much higher frequencies, ultra short wavelengths, must be used as the carrier wave of a television transmitter.

If, in the interests of economy in receiver and transmitter construction, or to leave more space " on the air," we restrict the maximum frequency, we reduce

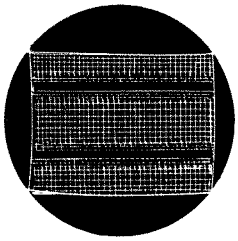
(*Continued on page 36*)

FAULTS IN TELEVISION RECEIVERS

AND THEIR CAUSES

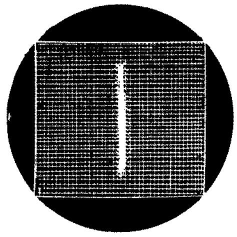


50 FRAMES

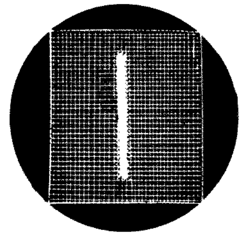


25 FRAMES

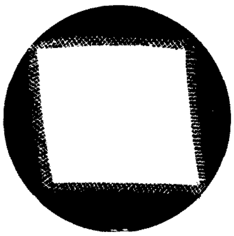
Hum on grid of Cathode-ray tube. Faulty smoothing or decoupling, or pickup in leads.



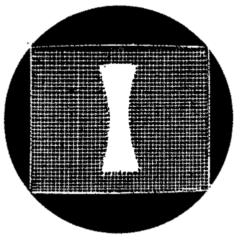
Line scan disconnected. Faulty valves or disconnection in scan unit.



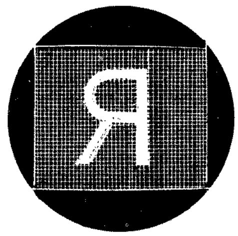
Frame scan disconnected. Faulty valves or disconnection in scan unit.



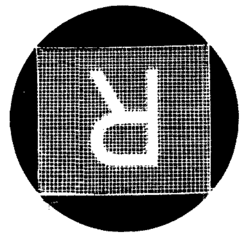
Hum on deflector coils. Faulty smoothing.



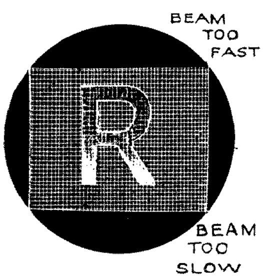
Line scan deflector coils in opposition. Reverse one coil.

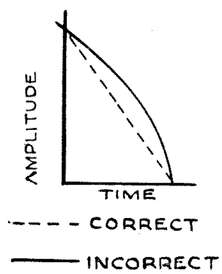


Line scan connected left for right. Reverse leads of deflector coils.

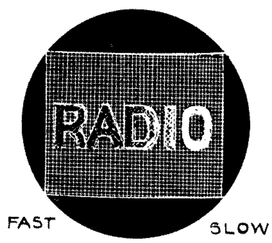


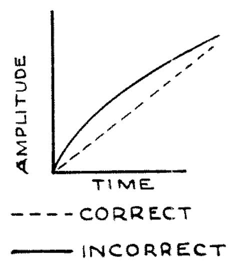
Frame scan reversed. Reverse leads.



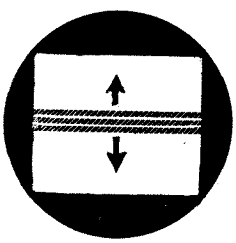


Non-linear pulse in frame scan. Probably saw tooth generator pulse.



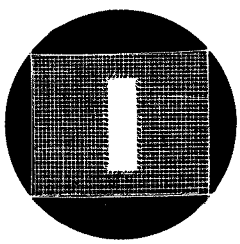


Non-linear pulse in line scan. Faulty valve in line scan unit.

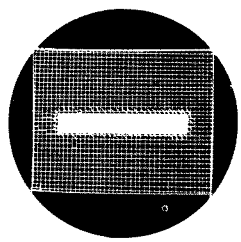


LINES MOVE UP OR DOWN

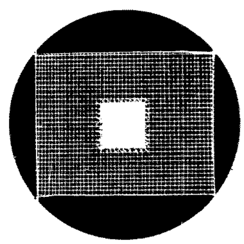
No frame hold. Fault in frame scan synchronising unit.



Insufficient line amplitude. Faulty valve or low H.T. to line scan unit.



Insufficient frame amplitude. Faulty valve or low H.T. to frame scan unit.



Both amplitudes small. Low H.T. to scan units. Faulty rectifier valve.

The sketches above are intended to give an approximate idea of the most obvious faults in a television receiver which are made apparent on the screen. They should not be interpreted too literally as in some instances the same effects might be produced in other ways.

Scannings and Reflections

WHILE THE PALACE BURNED

The Crystal Palace was, of course, clearly visible from the Alexandra Palace, and it seemed rough luck on the Baird engineers, who still assist the Alexandra Palace staff, to have to carry on with their job while their headquarters were being gutted. It must have been a difficult matter for them to have to concentrate under such conditions.

THE GALE DAMAGE

As regular lookers-in know, a very high wind put television off the air on December 14th. Both sets of aerials were damaged. The horizontal arms which carry the aerial arrays are hinged in the centre and these appeared to be bent upwards owing to the stays having broken. Efforts were immediately made to remedy the defect, and the ordinary B.B.C. engineers in spite of the high winds climbed the mast to make an inspection of the damage and actually succeeded in repairing the lower aerial, which is used for the sound transmissions, so that an announcement could be put out at 9 p.m.

As the repairs had to be continued after dark some high power studio lamps were used to illuminate the mast which looked most impressive under the floodlight effect, a point the B.B.C. could well bear in mind for the coming Coronation decorations. The gales also took its toll of windows, large quantities of broken glass being strewn around the ground about the south-east tower.

THE MISSING ANNOUNCER

Feminine lookers-in are wondering where all the dresses are that the lady announcers were reported to have had. On the evening transmissions, two evening dresses appear with great regularity. While on the subject of announcers, one can't help thinking that the programme people don't seem quite to know what to do with them. Sometimes they are seen for every announcement and then for a time they are just voices. Surely the former method is correct considering they were selected for their appearance.

TRANSATLANTIC TELEVISION

International interest has been aroused among radio engineers by a statement just made by Marchese Marconi that television will soon span the Atlantic. Actually, television signals from Germany have been picked up in New York.

"We have maintained communication across the Atlantic on short-wave lengths," said a G.E.C. research engineer, "and are exploring the possibility of ultra short-wave transmission for long distance broadcast for television.

"We know that a broadcast on 15 metres can get across the Atlantic, but the objection to using this band for television is largely one of cost. Television takes up too much space in the ether. If television were broadcast from this country to America, the space would have to be obtained at the expense of normal wireless telephony communications. Telephony bands are only 10,000 cycles per second apart, whereas television bands are 1,000,000 cycles per second apart and as much as 3,000,000 cycles for very high definition.

"The growing use of wireless telephony will make it practically impossible for enough space on the wavelengths now in use to be sacrificed, except perhaps for 90-line television requiring 100,000 cycles per second, which might give a just satisfactory close-up of one person. From the beginning of television, therefore, we have been experimenting on short wavelengths, and it is quite possible we may be able to broadcast internationally pictures of a full 400-line definition in the future."

IMPROVED SOUND

A great improvement has been recently noticed in the quality of the sound side of the Baird system transmissions. This, of course, is due to the fact that the Baird electron camera is being extensively used and in consequence the sound is direct, like normal broadcasting. Previously, most of it was first recorded on the film in the Baird intermediate film system which, like all recording devices, does not show up too well compared with a direct system. In passing it might be mentioned that the Baird sound equipment was designed by Mr. Ingham, who, prior to joining the company, was a B.B.C. research engineer.

THE B.B.C. CHARTER AND TELEVISION

In the drafts of the Royal Charter for the B.B.C., which comes into operation on January 1, the introduction of television has necessitated a new clause. The Corporation is authorised to produce, manufacture or otherwise acquire films, film material and apparatus for use with films, and to employ such films and apparatus in connection with the Corporation's broadcasting service. There is a proviso that the films may not be used for any purpose other than television.

THE BAIRD ELECTRON CAMERA

The Baird Company are to be congratulated on the steady improvement they have effected in their electron camera transmissions. At first the pictures were rather ragged, but it has been noticeable that the whole series with this system show a record of difficulties overcome, and at the time of writing they leave very little to be desired. The flexibility of this system compared with the intermediate film system, of course, needs no comment, and it has been a matter of general wonder that it was not adopted from the outset for the Baird Company had this system working perfectly in their laboratories some months ago.

TECHNICAL POSSIBILITIES

During the afternoon session of the recent anti-aircraft defences transmission one of the large reflectors of a searchlight was removed to show it to lookers-in and for a few moments it was turned to such an angle as to give a wonderful reflected view of the aerial mast. Incidentally, the two transmissions showed what can be done technically with television, and great praise is due to the engineering staff responsible. From an enter-

MORE SCANNINGS . . . . . .

tainment point of view it was, however, hardly worth while.

A LIFT AT A.P.

The one thing that appeared to have been forgotten in the structural alterations to the Alexandra Palace was a lift, and there have been many complaints from both staff and artists because of the omission. However, work has now been undertaken on the installation of a lift and its erection is well on the way.

PROGRAMME TECHNIQUE

There has been considerable improvement in programme technique during the past month and no doubt the use by the Baird Company of electronic scanning has done much to facilitate this by enabling the intervals, which were due to the necessity of changing the film, etc., to be almost entirely eliminated. It has also been noticeable that there has been less interference in the transmissions by the intrusion of people or their shadows who were not actually intended to be in the picture.

THE BAIRD BIG SCREEN

Mr. J. L. Baird is to be congratulated on his achievement of producing a really big television picture. A picture of an area of about fifty sq. ft. is no mean accomplishment and from the technical description which appears on other pages of this issue it is clear that he has tackled the problem on original lines. The installation at the Dominion Theatre in Tottenham Court Road is a permanent one. Actually, practically nothing can be seen of the gear, for in order to comply with the L.C.C. regulations it is entirely boxed up in metal cases, and these and flexible metal tubes carrying the cables are all that can be seen. In operation the gear is almost silent and all that can be heard is the faint whirr of the motor, which is easily drowned by the loudspeaker.

N.B.C. TELEVISION

The first large-scale television show was recently staged in New York, when the National Broadcasting Company gave a demonstration to about two hundred people in a room in Radio City. The transmission was made from the top of the Empire State Building.

TELEVISION IN THE HOUSE OF COMMONS

Two television sets have been installed in the Grand Committee room of the House of Commons, and M.P.'s can now watch the televising of theatrical scenes, wrestling, dancing, and other entertainments. Mr. Ramsay MacDonald has announced that television developments are being watched in view of the suggestion that the Coronation ceremony in Westminster Abbey might be televised. The B.B.C. obtained the approval of the Speaker to instal television in the House.

TELEVISION JARGON

At the annual dinner of the London and Home Counties branch of the Cinematograph Exhibitors' Association, the Postmaster-General, Major Tryon, protested against the new jargon of television. He objected to being "televised," and still more to describing the people who watched the result as "viewers." He added that impartial experts assured him that British television was the best in the world.

Another speaker (Mr. Philip Guedalla) said: "I see references to a 'television hostess.' What can this be but a long-distance chorus girl."

THEATRES AND TELEVISION

At the annual meeting of the Provincial Entertainments Proprietors' and Managers' Association, the members received a deputation from the Musicians' Union, to discuss various aspects of the situation arising from the B.B.C. monopoly of television.

The annual report states: "A problem that will shortly loom largely is that of television and its handling by the B.B.C. One section of the entertainments industry already sees danger looming in the shape of the powers with which the great Corporation may be endowed."

Further references to the situation are made in the report of the Parliamentary Agents, which is appended. This states: "The B.B.C. Charter for the next ten years is shortly to be laid before Parliament, and it is expected to be on much the same lines as the original Charter. In view of the development of television, efforts have been made by theatrical interests to persuade the Postmaster-General to make special provision for their future protection."

ALEXANDRA PALACE IN SOUTH AFRICA

There does not seem to be any limit to the range of the A.P. television sound transmission. Yet another reader, Mr. G. C. J. Angilly, regularly picks up both sound and vision signals in Cape Town. The receiver used is a simple super-regenerative type using two valves only. These long-distance reports lead one to hope that before very long the actual guaranteed service area may greatly exceed the present estimated range.

TELEVISION PROGRAMMES

It is understood that the Radio Manufacturers' Association is to approach the B.B.C. with a request that the programmes should be improved. It is claimed that dissatisfaction amongst manufacturers and traders is causing a decline in sales. It is hoped, in addition, that the hours of transmission will be increased early in the New Year.

TELEVISION IN THE THEATRE

Over £350,000 is involved in the new Prince of Wales Theatre. It is to be equipped with television projection apparatus so that important items can be flashed on the screen, while normal radio will also play its part.

AMATEUR 5-METRE ACTIVITIES

Amateurs in this country are doing some wonderful work on 5 metres and are proving beyond all doubt that this wavelength has not a limited range as is generally accepted. American signals have been picked up in South Wales, Essex, and also in North France. A North African station has been logged in London, while several German amateurs are able to send out signals over several hundred miles. What the ultimate range of these signals will be one cannot forecast, for rumours are prevalent that a New Zealand 5-metre signal has been picked up in this country.

BETTER AMERICAN TELEVISION

The Radio Corporation of America have concluded a series of successful experiments with 343-line pictures and are now turning their attention to better definition.

Agreement has been reached between several companies, including R.C.A., Philco, Farnsworth and Don Lee, to increase the frequency to 441 lines. These companies will all transmit signals that can be picked up on one particular type of receiver. The price of these receivers has still been maintained at a little over £100.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

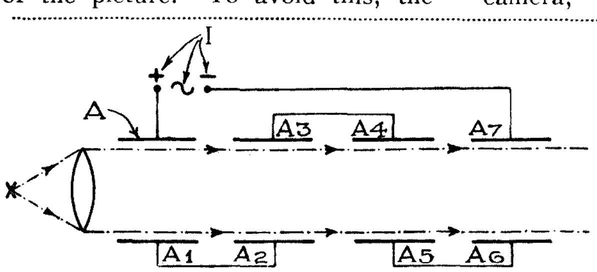
Specially Compiled for this Journal

Patentees:—Marconi's Wireless Telegraph Co., Ltd. :: H. M. Dowsett and L. E. Q. Walker
L. R. Merdler and Baird Television Ltd. :: W. S. Brown

Kerr Cells

(Patent No. 453,136.)

When using multi-electrode Kerr cells for receiving television signals, the difficulty arises that the inter-electrode capacity tends to by-pass the higher signal frequencies, and so leads to a falling-off in the quality of the picture. To avoid this, the electrodes are connected in series with each other, so that their overall capacity is much reduced.



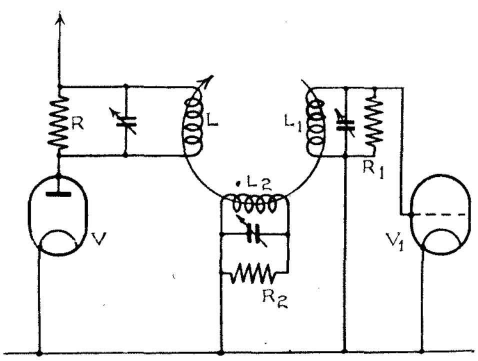
Multi-electrode Kerr cell Patent No. 453, 136.

As shown in the diagram, the signal is applied across the terminals I and the series circuit is from electrode A through the cell to electrode A_1. The latter is connected, as shown, to electrode A_2, the circuit proceeding through the cell to A_3, thence to A_4, and so on to the last electrode A_7, which is connected to the opposite terminal of the input I. Although the voltage required to produce a given variation of light intensity is doubled, the capacity of the cell is divided by four, and high-frequency losses are correspondingly reduced.—*Marconi's Wireless Telegraph Co., Ltd., H. M. Dowsett* and *L. E. Q. Walker.*

Television Amplifiers

(Patent No. 453,847.)

The coil L in the anode circuit of the first I.F. valve V of a superhet receiver for television signals is tuned to the lower limit of the frequency band, whilst the coil L_1 in the grid circuit of the next valve V_1 is tuned to the upper limit. A third coil L_2, mutually coupled to the other two, is tuned to the middle of the frequency band. Each of the tuned circuits is damped by a parallel resistance R, R_1, R_2. The coupling gives a uniform response over the whole of the frequency band to be passed, with a sharp cut-off at both ends.—*L. R. Merdler* and *Baird Television, Ltd.*



Television amplifier circuit Patent No. 453,847.

Television Cameras

(Patent No. 454,422.)

In the Iconoscope form of television "camera," the picture to be transmitted is first focused on to the photo-sensitive electrode of a cathode-ray tube, and the resulting "electric image" is then discharged by scanning the electrode with the electron stream from the "gun" part of the tube. Usually, the sensitive surface of the electrode faces at least partly towards the gun or cathode end of the tube, and the picture is projected on to it from the same end. But it would obviously be more convenient to be able to focus the picture on to the outer face of the electrode, *i.e.*, the one which is seen from the bulb end of the tube.

This, however, gives rise to difficulties, because the sensitive electrode is formed by covering a thin sheet of aluminium with a layer of aluminium oxide on which a large number of sensitive caesium globules are deposited. The globules are insulated from each other and from the aluminium backing by the oxide layer. Now if the sensitised layer is deposited on the surface nearest the bulb, so that it faces away from the scanning stream, it is obvious that the electrons must first penetrate the aluminium backing-plate before they can discharge the sensitised globules and so produce the signal currents.

To overcome the difficulty, the electrode as a whole is made impervious to the scanning stream, but is provided with a large number of small metal "plugs," which extend through, from the scanned surface to the opposite face, and are sensitised at the end on which the picture is focused.—*Marconi's Wireless Telegraph Co., Ltd.*

Cathode-ray Tubes

(Patent No. 454,486.)

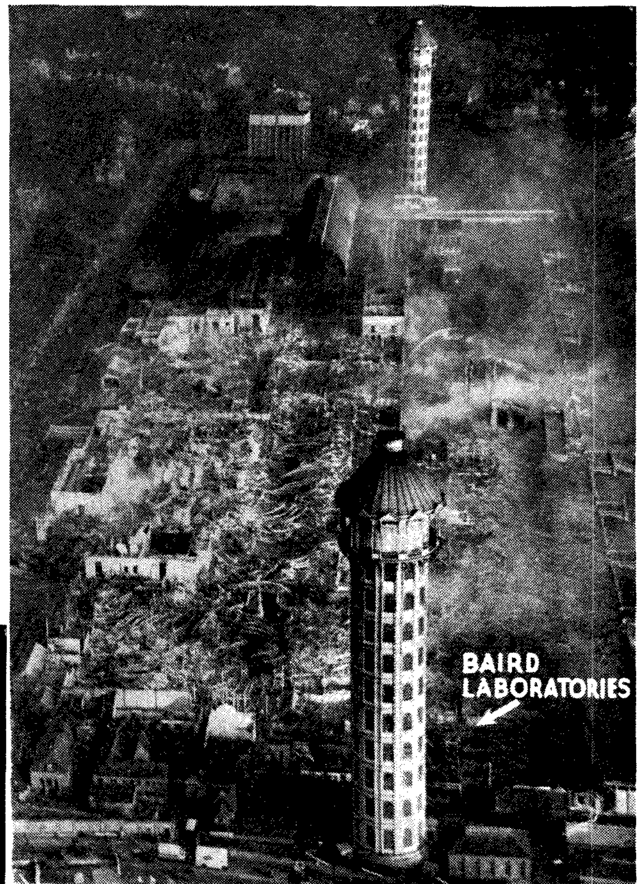
The mosaic-cell electrode on which the picture to be transmitted is first focused is usually set at an angle to the "gun" of the cathode-ray tube, so as to allow the electron stream from the latter to scan and discharge the same surface that receives the picture. This arrangement is liable to cause the base-line both of the line and picture scanning frequencies to "wander," and to become "saw-toothed" instead of straight. In addition, it gives rise to parasitic disturbances at the framing frequency.

According to the invention these effects are overcome by disposing an auxiliary electrode system between the gun part of the tube and the photo-electric screen. Suitable biasing potentials are applied to the extra electrodes in order to produce a "compensating" potential gradient, which minimises the spurious effects already mentioned.—*W. S. Brown.*

BAIRD LABORATORIES DESTROYED IN CRYSTAL PALACE FIRE

THE disastrous fire which almost completely destroyed the Crystal Palace on the night of November 30th extended to the Baird laboratories, which occupied a considerable area of the south-west corner of the Palace; the whole of the laboratory equipment was destroyed.

As is well known, the Baird Company have conducted all their recent research work at the Palace and that portion occupied by them had been stucturally altered internally to provide a complete television transmitting station, the aerial being on the south west tower with the remainder of the premises equipped with studios



The photograph on the left was taken during the height of the conflagration and it shows approximately that part of the Palace which was occupied by the Baird laboratories. Fortunately, the receiving set production department escaped the full force of the blaze and comparatively little damage was done here. The photograph above was taken at 9 a.m. on the morning after the fire and it will be seen that the Baird laboratories are on the fringe of the destruction.

and research, production and servicing departments.

During the progress of the fire it was thought that no part of the Baird premises would escape, and there were fears that the south-west tower, which was adjacent to the Baird premises and supported the aerial, would collapse. Investigation when the fire had been got under control, however, revealed that although the administrative offices, research department and studios had been entirely gutted, the production and servicing departments had escaped almost unscathed.

The official announcement made by the Baird Company respecting the damage done is as follows:

" Although a considerable amount of property was damaged by the fire, an inspection carried out by our experts revealed that the receiving sets production department escaped the full force of the blaze. In addition, the servicing and testing departments were undamaged, and consequently the deliveries of sets to the public will not be effected. The directors wish to state that the regular daily transmissions of television programmes by the B.B.C. from Alexandra Palace, which during this week are being radiated by means of the Baird system, will not be affected in any way."

It was announced later that the Baird Company's property and equipment at the Crystal Palace was fully covered by insurance.

We understand that the Baird Company are already negotiating for new premises where large scale production of their receivers and transmitting gear could be undertaken.

At one time there was a considerable prospect that the Crystal Palace would be used as the site for the B.B.C. London television station and now, as events have turned out, it seems fortunate that the Palace was not selected, otherwise we might at this date have been without television.

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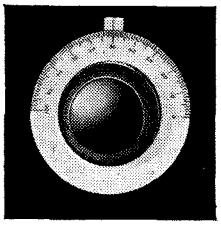

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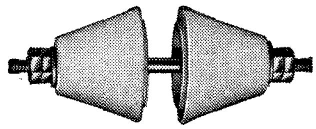
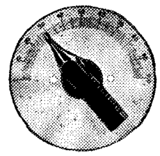


For carrying H.F. leads through metal baseboards with minimum loss. Glazed Frequentite Insulator Cones. 4BA Brass Rod Conductor. Cones 1⅛" long. 1⅞" max. diam. No. 1018. **Price 2/-.**



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A direct control comprising 3" satin finish aluminium dial engraved 0-100°, with elegant shaped bakelite pointer knob. For ¼" spindles only. No. 1027. **Price 1/3.**

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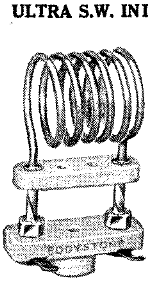
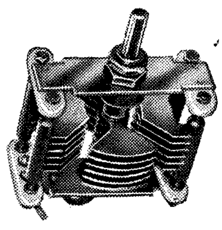


Wound with 14 gauge high conductivity copper wire, heavily silver plated. A separate Frequentite base with silver-plated sockets provides easy and efficient coil changing. No. 1050.

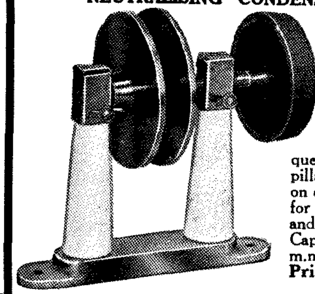
3 Turns	1/6
4 "	1/6
5 "	1/7
6 "	1/8
8 "	1/10
Frequentite Base for above No. 1051	1/-

SPLIT STATOR CONDENSER.

Heavy brass construction, plates with polished edges, soldered together. Insulated bearings. Screened non-inductive pigtail. Frequentite insulation. **Capacity** —One side: Min. 5 m.mfd. Max. 40 m.mfd. Two sides in parallel: Min. 10 m.mfd. Max. 80 m.mfd. As series gap: Min. 3 m.mfd. Max. 20 m.mfd. **No. 1068 Price 12/6**



NEUTRALISING CONDENSER



Of solid construction, with turned brass plates, screw adjustment. Frequentite insulating pillars, mounted on cast base. Ideal for Eimac 150 T. and similar valves. Capacity: 3 to 12 m.mfd. **No. 1067 Price 12/6**

FULL of INTEREST to SHORT-WAVE ENTHUSIASTS

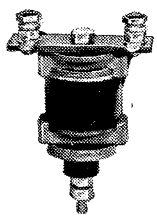
Illustrated constructional articles for building simple S.W. battery sets; battery and A.C. mains superhet, S.W. receivers with A.V.C.; Ultra S.W. Radio Telephone; Transceiver; S.W. Converters; Crystal-controlled Amateur Bands Transmitter, etc. From your Radio Dealer, W. H. Smith & Son, or from Stratton & Co., Eddystone Works, Birmingham, 5.
London service:—
Webb's, 14, Soho Street, W.1.

EDDYSTONE 1937 SHORT WAVE MANUAL

ULTRA SHORT-WAVE H.F. CHOKES

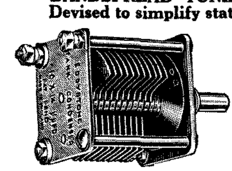
These chokes are single layer space wound on DL-9 formers, and have an exceedingly low self-capacity. 2½-10 metres.
No. 1011. D.C. Resistance 1.3 ohms. 2.5 to 10m. **Price 1/3**
No. 1021. D.C. Resistance 0.4 ohms. 2.5 to 8m. **Price 1/3**

IRON CORED FILAMENT CHOKE



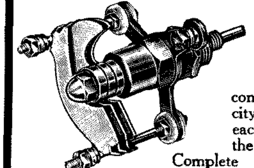
For use in filament circuit of battery operated Superhet Receivers using electron coupled oscillator. No. 1062. **Price 3/6.**

BANDSPREAD TUNING OUTFIT.
Devised to simplify station selection.



The Tank condenser unit has a capacity range of 10 × 14 m.mfd., achieved by a patented step by step device. Complete with scale and knob.

Tank Unit:
Cat. No. 1042. ... ... **Price 6/-**



In parallel with the Tank capacity is the slow motion Band-spread Trimmer condenser, with a capacity slightly greater than each step by step of the Tank condenser. Complete with dial

Trimmer Unit
Cat. No. 1043 ... ... **Price 6/6**

SEND FOR NEW ILLUSTRATED COMPONENT LIST—FREE ON APPLICATION

EDDYSTONE SHORT WAVE COMPONENTS

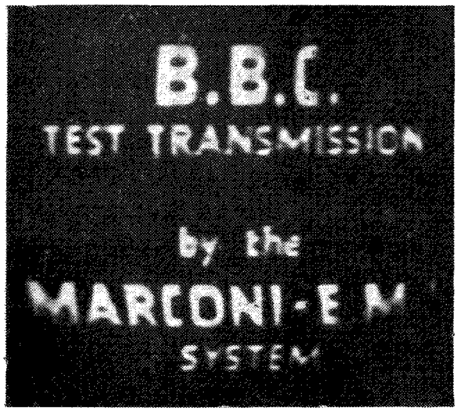
STRATTON & CO., LTD., Bromsgrove Street, BIRMINGHAM. LONDON Service: Webb's Radio Stores, 14, Soho Street, Oxford St, W. 1

THE PROBLEMS OF PHOTOGRAPHING TELEVISION

By R. C. Hanner

There are difficulties in photographing a television picture which are not immediately apparent. This article describes these difficulties and explains how they may be overcome.

AMONGST all the publicity which the press in general has given to television very few attempts have been made to reproduce the image of the television screen and pictures which have been published



The B.B.C. Test Transmission visual announcement. This shows receiving tube rather too heavily biased, giving a very heavy black and white effect. Note how the M. & I. on E.M.I. are cut off, owing to the curvature of the receiving tube. Exposure three sec. F/8 Kodak super sensitive pan. film.

show marked signs of retouching or faking. Photographers, professional and amateur alike, have tried to get pictures, but with far from satisfactory results.

One of the greatest stumbling blocks to the average photographer, who wishes to photograph a television image, is a complete lack of knowledge of how the picture is formed.

The photographer looking at a television screen of the cathode-ray type generally forms the opinion that there is a reasonable amount of light available to take a picture, which is true, but he is not generally aware of the fact that only a very small area of the scene is illuminated at any given instant, and that which looks like a well illuminated area is, in reality, only darkness.

Now to explain this more fully let us inspect some actual figures, taking the Baird system first. This is a 240-line picture with a picture-frequency of 25 per second, that is to say a spot of light draws 240 lines across the end of the cathode-ray tube, 25 times per second, the actual size of the spot of light, if everything is correctly set, being .000013 of the area (including synchronising) of the television image.

Now let us see how much time is spent in drawing, say, one line. 240 lines are drawn in .04 second, therefore one line in .00016 second, and as there are the equivalent of 320 spots of light in one line the time taken for one spot to travel its own length is .0000005 second. Simply put, all this means is that if one opens a camera shutter for one second the actual time the photographic emulsion is exposed will be 25 short exposures of 1/2,000,000 second, that is to say, a total of 1/80,000 a second, which is not much compared with the usual photographic exposures.

In the Marconi-E.M.I. system, the period of exposure is less. In this

One of the lady announcers. This is an example of watching one's chance. It was noticed that the announcer kept looking down at her script and an effort was made to photograph directly she looked down. Unfortunately the exposure was just too long and traces of movement have spoilt what might have been a very good result, the eyes being recorded mostly cast down though the shutter was not quite closed when the eyes were looking at the camera. Exposure 2 record F/2.9 S.S. pan. Kodak film.

system 405 lines are used on 25 pictures per second though the system of scanning is different. 202½ lines scan half the total area of the image in 1/50 of a second while the second half is scanned in another 1/50 second, the two halves being interlaced.

Left: The tube biased to about correct brightness for ordinary viewing. Again note slight cut off in brilliancy of the I in E.M.I. Another effect is also noticeable, namely, the white edge on right of picture; this white edge appears to be present in varying degree in all M.-E.M.I. pictures.

Right: Tube biased rather too brightly for photographing two tones black and white. The general curvature and angle of the Marconi-E.M.I. are due to two effects, one, curvature of tube, two local tuning circuits not quite adjusted to incoming synchronising signal.

In this system the time taken for one spot of light to travel its own length is .00000017, so a one-second shutter exposure gives the emulsion an exposure equal to 1/250,000 second. On the surface these figures seem to make the photography of a

Leslie Mitchel. Television announcer just about to make an announcement. An example of getting a picture before the subject moves. Exposure half sec. F/2.9 Kodak super S. pan. film. The white shading where the black suit cuts the picture edge appears in most pictures on one of the systems of television.

television image impossible. Luckily the light of a cathode-ray tube is very intense and it is quite possible to get a printable negative with a shutter speed of one second using a suitable camera and emulsion. Shutter speeds of 1/10 second have produced very thin negatives, while exposures of 1.5 to 2 seconds give ample exposure.

The lens must be fast, the writer uses a Dallmeyer F/2.9 Pentac lens and Kodak super sensitive panchromatic film, developed in a normal metol-hydroquinous developer.

Unfortunately, though ample exposure is easily obtained, most of the television screens contain fairly rapid movement, which produces a blurred result when adequately exposed. Few scenes televised could in the ordinary way be photographed much more slowly than 1/10 of a second without blurr, so one is rather limited to subject from an ordinary transmission and much patience is required to get

This picture must be one of the best known scenes to television experimenters, having been used for testing purposes by the Baird Company for nearly two years. The picture is from a loop of film and the artist slowly turns her head, faces the looker-in and then with great rapidity turns her face left. The subject gives photographers a chance to know what is coming, and though the subject is never quite still a one sec. exposure with a F/2.9 lens S.S. pan. Kodak film recorded the picture. In the original the scanning lines can be seen. The four faint horizontal lines are produced by the scanning disc at the transmitter, which rotates four times per picture.

a satisfactory picture. Often announcers are comparatively still at the beginning or end of a transmission. The same applies, though to a lesser extent, with artists. Sometimes test transmissions are made when somebody sits in a chair reading for some minutes on end. There is definitely as much luck in choosing the right time to expose as in any gambling game yet invented.

Left: This close up was from a news reel recently televised. In the original the scanning lines are most clearly marked. The mark between the eyes is a piece of faulty emulsion. Exposure 1/10 sec. F/2.9 Ilford hypersensitive plate.

Right: Scene from "Marigold." Rather an imperfect result due to contrasting studio lighting and running the receiving tube with the general "brightness" too low for photographing. Original shows scanning lines. Exposure 1/10 sec F/2.9 Ilford hypersensitive pan. plate.

Another big factor in successful television photography is the brightness at which the cathode-ray tube is operated. Obviously the brighter the the tube the shorter the exposure. If the brightness of a tube is increased, the picture appears, to the eye, to become flat. The shadows are lightened but the high lights do not get proportionately brighter so the gamma is reduced. This is desirable from a photographer's point of view, as the average television picture is

Elizabeth Cowell taken as she looked down to read announcement. Spots on nose and mouth photographic blemishes. This picture is another example of what can be done if the right moment is chosen. Exposure 1/10 sec. F/2.9 Kodak S.S. pan. film.

generally tonally distorted (if in no other way) by an excessively high gamma. This tendency for a high gamma or contrasty pictures is found in the moving picture, especially a few years ago, and in most amateurs' snapshots and, broadly speaking, most people prefer it, so it cannot be considered detrimental to a television picture.

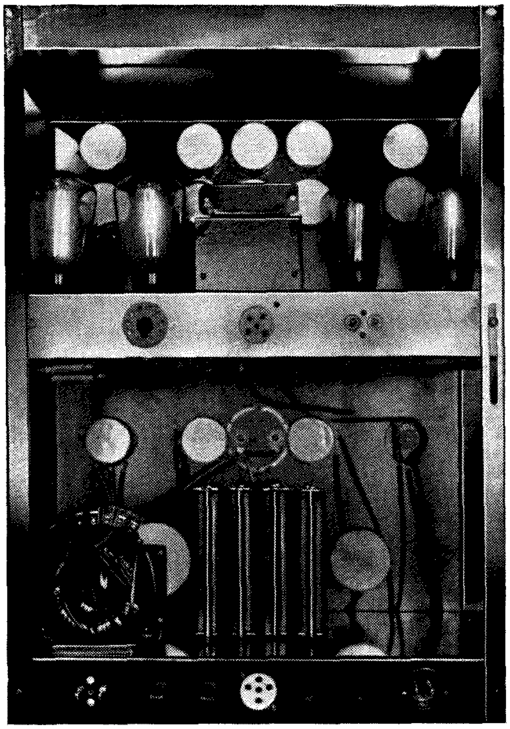
The three prints of a B.B.C. caption card transmitted prior to the opening of the station clearly illustrate the effect of adjusting the picture brightness. The third would produce the best setting for photographing average scenes, though obviously for a caption a strong contrast is best.

There is also another problem in photographing a television image which must be mentioned, namely,

(*Continued at foot of page 25*)

A "UNIVERSAL" CATHODE-RAY TUBE EQUIPMENT

The first of a short series of articles describing the construction of a complete cathode-ray tube equipment which will prove of great use to the serious experimenter. The " professional " appearance of the unit will add to its value as a permanent laboratory appliance.



Rear view of equipment showing assembly in rack.

THE cathode-ray equipment about to be described is intended to make a tube of large or medium diameter serve both as a television reproducer or as a laboratory instrument for all the various purposes to which it can be put. It must be pointed out at the start that the construction of such an equipment requires more care than that sometimes bestowed on an experimental layout, and in addition it is assumed that the experimenter has a reasonably well-equipped workshop for the various metal-working jobs involved in assembling the unit. A certain degree of flexibility is allowed in the choice of components, consistent with quality and size, and where alternatives are not desirable this is clearly indicated in the text.

General Layout

The equipment is assembled on an " Eddystone" transmitter chassis and occupies two racks, the lower containing the H.T. controls for the tube and an external A.C. supply unit and the upper a double time-base unit which can be adapted for wave-form observations or for scanning at any range of speed up to 400 lines and 50 pictures per second. With the exception of the " input " terminals all connections to the unit are made at the back by means of flexible leads, which arrangement makes for neatness when working.

One of the advantages of an all-metal construction is the efficient shielding provided against mains interference, a point of particular importance in high-speed scanning. The risk of shock from any part of the equipment is minimised by the fact that the H.T.+ is permanently connected to chassis and the high voltage leads are under the lower rack out of reach of accidental contact. On the other hand the use of an earthed H.T.+ supply necessitates the careful insulation of parts which are at a lower potential, and this is done by the use of special high-tension cable for the wiring and by fitting paxolin bushes for the various controls which project through the front of the panel. Parts which require special attention will be mentioned as the construction proceeds.

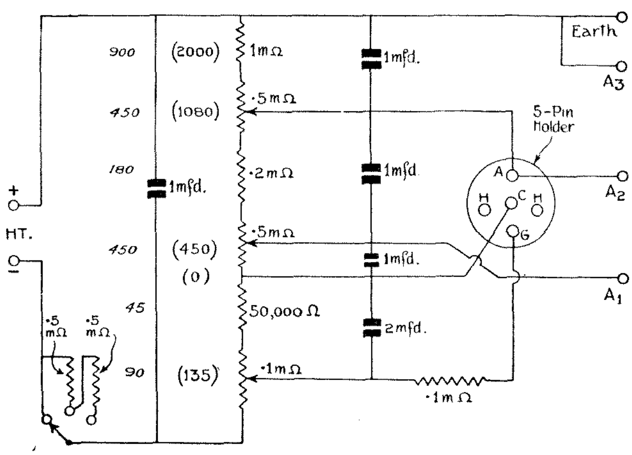


Fig. 1.—Circuit diagram of resistance chain.

Chassis and Panel

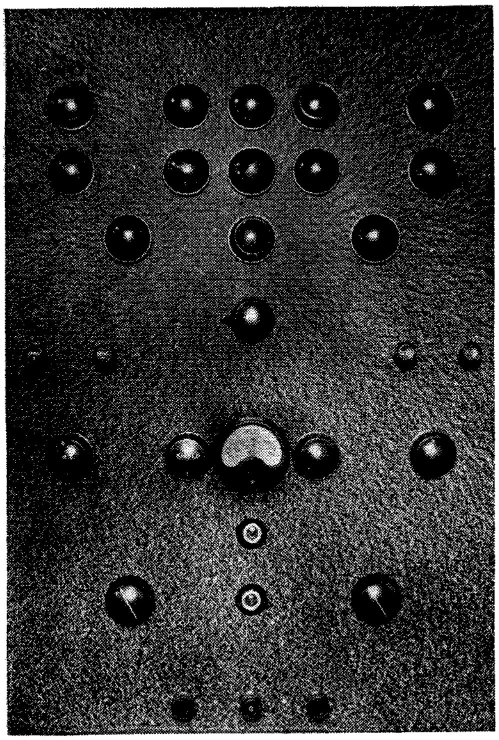
As said above, the chassis is an Eddystone 3-tier transmitting rack (Cat. No. 1047) which can be obtained from C. Webb, of Soho Street, or direct from the manufacturers, Messrs. Stratton & Co., of Bromsgrove Street, Birmingham. When unpacking, care must be taken not to scratch the enamel finish of the panel or the chassis; all marking out should be done with the panel resting on a padded surface of paper or felt. The chassis racks are ready drilled for joining to the panel and uprights and note must be taken of the position of these holes when marking out so that the outlet sockets are on the true back of the racks. The front edge of the rack which fits against the panel is undrilled.

Design of H.T. Unit

The supply for the tube and the time-base is obtained from separate transformers and rectifiers mounted in shielded boxes away from the equipment and connected to it by the flexible leads mentioned above. It is not proposed to deal in detail with the requirements of the rectifier units as these are standard practice and have been described already in this journal (see May issue).

The question of the voltage available will also have

CATHODE-RAY TUBE EQUIPMENT



View of front panel showing arrangement of controls.

to be decided by the individual constructor, although it is suggested that 2,000 volts is sufficient for a small tube with a possible increase to 3,500 for medium tubes. Above 8 ins. diameter the voltage required by the bigger tubes requires larger and more expensive condensers and the need for careful assembly and insulation becomes even more important. For ordinary experimental work an 8-in. tube is usually adequate although it is not capable of resolving the highest definition pictures as well as a 10-in. or 12-in.

If the equipment is intended for ordinary laboratory work with occasional television monitoring a 5-in. or a 6-in. tube will be quite suitable. In any case the calculation of the resistance chain to suit the particular tube used is not a difficult matter and it will be sufficient to give one example to suit a small Ediswan high-vacuum tube. Some makes of tube are fitted with three anodes for accelerating the beam and it is probable that future developments will tend to favour this type. It is therefore desirable to provide for three H.T. tappings on the resistance chain to avoid alteration of the layout at a future date. The extra tap can be brought out to a separate terminal and disregarded until required.

Values of Resistance Chain

The operating voltages of the Ediswan 5H tube are:

1st Anode: 800 approx.
Grid: 200 approx.

To allow of the use of tubes of a different type and operating data the widest possible range is provided in the adjustments of potential. The resistance chain is made up as shown in the diagram of Fig. 1, an H.T. voltage of 2,000 being assumed.

Neglecting the current taken by the tube itself, the load imposed by the resistances is 2,000/2.3 megs. in the maximum H.T. position or 0.9 ma. approximately. The voltage drop across each section of the resistance are shown in italic figures, while the actual value of the potential with respect to the cathode of the tube is given alongside in brackets. In the case of the variable resistances the value is, of course, the maximum obtainable. By constructing a similar diagram the resistance chain can be adapted for any special operating conditions.

The potentiometer connected to A_1 is capable of giving approximately 400 volts for tubes which require a third anode tap. If two-anode tubes are used, this tap is not connected and the A_2 and A_3 (earth) terminals only are used.

At the negative end of the chain two extra resistances are inserted by means of a three-way switch ("Kabi"). This enables the overall H.T. voltage applied to the tube to be decreased with a consequent increase in sensitivity without appreciable alteration of focusing conditions. Values of 0.5 megohm are shown and with the switch full in, the current through the chain drops to approximately 0.6 ma. lowering the voltage between cathode and final anode to 1,300 volts approximately. A finer adjustment of voltage could be made by reducing the values of these resistances and it is an easy matter to replace them at any time when the tube is being tested.

Each tapping in the chain is by-passed by a 1-mfd. condenser as shown, with the exception of the grid-cathode condenser, which is 2.0-mfd. This need not be of a high working voltage as the grid-cathode potential seldom exceeds 200 volts for any type of tube. It is preferable to use a moulded case for this condenser to minimise the risk of flash-over to the chassis, which is at full H.T. potential with respect to the cathode. The other by-pass condensers are oil- or jelly-filled with a working voltage of 2,000, which allows ample margin of safety.

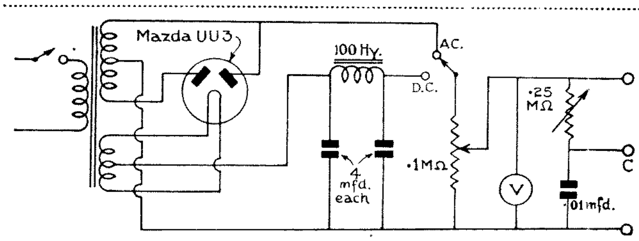


Fig. 2.—Circuit for providing A.C. and D.C. for calibrating tube deflections.

The suggested list of components is then as follows:

Resistances: Dubilier or Erie:
- 1 megohm 2-watt type,
- 0.2 megohm 2-watt type,
- 50,000 ohms 1-watt,
- 100,000 ohms 1-watt,
- 2—0.5 megohm 2-watt type.

Condensers:
- 4—1-mfd. 2,000-volt working (Dubilier or T.C.C.),
- 1—2-mfd. 500-volt working (Dubilier or T.C.C.), (moulded case),
- 1—.1-mfd. 3,000-volt working.

Potentiometers:
- 2—0.5-megohm,
- 1—0.1-megohm (Reliance Mfg. Co.).

CONSTRUCTIONAL DETAILS

Sundries:

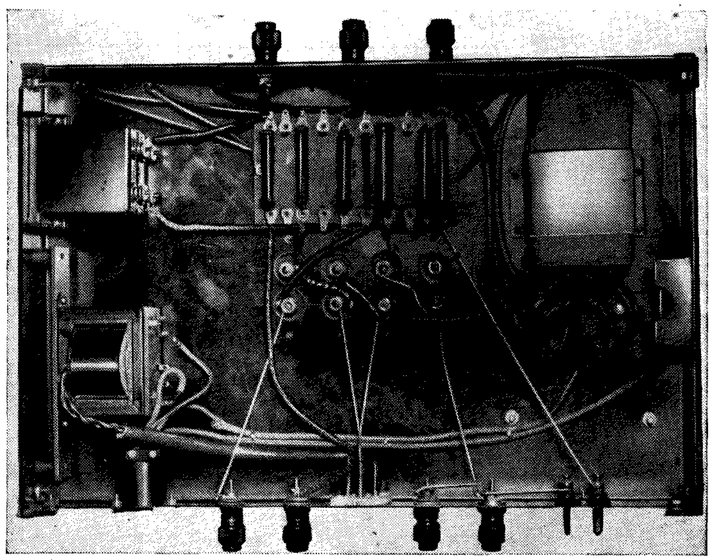
- 1 "Kabi" 3-way switch (F.W. Lechner),
- 1 Steatite 5-pin valveholder (Eddystone),
- 1 Sunk mains socket (Bulgin type),
- 4 Belling-Lee terminals marked A_1, A_2, A_3 and Earth,
- 1 Ten-way group board (Bulgin).

If the unit is to be used with an indirectly-heated tube it is convenient to supply the cathode heater from a small separate transformer mounted under the chassis, thus avoiding an extra pair of leads from the H.T. unit which require insulating carefully from the chassis. A directly-heated tube is best supplied from an accumulator and extra terminals will have to be provided at the back for the purpose. Directly-heated tubes will also need a series resistance for the control of the current and this will have to be inserted in the front of the panel. The tube used with the equipment takes 1.0 amp. at 2.0 volts indirect heating and the transformer can be seen in the photograph of the underside of the chassis.

Small transformers of this type can be obtained from the Keston Manufacturing Co., Dulwich, having the usual primary taps and a 2.0 volts centre-tapped winding. The transformer is insulated from the chassis by mounting on a strip of paxolin as shown in the detail of Fig. 3.

Calibrating Circuit

Included on the H.T. control panel is a circuit for providing A.C. and D.C. for calibrating the tube deflections. The arrangement is shown in the circuit of Fig. 2. A standard 250-0-250 transformer is connected to a rectifier and smoothing circuit in the usual manner, the output being connected to a 100,000-ohm wire-wound potentiometer. A single-pole change-over switch connects the potentiometer to either the smoothed D.C. or to one side of the secondary winding for A.C. Across the potentiometer is a voltmeter (moving-iron) and two output terminals which can be seen in the photograph of the front panel. A phase-splitting circuit is also connected across the potentiometer consisting of a condenser of 0.1-mfd. and a resistance of 0.25-megohm. The junction of these is taken to the centre terminal on the panel marked C. The supply is controlled by the two switches seen in the centre above the terminals, the upper switch being in the primary of the transformer and the lower one being the change-over switch from A.C. to D.C. If one of each pair of the plates of the tube is connected to the outer terminals, the centre being connected to the remaining two plates and to anode, a circular trace will be drawn on the tube screen on which a waveform can be projected in the usual way.



Photograph of underside of base showing wiring and positions of components

The components required for this part of the unit are as follows:

Mains transformer 250-0-250, 2-0-2 for rectifier. (The one used in the original model was a special toroidal type obtainable from F. W. Lechner, but a standard model will be equally suitable.)

100-henry choke (Sound Sales).

2—4-mfd. electrolytic or paper condensers (T.C.C. or Dubilier).

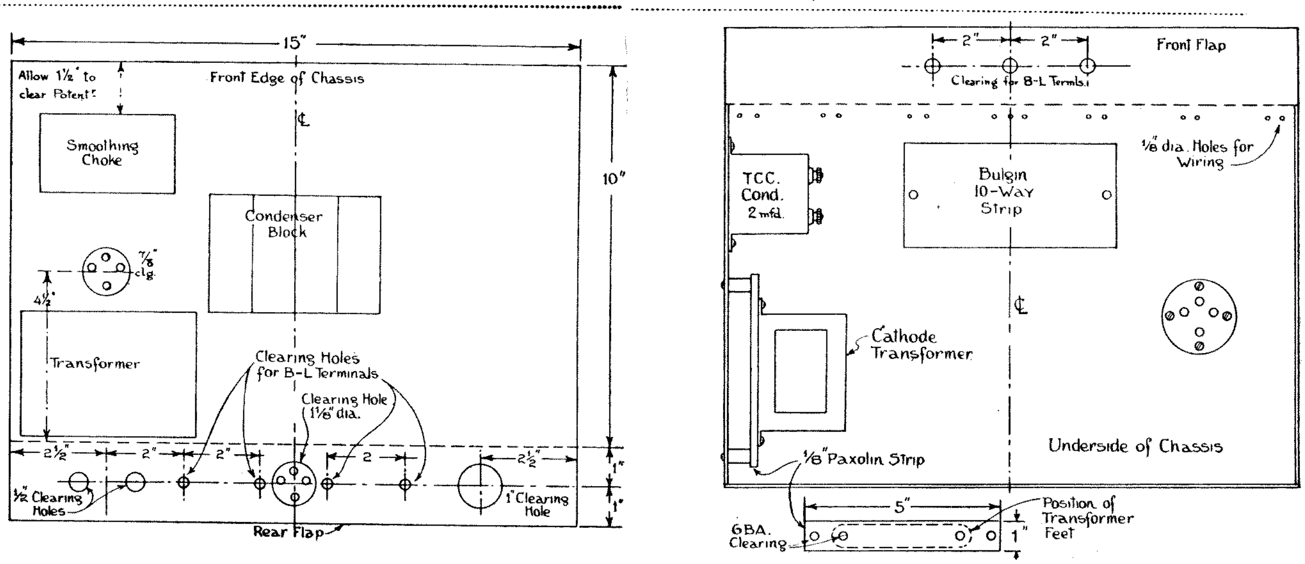


Fig. 3.—Diagrams of upper and under sides of base showing positions of components.

BUILDING CATHODE-RAY TUBE EQUIPMENT

These condensers are preferably obtained in insulating cases as they are not to be connected to chassis.
4-pin chassis-mounting valveholder (Bulgin, Clix, etc.).
Single-pole switch (Bulgin type S.80).
Two-way switch (Bulgin type S.81).
Sunk socket (Bulgin type P.20).
3—Belling-Lee terminals. Type B.
1—100,000-ohm wire-wound potentiometer 10-watt type (Reliance Mfg. Co.).
1—0.25-meg. potentiometer (Reliance Mfg. Co.).
1—0.1-mfd. condenser (T.C.C. or Dubilier, 1,000 volts working).
1—0-250 volts moving-iron voltmeter, 2 ins. diameter (Ferranti, Weston or similar reliable make).

Marking Out the Chassis

Exact drilling instructions for the mounting of the components is not given since they depend on the type used. The diagram of Fig. 3 shows the position of the condensers and the rectifier circuit and the drilling of the rear flap for the inlet sockets and the connection to the tube. This is made by means of the 5-pin steatite holder shown in the centre of the flap in the photograph on page 19. The inlet sockets for the H.T. to the resistance chain and the 240-volt mains for the transformers are deliberately made different to avoid risk of plugging in the wrong socket.

After the clearance holes for these components have been cut, the position of the condensers is best marked out by laying them on the top of the rack and scribing through the fixing holes. It will be noted in the photograph that these condensers have been mounted upside down, the terminals projecting through clearance holes in the metal. This has the advantage of completely protecting the terminals from accidental contact and simplifying the wiring, but it involves the drilling of extra clearance holes which may be tedious for a worker without the necessary washer cutters. The metal of the chassis is, however, sufficiently thin to be cut through with an ordinary wood-working centre-bit if a hole for the pivot is previously drilled. The condensers are then mounted on the chassis by means of two lengths of ¼ in. brass rod tapped at each end for 6 B.A. screws.

If T.C.C. condensers are used it will be found that the conical insulating bushes surrounding the terminals will act as locating bushes and hold the condenser rigid, but with Dubilier condensers care must be taken that the terminal is quite free in the clearing hole and does not shift after the condenser has been tightened down.

The holes for the three terminals in the front flap will also be carried through the front panel, and after the chassis has been drilled it is advisable to temporarily attach it to the front panel and scribe through the holes to ensure that they will register when the assembly is nearing completion.

Connections to the various resistances are made through holes drilled in the top of the chassis near the front edge. The approximate position of these holes has been indicated, but they are not critical. The condensers of the rectifier circuit must be mounted to allow a slight clearance for wiring to pass behind them. If they are not provided with horizontal mounting holes a thin aluminium strap can be bent to hold them in position as shown in the photograph.

The fixed resistances are accommodated on the Bulgin 10-way strip shown fixed on the underside of the chassis. The strip should be held off the chassis by insulating bushes about ¼ in. long, and 6 B.A. long screws passed through clearing holes in the chassis.

Wiring

After the components have been assembled the wiring of the chassis can be carried out with the exception of the leads to the components mounted on the front panel. No special instructions are required for the connecting up, other than the need for the greatest care in the insulation of the leads, particularly those which go to the grid and cathode of the tube. The leads from the small transformer are soldered to the filament pins of the steatite valve-holder and an extra piece of thick systoflex is slipped over the twisted leads to insulate them thoroughly from the chassis. It is important that the centre tap of the heater winding be connected to the cathode by a separate lead and *not to chassis*. If this connection is wrongly made the full H.T. voltage will be applied to the insulation between heater and cathode in the tube and they will break down. If accumulator heating is used for directly-heated tubes the terminals must be well bushed where they pass through the framework.

The wire suitable for high voltage is stout rubber-covered flex which is sold under the name of ignition flex, but there is no necessity for the large diameter covering to be used. Alternatively, copper wire with two thicknesses of best quality systoflex is permissible, but it should be reinforced by bushing where it passes through holes in the chassis.

As far as possible all leads should be mounted rigidly in air and for this purpose 18 or even 16 gauge is preferable.

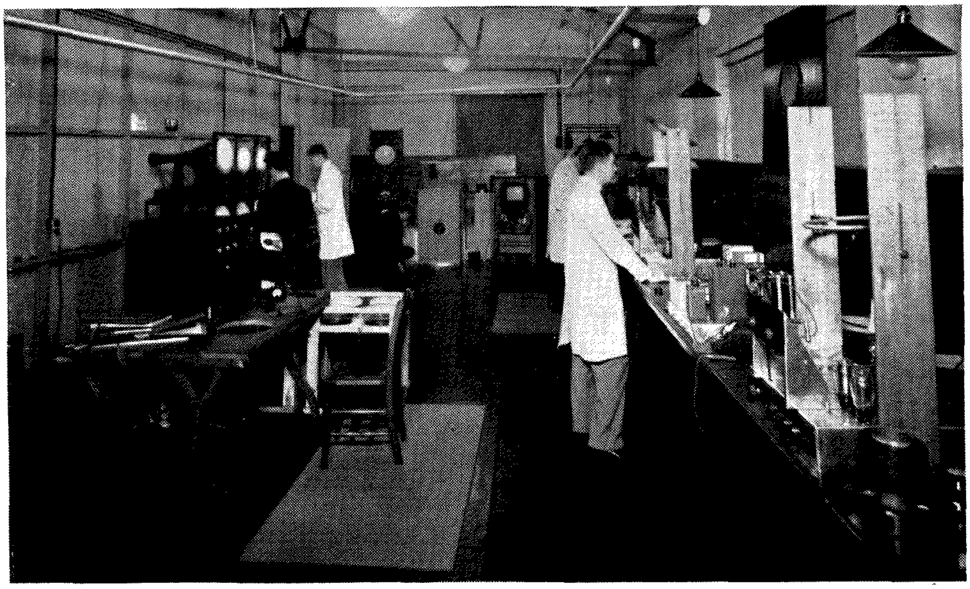
The input to the grid of the tube from the television receiver is the only part of the design which presents difficulty on account of the capacity of the leads from the unit to the tube. If the grid connection is broken at the point where the 4-pin socket is connected there is the extra length of flexible lead from the socket acting as a shunt capacity.

This will be appreciable at 2 megacycles, and a better plan is therefore to connect the output from the receiver to the tube close up to the actual socket. Accordingly no provision has been made on the chassis for a connection to the grid, but if required a pillar terminal similar to the Bulgin type SW 59 can be fitted on the chassis immediately above the grid contact of the 4-pin socket. The lead from the terminal can then be taken through the chassis direct to the grid socket the hole being drilled of ample diameter to clear the wire and reduce the capacity to chassis.

This terminal must not be connected to the receiver without an intervening condenser which must be of sufficient working voltage to withstand the full H.T. volts to chassis.

In the next article the layout of the time-base and front panel will be described.

This photograph shows the cathode - ray tube test department at the Ponders End Works of the Ediswan Co.



The two test receivers are at the far end and to the left of these is a monitoring panel. On the left is the tube life test rack.

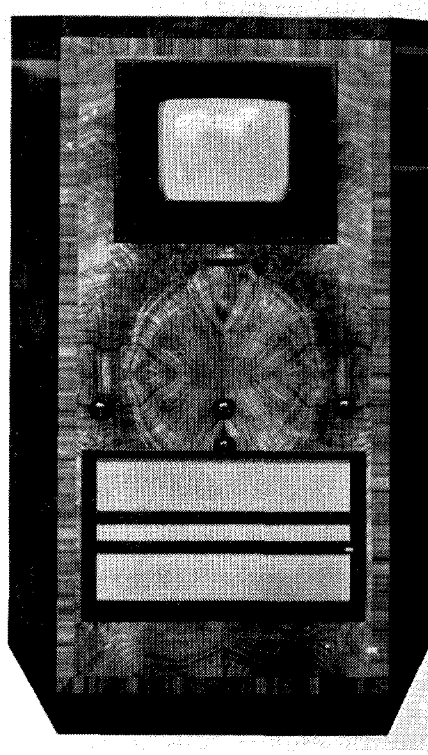
CATHODE-RAY TUBE RESEARCH AT THE EDISWAN LABORATORIES

ONE of the first concerns to realise the potentialities of the cathode-ray tube was the Edison Swan Electric Co., Ltd., and for very many years now they have conducted intensive research into the many problems that were involved. Originally this work was carried out in the special valve department at Ponders End Works, but progress in television has rendered necessary a separate laboratory devoted entirely to this highly specialised work. It is interesting to note that the laboratory is but a few steps from the original building in which Sir J. A. Fleming produced the first radio valve.

Television has also necessitated the development of some special receivers and also an experimental scanning equipment in order that the tubes may be tested under actual working conditions. This latter is a complete film transmitter, provided with an associated monitoring panel, which can be linked by line with any apparatus which it is desired to test. The laboratory is thus quite independent of the B.B.C. transmissions and development work can proceed all day.

Ediswan C.R. Tubes

The range of Ediswan cathode-ray tubes consists of the types 5H, 7H, 10H and 12H having screen diameters of 5, 7, 10 and 12 inches respectively. The 5H and 7H are intended for ordinary cathode-ray oscillograph work or in monitoring positions in connection with television transmitters or experimental scanning equipments. The 10H and 12H are essentially for use in domestic television receivers. They have been designed to give bright, well defined black and white pictures, similar in tone to the modern cinema picture. All tubes incorporate two pairs of deflector plates for electrostatic deflection of the electron beam. The latest types of high vacuum tubes possess high luminosity screens, improved focusing properties, freedom

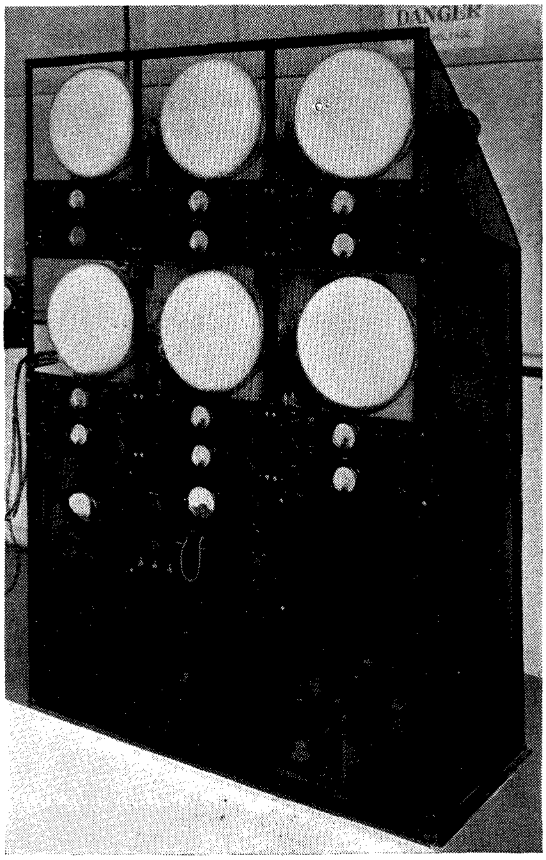


Test Receiver No. 2 designed to give the highest fidelity irrespective of cost.

from cathode disintegration due to ionic bombardment, and improved modulation characteristics so necessary for satisfactory television picture reproduction.

DETAILS OF THE EDISWAN TEST RECEIVERS

The actual manufacture of the tubes is carried out in the special valve factory (with the exception of the blowing of the glass bulbs, which is done at the B.T.-H. Co.'s works). The electrodes, etc., which constitute the " working " parts of the tube come from the presses and are hand assembled with the aid of jigs. All parts are held securely in their correct positions by spot welding. Mica separators and insulators are used throughout to secure rigid and accurate alignment of all the electrodes. The nickel cathode is of the indirectly-heated type and is coated with a barium compound. The coating is at the top end of the cylinder and not along the sides as in the ordinary radio valve.



Tube life test rack. Tubes are taken from each batch produced and run under actual television conditions at full operating voltage until the tubes are destroyed. Recent improvements have resulted in an increased length of tube life.

The complete electrode assembly is mounted on a glass pinch similar to that in a radio valve and the whole unit is placed in the bulb and sealed off in a rotary sealing machine. The tube is then exhausted on a specially designed rotary exhaust machine which automatically applies the necessary high temperature for baking out occluded gases. The necessary voltage is also applied to the heater to activate and outgas the cathode.

After the activation of the cathode, H.F. heating is employed to volatilise the barium getter to ensure that there shall be no deterioration in performance during the life of the tube due to further liberation of gases. The cap is then fixed to the tube with special cement and the leads insulated and connected to their proper contacts.

The rigorous tests to which the tubes are subjected include the checking of the cathode emission, screen brightness, shape of raster or scan modulation characteristics, cathode heater voltage and current, and shift of scan with grid control. Care is also taken to see that the variations in anode volts for spot focus are within prescribed limits. All tubes are tested at excessively high voltages to ensure that no breakdown or flash-over can occur when the tube is in normal use. A number of tubes are taken from each batch produced and run under television scanning conditions at full operating voltages and current on the life test rack.

Special Test Receivers

Three special receivers have been designed in order that the tubes and associated components can be tested under actual working conditions that would be met with in practice. In addition to the tubes these components consist of receiving valves, rectifiers, thyratrons, transformers and loudspeakers, all of which are produced by the Ediswan Company and its associated companies.

We were enabled to see these receivers working both from the Alexandra Palace transmissions and by line from the laboratory transmitter. It was of particular interest to note the difference in reproduction between each type, though this difference was only slight: each receiver gave really excellent results. It should be noted that the Ediswan Co. do not propose to market a receiver, the models shown being used solely for test purposes.

As these receivers differ so radically it will be of interest to describe them in some detail.

Receiver No. 1 (an experimental panel model) was designed and tested nine months before television transmissions were available by modulating a local 45 mc. oscillator from a film scanner using 240 lines and 25 frames per second.

It was originally fitted with a 7-in. tube, which was subsequently replaced with a 10-in. and then a 12-in. tube as at present.

At first it was designed to receive only television pictures by the Baird system, but is now suitable for reception on both Baird and E.M.I. systems. It is used in the laboratory for monitoring purposes and as a standby for demonstration purposes. It operates on the superheterodyne principle.

Receiver No. 2 (an experimental cabinet model) is radically different from No. 1 receiver. The objective in this set was to attain the highest fidelity in the picture reproduction irrespective of the cost, so that it could be used as a standard and by means of which other less costly (commercial) sets or circuits could be compared. In this set, sensitivity was sacrificed to " quality " in the vision section which employs six band-pass circuits tuned to give substantially uniform amplification to the vision carrier, the side band frequencies, i.e., 45 ± 2 mc. The R.F. amplifier is followed by a special diode detector and one D.C. type video amplifier stage which is connected directly to the control electrode of the cathode-ray tube, thus controlling directly the D.C. bias on which is superimposed the modulating video (picture) frequencies.

The sound receiver works on the super-heterodyne principle but is connected to a common aerial through a low impedance transmission line. It employs a frequency changer, two I.F. stages (1 mc.), second detector amplifier (DD triode) and two power amplifiers arranged in push-pull.

The audio response is substantially uniform between 50 and 10,000 c.p.s. Advantage is taken of this high sound quality by using dual high-fidelity speakers for sound reproduction.

Including the time base circuit, which employs relaxation oscillators for both line and frame and two paraphase connected amplifiers, there are 25 valves used in all. It should be mentioned that this set was completed and tested before television transmissions were available by means of locally modulated oscillators and special impulse generators which were designed to simulate the synchronising impulses which are now transmitted by the Baird and Marconi-E.M.I. systems respectively. It may also be mentioned that pictures from this set were demonstrated to the public at Radio Olympia for 10 days. The set worked consistently well without any re-adjustment having to be made, and has been in use daily at the laboratory ever since.

Receiver No. 3 is a domestic cabinet model designed to indicate how far the circuit could be simplified, the number of valves reduced, operation simplified, and overall dimensions reduced, without material effect on either picture or sound reproducing qualities.

A major change was the mounting of the cathode-ray tube vertically and viewing the picture indirectly by means of a special mirror. This arrangement enables the overall size of the cabinet to be reduced.

The vision channel comprises a frequency changer type AC/TH.1, which converts the vision carrier frequency to an I.F. of 4.5 mc. Three band-pass I.F. stages pass a band width of over 2 mc. using two AC/SP.3 amplifiers followed by a midget diode type V925, second detector.

The resultant vision modulating frequencies are amplified through a two-stage video amplifier employing AC/SP.3 valves. The video amplifier is resistance-capacity coupled and choke connected to amplify uniformly the full range of video frequencies up to 2 mc. A diode is associated with the output stage to regulate automatically the average brightness of the picture by the application of a D.C. component together with the picture modulating impulses to the cathode-ray tube control electrode.

In the sound channel the common frequency changing valve converts the sound carrier frequency to an I.F. of 1 mc. A filter in the anode circuit of the F.C. completely separates the sound and vision I.F. Three band-pass circuits are used to allow the full range of sound modulating frequencies only to be passed to the combined second detector amplifier. Two AC/S.2 PEN and one DD/PEN valves are used in the sound receiver.

Time Base and Synchronising Filter Circuits

The synchronising impulses are fed from the output stage of the video amplifier through a separating and phase reversing valve type AC/TP.

The " line " and " frame " impulses are then applied to two relaxation oscillators, T.31 Thyratrons, respectively. The latter generate the " line" and " frame " saw-tooth impulses which are amplified through two paraphase-connected amplifiers employing two AC/P valves respectively, and then applied to the horizontal (line) and vertical (frame) electrostic deflecting plates of a 12-in. cathode-ray tube.

The rectifiers consist of a half-wave MU2 (mercury) rectifier which delivers approximately 5,000 volts D.C. to the final anode of the cathode-ray tube. Another, which employs two MU2 rectifiers (full wave) and delivers approximately 1,100 volts D.C. to the time base circuit, and another which supplies 280 volts D.C. to the sound and vision receivers and uses one UU4 full-wave rectifier.

Pre-set controls are provided for initially adjusting focus, picture ratio, line and frame speeds, and amplitudes, and control grid bias. The gain control on the vision channel enables the picture contrast to be adjusted by the user. The set is tuned in automatically to the vision carrier by tuning the local oscillator until the sound carrier is heard.

At Ponders End this receiver is used with both gain controls nearly to minimum when connected to a half-wave dipole at ground level. Its measured sensitivity is approximately 200 uV, and this input will fully modulate a 12-in. cathode-ray tube with a grid base of between 15 and 20 volts peak.

Problems of Photographing Television

(*Continued from page* 18)

synchronisation. Modern high-definition television is synchronised to a high degree of perfection, when the eye is the judge, but over periods of, say, two seconds quite a lot of unsteadiness is sometimes noticeable in a receiver as seen by a camera. So that when the artist is still, with ample exposure and sharp focusing, and the result is blurred, unsteady synchronism was probably the cause. A good photograph of a television image should show the scanning lines on close inspection.

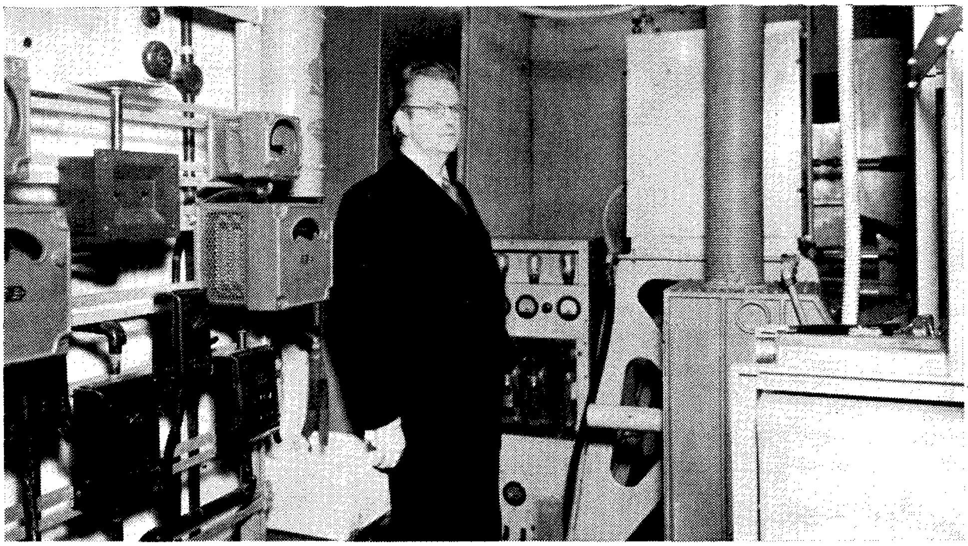
Earlier it was mentioned that in the Marconi-E.M.I. system the scanning is interlaced. Sometimes receivers do not interlace properly, with the result that the scanning lines are very clearly marked, definition is reduced, but generally speaking photographically the intensity is doubled. In such a case the picture appears apparently more exposed than others for a given exposure.

Those who use electronic exposure meters will find that the more sensitive type will give a reading of the average cathode-ray tube of such an order as to indicate an exposure of about one second at F/3 with an H. & D. speed of 1,000. The colour of the light, of course, plays an important part, the greenish tubes are more actinic than the black and white or sepia tubes. This apparent increase in actinic value may, of course, be due to " afterglow " of the fluorescent screen, which will naturally increase the exposure in some cases quite a considerable amount, and in every case increases the apparent exposure to some extent.

It is hoped that having pointed out the reasons for the difficulty of photographing a television image, photographers will attack the problem with renewed vigour, as good photographs of television images are few and far between.

BAIRD BIG-SCREEN TELEVISION

A NEW MECHANICAL DEVELOPMENT BY MR. J. L. BAIRD.



Mr. J. L. Baird in the projector room at the Dominion Theatre, Tottenham Court Road.

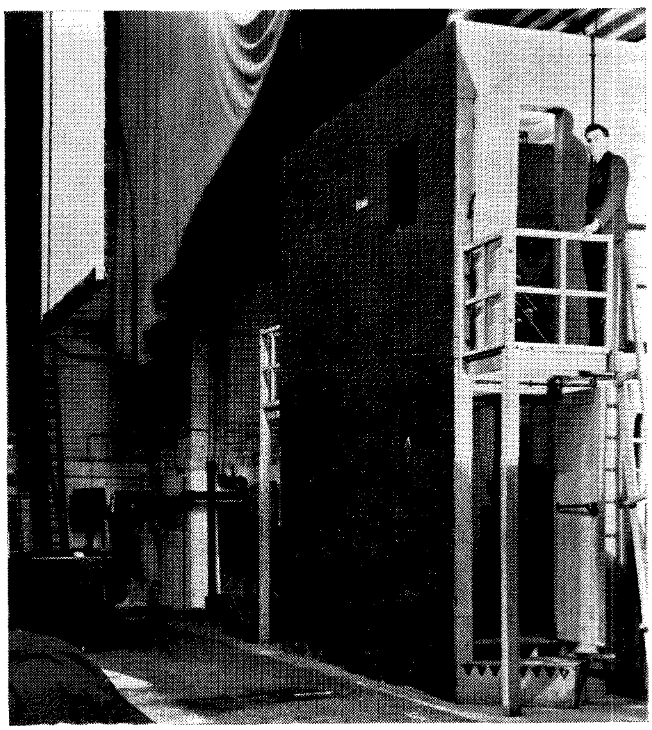
IT has been known for some time that Mr. J. L. Baird has been working in his private laboratory upon the development of television apparatus for the production of large pictures suitable for use in cinemas and other places where the audiences would be large. On Sunday, December 6, Mr. Baird gave a private demonstration of what he had accomplished.

The present purpose of this apparatus is to show a greatly enlarged image of a lecturer or entertainer to his audience. The microphone enables the speaker to be heard throughout the largest auditorium. The Baird television screen magnifies his image as the microphone magnifies his voice and enables him to be seen clearly from any part of a large hall.

The demonstration was given at the Dominion Theatre, Tottenham Court Road, and the speakers and performers were transmitted by land line from a room in the top of the building. The system is, however, applicable to wireless transmission, and experimental tests have already been made between the Dominion Theatre and the Crystal Palace.

It had, as a matter of fact, been intended to give the demonstration by means of an experimental radiation from the Crystal Palace, but unfortunately the recent fire destroyed a portion of the Baird experimental transmitting equipment, and made this impossible. It should be understood that this mass viewing equipment is not intended for receiving entertainment programmes broadcast by the B.B.C. as except by permission, no B.B.C. programmes can be presented to viewers publicly. The Dominion Theatre will, however, be in a position to make its own arrangements to use the "Super Screen" for its own purposes by means of a private transmission, so that any event which the management would like to cover could be presented to an audience. In the cinema itself, artists can, of course, be put on the screen at a moment's notice.

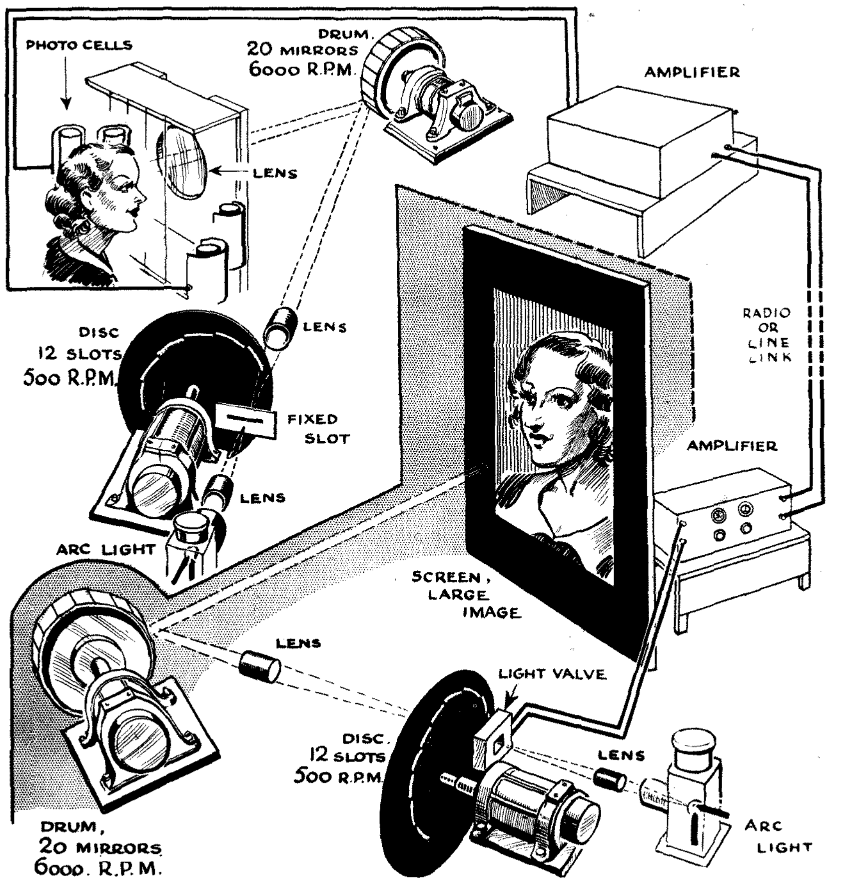
In apparatus of this kind there are two essentials—adequate light and a sufficiently large screen. With both these Mr. Baird has attained a large measure of success. The size of the screen, which is entirely covered by the picture, is 8 feet by 6 feet 6 inches which, although it falls short of the cinema screen, is of sufficient size to be seen clearly by the average theatre audience from any part of the house. The picture as shown is not so bright as the average cinema picture, but nevertheless, considering its size, it shows remark-



A view behind the scenes at the Dominion Theatre, showing the projector.

able progress. Only head-and-shoulders close ups were transmitted as the space available in the small transmitting room at the top of the building would only admit of this, but there seems no reason why external views should not be possible provided the required amount of detail was not excessive. The definition is 120 lines vertical scanning and a vertical picture.

The success of the system is largely due to the scanning system employed, which has many novel features. One important result of this is that although the picture frequency is only 16⅔ per second there is practically no flicker which is due to the multi-mesh method of scanning.



Schematic drawing of the Baird Multi-mesh mechanical transmitting and receiving system.

Multi-mesh Scanning

In the Baird multi-mesh scanning system, a secondary field is formed made up of two or more primary interlaced scans. This secondary scan is then repeated a number of times, being displaced at each repetition. In the particular form used in the present apparatus, the secondary scan consists of two 20-lines intermeshed to form a scan of 40-lines. This 40-line field is then repeated three times, in each case laterally displaced to interlace with the other fields and form a final field of 120-lines. This system gives the following advantages over straight scanning:

(1) The frame frequency is very much higher, being the same as the frequency of the primary 20-line scan. Thus, the communication channel may have a much higher low-frequency cut off.

(2) Flicker is considerably reduced.

(3) By using a scanning spot such that the secondary scan completely fills the field, a great increase in light efficiency is obtained with relatively small loss in definition.

(4) An optical system of great simplicity and very high efficiency can be employed.

The Transmitter

The transmitter consists of a slow-speed slotted disc in combination with a high-speed mirror drum. The crater of an arc lamp is focused on a slot in the diaphragm in front of which the disc revolves. The slots in the disc, as they pass over the slot in the diaphragm, form an aperture which moves backwards and forwards as the disc revolves. The light from this aperture passes through a lens on to a mirror drum which projects the rapidly moving spot of light over the scene being transmitted. As the drum revolves, the screen is covered by a succession of strips, the number of slots and the number of mirrors in the drum, together with their relative speeds, determining the number of lines in the picture. By choosing a suitable combination, any desired number of lines can be obtained.

The present apparatus gives a field with 120 lines, the disc having twelve radial slots and revolving at 500 r.p.m., while the drum has 20 mirrors and revolves at 6,000 r.p.m. This gives a picture frequency of 16⅔ per second.

The type of field used at the transmitter is such that the spots do not overlap.

Pick-up is by the usual system of photo-electric cell as with the ordinary spotlight system.

The Receiver

The scanning arrangements of the receiver are identical with those of the transmitter. An arc lamp is used as the light source, and a Kerr cell forms the light valve. The scanning system is shown by the diagram above, and it will be observed that the scanning spot is enlarged so that the secondary scan completely fills the field. By this means a substantial increase of light is obtained with a relatively small loss in detail.

It is interesting to note that the Baird Multi-mesh system is a modification of the intermeshed system originally used by Mr. Baird as far back as 1923, his original apparatus, now in the South Kensington Museum, utilised a similar slotted disc, but in this original apparatus a lens disc was used in place of the present mirror drum. The system was abandoned at that time as for low definition work a complex system

(Continued at foot of next page).

STUDIO & SCREEN

A MONTHLY CAUSERIE on Television Personalities and Topics

by K. P. HUNT

Editor of "Radio Pictorial"

PULLING pictures out of the air is something of which you don't seem to tire. I have already discovered that I can always 'phone up those friends of mine who possess a television receiver any time between 9 p.m. and 10 p.m. and be certain of catching them in! A man with a television receiver is never out when programmes are on.

Before commenting on the principal programmes of the month, I should first mention that a welcome improvement in studio technique is being effected, and during December in particular one or two changes have been made of a fundamental character.

The most important of these came into operation early in the month and was nothing less than the total elimination of intervals between programme items. After the introduction of this innovation, the effect was that each successive shot or change of material slides continuously, not abruptly, into the one succeeding it.

An official at Alexandra Palace gave me as his opinion that this elimination of programme intervals constitutes one of the most important advances in studio technique made since the high-definition programmes began. He explained to me that there is more in this development than at first might be supposed. It has, for example, largely reduced the eye fatigue which previously was caused by those abrupt changes of scene and screen tone which were inseparable from the old arrangement of definite intervals. The new scheme also appeases the lookers' natural impatience to see more, and has abolished that subconscious feeling of dissatisfaction which, although not aroused by a break in the ordinary aural radio programmes, is most distinctly evident when looking at an interrupted programme on the television screen.

This same B.B.C. official informed me that, speaking approximately, as much as one-quarter of the time that television was on the air was consumed under the old arrangements by intervals. He pointed out that, in consequence, the new non-stop regime has greatly increased the amount of work for the B.B.C.'s staff.

Miss Marietta Serle, who has had television experience in Holland.

* * *

The other major innovation at Alexandra Palace during the month has been the introduction of the Baird electron camera into actual studio transmissions.

And that reminds me to point out what a tremendously lucky thing it was that two of these electron cameras happened to be at Alexandra Palace when the recent disastrous fire took place at the Crystal Palace. One of the Baird Company's officials told me that all the other cameras which were housed at Crystal Palace were destroyed in the conflagration.

"It was purely providential," he added, "that we happened to have two of the cameras at 'Ally Pally.'" These two cameras, I gathered, are the only two of the adopted kind in existence in this country.

* * *

Notwithstanding the introduction of the electron camera, notable efforts have been made during the month to improve the working of the intermediate film system, from the studio point of view.

One of the drawbacks of this system which was experienced early in the old programme and which caused some dissatisfaction, was that after about 16 minutes the spool of film ran out and an interval necessarily had to occur. At times this caused considerable difficulty at the studio end, because it meant break-

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"Baird Big-Screen Television"

(*Continued from page 27*)

of scanning unduly complicated the apparatus at a time when television technique was not sufficiently developed to utilise its advantages. When the introduction of ultra short waves opened out the possibility of high definition television, work was recommenced with the multi-mesh system as far back at 1929.

The system can be used for cathode-ray reception and electronic transmitters, and experimental work in this direction is now going on. In Mr. Baird's own words:—

"The multi-mesh system has certain advantages over straight scanning and simple interlacing as at present used, and experimental work in its development is being actively proceeded with. This, in effect, means that we are experimenting with a new system of television which has marked potential advantages over those in use at present."

At the demonstration at the Dominion Theatre various artists were introduced by Mr. Will Hay, and finally Mr. Baird appeared and answered questions relating to the system, the questions being put to him via a telephone which was available in the auditorium. The present apparatus is of the fixed focus type and in order to ensure that artists kept at the proper distance from the scanner wires were stretched across at face level.

PROGRAMME PERSONALITIES

ing into performances in an inconvenient manner, resulting in uncompleted turns, and generally upsetting the programmes.

The innovation which completely removes these objections was put into operation at the Palace on December 14. Briefly, the idea is that the reels now installed accommodate film rather more than double the length of the old reels. This permits a continuous showing, I am told, of about 39 minutes.

Lookers who enjoyed the transmissions of "Picture Page" may not have known that the interruptions were caused in this manner, and the improvement I have mentioned as beginning in the middle of December means that a complete variety programme can now be broadcast on the intermediate film system without the interpolation as hitherto of excerpts from the spotlight studio. Mentioning "Picture Page," reminds me to say that it is still probably the most popular regular feature.

Leslie Sarony, other half of the "Two Leslies," made a hit on the television screen.

Reviewing the programmes generally, a successful effort has been made during the month to brighten up the fare, and everyone has noticed that there has been much more fun in the programmes. I should mention in passing that Claude Dampier (the "Professional Idiot") gave an extremely amusing broadcast; Leonard Henry's humorous performance was very choice; Flotsam and Jetsam also put up another remarkably fine show. Leonard Henry, by the way, tells me he is very keen about television. Ordinary broadcast listeners who remember the "Aspidistras" found them doubly funny when seen on the television screen. These clever performers did a similar act in Mid-Victorian setting in the B.B.C.'s old 30-line studio. Bruce Bairnsfather also put over a noteworthy programme.

One of the prominent television debutantes of the month was Marietta Serle, a pretty Dutch girl from Amsterdam where she has been estab-

Bransby Williams, famous character actor, who was televised as "Scrooge" on Christmas Eve.

lished five years as a teacher of singing and diction. She is also attached to the Conservatory of The Hague. During this time she has been a regular broadcaster in Holland, Belgium, Switzerland, Luxembourg and France.

The Philips' concern at Eindhoven, Holland, chose her as their television personality for demonstration purposes, and she had the distinction of appearing at demonstrations of the

Anne Ziegler, the well-known broadcasting star, who made her first television appearance last month.

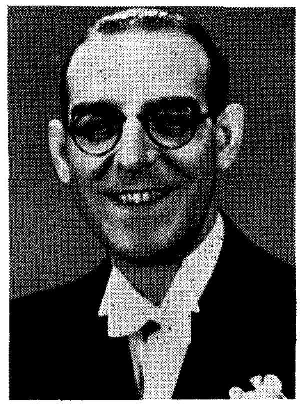
Philips' system before Princess Juliana of Holland, Prince Bernhard, and many Dutch and foreign television committees.

I met Marietta during her visit to England on the afternoon of her first television programme. She is a charming girl, and convinced me of her versatility by singing in Dutch, French, English and German, accompanied by her guitar. I thought she had gone back to Amsterdam on the day following, but was surprised to get a telephone message from her, saying that after getting all her bags packed and being on the point of departure, she had received an urgent summons from Alexandra Palace to do another programme before she left!

* * *

Guila Bustabo, the 16-year-old girl violinist, was televised twice during December. She has given recitals all over the world and is regarded as a prodigy. She wears her hair down her back, I am told, and cut rather a distinctive figure at the Palace.

Harry Pringle was responsible for the television Christmas party, which included a number of veteran variety artists. The titbit on Christmas Eve, however, seemed to me to be Bransby Williams, who was televised as

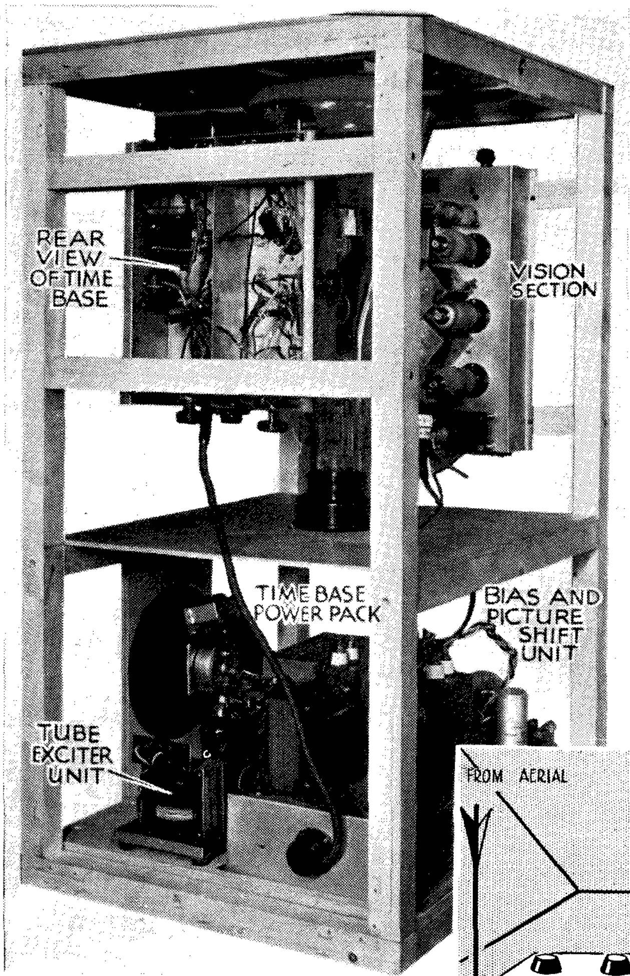


Leslie Holmes, of the "Two Leslies," made a successful debut in television last month.

"Scrooge." He is famous for the wonderful Dickens impersonations, which he has been doing for years, both on the stage and aural radio.

The television programme on Boxing Day afternoon was also notable, and I was glad to see that Sutherland Felce, who is known as "The Radio Joker," appeared in this. This was his third appearance in television last month. He was televised twice recently with Henry Hall, but is not a stranger to television as he spent a good deal of time in the B.B.C.'s old 30-line studio, from which he was televised about 20 times.

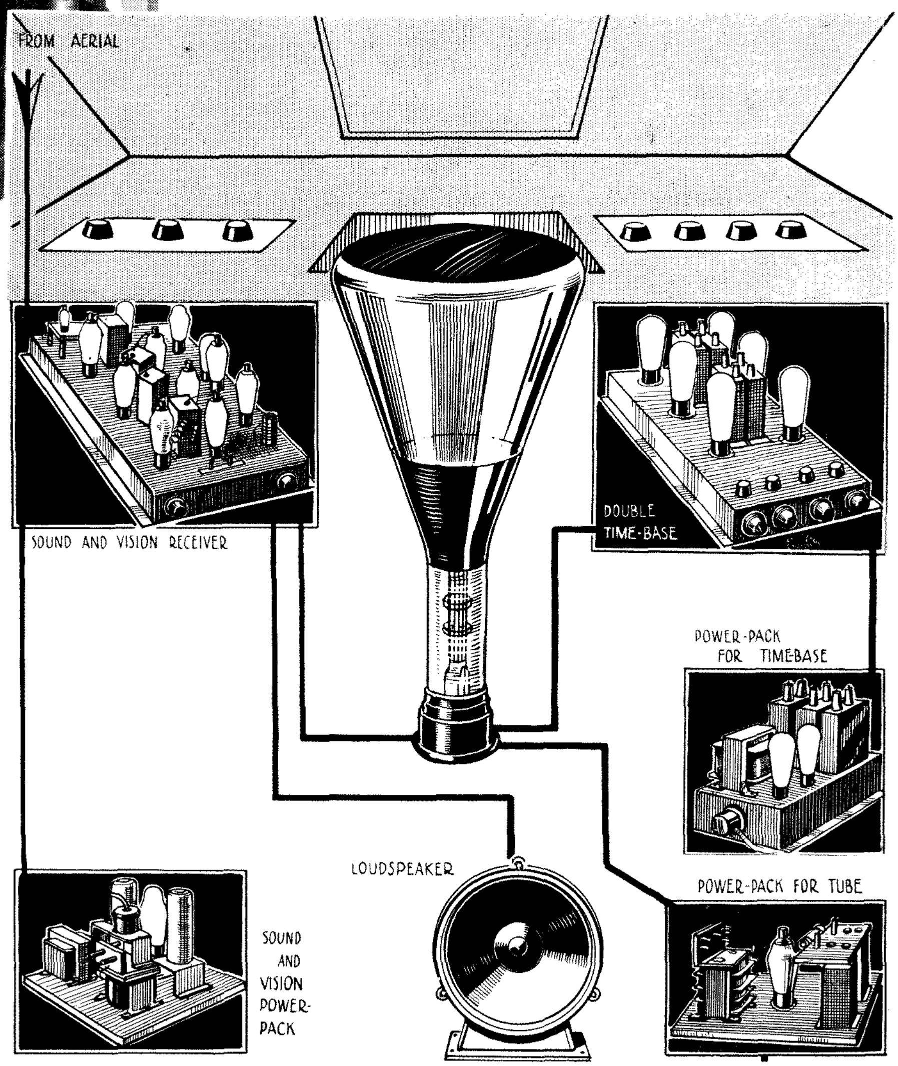
(Continued on page 62)



"TELEVISION'S" GUARANTEED

CATHODE-RAY RECEIVER

SUMMARY OF LAYOUT AND COMPONENTS WITH COMPLETE CIRCUIT DIAGRAM



WHAT A READER SAYS

"RECEPTION NOTHING SHORT OF A MIRACLE"

Gentlemen,

I feel that I should like to congratulate you for placing the public in the possession of details for constructing receiving apparatus.

Having some experience of the low-definition that preceded this service, I consider the reception to be had on the set that you describe as nothing short of a miracle. I had taken the "guaranteed" with a grain of salt, but I must apologise on this score, as I can quite understand your confidence in your protégé.

The short-wave reception of music and speech appears to me to be better, both in clarity and lack of interference, than the majority of long and medium-wave broadcasts. As far as the vision side is concerned, the simplicity of control (particularly noticeable after the old days of synchronising trouble) is very surprising, as once the picture is obtained it remains in position and requires practically no subsequent adjustment.

It is a magnificent hobby for those people with a mechanical, or electrical, bent; and I doubt if anything within the last decade has arisen which will so appeal to the old-time wireless fan in its wide ground for experimental work.

COMPLETE LISTS OF COMPONENTS USED

COMPONENTS FOR VISION RECEIVER

CHASSIS.
1—To specification (Burne Jones).

CONDENSERS, FIXED AND VARIABLE.
2—30 m.mfd. trimmers type 1023 (C) (Eddystone).
1—.1 type PCP1 (C1) (Bulgin).
1—.1 type PCP1 (C2) (Bulgin).
1—.1 type PCP1 (C3) Bulgin).
1—.0005 type M (C4) (T.C.C.).
1—.1 type PCP1 (C5) (Bulgin).
1—.1 type PCP1 (C6) (Bulgin).
1—.0001 type M (C7) (T.C.C.).
1—.1 type PCP1 (C8) (Bulgin).
1—.1 type PCP1 (C9) (Bulgin).
1—.1 type PCP1 (C10) (Bulgin).
1—.1 type PCP1 (C11) (Bulgin).
1—900/40 (C12) Eddystone).
1—.1 type PCP1 (C13) (Bulgin).
1—.1 type PCP1 (C14) (Bulgin).
1—.1 type PCP1 (C15) (Bulgin).
1—.1 type PCP1 (C16) (Bulgin).
1—.1 type PCP1 (C17) (Bulgin).
1—.1 type PCP1 (C18) (Bulgin).
1—.0001 type M (C20) (T.C.C.).
1—.1 type PCP1 (C21). (Bulgin)
1—.1 type PCP1 (C22) (Bulgin).
1—.01 type 300 (C23) T.C.C.).
1—.01 type 300 (C24) (T.C.C.).

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

CHOKES, HIGH-FREQUENCY.
1—Type T.U.S.1. (2) (Mervyn).

HOLDERS, VALVE.
7—Chassis mounting type standard, 7-pin (Clix).
4—Chassis mounting type standard, 4-pin (Clix).

PLUGS, TERMINALS, ETC.
1—Aerial connecting plug type 1047 (Belling Lee).
3 terminals type B (Belling Lee).
1—10 point plug type 1251 (Belling Lee).

RESISTANCES, FIXED AND VARIABLE.
1—50,000 ohm type 1 watt (R1) (Erie).
1—50,000 ohm type 1 watt (R2) (Erie).
1—100 ohm type 1 watt (R3) (Erie).
1—1,000 ohm type 1 watt (R4) (Erie).
1—50.000 ohm type 1 watt (R5) (Erie).
1—50.000 ohm type 1 watt (R6) (Erie).
1—200 ohm type 1 watt (R7) (Erie)
1—1,000 ohm type 1 watt (R8) (Erie).
1—100 ohm type 1 watt (R9) (Erie).
1—10,000 ohm variable potentiometer (R10) (Bulgin).
1—1,000 ohm type 1 watt (R11) (Erie).
1—250 ohm type 1 watt (R12) (Erie).
1—1,000 ohm type 1 watt (R13) (Erie).
1—250 ohm type 1 watt (R14) (Erie).
1—1,000 ohm type 1 watt (R15) (Erie).
1—250 ohm type 1 watt (R16) (Erie).
1—1,000 ohm type 1 watt (R17) (Erie).
1—10,000 ohm type 1 watt (R18) (Erie).
1—50,000 ohm type 1 watt (R19) (Erie).
1—10,000 ohm type 1 watt (R20) (Erie).
1—20,000 ohm type 1 watt (R21) (Erie)
1—300 ohm type 1 watt (R23) (Erie).
1—20,000 ohm type 1 watt (R24) (Erie).
1—50,000 ohm type 1 watt (R25) (Erie).

SUNDRIES.
1—Bracket for condenser drive (Mervyn).
1—Cord cable (Mervyn).

TRANSFORMERS, I.F.
4—Special shielded type T1F1 (Mervyn).
1—Special shielded type T1F2 (Mervyn).

VALVES.
2—MSP4 (Osram or Marconi).
1—X41 (Osram or Marconi).
4—TSP4 (Mullard).
1—D42 Osram.

COMPONENTS FOR SOUND RECEIVER

1—Westector WX6 (Westinghouse)

RESISTANCES.
R 1— 50,000 1 watt type (Erie)
R 2— 50,000 ,, ,,
R 3— 200 ,, ,,
R 4— 50,000 ,, ,,
R 5— 20,000 ,, ,,
R 6— 50,000 ,, ,,
R 7— 50,000 ,, ,,
R 8— 300 ,, ,,
R 9—100,000 ,, ,,
R10—½ megohm ,, ,,
R11— 20,000 ,, ,,
R12— 100 ,, ,,
R13— 10,000 ohm potentiometer Bulgin

CONDENSERS.
C 1—.1 type PCP1 (Bulgin).
C 2—.1 type PCP1 (Bulgin).
C 3—.0001 type M (T.C.C.).
C 4—.1 type PCP1 (Bulgin)
C 5—Variable type 900/40 with slow motion head No. 1012 (Eddystone).
C 6—.1 type PCP1 (Bulgin).
C 7—.0001 type M (T.C.C.).
C 8—.01 type 300 (T.C.C.).
C 9—.01 type 300 (T.C.C.).
C10—50-mfd. 12-volt working type E.C.3 (Bulgin).
C11—.1 type PCP1 (Bulgin).
C12—.01 type 300 (T.C.C.).
C13—.01 type 300 (T.C.C.).

COILS.
L1—6 turns bare copper or Eddystone type 1050.
L2—4 turns bare copper or Eddystone type 1050.
L3—4 turns bare copper or Eddystone type 1050.

TRANSFORMERS.
2—I.F. transformer suntuned 115 Kc (Varley)

LOUDSPEAKER.
1—37J (W.B.)

SUNDRIES.
2—Valve top connectors (Belling & Lee).
connecting wire and flex, etc.
3—Seven pin-valveholders (Clix).

VALVES.
1—T.H.4 (Mullard).
1—V.P.4 (Mullard).
1—AC2/Pen (Mazda).

Components for POWER UNIT OF VISION AND SOUND RECEIVERS

BASEBOARD.
1—Wooden baseboard to specification (Mervyn).

CASE.
1—Metal protecting case (Burne Jones).

CONDENSERS, FIXED.
1—4-mfd. electrolytic type DWL 1764 (Hunt).
1—8 plus 8 mfd. electrolytic type DWL 2657 (Hunt).

CHOKE, LOW-FREQUENCY.
1—Split choke 50 henry 120 Ma (Sound Sales).

HOLDER, VALVE.
1—4-pin chassis mounting type standard (Clix).

PLUGS, TERMINALS, ETC.
1—Mains input connector type 1014 (Belling Lee).
1—Bracket complete with 10 point (Belling Lee) socket (Mervyn).

SUNDRIES.
1—Bracket for valve and electrolytic condenser (Mervyn).

TRANSFORMER, MAINS.
1—Special to specification (Bryan Savage).

VALVE.
1—U 12 (Marconi).
1—DSL/1 (Ediswan)

COMPONENTS FOR SCANNING CIRCUITS

FIXED RESISTANCES—One Watt (Dubilier).
3—1-megohm
1—200,000-ohm
3—150,000-ohm
1—100,000-ohm
1—500,000-ohm
1—85,000-ohm
1—30,000-ohm
1—20,000-ohm
1—15,000-ohm
1—10,000-ohm
1—5,500-ohm

Half Watt (Bulgin).
4—5-megohm
4—2-megohm.

POTENTIOMETERS (Reliance).
2—2.0-megohm
2—0.5-megohm
2—0.1-megohm
2—50,000-ohm
2—100,000-ohm special with centre tap.

CONDENSERS (Dubilier).
2—Type 4001 50-mfd. 12-v. working.
1—Type 3004 50-mfd. 50-v. working.
1—Type 3016 12-mfd. 50-v. working.

B.I. (Mervyn)
4—0.1-mfd. 2,000-v. working, tubular.
2—0.1-mfd. 1,000-v. working, tubular.
2—0.001-mfd. 1,000-v. working, tubular.
1—0.1-mfd. 1,000-v. working, tubular.
1—0.005-mfd. 1,000-v. working, tubular.

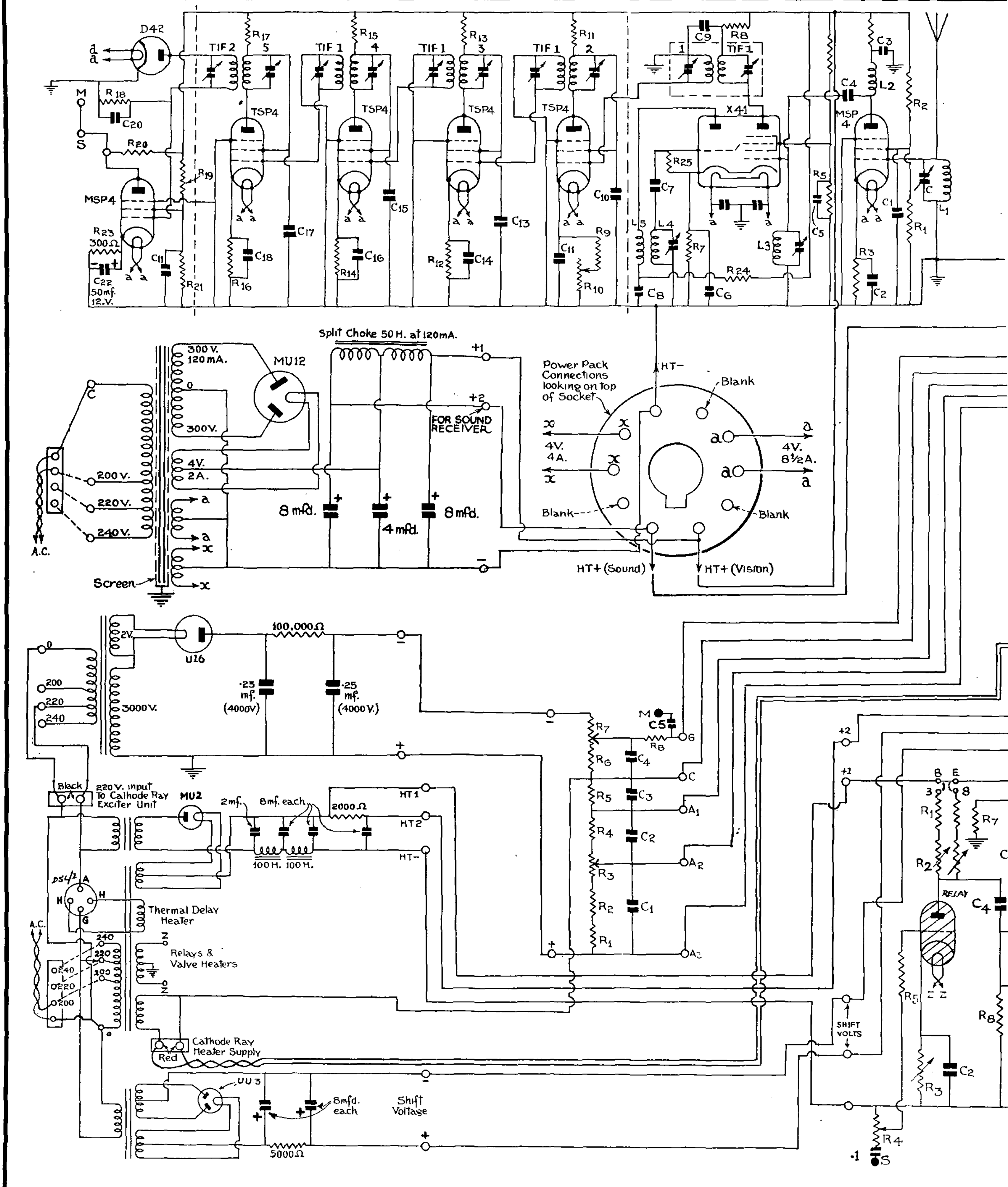
VALVE HOLDERS.
6—Chassis mounting 5-pin (Bulgin).

SUNDRIES.
1—5-pin plug and socket type 1260 (Belling-Lee).
1—Type P.20 Mains connector (Bulgin).
1—Type SW41 5-pin socket (Bulgin).
1—Type P.3 5-pin plug (Bulgin).
2—Bulgin S.81 B. switches
2—Bulgin C.31 group boards
2—Valve top caps (Bulgin).

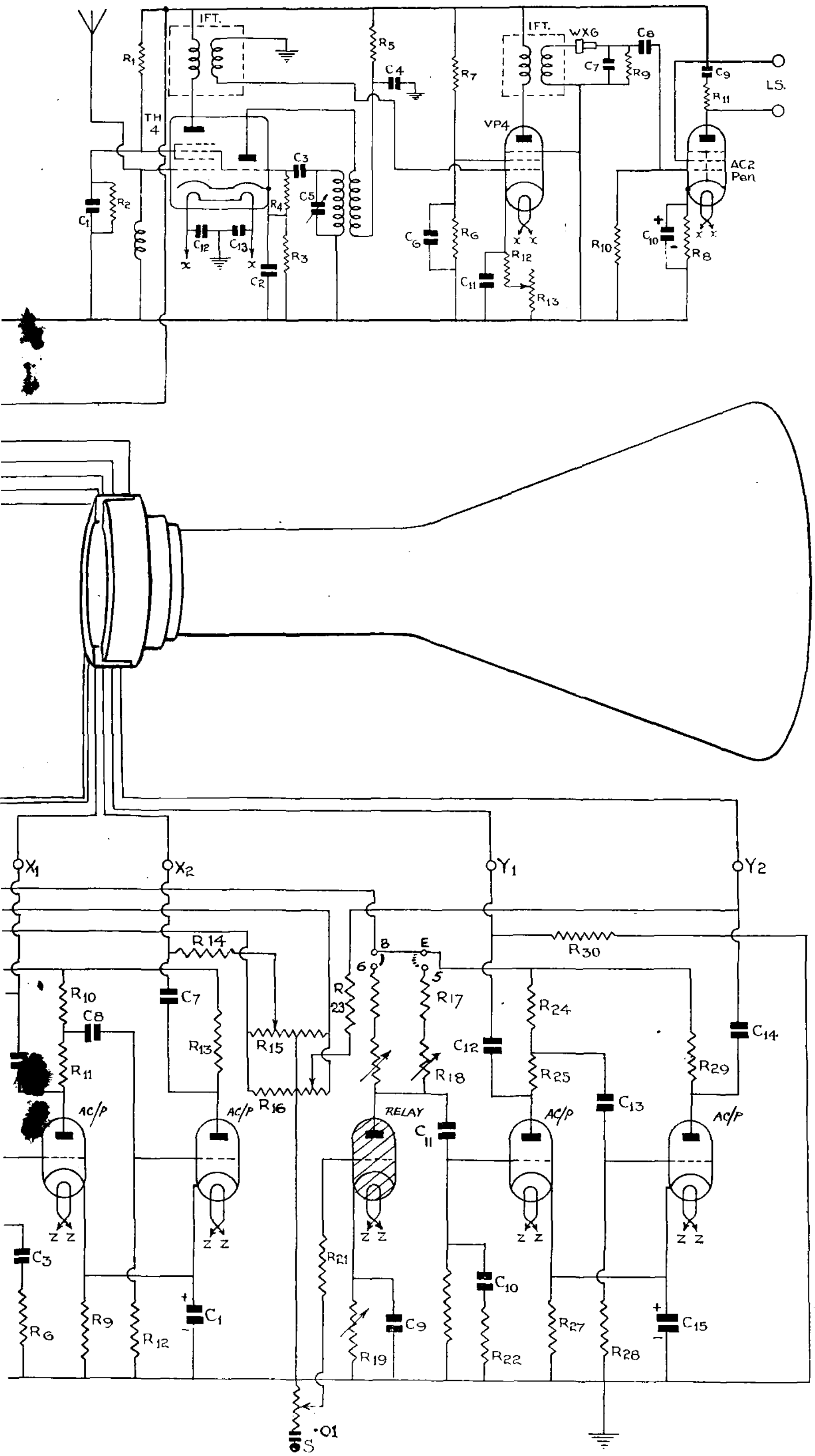
VALVES.
2—T.31 Thyratrons (Mazda) or Ediswan HE/A.C.1.
4—A.C./P. (Mazda)

(*Components continued on page 33*)

THE COMPLETE CIRCUIT DIAGRAM OF " TELE



VISION'S" GUARANTEED CATHODE-RAY RECEIVER



Components continued from page 31

Components for TIME BASE POWER PACK

CHASSIS.
1—Special metal chassis and cover (Mervyn).

CONDENSERS, FIXED.
3—8-mfd. 1,000 volt (B.I.-Mervyn, or T.C.C.).
1—2-mfd. 1,000 volt (B.I.-Mervyn or T.C.C.).
1—8 plus 8-mfd. condenser (B.I.-Mervyn).

CHOKES, LOW-FREQUENCY.
2—100 henry 30 M/a (Keston Manufacturing Co.).

HOLDERS, VALVE.
3—5-pin type VH19 (Bulgin).

PLUGS, TERMINALS, ETC.
1—Plug top valve connector type 1156 (Belling-Lee).
1—Fused voltage-change input conector type 1088 (Belling-Lee).
2—Terminals type B red (Belling-Lee).
2—Terminals type B black (Belling-Lee).
2—Terminals blocks type 1039 (Belling-Lee).

RESISTANCES, FIXED.
1—5,000 ohm type 1 watt (Erie).
1—2,000 ohm type 1 watt (Erie).

SUNDRIES.
Connecting leads, wire and sleeving.
1—Bakelite strip.

TRANSFORMERS, MAINS.
1—Filament transformer (Keston).
1—H.T. transformer (Keston).
1—Shift transformer (Keston).

VALVES.
1—MU2 (Mazda).
1—DSL/1 (Mazda).
1—U.U.3 (Mazda).

Components for CATHODE-RAY TUBE POWER PACK.

TRANSFORMER.
1—Mains transformer (London Transformer Products, Ltd.).

CONDENSERS.
2—.25-mfd. 4,000-volt working (B.I.-Mervyn)

SUNDRIES.
1—1000,000-ohm, 1-watt resistance (Erie).
1—Chassis and cover (Mervyn).
1—5-pin valve holder baseboard type (Bulgin)
1—Valve (Osram U16 or Mullard H.V.R.).

Components for RESISTANCE CHAIN.

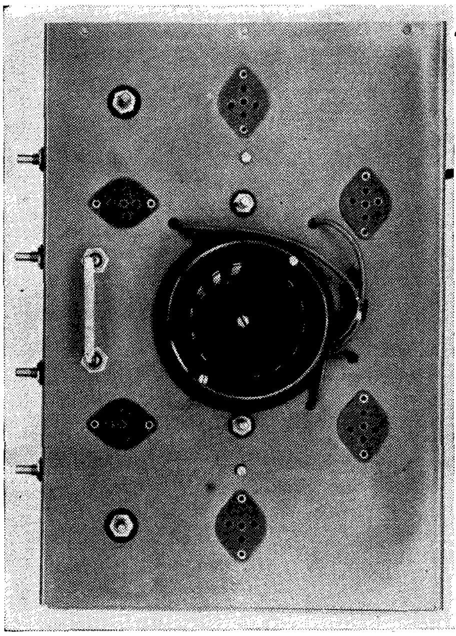
R1 2.0 megohms (2 W).
R2 1.5 megohms
R3 0.5 megohm
R4 1.0 megohm
R5 0.4 megohm
R6 0.1 megohm
R7 0.1 megohm
R8 2.0 megohms (¼ W).
C1 0.5 mfd. 4,000 V. wkg.
C2 1.0 mfd. 1,500 V. wkg.
C3 1.0 mfd. 500 V. wkg.

"Television and Short-Wave World," January, 1937.

AN ALTERNATIVE TIME BASE FOR THE RECEIVER

As an alternative to the time base that was described last month a second one has been developed with which simplification at many points has been possible, though it follows the usual type of circuit. With simplification it has been possible to reduce the cost.

As will be seen from the photographs the tube is mounted on the time base chassis and this therefore will entail some modification to the complete receiver; also battery bias is employed and owing to the position of the tube the time base is not so readily accessible for experimental purposes. It may be used in our Guaranteed receiver with safety, particularly as the same power pack will be entirely satisfactory and if the construction is carried out as described no trouble should be experienced.



Top view of time base

In its present form it is designed for double electrostatic deflection and for use with a cathode-ray tube that has its third or final anode earthed. (The Guaranteed Receiver is of this type.) It therefore should not be used in any other way.

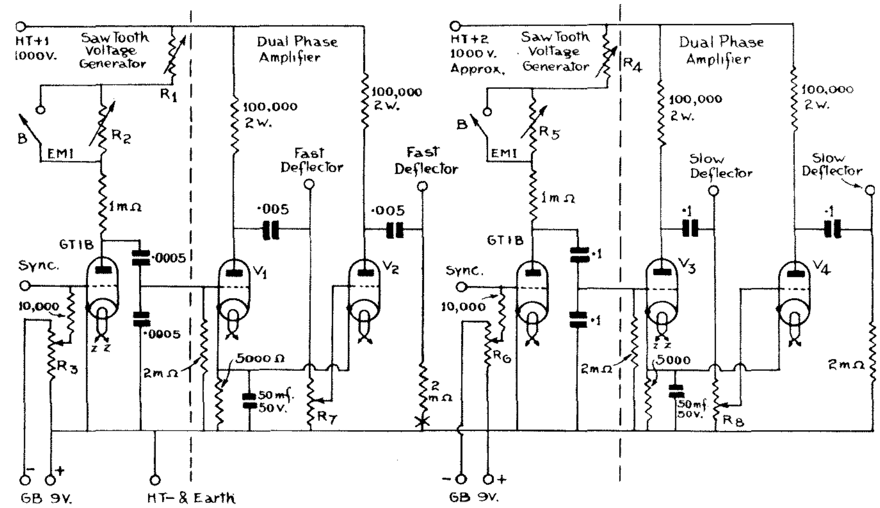
The design is by W. J. Nobbs, F.I.S., A.M.I.R.E., and the complete kit is available from the Mervyn Sound & Vision Co., Ltd.

Special Features

Before proceeding to the construction certain features should be pointed out.

In the first place entirely disregard the gas discharge circuit and examine the amplifiers. It will be seen that both sections (frame and line) are identical with the exception of coupling condenser. The description of one section, therefore, will cover both.

In the second place phase inversion is taken care of by tapping off part of the voltage on the resistance used to return the deflectors to the cathode-ray tube third anode. It will be seen that simplification has taken place at this vital point with the consequent reduction in the number of components, construction time and cost. The reduction in components and necessary wiring allows the wiring to be carried out carefully. It must be realised that anti-capacity wiring and spacing should be employed in order to ensure that the "fly-back" time is not unduly prolonged, otherwise the picture on the left-hand side will be cut off. Where the flyback time is too long it is possible to "loose" five or ten per cent. of the picture. This point will be dealt with later.



The circuit of the alternative time base

Thirdly, bias for the deflector plates is not provided, as under normal conditions the picture can be centred by adjustment of the condenser values connecting the deflector plates to the valve anodes. This method is only useful when the picture is not too far out of position. The alternative is to connect the appropriate return to a potentiometer across the H.T. supply. This simply means that if the deflector from the first valve, when joined to the centre point of the potentiometer, places the picture further off centre it will be necessary only to take the first deflector return to its proper point and connect the second deflector to the centre of the potentiometer. An adjustment will then bring the picture into correct position.

This potentiometer is connected with stiff wire directly into the wiring and is then self-supporting. Once the adjustment is made it need not be touched. This component is not supplied with the kit, but it is available at a low cost. It is light in weight and is easily supported in the wiring.

Complete separation of both line and frame sections is necessary and accordingly a metal screen is provided.

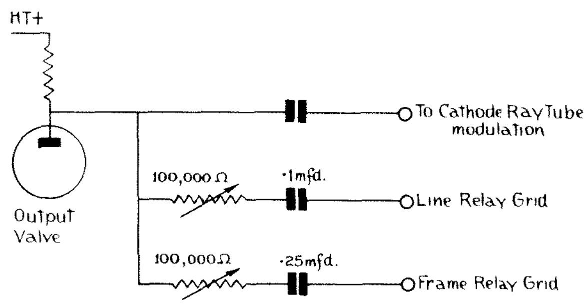
A single hole is provided on the chassis so that the cathode-ray tube holder can be mounted and rotated to bring the scanning field square with the cabinet mounting.

The chassis can be mounted either vertically or horizontally, which gives the choice of either viewing the pictures directly on the end of the tube or via a mirror.

In considering the gas discharge tube circuits it will be noticed that they follow conventional form with one or two variations. The amplifiers are designed to give a high voltage linear output so that the gas discharge relays may be operated at low anode voltages.

Taking the anode circuit it will be seen that the series " charging resistances " are in two sections, one section of which can be shorted out. It is then only necessary to provide one variable control for one system and a further variable control in the shorted-out section for the other system. The charging condenser is in two parts and the centre is taken to the grid of the first amplifying stage.

The gas discharge tube grid circuit employs a fixed



Connections for simple synchronising the double time base

resistance of low value with the return taken to a potentiometer across a separate bias supply. The simplest form is a grid bias battery although a mains-operated unit may be used. It is unwise to employ self bias or obtain the required 9 volts in the negative lead by a dropping resistance. Both these schemes may be used, but the disadvantages considerably outweigh the advantages. This point should be kept in mind as it has an important bearing on simple operation.

Synchronising of the picture is obtained in a simple way. Although there are many ways in which it can be achieved with perfect results they all require careful adjustment. The method that will be shown later will prove entirely stable for long periods and as it is so simple it is the best for all initial work.

It has been stressed that the amplifying side be examined separately from the gas-discharge tube circuits. If the complete circuit is always viewed from this angle no confusion should ever exist if and when it is decided to experiment with hard valve " saw-toothed " wave form generators.

It will be seen now that we have two circuits, one a " saw-toothed " wave form generator (provided by the gas-discharge tube) and an amplifier (provided by the dual phase valves.)

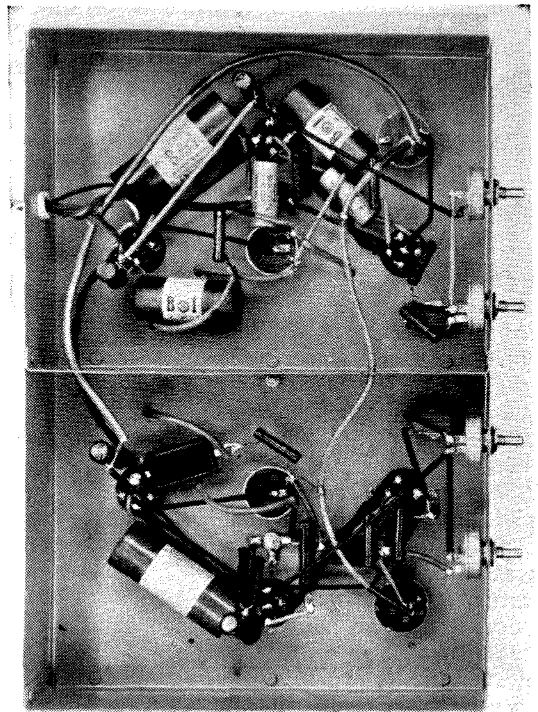
The H.T. supply to each complete section is separate in order to prevent mutual coupling via the H.T. supply. If the two complete sections are not kept separate it will be almost impossible to obtain an interlaced picture to the E.M.I. transmission. Even when the circuits are perfectly decoupled it is difficult to maintain the interlacing.

Construction

To proceed to the constructional work. The steel chassis is provided with the valve holders as well as the charging potentiometers, bias controls and phase reversing potentiometers mounted. For convenience these are marked by letters which co-related with the list of components.

Wire all the heaters 3 to each section with twisted leads in the usual manner.

Work on the amplifiers should be undertaken first. The bias resistance and its condenser should be soldered into position. Solder the grid leaks in position and the



Underside view of alternative time base

phase reversal potentiometer connections. Next the anode resistances and the deflection condensers; note that heavy rubber leads should join the deflector condensers to the cathode-ray tube base, the leads being taken through the holes provided. Do all the under chassis wiring and push the deflector leads through the holes in the chassis. They can then be soldered on when the chassis is turned over. The remaining connections will not be difficult and examination of the wiring in the photographs should make clear any point that may be doubtful.

The circuit diagram has been drawn so that each stage is clearly shown. When the wiring is complete examine it very carefully to see that no mistakes have been made and that all connections are secure.

Operation

When satisfied that everything is in order insert the valves and gas-discharge relays in the correct holders and switch on the H.T. and L.T., not forgetting to connect a 9-volt bias battery. If all connections have been made correctly alteration of the controls should result in a change in pitch of the gas-discharge tubes as the noise can usually be heard via the valves. To make quite sure a pair of telephones may be connected to the valve anodes and earthed via a .1 mfd. condenser. The " saw-toothed " voltage generated should now be clearly heard.

Next month: Complete ajustment and operation of both time bases

"ELECTRONIC TELEVISION" (Continued from page 9)

the detail accordingly. The Alexandra Palace transmissions are somewhat restricted in this manner even on 400 lines.

So much for the highest frequency. What is the lowest frequency? It is, as a matter of fact, zero, that is in electrical language d.c. and almost as difficult to transmit and amplify by radio apparatus as is a very high frequency.

It is not difficult to see why zero frequency is necessary. It is really the average brightness of a picture which may change very slowly from scence to scene, for example, if there is a sunny scene, a cloud may come up, taking perhaps 20 seconds to darken the picture, or, in other words, the system must record a change taking place at the rate of 1/20th of a cycle per second. Not only the rapid change from black to white must be transmitted, but also the steady " d.c. component " corresponding to the background. An actual picture is not as a rule so simple, and its d.c. component is determined by the general average light of the whole picture.

If the picture is a " still " picture, it is easily proved that the d.c. component remains constant, and the next lowest frequency that may have to be transmitted is that of the picture repetition 25 cycles per second.

A " close up " of someone speaking is very nearly a still picture for the purpose of this argument, and it will be seen that for such pictures we might eliminate all frequencies below 25 per second. This would simplify apparatus, and might conceivably be used if television were operated as an adjunct to the ordinary telephone service between subscribers.

However, if the picture is moving, the average intensity may change at any lower frequency and this change must be faithfully transmitted.

Fig. 10 shows the frequencies in different parts of the system. The top line represents the frequencies in cycles per second that might be present in a picture when converted to electric current; as we have just argued, they may be from zero to 1½ million and of varying amplitude.

Sound accompying the picture needs only the range from, say, 50 to 10,000 cycles. The synchronising signal comss at the end of every line 10,000 per second, and again of longer duration at the end of every picture, 25 per second.

At the transmitter these sound and vision frequencies are made to vary the true radio frequency which is to be radiated. The radiated waves which carry the sound and vision are respectively 41.5 and 45 million cycles, and the next line indicates how the necessity of carrying the sound and vision modifies these waves so that they overlap the neighbouring frequencies, producing what are known as side bands. The sound band is too narrow to be shown on this scale.

The receiver has an oscillator tuned to 42 million cycles. Just as two tuning forks a little out of tune make a low-frequency beat note, so the receiver gives us two electrical beat frequencies, one for sound, one for vision, which we can separate by resonant circuits, each to do its own job.

Synchronising Impulse Separator

Fig. 11 shows a circuit which can be used in the receiver to separate the synchronising impulse from the picture. The pentode valve with a high impedance in the grid circuit has an input output curve which flattens off. It is adjusted so that it is completely loaded to the flattening point by black. A portion of the combined signal is tapped off, but in the anode of the valve only the synchronising signal appears, and is transmitted to the time base. The picture cannot get through to cause false synchronisation because it is lost in the flat top of the curve.

Contrast

It is important to know what range of contrast is necessary in television. In outdoor scenes, the range is about 50,000 to 1, but the eye does not observe all these at once as it adjusts itself by accommodation to the mean brightness and can then see perhaps a brightness 1 per cent of that as not quite black—upper limit doubtful.

A home cine works with less contrast ratio than this, say, 60:1, and in fact a good deal less contrast even down to 25:1 gives pretty good results.

Cathode-ray tubes are operated at a better contrast range than this.

Flicker

The light from a cinema picture or a television screen is essentially intermittent, and unless the pictures are repeated frequently enough, they flicker badly. The frequency necessary for repetition to avoid flicker, depends entirely on the brightness.

In interlacing methods 25 pictures per second are still shown, but each picture is scanned twice, missing alternate strips the first time and looking at them the second.

Iconoscope

The photo-electric cell has been described as a device passing an electrical current which depends on the light falling on it.

An Iconoscope (image viewer) makes use of the idea of combining a great many such cells together by depositing on a plate minute globules of caesium metal. Such a mosaic may contain several million globules. It is placed inside the evacuated bulb and connected in an electrical circuit so that each globule forms a little condenser between itself and the conducting back plate.

An electron beam is made to scan it, and the picture to be transmitted is focused on it. In the dark, the beam electrons each time they reach a globule, charge it up to a definite voltage (determined by secondary emission); all little cells reach a steady potential. Wherever there is light on the plate from the image, photo electrons go to the anode making the plate more positive. Next time the beam comes, it gives up some electrons to this patch which has lost them and so causes an impulse of electricity in the amplifier connected in the circuit.

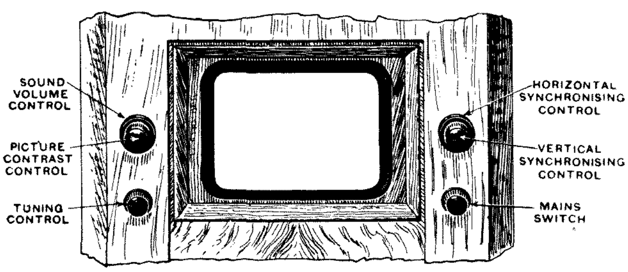
The extreme importance of the Iconoscope arises from the fact that the light from the image can do its job of releasing photo-electrons all the time, while the electron beam itself is away scanning some other part of the picture. The beam returns every 50th of a second, say, but is actually dwelling on a picture point for only ½ millionth of a second each. In nearly every other system, the photo-cell is only allowed to look at the object for the time taken to scan one picture element.

THE CONTROLS OF A TELEVISION RECEIVER—AND HOW THEY ARE USED

WITH PARTICULAR REFERENCE TO THE G.E.C. RECEIVER

THE control of a television receiver may be considered under two headings—(1) the operation of the controls which enable a picture to be obtained either by the Baird or Marconi-E.M.I. systems, and (2) the setting of the pre-set subsidiary controls which, once adjusted, will only require resetting with some alterations of conditions.

The former controls are readily accessible on the front of the cabinet and it may be said at once that their adjustment is quite as simple as with any broadcast receiver. It follows, therefore, that anyone who can tune an ordinary wireless receiver will be able to master the control of a television receiver after five minutes' experience with it. Another point is that once the receiver has been adjusted it can be put into use at a future time by the mere turning of the on/off switch.



This drawing shows the normal controls on the G.E.C. receiver.

This latter statement perhaps needs a little qualification for my personal experience has been that there is a slight variation in the transmissions that calls for a little adjustment of the controls if the best results are to be obtained. In any case, however, the mere act of switching on will produce a picture and the further adjustment which may be desirable is quite a simple matter. This means that any member of a family will be able to make full use of the receiver.

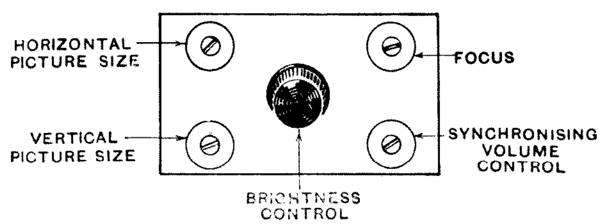
The following notes are based upon experience with the G.E.C. (Model B.T.3702) television and all-wave receiver. The latter, of course, although contained in the same cabinet, is quite distinct from both the sound and vision sections of the television receiver so the following remarks deal primarily with this.

The veriest novice can secure excellent pictures with the G.E.C. receiver.

The Simple Controls

The main control is the 4-position on/off switch (see Fig. 1), which from the normal "off" position can be moved into one position in an anti-clockwise direction and into two positions clockwise, again from the normal " off " position. The anti-clockwise movement switches on the all-wave radio receiver and the clockwise movement switches "on" for the reception first of the Baird system and in the second position of the Marconi-E.M.I. system. As remarked before, providing that the receiver is properly adjusted, the operation of this switch will produce a picture when a transmission is taking place.

When this switch is operated, after a few moments a spot of light appears on the screen and quickly begins to move to produce the scan, the amplitude of movement being small at first, but steadily increasing in both horizontal and vertical directions until the entire screen is covered. If there is no transmission on, the intensity of the light gradually decreases until the scan is barely visible and the screen becomes almost entirely dark. If, however, a transmission is taking place then the pic-



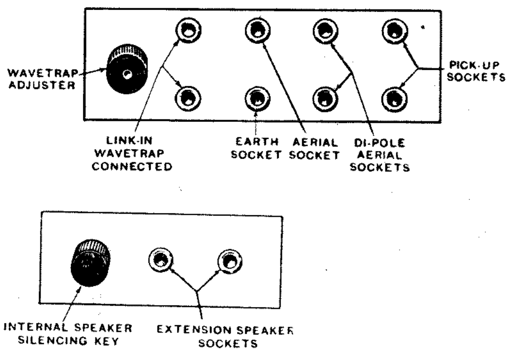
The " Brightness " and four preset controls are accessible through a small door in the side of the cabinet.

TUNING FOR BEST RESULTS

ture quickly begins to form, and before the screen is completely covered by the scanning lines it is possible to observe the details. After the screen is entirely covered the picture slips a few frames and then automatically centres itself and after this it will remain rock steady for the entire duration of the programme.

The second control is for tuning both the sound and vision signals. With the G.E.C. receiver the tuning of the sound signals is much more critical than that of vision, and therefore when the sound is tuned in, the vision is also automatically correctly tuned; the latter can be received beyond the limits of the sound on either side. A stop is provided on this control so that, in any case, the tuning can never be much out of adjustment.

A sound volume control is provided for the sound part



These are the terminal panels on the back of the cabinet. Connections are made by plugs.

of the television signals and with this the volume can be varied from a whisper to full volume.

Concentric with the sound volume control is a picture contrast control which is the vision equivalent of the sound volume control. Rotation of this in an anti-clockwise direction decreases the brightness of the screen, but increases the contrast. It will be appreciated that the operation of this control, although not essential, is very useful when the contrasts in the transmission are not sufficiently great, as for instance in the case of a light costume against a light background, or during the transmission of a film of a somewhat flat character.

On the other side of the cabinet are the line and frame synchronising controls, which rarely require touching. These two controls are concentric, but are intended for separate operation. As a rule they only require adjustment after having switched from one system to the other, and the effect of turning one or the other of these two controls becomes at once so apparent by the appearance and movement of the picture that one cannot fail to get them into proper adjustment quite easily. To those who had experience of the old 30-line transmissions with the picture hunting up and down, the synchronising of the G.E.C. receiver is a revelation—a slight touch to the controls and the picture remains rock steady for the entire duration of the programme.

Subsidiary Controls

The controls which have been mentioned above are the only ones which it is *essential* to operate under any conditions whatever, and it speaks well for the design of the receiver that with these simple adjustments such perfect results and steady pictures can be ensured.

There are five subsidiary controls in the G.E.C. receiver and these are mounted on a panel which is accessible through a small door in the side of the cabinet. Only one of these—the brightness control—is intended for hand operation. The remaining four can only be adjusted by means of a tool, and they are set by the manufacturers and are not intended to be touched except in some such event as the cathode-ray tube being changed. These controls are: (1) the horizontal picture size, (2) the vertical picture size, (3) focus, (4) synchronising volume control.

The G.E.C. receiver has already secured for itself the reputation of providing exceedingly good definition; usually the picture can be examined at very close quarters and found to contain amazing detail, in fact more than would be thought theoretically possible. It is by what might be termed the finer " nuances " of control that full advantage may be taken of this and my experience has shown that by careful adjustment of the brightness control (which is the only hand-operated subsidiary control) in conjunction with the contrast control the full resources of the instrument can be secured.

One may sum up the whole matter of television receiver control by saying that the merest tyro cannot fail to obtain excellent pictures after five minutes' experience, but that the finest results are dependent upon a certain amount of acquaintance with the receiver and a little practice in its operation. It is interesting to note that the modern television receiver is " foolproof " in so far as its control is concerned—that is misuse of the controls cannot in any way damage the receiver, and the user, despite the high voltages that are employed; is not exposed to the slightest risk of shock.—H.C.

Components for the Television Constructor

EXPERIMENTERS and students interested in high- and low-definition should make a note that Messrs. H. E. Sanders and Co., of 4 Gray's Inn Road, W.C., are able to supply apparatus for 30,240 and 405 line reception and transmission.

They also have a complete stock of measuring instruments by well-known makers at very low prices. For the advanced worker galvos, Wheatsone bridges, impedance bridges, oscillographs, etc., are available at remarkably low prices.

We strongly advise readers interested in such instruments and apparatus to get in touch with Messrs. H. E. Sanders, who are one of the few firms catering for the scientific experimenter.

Meters suitable for transmitting work are also available and readers will be able to obtain high grade instruments at a fraction of their original cost.

The British Short-Wave League

This league has now been active for nearly a year, during which time the membership has increased to over 400. Transmitting members include SU1KG, W4UP, W6NDF, W2IXY, G5LP, G6GR, G12CC, and G6LX and G6PD, who act as technical advisers.

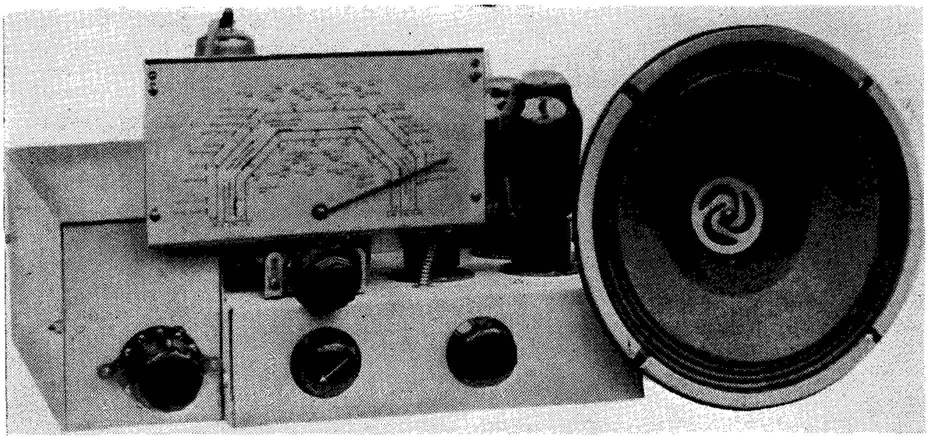
Full information can be obtained from F. A. Beane, Esq., Ridgewell, Essex, who will supply a specimen copy of the " Short-Wave Review," for 2d., post free.

A 4-Valve All-wave Super-het

We have pleasure in introducing this 3-channel receiver built on commercial lines. It has undergone extensive tests so that readers can construct it with every confidence. The cost of the components will also represent a big saving over a commercial set of a similar type.

FOR several years enthusiastic short-wave amateurs have known the full value of short-waves. It has been possible with quite simple apparatus to receive programmes from America, Africa and Australia with such regularity that listeners have been tuning in to particular programmes just as they would to items from the local regional.

The average listener with a broadcast receiver is inclined to be sceptical, and in the few cases where a short-wave receiver was tried, lack of experience did not allow of satisfactory results. Thanks to the flood of commercial all-wave receivers, short-wave bands are now receiving the attention they deserve, and everyone who can afford it is investing in an all-waver when their old receivers need replacing.



If the loud-speaker is mounted just above the tuning dial the receiver will have a very pleasing appearance. The wave-change switch has a positive action and is a part of the complete tuner.

Home constructors can build three-channel receivers that equal the commercial instrument in performance, and at the same time save a considerable sum of money. For a long time we have noticed the need for an absolutely fool-proof all-wave receiver, not for the short-wave fan interested in amateur reception, but for the average man wanting to hear long-distance foreign stations that have programme value.

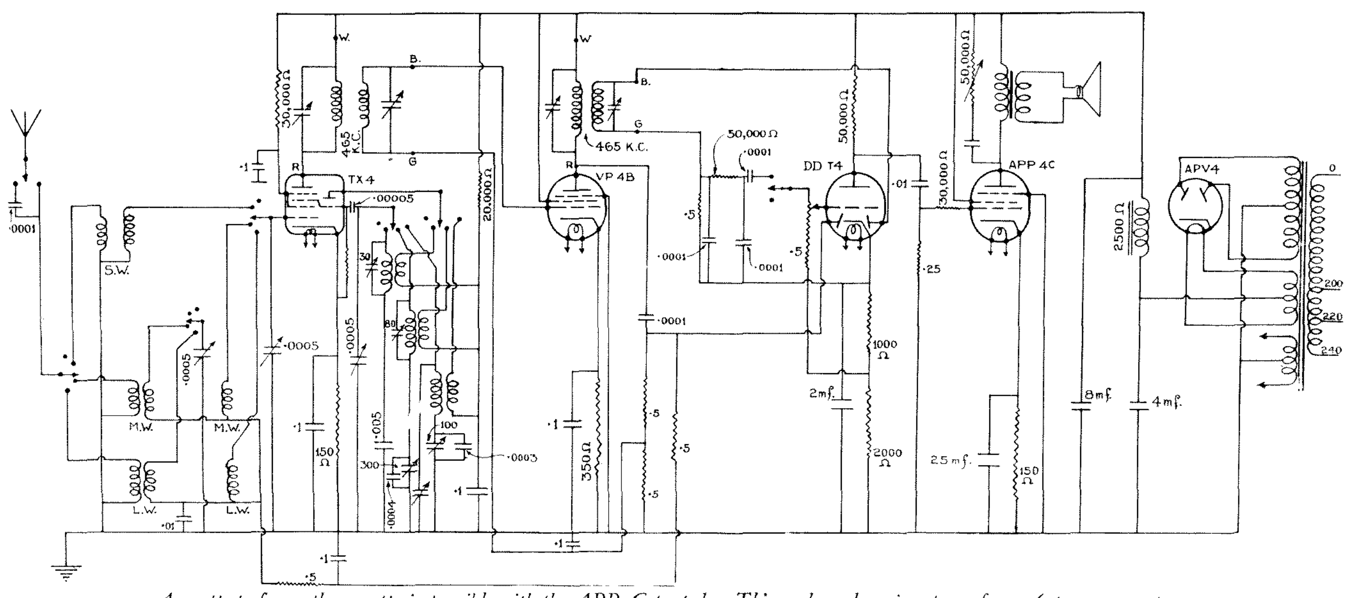
Guaranteed Performance

We present this four-valve all-waver after it has undergone extensive tests, so that we can guarantee its performance even in the hands of non-technical listeners.

No ultra-modern ideas have been embodied unless they absolutely warranted inclusion. All complications have been weeded out, so that the receiver is a straightforward one that will bring in stations on wavelengths of between 16 and 2,000 metres.

A Triode-hexode Mixer

The circuit consists of a triode-hexode combined detector oscillator, followed by a single stage of intermediate-frequency amplification feeding into a double-diode triode, second detector, audio amplifier and A.V.C.

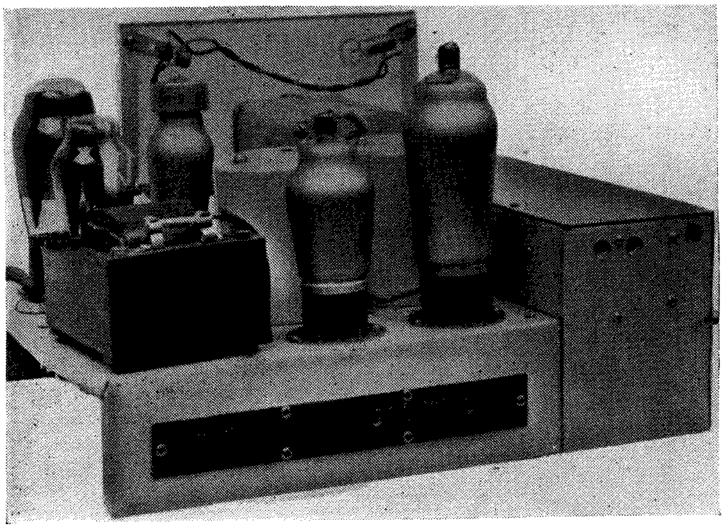


An output of over three watts is possible with the APP4C pentode. This 3-channel receiver tunes from 16 to 2,000 metres.

Wired and Matched Tuned Circuits

amplifier. In the output stage is a new type of stabilised pentode that gives an output of well over 3 watts with really good quality. Finally, a full-wave valve rectifer supplies 250 volts at 60 ma. of high tension.

We have realised that the non-technical constructor always has trouble when building an all-wave receiver in matching up the coils and condensers so that the receiver gives maximum amplification on all wavebands.



All external connections are made to this special Clix strip which is mounted on the lip of the chassis. Padding condensers can be seen at the back of the tuner.

A New Wired Tuner

This problem has been overcome in a very definite manner. The heart of the receiver consists of a complete set of coils for the grid and oscillator circuits, complete with all trimming and padding condensers and a multi-contact switch. This tuning unit, made by B.T.S., is completely wired and lined up before it is supplied to the constructor, so in addition to the worst job—ganging—being already done, a very considerable portion of the wiring is effected by the makers.

Again, with the I.F. transformers. Without the necessary apparatus it is very difficult accurately to line up the four windings in the I.F. transformers to 465 kc. Here again we have arranged with the manufacturers to match up these transformers by means of a crystal frequency meter. The circuit is such that the extra capacity due to the wiring is so small that little variations can be taken up by the constructor without any trouble at all.

It will be appreciated that this finally removes the few snags confronting set builders, for the rest of the wiring follows standard practice.

A steel chassis already drilled is supplied by Peto Scott and attached to this on the left-hand side is the tuning unit and switching. At the back of the chassis a slot has been cut to take the Clix input strip, which is a special component designed for this receiver. The one strip takes the aerial, earth, pick-up and mains adjustments contacts, so that there are no terminals to be fitted.

Mounting the Mains Transformer

In the right-hand corner is another special component, a mains transformer mounted so all the connections are through the bottom of the chassis. This helps to keep wiring neat and tidy. Mounted in the centre of the chassis is the three-gang Baby Jackson condenser and the special aeroplane type dial.

So as to reduce cost, an energised loudspeaker is included, so the field coil can be used as a low-frequency choke. This arrangement plus 12-mfd. of smoothing is ample to provide absolutely silent background even on weak short-wave stations.

Instead of suspending small condensers and resistances in the wiring, we have utilised two group boards. In this way the actual appearance of the receiver is improved, while constructors will find it easier to wire to an anchored component than to one that has to be suspended.

Readers who have had difficulty in mounting the conventional tubular electrolytic condensers on steel chassis will appreciate that we have changed over to a cardboard case type of condenser with fixing lugs so that it can be bolted to the underside of the chassis. Also this reduces cost very considerably.

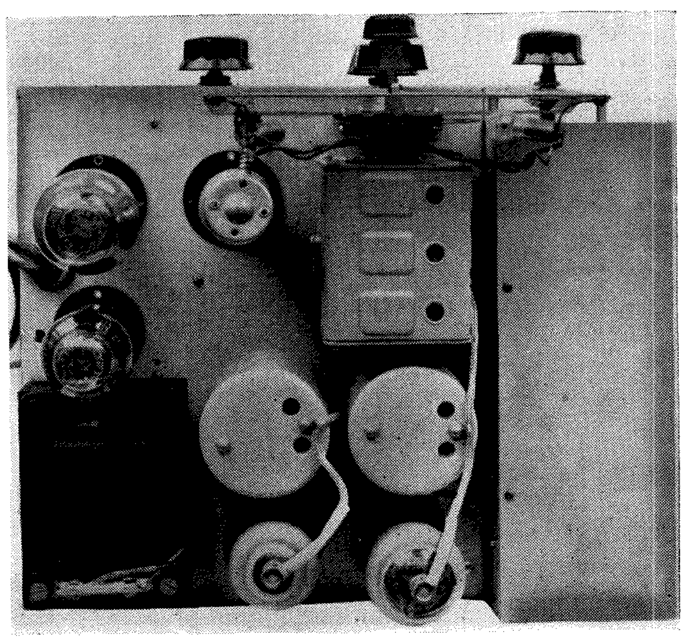
There are four controls on the front panel. To the extreme left wavechange, in the centre the master volume control and on-off switch, to the right the continuously variable tone corrector.

In the centre by the volume control is the tuner which has concentric with the main knob a small trimming condenser to take up any variation that might occur in ganging.

A.V.C.

An automatic volume control circuit, if it is to be of any use, must be carefully worked out. It is essential that the double-diode-triode valve specified be used, otherwise the circuit values may not be suitable. Refer to the circuit a moment of the A.V.C. section. It will be seen that one of the diodes in the DDT4 valve rectifies H.F. from

This plan view gives a good idea of the positions of the components. A special feature is the easy way in which the trimmers can be adjusted.



The I.F. Circuit :: Component Mounting

the VP4B, the current being passed across a .5 megohm resistor which feeds the voltage developed across it back to the triode hexode in the first stage.

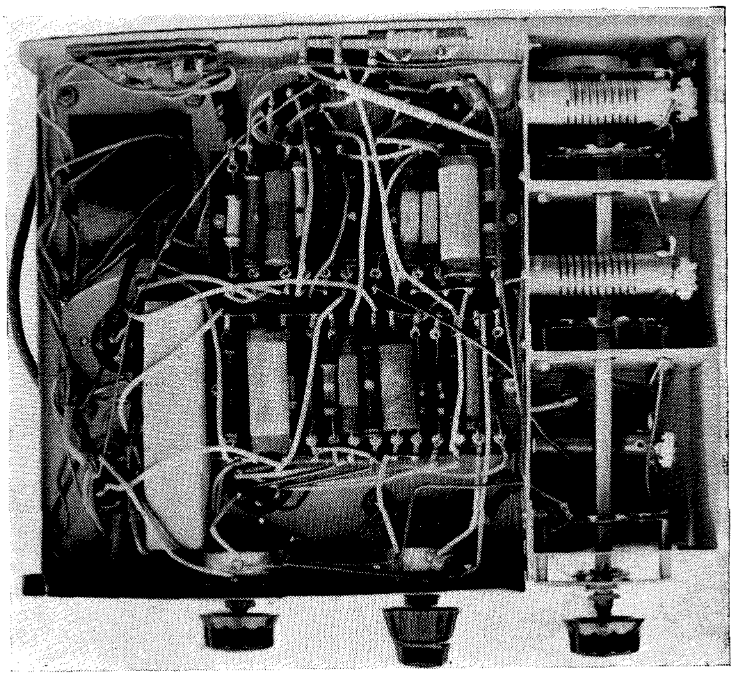
As the signals increase, so the amount of bias applied to the grid of the TX4 is also increased. A weaker or fading signal allows the rectified current, and in turn the grid bias voltage, to drop, causing the overall stage gain to rise. This see-saw action enables a predetermined volume to be maintained, even though there may be variations in the strength of the signal received.

Correspondence has shown that constructors are not all clear just how the electrolytic condensers are connected. It should be remembered that condensers of this type always have their negative side connected to earth or chassis. This applies also in grid bias circuits where a negative voltage is being given to the grid of the valve.

I.F. Connections

The intermediate-frequency transformers must also be connected the correct way round, and to prevent any error in this circuit, the primary and secondary leads have been colour coded. For example, in both transformers, red is connected to anode, white to high tension, black to the grid of the valve in one case and to the diode in the second with green being the earthy connection. Also the condensers shown in parallel with primary and secondary are small mica-dielectric trimmers mounted inside the transformer case.

By careful arrangement of components quite a number of conventional condensers, etc., have been omitted. The whole idea in the design of this receiver was to keep the cost as low as



The entire tuning system is already wired and lined up by the makers so eliminating the worst part of home set building.

possible so that constructors must adhere very strictly to the recommended layout. It will be noticed that no H.F. chokes or anode by-pass condensers are used. Also the smoothing choke has been omitted in addition to the normal buffer condensers across the anodes of the rectifying valve. These omissions have not affected the performance in any way but have reduced the total cost very considerably. Both group boards carrying condensers and resistances are mounted off the chassis approximately 1½ ins. by means of 4 B.A. brass studding. The two variable resistances on the front of the chassis have dead spindles which are automatically earthed. A point here, however, is that two washers are mounted behind the chassis so that the control knobs are more or less flush with the front of the cabinet. It should also be remembered when mounting the tuning condenser that this should be recessed slightly so that the control knob is flush with the remaining three knobs. In this way the receiver assumes a very commercial appearance.

Another trouble-saving idea for constructors drilling their own chassis is that instead of drilling a 4 B.A. round hole make it slightly oval so as to take up any discrepancies that might occur in marking out the positions in the first place. A little slack when mounting the condenser can easily be taken up.

Dial Illumination

In the theoretical circuit we have not shown the connections for the two dial lights, for these are an optional refinement. However, there is sufficient output from the 4-volt heater winding to run two .3 amp dial lights, so that we suggest two leads be taken from the heater terminals of the APP4C pentode valve to the dial lights which are wired in parallel. Also we suggest the use of 6.3-volt .3 amp. bulbs in this circuit. An alternative scheme is to connect a 5-watt bulb across the mains input.

Components for A 4-VALVE ALL-WAVE SUPER-HET

CHASSIS.
1—Steel 9 in. by 10 in. by 2½ in., with ⅜ in. turned down both ends (Peto-Scott). Strip (Peto-Scott).

CONDENSERS, FIXED.
1—8 plus 4 mfd. electrolytic 500 volt working, in cardboard case (Ferranti).
1—2-mfd. type AT (T.C.C.).
6—.1-mfd. type tubular (T.C.C.).
4—.0001-mfd. mica type 690W (Dubilier).
3—.01-mfd. type tubular (T.C.C.).
1—25-mfd. 25 volt type AT (T.C.C.).

CONDENSER, VARIABLE.
1—.0005-mfd. screened three-gang type Baby (Jackson Bros.).

COIL.
1—Completely wired coil unit (B.T.S.).

DIAL, SLOW MOTION.
1—Dual ratio complete type 2131 (Jackson Bros.).

HOLDERS, VALVE.
4—7-pin type standard chassis without terminals (Clix).
1—5-pin type standard chassis without terminals (Clix).

PLUGS, TERMINALS, ETC.
3—Valve caps type 1175 (Belling-Lee).
1—Double mains adaptor (Clix).

RESISTANCES, FIXED.
3—30,000-ohm ½ watt (Bulgin).
3—500,000-ohm ½ watt (Bulgin).
1—50,000-ohm ½ watt (Bulgin).
1—50,000-ohm 1 watt (Dubilier).
1—500,000-ohm 1 watt (Dubilier).
1—350-ohm type 1 watt (Dubilier).
1—20,000-ohm type 1 watt (Dubilier).
1—2,000-ohm type 1 watt (Dubilier).
1—1,000-ohm type 1 watt (Dubilier).
1—250,000-ohm type 1 watt (Dubilier).
2—150-ohm type 1 watt (Dubilier).

RESISTANCES, VARIABLE.
1—50,000-ohm potentiometer (Erie).
1—500,000-ohm potentiometer with two-point switch (Erie).

SUNDRIES.
2—Group boards type C35 (Bulgin).
14 ft. 22-gauge tinned copper wire (Peto-Scott).
14 ft. 2-mm. insulated sleeving.
2 ft. 6 in. 16-gauge tinned copper wire.
3 ft. 6 in. metal braided and insulated wire.
5 ft. 2-mm. flex.
1—4-way loud-speaker lead type BC2 (Bulgin).
1—9 ft. mains cable (Peto-Scott).
1—Large grommett.
3—Anti-vibration rubber grommetts.
Quantity of roundhead screws with nuts, shake-proof washers and soldering tags (Peto-Scott) complete mains input, aerial, earth and pick-up.

TRANSFORMERS, I.F.
2—Type 46SKC (B.T.S.)

TRANSFORMER, MAINS.
1—Special to specification (B.T.S.).

VALVES.
1—TX4 Met. (Tungsram).
1—VP4B Met. (Tungsram).
1—DDT4 (Tungsram).
1—APP4C (Tungsram).
1—APV4 (Tungsram).

An Autodyne Aerial Coupler

These details of a universal aerial coupler will interest all who are regular listeners on the short-wave bands. This coupler is used by that well-known Australian amateur Don. B. Knock, VK2NO, from whom this information was obtained.

IT is well known that to obtain maximum signal strength with almost any type of receiver, the aerial circuit should be carefully tuned. During the past year or so I have applied various types of aerial tuners to all kinds of receivers and always to advantage. The effect has been to increase signal strength at least one point without any increase in noise level. As no additional valve coupling is employed there is no gain in valve noise, which is unavoidable when the number of stages in the receiver is increased.

After testing all kinds of receivers, both amateur and commercial, I came to the conclusion that a universal coupler of some kind was essential. It is needed most on short-waves, and has to be suitable for the bands between 10 and 80 metres.

The only objection to plug-in coils is the trouble of coil changing. When quick changes are needed from band to band, as when two receivers are being compared for signal strength, etc., no accurate checks can be made unless some very quick switching system is in use.

A simple coil turret built on commercial lines was made out of an old bakelite tuning drum of the edge-control pattern This was used to accommodate four honeycomb type coils which were mounted within the drum on small insulated pillars. The contacts from the coils were taken to brass pins which were tapped into the wall of the drum.

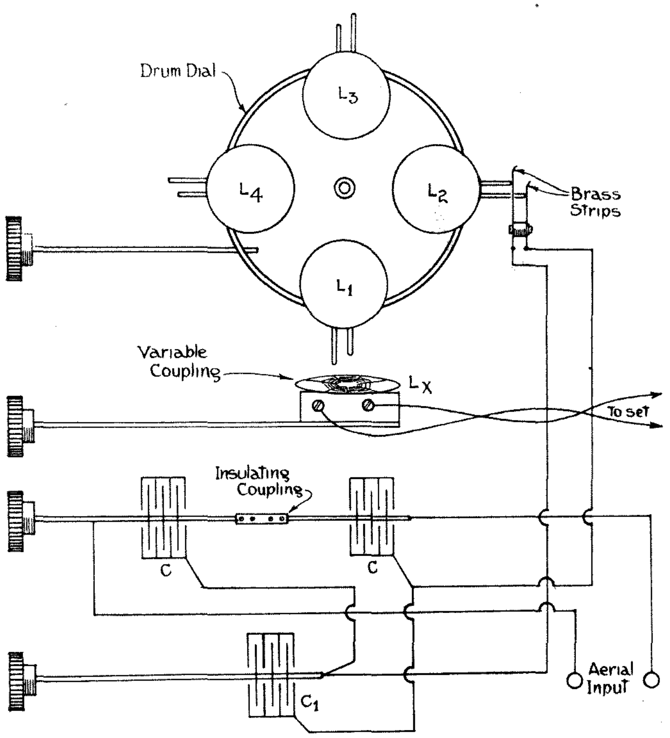


Fig. 1.—There is nothing in this unit that cannot be made by the average constructor. A small improvement can be made by enclosing the components in a metal container so as to prevent any stray pick-up. All coils are of the flat pancake type which have proved to be most satisfactory despite their old design.

Just how these coils are laid out can be seen in Fig. 1. Two contacts made from phosphor bronze or brass strips were arranged so that as the drum was rotated the pin contacts connected with the two external contacts. Across the external contacts were connected the parallel and series aerial tuning condensers, as can be seen from the theoretical circuit, Fig. 2.

First of all, construct the coils for the four wavebands. The following dimensions are satisfactory only with the .0001-mfd. parallel tuning condenser. All the coils are of the spider-web type with an outside diameter of $1\frac{1}{2}$ in., 26 D.S.C. wire is used throughout, and the following turns are required. L1, 3 turns; L2, 5 turns; L3, 10 turns; L4, 25 turns. These coils will cover, when tuned with a .0001-mfd. condenser, all wavelengths between 10 and 85-90 metres.

Coils and Tuning

The coupling coil, LX, is mounted on a conventional moving-coil holder and is so arranged that it is parallel with which ever coil is switched into circuit. Condensers in series with the aerial feeder leads are of .0001-mfd. capacity, and can be of the two-gang type providing the rotors are insulated.

In addition to increasing the efficiency of almost every receiver, this type of coupler can be used to advantage when the listener is troubled with bad pick-up of local interference. The unit can be made to include a Faraday screen between the coupling coil, LX, and the aerial coils. In this case the coupling coil must be completely screened—except for the Faraday screen—and mounted in a metal box. The output leads to the receiver must be well screened and, if the job is to be done thoroughly, the entire receiver should be in a metal box, otherwise most of the efficiency of the screened input circuit is lost.

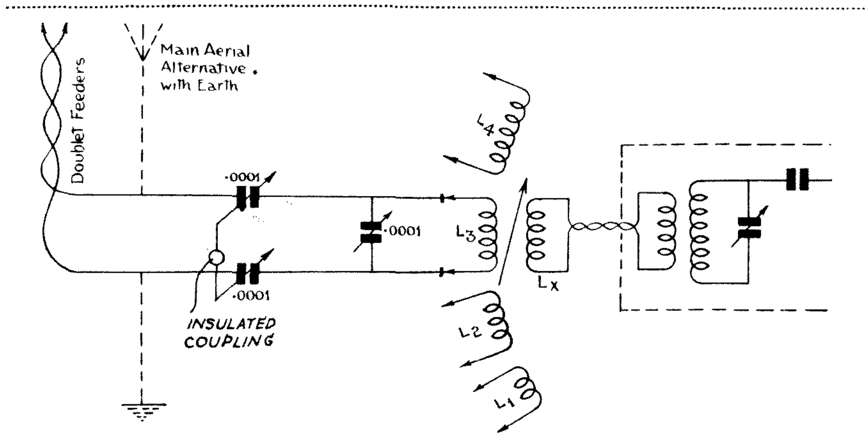
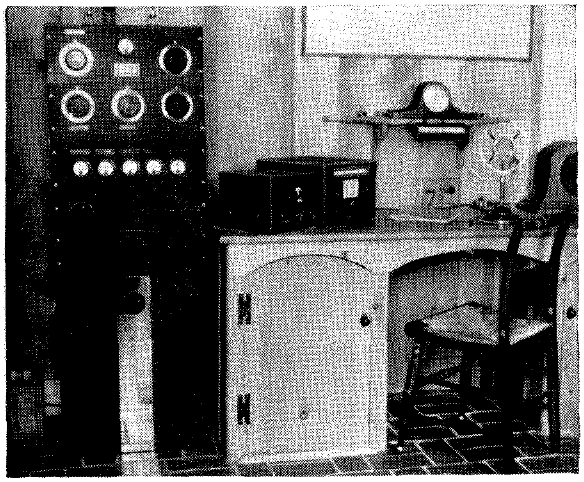


Fig. 2.—This theoretical circuit illustrates how the coupler can be used with almost any receiver.



This is the author's station, W1AJZ, located at Harwichport, Mass, which is so well heard on the high-frequency bands.

Extending the High-frequency Limit of a 15 Mc. Transmitter

By Rienzi B. Parker, Ph.Dd., W1AJZ

RECENT developments in valve and circuit design make comparatively simple the construction of radio transmitters for frequencies up to 30 mc. A harder problem is to obtain operation on the higher frequencies from a transmitter which has a 15 mc. high frequency limit. The chief difficulty lies in the fact that the range traversed in passing from 15 to 30 mc. is equal to the entire frequency span between 0 and 15 mc. The practical result is that excitation from the driver stages decreases, because tube and circuit efficiencies are lowered; while the final stage, due to increased losses in the grid and its associated circuits, requires greater driving power. Thus

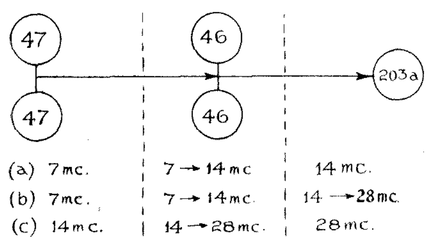


Fig. 1.—This is the original valve line-up for 20 metres.

the transmitter is doubly handicapped, and a design which is satisfactory at 15 mc. performs indifferently or not at all when operation on 30 mc. is attempted.

If a transmitter is modified in order to extend its high frequency limit, physical restrictions imposed by the original design present another difficulty. Little choice remains between power supplies, tubes, and circuits. The object desired is the best results with the least change in the original unit.

Many amateurs have transmitters unsuited for operation at 28-30 mc., so the method will be described by which a transmitter was adapted for these frequencies. While the information applies directly to but one case, the principles outlined should prove helpful generally.

Fig. 1 (a) is a diagram showing, at

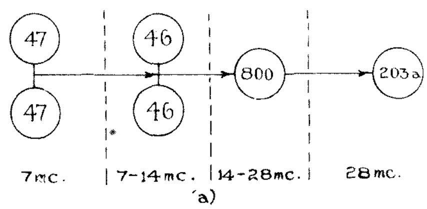


Fig. 2a.—An additional stage is required for 10-metre work.

14 mc., the original radio frequency conversion in the W1AJZ transmitter. Coupling between stages is capacitative; and the 47 and 46 valves of the exciter are connected, not in push-pull, but in parallel.

The simplest means of obtaining 28 mc. operation from such a design is by doubling in the final stage as indicated in Fig. 1 (b). This procedure was unsatisfactory. One weakness of the system is that the final valve requires much larger drive to work efficiently as a doubler than as Class C. No such increase could be obtained from the system shown. Consequently, output was small and the dissipation rating of the valve was exceeded by a wide margin.

More serious than poor efficiency was the fact that, under such conditions of

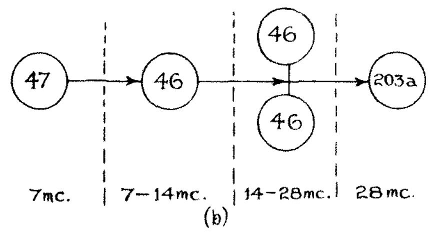


Fig. 2b.—The additional valve in the exciter is an advantage.

operation, the final stage interlocked with the preceding driver. This resulted in the generation of spurious frequencies. Although the final operated on 28 mc., usually several other frequencies were present, ranging in value from approximately 45 to 12 mc. These changed in number and value as tuning adjustments were made, and could not be eliminated. As such frequency generation is not in accord with best amateur practice, the scheme of doubling in the final stage was abandoned.

Another simple modification was the use of a 14 mc. crystal, radio frequency conversion in the transmitter as indicated in Fig. 1 (c). This procedure also gave poor results. The fault did not lie in the crystal itself, which was a

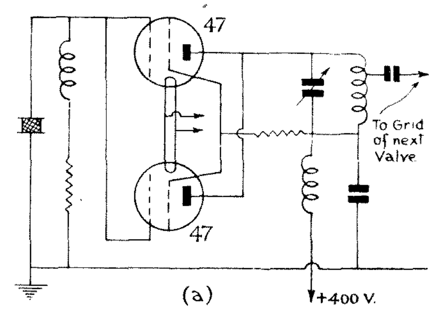


Fig. 3a.—The original crystal stage.

persistently good oscillator; but rather in a requirement, imposed by the original design, that the doubler stage be driven relatively hard for adequate output. Such drive was obtained only by heavily loading the oscillator. This was not a serious drawback in itself, for crystal r.f. current decreases with oscillator load and there is less danger of fracture. The trouble was that when the oscillator was heavily loaded, the crystal would not start unless the tank circuit were detuned. No adjustment of L/C ratios, screen and plate voltages, or coupling values remedied this fault. Consequently, operation with a 14 mc. crystal was discarded.

It now became evident that an addi-

The C.O. Stage and General Transmitter Building

tional r.f. stage was necessary for 28 mc. operation. Examination of Fig. 1 shows that this stage could be located as in Fig. 2 (a). In this case the stage would employ an 800 or equivalent valve, powered by the 1,000-volt supply of the final. This arrangement was preferable for largest output. Unfortunately, the 1,000-volt supply was loaded to maximum when meeting the common requirement of final stage and class B modulators. So the decision was

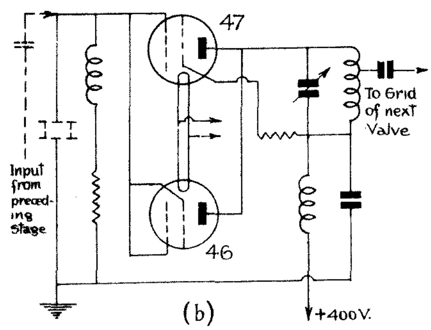


Fig. 3b.—Results are more satisfactory with this arrangement.

made to place the extra stage in the exciters as shown in Fig. 2 (b). Here mechanical problems were simplified, cost was lowered, and the arrangement came within the limits of the power supplies. The only disadvantage was that the final stage must be operated considerably below its rated 200 watts input. This was not a serious drawback, so work was started along these lines.

The first step was to build a conventional crystal oscillator. When this was finished, the circuit of the former oscillator was slightly modified. The original circuit is shown in Fig. 3 (a), the modification in Fig. 3 (b). The new oscillator was mounted in the rack and connected. The results obtained with this arrangement were satisfactory.

The diagrams of Fig. 4 show at (a) the frequency conversion for 28 mc., and at (b) for 14 mc. For frequencies of 7 mc. and lower, the new oscillator is not used. The valve is removed and plugged into the proper socket in the original oscillator, the 46 valve being removed from this stage. Fig. 4 (c) makes this clear, and comparison with Fig. 1 (a) shows that the valve line-up for the lower frequencies remains practically unchanged from the original design. The only difference is that but one valve is used in the oscillator instead of two. This is adequate, for at 7 mc. and below the power added by the second valve is unnecessary.

In order to secure adequate output at 14 and 28 mc., the exciter stages must be driven relatively high. While this is dependent to some extent upon the activity of the crystal, no trouble should be experienced with the excellent 7 mc. plates now available.

With particular reference to 28 mc. operation, it should be noted that capacitative coupling between r.f. stages has been retained. With this system satisfactory performance is impossible unless careful attention is given to the number of turns in the tank coil for each exciter stage, and to the location upon it of the grid tap of the succeeding stage. The total number of turns in the tank and placing of the tap can be determined only by experiment. As the grid tap is moved towards the point of high r.f. potential on the coil, less turns will be required because grid-filament capacity is added across more of the tank. It is best to wind as many turns as possible, starting with the grid tap near the centre turn. However, if too many turns are used, tapped too far down, exciter output will be inadequate. The balance which must be struck is very delicate; but once the number of turns and location of the grid tap are fixed, the arrangement is permanent. Coils for the exciters are wound on 1½-in. formers with No. 12 wire, spaced so that the winding occupies about one inch, except the 28 mc. doubler coil. This is wound on a 1-in. former, wire size and spacing being unchanged.

Note Grid Current

Grid coupling capacities and grid bias resistors in the exciter stages are also critical in affecting performance. Here again it is impossible to recommend definite values, for only experiment can determine the best. For the transmitter studied, the optimum coupling capacities were found to be 100 mmfd. between oscillator and first doubler, 1,000 mmfd. between other stages, while the

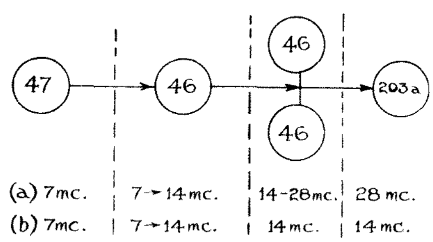


Fig. 4a.—Shows the circuit for 10-metre operation and Fig. 4b for 20 metres.

grid bias resistor values were established as 25,000 ohms for the first doubler and 5,000 ohms for the second doubler, no battery bias being applied in either case. It is unlikely that these values could be used in another exciter unless of identical design.

Changes in exciter performance are best observed by noting rectified grid current of the final stage, measured by a milliammeter in the grid return. Such observations are not comparative, however, if either the grid resistor or battery bias of the final are changed during the period of adjustment of the exciters.

Under the precautions just outlined, proper 28 mc. operation has been secured. Performance on 14 mc. has been improved, for the drive to the final

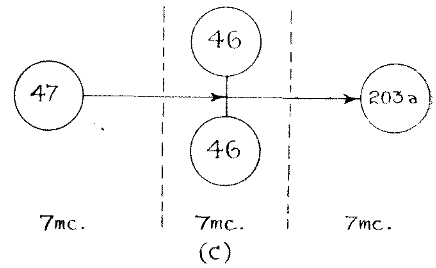


Fig. 4c.—This is the final valve line-up when used on the lower frequencies.

stage, as measured by rectified grid current, increased 35 per cent. When the final is loaded to 200 watts input on 14 mc., 40 ma. is evident in a grid return completed by a 2,000-ohm bias resistor and 32 volts bias battery. This represents an excellent drive at this frequency from valves as low powered as a pair of 46's.

The total power available for exciter stages is limited to 80 watts by the power supply. All valves are operated at 400 volts plate. The plate currents of oscillator and first doubler respectively are 30-35 ma. and 40-50 ma. for either 14 or 28 mc. The pair of 46's draw 80 ma. when operating on 14 mc. as a neutralised amplifier. As doublers for 28 mc., they draw 100 ma. In this case the plate current creeps slightly and reaches equilibrium at about 110 ma., after which it remains static indefinitely.

Plate voltage to the final stage is reduced for 28 mc. by means of a 4,000-ohm 100-watt resistor in the plate supply lead. Typical operation is 700 volts at 140 ma. These values present the same class C load to the modulation output transformer as the full rating of 1,000 volts and 200 ma., the load being 5,000 ohms in either case. They represent practically 100 watts input adequately driven at 28 mc.; for rectified grid current, with the final loaded to this input, is 15 ma. through the resistor and batter bias mentioned above. Measurements of r.f. power output indicate that efficiency is not less than 60 per cent., probably 65 per cent. There is no evidence of spurious frequency generation; and in communication on the 28 mc. amateur band, the transmitter performs satisfactorily.

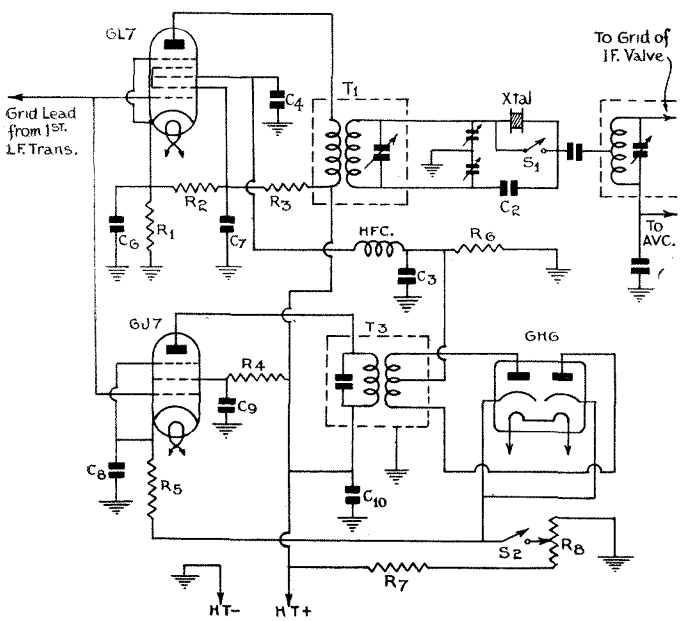
The Short-wave Radio World

A Reveiw of the Most Important Features of the World's Short-wave Literature

A Crystal Filter and Noise-silencer

W1DF, George Grammer, describes in the October issue of QST an efficient crystal filter and noise-silencer which, although it was designed for a specific receiver, can be adapted by the amateur for almost any modern super-het.

The circuit arrangement is shown below, in which a 6L7 is an extra I.F. amplifier preceding the crystal filter.



As most of the noise in the average large amateur super-het comes from the intermediate-frequency stages this silencer should be of particular interest to constructors.

Silencing voltage is applied to the No. 3 injection grid, while the 6J7 and 6H6 are noise amplifier and rectifier respectively.

Silencing takes place before the signal reaches the signal, so preventing shock excitation of the crystal by the high noise voltages. Control grids of the 6J7 and 6L7 are paralleled and obtain I.F. voltage from the grid contact which normally goes to the I.F. valve.

The voltages on the 6L7 are adjusted so as to give most effective noise-silencing rather than extra I.F. gain, but under such conditions there is an appreciable increase from the additional I.F. amplifier which makes up for the slight loss involved by the introduction of a crystal. W1DF claims the gain of two times in this stage.

The bias resistor, R1, as well as the resistance network, R2 and R3, have been chosen to apply a few volts bias on the control grid and between 30 and 40 volts on the screen. The idea of this is to make No. 3 grid, to which the silencing voltage is applied, give more effective control than is possible with normal bias and screen voltages.

In the silencer circuit the 6J7 noise amplifier is biased normally, but the cathode is connected to the moving arm of a variable resistance, R8. This enables bias applied to its grid to be varied between a minimum of 3 volts and a maximum of 20 volts. By setting the control to a point where the noise circuit starts to operate it also acts as a threshold control.

The cathodes of the 6H6, rectifier, are connected to the moving arm of R8 so as to bias the diode anodes. This makes sure that rectification will not take place until the incoming signal or noise reaches a predetermined level.

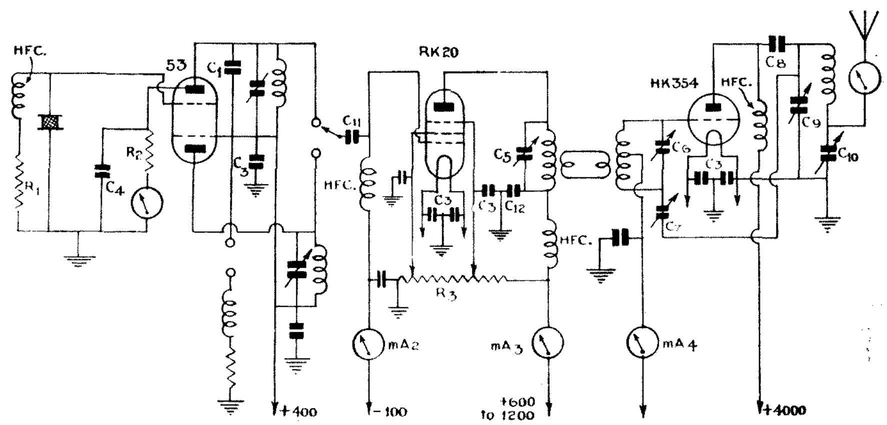
Switch 2 opens the cathode circuit of both valves, so cutting the noise-silencing circuit out of action. Component values are as follows: C2, .000015 mfd.; C3, .0001 mfd.; C4 and 5, .00005 mfd.; C6 to C10, .1 mfd.; C11, .01 mfd.; R1, 2,000 ohms; R2, 50,000 ohms; R3 and 4, 100,000 ohms; R5, 300 ohms; R6, 100,000 ohms; R7, 30,000 ohms; R8, 30,000 ohms. C1 does not really concern the constructor, but for guidance it is a split stator, 50 mmfd., and is used to tune the secondary of T1. A suitable condenser can be obtained from Messrs. Wingrove & Rogers.

A Three-stage All-band Kilowatt Transmitter

American designers manage to obtain a very high input to the final stage with comparatively simple apparatus. We feel sure that readers will be interested in the design of a transmitter by W6LDB, which was described in the October issue of the Californian publication, *Radio*. It is a three-stage affair with a twin triode 53 used as a crystal oscillator and buffer amplifier or frequency doubler, followed by an RK20 and an HK354.

This rig gives stable operation on 40, 20 and 10 metres, and it is claimed that at least on 40 and 20 metres there is a possibility of overdriving tthe RK20 from the 53. For this reason it will be noticed that capacity coupling is used between the 53 and the RK20, and if this is a variable capacity, the amount of drive can be increased or decreased as required. Capacity coupling is rather a poor arrangement, but the designer mentions that as the exciter gives more than enough drive, it was decided to under-drive the pentode which would be more than compensated by ease of handling.

Neutralising of the final amplifier is in the grid circuit, so for that reason a balanced grid has been used with a carefully wired condenser so that the total external capacity is a fair imitation of



With only three stages this transmitter will handle an input of 1000-watts on 20-metres. It is also suitable for 10-metre operation with reduced power.

1,000-Watts Input on 20 Metres

the filament-grid capacity of the HK354. This resulted in fixed neutralising on the three wavebands.

It will also be noticed that no D.C. voltage is applied to C9, the anode tank condenser. Maximum H.T. is fed directly on the anode of the valve and blocked from the tank circuit by means of a high voltage .001-mfd. condenser. This, incidentally, is a very sound scheme for it reduces the possibility of accidental short circuits in the tank circuit, as the coils and condensers are at earth, D.C. potential.

Several precautions have been taken in the construction, particularly in the RK20 stage. This valve has its anode circuit effectively screened from the grid end, while the screen and suppressor chokes with their associated by-pass condensers are connected actually to the valve socket terminals.

For class C operation, the RK20 and the grid of the final are adjusted for maximum grid current. Cut-off bias is obtained from batteries and also from the rectified excitation current through the grid resistance of 7,000 ohms. The measured bias voltage is exactly two-and-a-half times cut-off with 50 ma. of grid current.

For 20-metre operation a 40-metre crystal is used doubling in the second section of 53, the RK20 operating as a straight amplifier. On 40 metres all stages are on the same frequency.

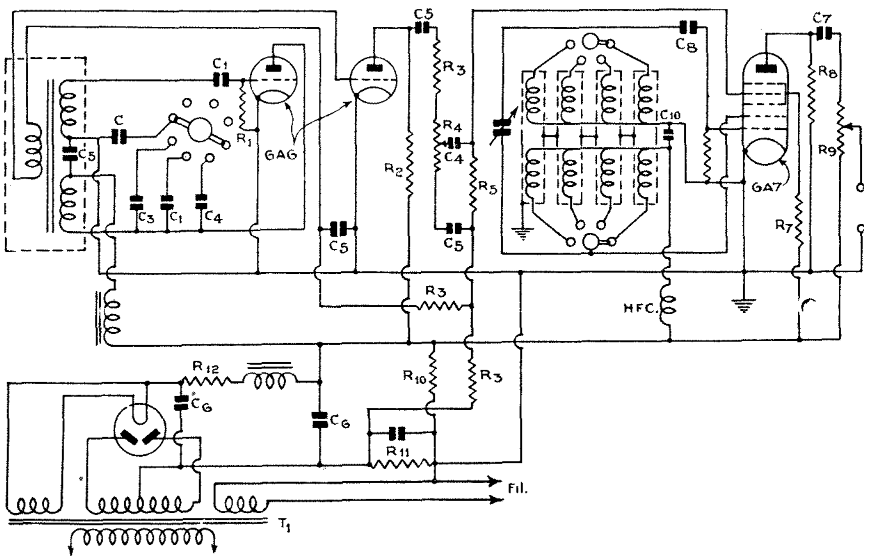
Operation on 80 metres can be either with an 80-metre crystal or with a 160-metre crystal doubling in the 53 stage.

On 10 metres the input to the final amplifier may have to be reduced owing to lack of drive from the RK20. This point, however, could be overcome by the use of a 20-metre crystal unit.

An All-wave Line-up Oscillator

In the July issue of the American publication *Radio* there appears constructional details of an efficient line-up oscillator that is very suitable for English amateurs and service engineers.

It is well known that an oscillator of this kind should have an R.F. output with a continuously variable modulation from 0 to 100 per cent. It should also be possible to reduce the input to the receiver under the test to zero without going to the trouble of fitting extensive swing. In addition the audio and radio frequency modulation controls should be entirely independent of each other without interaction.



The modern all-wave super-het has to be carefully lined up in the I.F. stages with an oscillator. This circuit is very effective.

This oscillator takes full care of all these points. It uses a 6A6 audio oscillator and coupling valve with a 6A7 as the grid modulated radio-frequency oscillator.

The transformer for the audio oscillator is made up of 3 windings, a 500-turn grid coil at the bottom, a 500-turn plate winding, and finally, a 10-turn secondary to drive the audio-coupling valve. 36-gauge wire is used for the coils which are mounted on a former ¾ in. by ¾ in. by 1 in.

Three layers of wax paper are wound in between individual coils, the completed unit being held together by adhesive tape. The core can be made up from old L.F. transformer irons stacked with 1/100th of an inch air gap.

Our Policy
"The Development of Television."

The audio oscillator operates at approximately 3,000, 1,500, 1,000 and 500 cycles. Fixed bias is used on the second section of the 6A6 and on the second control grid of the 6A7 in order to obtain complete stability.

More voltage than is needed is developed in the anode circuit of the coupling valve so that a 100,000-ohm resister is placed in series with the modulation control. This control has the zero end grounded, making it necessary to have it isolated from the grid and anode circuits. If the zero end is earthed through a condenser it will be impossible to obtain zero modulation.

The long-wave coils are standard dual range or can be made by unwinding a few turns from an old I.F. transformer.

Kentish Town and District Radio Society.

An interesting 5-metre field day was arranged by this society in conjunction with members of the R.S.G.B. in district 12.

A station was erected at Hadley Highstone under the call sign of G6NR, and excellent contacts were effected with stations within a radius of 20 miles. Reliable communication was maintained throughout the day from this QRA.

The apparatus used consisted of a push-pull oscillator with 8 watts input fed into an aerial consisting of a half-wave vertical, 30 ft. high, fed by feeders 29 ft. 6 in. long. Orthodox super-regenerative receivers were used; it was felt that more sensitive receiving equipment would have resulted in more contacts. Members present included G6NR, G6PI, 6TV, 2RX, 2XJ, 2OK, BRS2470 and other members of the Kentish Town and District Radio Society. G2HK and G5ZJ looked in during the morning and heard the receivers in operation.

Meetings are held weekly and particulars can be obtained from the Hon. Secretary, R. E. Pidsley, G6PI, 27 Herbert Street, Kentish Town, N.W.5.

Clix Speaker Control Panel.

A novel speaker control panel with twin plugs has just been issued by Messrs. Lectro Linx, Ltd., 79a Rochester Row, S.W.1. It consists of an external loud-speaker connector and a plug-operated switch for cutting out the internal speaker. The contacts are normally left closed, so keeping in circuit the loud-speaker in the receiver, but by moving the plug to the right in a rotary manner, the internal loud-speaker can be disconnected in favour of the external loud-speaker.

This useful accessory is priced at 1s. and affords very simple means of plugging in and out of circuit extension loud-speakers.

Stable Components in Short-wave Practice

By R. E. Blakey, D.Sc. (Eng.)

It appears that some of the modern short-wave components may not be entirely suitable for ultra short-wave work, while some of the deficiencies in modern receivers attributed to atmospheric conditions may be caused by mechanical variation of components. This article deals with this new angle in a complete manner.

IT has been agreed by all technical bodies that the higher the frequency used, the greater is the need for stable circuits and components. Generally speaking, short-wave components have reasonably low losses, but this is not the whole story if they are to be suitable for short-wave work. Consider as a good example a coil of 3μH shunted by a capacity of 12 μμF. This combination resonates at 11.31 metres, or 26525.19 kcs. Assume that due to a change in ambient temperature the inductance increases to 3.001 μH and the capacitance to 12.001 μμF. This combination will then resonate at 11.3123 metres or 26518.03 kcs. A drift of this amount would cause a change from one 9 kcs. channel into the next.

TABLE

ERIE. 5 Megohm Resistor.

RESULTS OBTAINED BY MESSRS. MARSHALL & SOWERBY.
Effective Resistance at

	27.5 Kcs.	50 Kcs.	100 Kcs.	300 Kcs.	1 Mc.	3 Mc.
Megohms ..	4.61	3.76	3.08	2.1	1.42	.84

LOEWE 5 Megohm Resistor.

RESULTS OBTAINED BY PROF. BOELLA.
Effective Resistance at

	9.2 Kcs.	19.3 Kcs.	40.3 Kcs.	100 Kcs.	226 Kcs.	516 Kcs.	1 Mc.	3 Mc.
Megohms	5.21	5.08	5.05	4.98	4.99	4.62	4.16	2.54

LOEWE 5 Megohm Resistor.

RESULTS OBTAINED BY MESSRS. MARSHALL & SOWERBY.
Effective Resistance at

	30 Kcs.	100 Kcs.	300 Kcs.	1 Mc.	3 Mc.
Megohms ..	5.36	4.89	4.78	4.58	4.08

SIEMENS-HALSKE "KARBOWID" 4 Megohm Resistor.

RESULTS OBTAINED BY PROF. BOELLA.
Effective Resistance at

	9.2 Kcs.	19.3 Kcs.	40.3 Kcs	100 Kcs.	226 Kcs.	516 Kcs.	1 Mc.	6 Mc.
Megohms	4.0	4.02	3.922	3.91	3.895	3.445	3.32	2.39

SIEMENS-HALSKE "KARBOWID" 1 Megohm Resistor.

RESULTS OBTAINED BY MESSRS. MARSHALL & SOWERBY.
Effective Resistance at

	1.6 Mcs.
Megohms	.75

Common fading is in many cases due to frequency shift when the receiver is being used on low wavelengths. This should convince readers of the necessity of obtaining stable components while the following basic principles in component design should help to prove the point. Since radio receivers are largely composed of inductances, condensers and resistances, each will be treated separately.

Inductances

Very few technicians have carried out such valuable and extensive work on the development of ultra-stable inductances as Mr. W. H. Griffiths, of H. W. Sullivan, Ltd., and to those who are sufficiently interested special attention must be paid to the papers mentioned in the appendix.

The average inductance in radio work is unstable in value owing to the non-rigid construction of the former. Ebonite, bakelite and certain types of paxolin and ceramic materials are unstable when raised in temperature and upon cooling do not necessarily return to their usual form. This is indeed the case when the material is stressed in such a manner as when being bound with turns of copper wire which expand to a smaller extent than the insulator. In these circumstances the copper winding tends to become slack due to its being stressed by the greater expansion of the coil former.

Since the inductance of a coil of a given number of turns is proportional to the length and diameter of the winding, a minute change in either of these dimensions will also cause a change in inductance. Whilst the change is very small it can be of the utmost importance as previously explained. It is not unlikely for a change equal to one part in three thousand to take place. If the capacity remains absolutely constant a frequency shift of almost 3,000 cycles per second would occur under the above conditions.

The Sullivan-Griffiths ultra-stable inductances consist of an ebonite cylindrical former mounted between bakelite end plates. The cylindrical former is segmented so that its diameter is determined by the fixing to the end plates.

A "loaded" ebonite is used for the cylindrical former and is of such length and the co-efficient of expansion such that a decrease of inductance due to expansion balances the increase due to diametral expansion of the bakelite end plates and copper wire. It should be observed that the temperature co-efficient of bakelite is similar to that of copper.

In a beat oscillator used in G.P.O. short-wave receivers no attempt at temperature compensation of the inductance is made, but instead an extremely rigid construction is obtained by a mechanical design while the coil and tuning condenser are enclosed in a Celotex lined screened compartment. This is a simple but effective arrangement.

Another form of stable inductance is that due to Mr. Albert Campbell which is wound upon a marble former. A similar design is also due to Dr. Max Wien, of the Physikalische Tecknische Reichanstalt.

A design recently produced by the writer and manufactured by Messrs. Everett Edgcumbe & Co., Ltd., utilises segmented cross section Keramot formers, the coil being slot wound. By accurate construction of the former a high degree of thermal compensation is achieved, while the use of a Keramot former ensures low losses at high frequencies.

At this point a summary can be made of the conditions necessary to produce an inductance which will remain stable over a wide range of temperature changes. An increase in temperature causes both the diameter and length to increase. The increase in diameter causes an increase in inductance, whilst an increase in the length of the coil causes a decrease in inductance. If one change counterbalances the other the inductance will be independent of temperature.

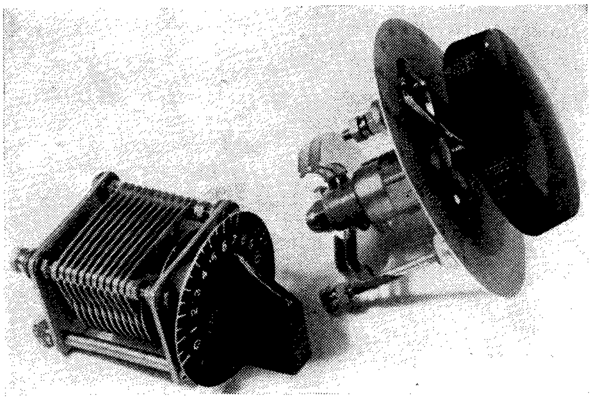
Quite recently Professor Groszkowski, of the State Institute of Telecommunications, Warsaw, stated that the measured change of inductance for a given temperature change does not agree with the value calculated from the change in dimensions and suggests that "skin" effect is the main cause of the discrepancy.

Condensers

The stability of an air condenser is dependent upon its geometrical relations in the same manner as an inductance. The capacity of a condenser is the combination of the thickness and area of plates plus relative spacing. To obtain stability these dimensions must be capable of proportionate expansion or contraction.

The first requirement is the suitable choice of metal for the plates and spacers. In a variable condenser a single end bearing is perhaps the easiest solution since it permits unmolested longitudinal expansion or contraction. The insulating supports for the stator vanes should preferably have an equal temperature co-efficient to the metal from which the vanes are made. At the same time the insulation material should have good high frequency characteristics. These features, in addition to that of sound mechanical design, present conflicting problems, the largest perhaps being the production of a good condenser at a reasonable price.

The following points have been determined. The use of aluminium vanes with brass spacers is not conducive to stability; also many of the ceramic insulators in use at present do not possess the desirable temperature coefficient of expansion for use with metals commonly employed in the construction of variable condensers.



The new Eddystone condensers for ultra-high frequency work are a good example of stable design. Both rotor and stator plates in addition to all spacers are all constructed of the same material, so having the same co-efficient of expansion.

Consider the fixed condenser of the mica type. It is interesting to note that reasonably stable models are obtainable for about £1, whereas some years ago £10 was the more normal figure.

One recent design of particular interest is the General Radio Company's type 505. The problems of moisture absorption by the mica, low high-frequency losses, small power factor and stability of operation have been tackled in an ingenious manner. In the course of manufacture the mica is heated to 300 degrees F. and is kept hot until it is finally assembled in the condenser. To keep the condenser free from moisture a mixture of silica gel and ground cork is enclosed with it. The entire condenser is then sealed off with resin and bees wax.

Silica gel is an interesting substance as it will absorb 30 per cent. of its own weight in water and still maintain in a closed space a relative humidity of less than 0.5 per cent. A condenser of this type is very useful in time base circuits.

Resistances

It may surprise some readers to learn that a so-called 1-megohm resistance may have an effective resistance of perhaps only 0.5 megohm at 1 mc. and even less at 10 mc., yet this is so with most composition resistors.

The papers mentioned in the appendix refer to this subject, but as they are of a highly technical nature a summary is given here in a simple manner.

If a D.C. voltage is applied across a resistor, the "volt-drop" along it will be linear, otherwise an absolute functions of Ohm's Law. If an A.C. voltage is applied various other items need consideration, such as the inductance and capacity of the resistance. The inductance in the composition type is of a very low value but the capacity requires consideration, as it appears to be almost entirely responsible for the effect mentioned. A summary of results is given in the table and from this it will be seen that the choice of resistances for high-frequenecy use is of the utmost importancee.

Appendix

(1) Standard Inductances for Wavemeters and other Radio Frequency Purposes. *Wireless Engineer*, Vol. VI. October, 1929.

(2) Inductances of High Permanence. *Journal of Scientific Instruments.* November, 1929.

(3) A New Radio Frequency Inductance Standard. *Wireless Engineer.* June, 1934.

(4) Accurate Wavemeter Design. *Wireless World.* pp. 113-115, also 148-150.

(5) Temperature Co-efficient of Inductance. Proc. I R.E. Vol. 23, No. 1, 1935.

(6) Temperature Co-efficient of Inductance. *Wireless Engineer.* Vol. 12, No. 147.

(7) Measurement of Inductance and Capacity. Campbell and Childs.

(8) Oscillators of Stable Frequency. Radio Research Board Publications.

(9) Notes on the Accuracy of Air Condensers for Wavemeters. *Wireless Engineer.* Vol. 4, pp. 754-757.

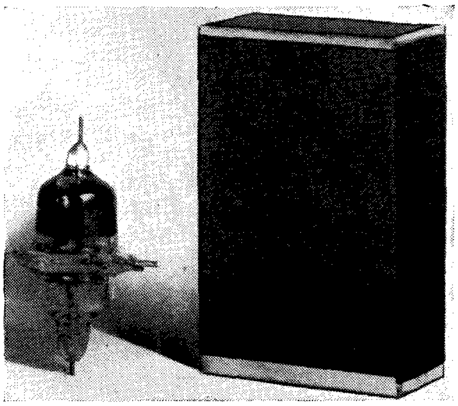
(10) Calibration of small Variable Condensers at Radio Frequencies. *Experimental Wireless.* 1928.

(11) Losses in Variable Air Condensers. *Wireless Engineer.* March, 1931.

(12) The Behaviour of High Resistances at High Frequencies. *Wireless Engineer.* Vol. 12, No. 141.

(13) On the behaviour at high frequencies of some types of high resistances in use in radio circuits. *Alta Frequenzza.* Vol. 31, No. 2, April, 1934.

(14) A further note of high resistances at high frequencies. *Wireless Engineer.* Vol. 12, August, 1935, No. 143.



Some idea as to the size of the acorn valve can be obtained from this photograph.

A 10-metre Acorn-valve Receiver

By J. W. Paddon, G2IS

Exceptional results are being obtained on the 10-metre band with simple receivers. This two-valver is very efficient and is easy to build.

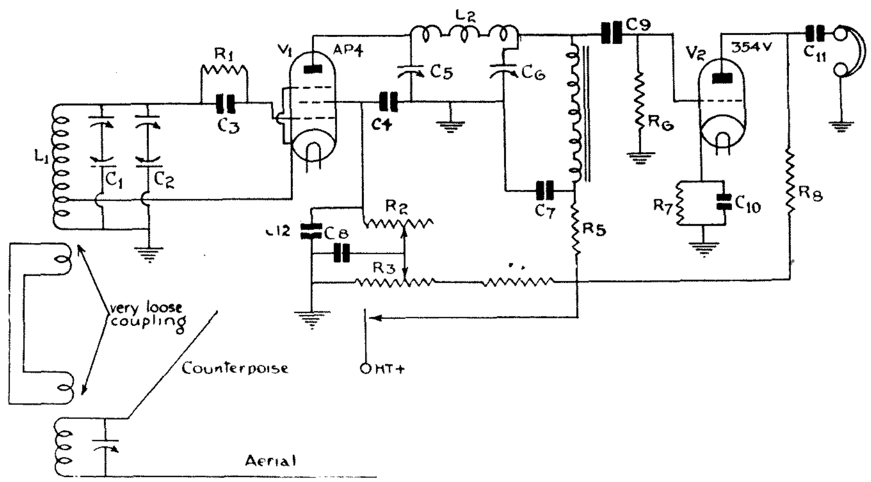
THIS two-valve regenerative detector was designed purely for the 7- and 10-metre bands. In planning the layout and choosing the components the liveliest consideration was given to the special problems which present themselves at U.H.F.

After thorough tests of a number of standard triode and pentode detector valves it was decided that the inherent capacity losses, the damping across the tuning coil and the leakage losses in the base were too high to be ignored. A Mullard type AP4 "acorn" H.F. pentode was accordingly obtained.

The "acorn" type of construction provides a valve with the anode pin protruding from one end and the grid from the other. An annular ring about the "waist" of the valve carries five widely spaced pins: H^1, H^2, K, G^2, G^3. The actual physical size is, as the name implies, about the same as a well nourished acorn. Brief study of the photograph will show that base losses are practically non-existent and that inherent capacity is at a minimum.

Valve Connections

The "Acorn" is clipped into a special Bulgin valve holder. The tiny contact pins are silver plated to reduce resistance loss and are fastened to a ring of low-loss material. The grid half of the AP4 protrudes through the centre of the ring while the anode half stands out on the opposite side. Using this mounting the valve holder is secured to the under side of the base panel of the set. The hole is cut concentric with the valve holder, while the grid half of the AP4 pokes through the base so that the anode and screen circuits are well screened from the grid circuit.



The circuit is a simple one but the component values must be strictly adhered to.

The tuning condensers had to be extremely "low loss," present good mechanical stability and, above all, be of such a design that they were electrically silent in operation. This point should be stressed—in .H.F. work a persistent grating noise may be caused by a vernier dial which has a metal mechanism.

The padding condenser chosen is a "Polar" split stator having two sections of 160-mmfd. each. The band spread is a special spaced "Polar" having sections of 30 mmfd. each. In both cases the sections are used in series. Thus the padding condenser has an effective maximum capacity of 80-mmfd. and the band spread of 15 mmfd.

This arrangement means that the resistance caused by losses in each condenser section are in series and their effect halved. Since the condensers are mounted on a ceramic insulant the total effective loss is negligible. Because the sections are in series the rotor is "floating" and must be driven through an insulated coupling.

It was found that the capacity between the two metal elements of the universal coupling was sufficient to cause instability and hence a ¼ in. hard rubber rod was used to drive the band spread condenser.

Condenser Mounting

The two condensers are mounted parallel each on four "Eddystone" 1½ in. insulating pillars. These support them with great rigidity and keep them well clear of any stray coupling. The condensers are connected in parallel by two short, direct leads. The tuning inductance, an Eddystone type 1020, is soldered directly on to the tabs of the band-spread condenser. The grid condenser and ½-watt grid leak are also soldered on to one of the tabs and the assembly sticks vertically down so that the end of the grid leak condenser comes within a fraction of an inch of the grid pin of the AP4.

Components for
A 10-METRE ACORN-VALVE RECEIVER.

CHASSIS AND PANEL.
1—Aluminium chassis, 8 in. by 10⅛ in. (B.T.S.).
1—Aluminium panel, 8 in. by 9 in. (B.T.S.).

CHOKE, HIGH-FREQUENCY.
1—Type HF21 (L2) (Bulgin).

CHOKE, LOW-FREQUENCY.
1—300-henry (L3) (Varley).

COIL.
1—Type 1050 8 turns (Eddystone)

CONDENSERS, FIXED.
1—100-mmfd. type 690W (C3) (Dubilier).
2—65-mmfd. type 978 (C5 and C6) (Eddystone).
1—300-mmfd. type 690W (C4) (Dubilier).
1—.5-mfd. type tubular (C7) (Dubilier).
2—1-mfd. type 50 (C8 and C12) (T.C.C.).
1—.03-mfd. type tubular (C9) (Dubilier).
1—25-mfd. type 25 volt (C10) (T.C.C.).
1—.25-mfd. type 50 (C11) (T.C.C.).

CONDENSERS, VARIABLE.
1—30-0-30 type E (C1) (Polar).
1—Type E two-gang (C2) (Polar).

DIAL, SLOW-MOTION.
1—To fit ¼-in. spindles (B.T.S.)

HOLDERS, VALVE.
1—Special acorn valve holder (Bulgin).
1—FW21 (Bulgin).

RESISTANCES, FIXED.
1—5-megohm ½ watt (R1) (Erie).
1—50,000-ohm 1 watt (R4) (Erie).
1—2,000-ohm 1 watt (R5) (Erie).
1—1-megohm 1 watt (R6) (Erie).
1—25,000-ohm 1 watt (R8) (Erie).
8—1029 Pillars (Eddystone)

RESISTANCES, VARIABLE.
1—50,000-ohm potentiometer (R2) (Reliance).
1—50,000-ohm potentiometer with switch (R3) (Reliance).

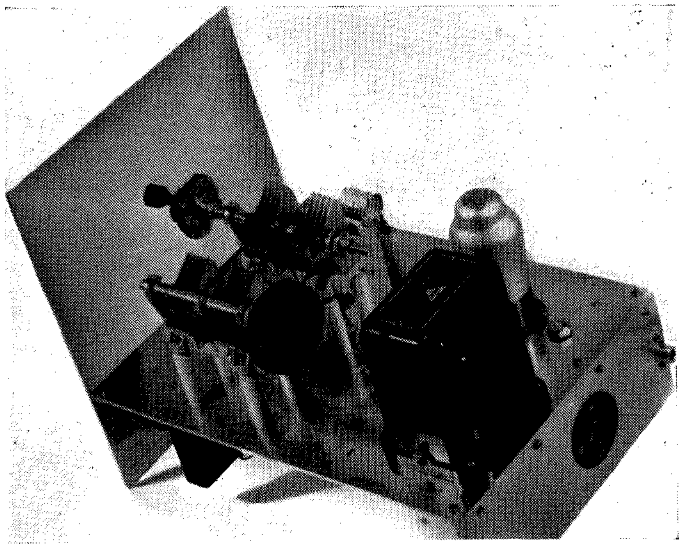
SUNDRIES.
Connecting wire and sleeving.
Small quantity ½-in. wood screws.

VALVES.
1—AP4 Acorn (V1) (Mullard).
1—354V (V2) (Mullard).

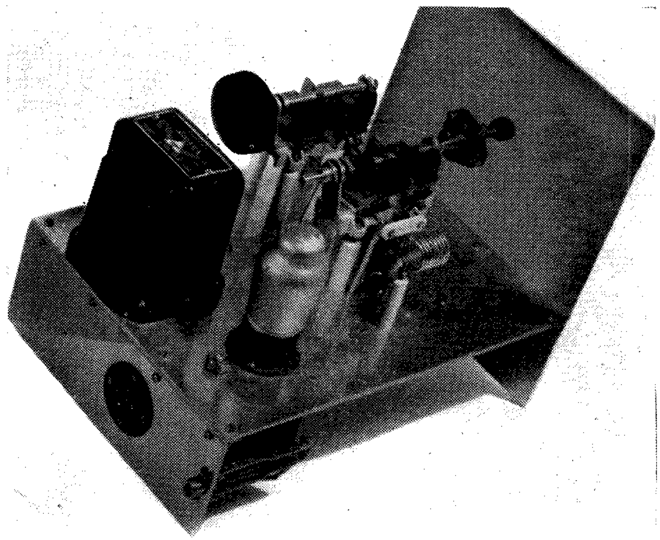
High-tension Voltages :: Power Supply

The Acorn valve holder is located below the sub-panel and in position so that the grid pin is almost directly below the grid end of the inductance. Connection is made to this pin by a tiny silver jaw which is on the end of a short *very flexible* lead from the grid condenser.

Two Eddystone pre-fix variable condensers type 978 are mounted below the sub panel. In practice these variable condensers can be replaced by good 100-mmfd. mica fixed condensers. A Bulgin U.S.W. R.F. choke is suspended between the stator pins and a flexible lead and clip make connection to the anode from one stator. The other stator is connected to the "high" (outer) side of a Varley 300-henry choke and also to the L.F. coupling condenser. The rotors of the two condensers are connected to the common earthing point.



The large double-gang condenser in this illustration is for band setting.



Notice how the detector valve, grid condenser and tuning coil are all closely linked together.

Reaction Control

The cathode and suppressor grid are connected by a short wire at the valve holder and the lead continued through the sub-base and soldered on to the tuning coil. The position of this tap controls reaction and it should be very carefully located by experiment. The screen is by-passed by a .0003 mica condenser by the most direct route possible. Reaction is controlled by screen potential variation. It was found that this was somewhat critical so a series variable resistance R2 was connected between the slider of the normal potentiometer resistance R3 and screen grid. The slight voltage drop across R2 provides a gradual and exact control while the voltage "selected" by R3 determines the approximate reaction point. The reaction control resistances must be most adequately by-passed to prevent severe noise when they are varied. It was found necessary to include an isolating resistance R4 between screen and the L.F. by-pass condenser C7.

The AP4 filaments are taken to the terminal socket in a screened lead. The capacity to the earthed screen provides adequate by-pass in this circuit.

The L.F. circuit is simple and standard and requires no comment, except that the anode voltage applied should not exceed 200 volts. In practice it will be found that a rather lower value will give the best signal-noise ratio.

The sheet metal used in the set is all $\frac{1}{8}$ in. aluminium as mechanical rigidity cannot be over emphasised at such high frequencies. Equally, whatever antenna is used must be strong, tight and not at all "floppy." A shaky lead-in will introduce definite instability.

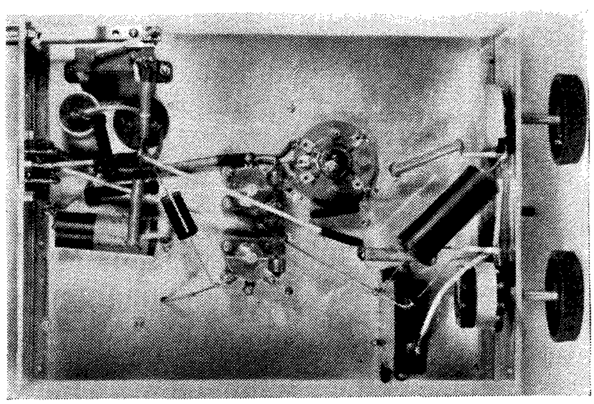
In operation, the band-spread condenser is set on mid scale and the padding condenser swung until the band is found. By a little judicious juggling the 10-metre amateur band may be set so that it covers the middle of the tuning scale with a comfortable margin on either side. Once the reaction tapping is correctly located it will be found that, although rather delicate, the control of reaction is smooth and that the point of optimum regeneration for phone reception can easily be attained.

No definite means of antenna coupling is recommended. The author prefers to use a very loosely coupled link to an external tank circuit to which the antenna is directly connected. This does, however, introduce a certain amount of "pulling." A single turn coupling coil to earth, located at the earth end of the tuning coil, proved effective with one antenna. A minute capacity, made by twisting a few inches of insulated wires, in series between antenna and earth proved effective in another case. In every case the lead-in must be brought in from the back.

Since the H.T. current consumption is only a few milliamperes it is most desirable to use battery H.T. The filaments may be run off A.C. with no great amount of induced hum but, since L.T. consumption is also small, an accumulator is to be preferred.

Some observations on its peculiarities

(*Continued on page* 64)



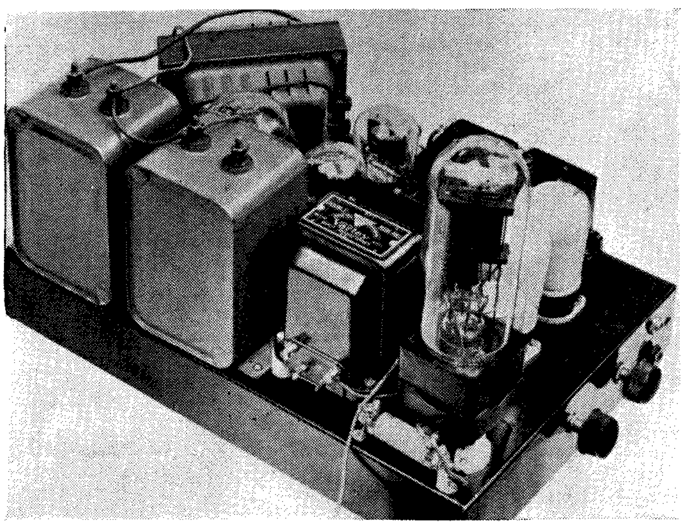
The Mullard AP4 valve is mounted in a special Bulgin low-loss holder.

A Beginner's Transmitter

By KENNETH JOWERS

How to build the Speech Amplifier, which is a final section in the transmitter, is fully described in this article

ONE of the principal features of modern pentode transmitting valves is the fact that they can be used with suppressor grid modulation. As previously explained in this series of constructional articles, suppressor grid modulation enables a comparatively small amplifier to be built so that a C.W. station can be converted to phone operation with the minimum of cost.

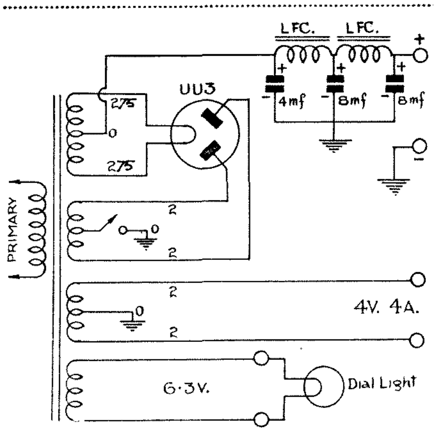


The 60-watt valve shown is only used for anode modulation. This valve has its own power supply on the same chassis.

Even though this transmitter is of a simple nature there is no need for the speech amplifier to be a small one suitable only for very low-power working.

The theoretical circuit is given on the next page and as can be seen, is quite straightforward and follows conventional practice. Provision has been made for gramophone and microphone mixing by the use of split inputs. The microphone is fed into the grid of an HL type of triode valve via a 500,000-ohm volume control of the new Dubilier type B. The grid of this valve is tied down to earth by means of a .5-megohm leak between grid and cathode.

In the gramophone circuit a similar type of arrangement is used except that the volume control has a value of only 50,000 ohms.



This power pack for the speech amplifier gives 275 volts at 60-M/a.

Both valves are individually biased by means of a 500-ohm series cathode resistance and shunted with a 25-mfd. electrolytic condenser. The idea of this separate biasing is to allow for the use of different valves in microphone and gramophone circuits. Occasionally, if the microphone has a low output then it is advisable to use a high gain triode in this circuit. Also with high output pick-ups it is sometimes advisable to use an L-type of valve in the gramophone circuit. By the use of separate bias as suggested alternative valves can be used without alteration to the amplifier

The Power Pack

So as to keep cost down to a low level, the power pack for this circuit only supplies 275 volts at 60 ma. and actually under load with a slightly lower H.T. drain delivers 300 volts.

The HL valves are arranged to consume about 5 ma. each, so that approximately 225 volts are actually applied to each anode. Although the resistance values are low, there is sufficient gain fully to load the AC/P valves, while, a 5,000-ohm resistance and 4-mfd. condenser provide adequate decoupling. The first two valves are transformer coupled to the push-pull AC/P's by mens of a low-ratio Ferranti push-pull transformer. This transformer should have shunted across each half of the secondary a 100,000-ohm resistance.

As the AC/P's take approximately 18 ma. each it was thought advisable again to use separate cathode bias in case of valve characteristic variation, and as it also allowed for the use of lower wattage resistances.

Anode Stoppers

Anode decoupling was not found necessary in the AC/P circuit, but a 100-ohm resistance was connected in series with each anode lead to prevent oscillation. This has proved to be most important. Incidentally one end of this 100-ohm resistance should be connected directly to the anode terminal on the valve holder.

Components for THE PUSH-PULL SPEECH AMPLIFIER POWER PACK.

CONDENSERS, FIXED.
2—8-mfd. type 802 (T.C.C.).
1—4-mfd. type 812 (T.C.C.).

CHOKES, LOW-FREQUENCY.
2—60-m/a (Bryan Savage).

TRANSFORMER, MAINS.
1—Special to specification giving 275-0-275 volts 60 m/a; 2-0-2 volts 2 amps.; 2-0-2 volts 4 amps.; 3.15-0-3.15 volts .3 amps. (Bryan Savage).

VALVE.
1—UU3 (Ediswan).

The approximate layout can be obtained from the illustration, but do not space the components to take up the whole of the bottom rack unless there is no possibility of anode modulation being needed in the future. It is very probable that when higher power is used anode modulation will be used, in which case room has to be left for a new high-power modulator valve.

On the third rack a space has been left for the power pack for the speech amplifier. This is of a very simple type, as shown opposite, consisting of a special mains transformer with three filament windings in addition to the high-voltage section. Two smoothing chokes mounted at right angles to each other and by-passed by means of 20-mfd.

(*Continued on page 54*)

Constructing the Power Pack and Amplifier

of capacity, ensure that there is no possibility of badly filtered H.T. being applied to the speech amplifier.

It will be noticed that a special winding has been supplied for heating the dial light, but those who already have a similar transformer, but without the 6-volt winding, should connect the dial light across the 4-volt winding used to heat the filaments of the AC/HL's and AC/P's.

After the power pack has been completely wired and checked, test for maximum voltage on all windings. The H.T. supply should be about 320 volts off load, while the two 4-volt filament windings should read about 4.2 volts.

The Speech Amplifier

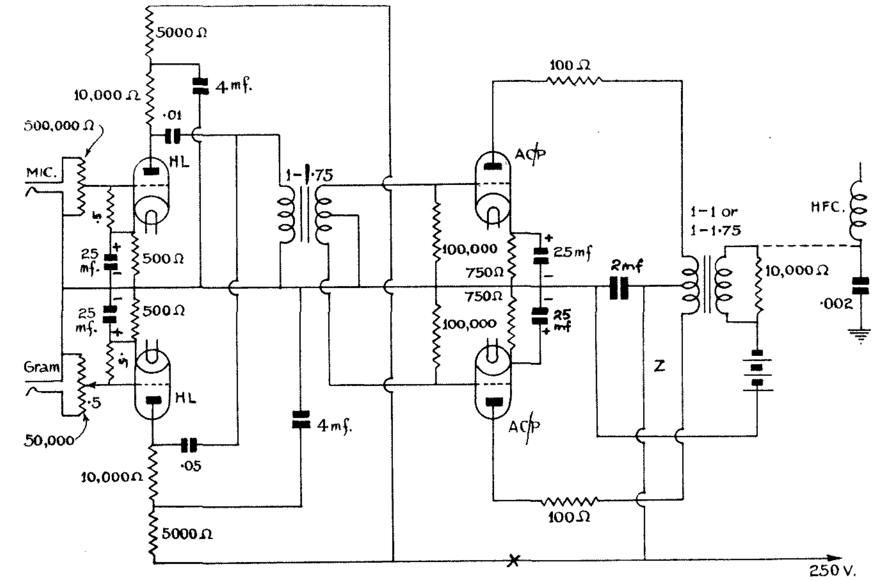
Construction of the speech amplifier should not present any difficulty. The four holes for the valve sockets can be drilled by means of a carpenter's brace and centre bit, but make sure that the holes are as large as possible for even with the low voltage used the anode terminals can arc over to the chassis.

All resistances and small condensers are mounted actually in the wiring and provided that the input circuit is carefully spaced and kept away from heater wiring, there is very little possibility of hum being set up. The inter-valve transformer should be wired up but not bolted to the chassis. Also leave the connecting wires to this transformer fairly long, for after the unit has been completed this transformer has to be rotated until a position is found where all hum is completely eliminated.

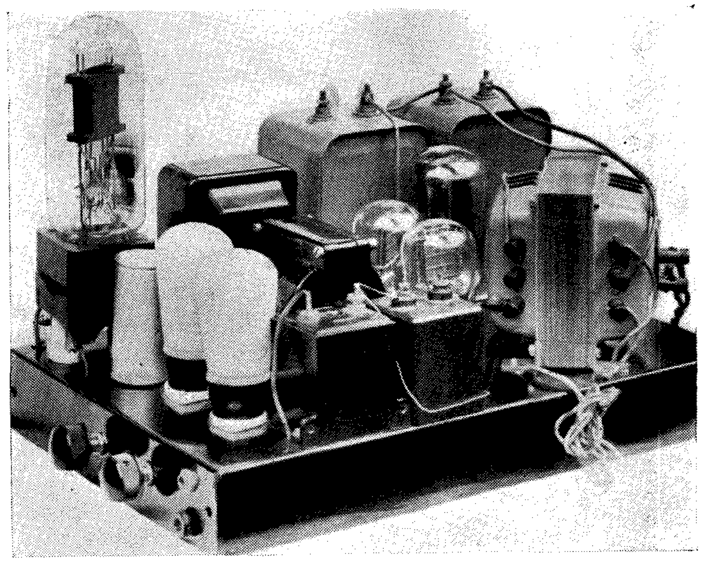
Both 100,000-ohm resistors are connected across the terminals on the secondary of the transformer, as this obviates the need for any additional wiring. Bias resistors and bias shunt condensers in the AC/P stages are mounted between cathode and chassis, so here again wiring is kept very short.

Four leads have to be brought down from the third chassis, two carrying 4 volts 4 amperes for the heaters of the four valves, and two carrying the high-tension supply. Where the high-tension supply wires pass through the chassis they should be very carefully insulated or taped up. Make a special point of bringing these heater leads down to the chassis on the anode side of the AC/P valves, otherwise there is possibility of hum being introduced. Of course, the four wires from the power pack are twisted.

It is advisable to check the amplifier on a loudspeaker before it is connected to the transmitter. As most loudspeakers are supplied with a tapped input transformer, the 1-1 transformer specified can for the moment be ignored. Connect a gramophone pick-up in circuit, making quite sure that the volume control and microphone section is at minimum, otherwise there is a possibility of hum being set up. A milliammeter connected at the point marked X on the theoretical circuit should read a steady 10 ma. for any fluctuations over



Alternative input sockets are provided for microphone or gramophone use. For modulation purposes use a 1/1 ratio transformer and for feeding a high power modulator use a 1/1.75 ratio. The theoretical circuit is shown above.



On the right is the speech amplifier showing the input circuits and volume controls.

Components for
A PUSH-PULL SPEECH AMPLIFIER

CONDENSERS, FIXED.
1—.01-mfd. mica type B775 (Dubilier).
1—.05-mfd. mica type B775 (Dubilier).
2—4-mfd. type LCA (Dubilier).
1—2-mfd. type LCA (Dubilier).
2—25-mfd. 25 volt type EC4 (Bulgin).
2—25-mfd. 50 volt type EC17 (Bulgin).

HOLDERS, VALVE.
4—5-pin chassis type ceramic less terminals (Clix).

RESISTANCES, FIXED.
2—.5-megohm ½ watt type HW31 (Bulgin).
2—500-ohm. type 1 watt WE10 (Bulgin).
2—10,000-ohm type WE2 (Bulgin).
2—5,000-ohm type WE1 (Bulgin).
2—100,000-ohm type HW25 (Bulgin).
2—750-ohm type 1 watt (Dubilier).
2—100-ohm type 1 watt (Erie).

RESISTANCES, VARIABLE.
1—50,000-ohm type B (Dubilier).
1—500,000-ohm type B (Dubilier).

SUNDRIES.
24—6BA ½-in. bolts with nuts and washers (Peto-Scott).
2—Coils of quickwyre (Bulgin).
1—Dial light type D35 (Bulgin).
2—Type J2 jacks (Bulgin).

SWITCH.
1—S123 (Bulgin).

TRANSFORMERS, L.F.
1—1-1.75 type AF7CS (Ferranti).
1—OPM1 (Ferranti) or
1—DP17 (Varley).

VALVES.
2—AC/HL Met. (Mazda).
2—AC/P (Mazda).

this shows overloading of the HL valve. Similarly a milliammeter connected at the point marked Z should read approximately 36 ma., but an upward deflection of 3 or 4 ma. is permissible.

Do not endeavour to check the microphone side on the loudspeaker, for there is every possibility of feed-back being set up which is very difficult to overcome. Use a gramophone pick-up for checking both halves of the circuit, for it can be taken for granted that if the pick-up works satisfactorily when plugged into both sockets, then the results will be satisfactory with the microphone.

During the tests on the actual transmitter it was suggested that the suppressor grid be connected to earth. Now that the speech amplifier is completed, the suppressor grid should be joined to one side of the secondary on the output transformer. Of course, as shown on page 724 of the December, 1936, issue, an H.F. choke is needed in this circuit by-passed by a .002 condenser.

Components for
A BEGINNER'S TRANSMITTER
Power Amplifier Section

CHOKES, HIGH-FREQUENCY.
1—1022 type (Eddystone).
2—Type 1010 (Eddystone.
COILS.
1—7-pin form type CT7 home wound (Raymart).
2—14-turn type 514 (Eddystone).
CONDENSERS, FIXED.
1—.01 type 4421 (Dubilier).
1—.002 type 620 (Dubilier).
CONDENSERS, VARIABLE.
4—.0001-mfd. type 979 (Eddystone).
DIALS.
2—Type 1026 (Eddystone).
HOLDERS, VALVE.
1—7-pin baseboard mounting ceramic (B.T.S.).
2—5-pin baseboard mounting ceramic (B.T.S.).
METERS.
2—0-50 M/a type 2 in. flush mounting (Ferranti)
PLUGS, TERMINALS, ETC.
1—5-way terminal saddle type 997 (Eddystone).
RESISTANCES, FIXED.
2—10,000 ohm type 1 watt (Erie).
1— 2,500 ohm type 3 watt (Erie).
SUNDRIES.
2—Stand-off insulators type ST (Raymart).
2—12 in. lenths ½ in. glass tubing (Peto Scott).
1—60 volt standard capacity H.T. battery (Vidor)
1—12 in. length 2 B.D. brass studding (Peto Scott).
SWITCHES.
2—Type S80T (Bulgin).
VALVES.
2—RFP/15 (362).

Across the secondary of this transformer connect a 10,000-ohm resistance.

The free side of the secondary should then be connected to a bias battery, after which the transmitter is ready for phone operation.

An aerial current of at least .4 amp. should be obtained with the transmitter operated with an input of 10 watts. When the carrier is effectively modulated there should be a distinct rise of nearly .1 of an amp. on peak speech.

Downward modulation, that is a decrease in aerial current instead of an increase, is due to either incorrect bias voltages on the pentodes or occasionally to overdrive—too great an output from the crystal—or too tight a link coupling. In any case these suggestions can be tried and alterations made in the voltages applied until proper modulation is obtained.

A complete circuit of the transmitter plus speech amplifier and power packs with switching is to be given in the next issue with the necessary modifications needed for anode modulation. If any constructor is in need of further or advance information this can be supplied on request. Please send a stamped addressed envelope.

Eddystone Radio Cabinets

The problem of housing the short-wave receiver or measuring apparatus has been solved by the introduction of a new range of steel cabinets by Messrs. Stratton and Co., Ltd., of Birmingham.

Foremost in this range is the type 1033, which is 17 ins. wide, 9½ ins. from back to front, and 9⅜ ins. high, and priced at 18s. 6d. A smaller cabinet at 12s. 6d. is 8½ ins. wide, 9½ ins. from back to front, and 9⅜ ins. high.

These cabinets can be inspected at the London showrooms, 14 Soho Street, W.1.

Pentodes for Transmitting —Some Practical Hints

By J. H. EDWARDS and H. G. COLEMAN

IT is safe to claim that almost every transmitting amateur has had experience with triode valves as power amplifiers. Quite a different state of affairs exists with pentodes, for these are still a comparative novelty in this country.

Many amateurs use them in exactly the same circuit that would be suitable for a triode and are disappointed at the unsatisfactory results.

Whereas a triode with its low impedance imposes a definite load on the tank circuit, the pentode under normal working conditions hardly imposes any such load, with the consequence that if the aerial load on the tank circuit is removed the impedance rises to a high value.

Since the valve does its best to drive the full wattage into this circuit, the effect of the high impedance is to cause an excessive H.F. voltage rise. In fact, the impedance will go on rising until the H.F. voltage becomes so much greater than the H.T. voltage that during the greater part of the negative swing the H.T. voltage is either negative or too low to take current. The same effect to a reduced degree will occur if the aerial is not coupled to the tank circuit in a manner that will produce sufficient load.

This is a condition likely to occur if the aerial has a high capacity and low radiation values. When the anode is only taking current through a small portion of the negative swing, the mean anode current will fall. The operator's natural response to this is to increase drive so as to bring the mean anode current up to its normal value. This results in the excess H.F. voltage in the tank circuit becoming even greater, and the proportion of time during which current flows less.

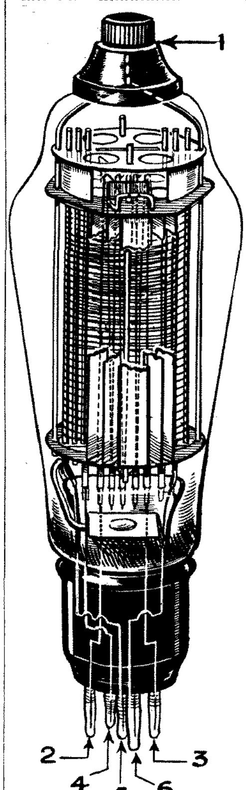
The reduction in anode current due to the excess H.F. voltage is accompanied by an increase in screen current, as the greater part of the current that will otherwise go to the anode goes to the screen.

With an anode load of three times the normal value, the peak anode current will be as high as ten times mean anode current, while the peak anode H.F. voltage is about twice the H.F. voltage.

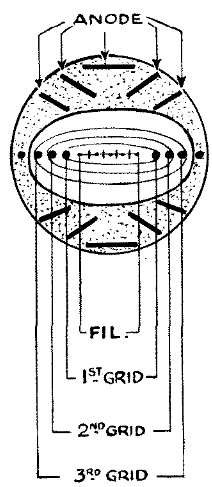
Under these conditions the demand for emission from the valve is excessive, and out of proportion to that for which it was designed. Also the voltages in the circuit become sufficient to cause flash-over.

Normally, pentodes do not need neutralising, consequently many points that have to be watched with unneutralised circuits can be completely ignored with triodes. If, however, advantage is to be taken of the internal screen of the pentodes, it is essential that several points be remembered. First, internal valve screening only prevents feed-back through the valve, and if electrostatic or magnetic coupling exists externally between anode and grid circuit, it will still be necessary to neutralise.

The previously mentioned point about the correct matching of the anode load here again becomes significant. If the anode load impedance is too high the extra H.F. voltage produced on the anode and other parts of the circuit makes the tendency to feed-back into the grid circuit very much greater. The consequences of this are that such circuits become completely unstable although they will be perfectly stable with the correct load impedance. It is also advisable to have the grid circuit as heavily loaded as possible so that any feed-back current passing into this circuit produce a minimum of voltage on the grid.



Transmitting pentodes need adequate external screening if they are to give maximum results. This is the well known 362 Valve Co.'s version of the RK20.



Do not control drive by reducing the coupling to the anode of the previous valve—thereby removing the load from the grid circuit, but to obtain the control by de-tuning the grid circuit in the direction of increased capacity. This not only maintains the load at maximum, but also diminishes the impedance of the grid circuit by placing the extra capacity in parallel with it.

Owing to the high efficiency of modern pentodes it is very important adequately to by-pass the H.F. current from the screen and suppressor grid. The by-pass condensers should be so connected that the shortest possible return circuit to the valve cathode is provided, otherwise a standing wave may be set up on the condenser leads, resulting in parasitic oscillation.

A tri-tet circuit does not work if the by-pass leads are taken straight to cathode, but they must be taken to a point as near as possible to the cathode tuner.

Another important point is that whereas in the case of a triode a very high grid bias is required to give maximum efficiency, totally different characteristics apply to pentodes. The main advantage of the pentode characteristic is that whereas the valve is working under a condition of effective impedance comparable with that of an over-biased triode, and with the high efficiency resulting from such high impedance, the positive potential on the accelerator grid enables considerable current to flow without the high drive which is necessary in the case of the over-biased triode, so that there is little advantage in using high bias with a pentode valve.

The use of too high a bias voltage leads to a reduction in the time during which anode current flows, and consequently there is a heavy demand on the valve in the form of peak emission required to maintain the normal anode current. A higher drive is also required in these circumstances, both in respect of voltage and current. The screen current will also be increased, so that when all allowances are made there is very little gain in efficiency but a very considerable increase both in wear and tear on the valve, and in the proportion of harmonics fed into the aerial circuit.

If a high grid bias is used in conjunction with too high an anode impedance, the two effects combine so that there is an increase in drive, screen current and valve strain.

A good indication of the anode load or grid bias being incorrect is to be found in the following three points.

(1) Excessive tuning dip in anode current.

(*Continued on page 64*)

How to Neutralise Effectively

Neutralising is one of the most important adjustments to be made to a transmitter. This article explains a simple but effective method of finding the correct neutralising position.

VARIOUS methods to effect neutralisation of driven amplifiers are used by experimenters all of which have varying degrees of efficiency.

The method in which a looped lamp is coupled to the P.A. tank coil is not an accurate one as it will be found that, holding the loop at one end of the plate coil, the glow will disappear when the point of neutralisation seems to have been reached. If the looped lamp is then coupled to the other end of the coil it will glow again. The neutralising condenser must then be slightly re-adjusted to find the new point of neutralisation—but, move the loop back again to the other end and once more the looped lamp will glow. This is caused by the slight unbalance of the neutralising circuit due to the capacity of the looped lamp and hand capacity to ground. The correct setting of the neutralising condenser will be about midway between the two settings thus proving that the method is unreliable.

The procedure recommended by G6BD in the April issue is to be preferred, but even this method has the disadvantage of the difficulty in detecting the minute flicker which is present when neutralisation is nearly perfect. The best procedure—the one that is used mostly by experienced amateurs—is neutralising by means of a grid meter.

Retuning

Any adjustment of the neutralising condenser affects the tuning of the valve supplying excitation (buffer, frequency doubler or oscillator) in the direction of detuning. The amount of detuning depends on the degree of coupling between the two stages but the effect is usually considerable. The cause of this is that the neutralising condenser offers a path to the centre tap for radio-frequency energy appearing in the grid circuit of the amplifier. To counteract this detuning it is imperative that the plate circuit of the exciting valve be retuned each time the neutralising condenser is adjusted. If this be not done the plate tank of the valve may be detuned so far that it will no longer be resonant and the tank coil of the P.A. will not show any indication of r.f. energy even though it be far from neutralised. This point is of great importance when the exciting valve is working as a doubler; it is probable that even a slight change in the capacity of the neutralising condenser will so far detune the plate tank of the doubler that the latter will no longer be resonant at the desired harmonic. The tolerance in this direction appears to be much less for a doubler than when using the same circuit as a straight amplifier.

If a D.C. milliammeter is connected in the grid circuit of the P.A. between the grid choke and the grid bias supply with the "plus" terminal nearer the bias supply any detuning of the plate tank of the exciting valve is very noticeable.

Neutralising procedure is then as follows. With the high tension disconnected from the P.A. tank coil and the filaments hot the exciting valve is tuned to resonance which will be evidenced by the peak reading of the grid meter (and, of course, the "dip" of the exciting valve plate meter). If the P.A. tank circuit is not neutralised there will be a kick of the needle as the P.A. tank condenser is tuned through the resonance point. Set the tank condenser at resonance, i.e., the lowest reading of the grid meter. Then adjust the neutralising condenser for maximum possible reading on the grid meter and retune the plate circuit of the exciting valve. Swing the tank condenser of the P.A. so that it passes through resonance and if the grid meter still kicks

(*Continued on page* 60)

(*Continued from page* 58)

repeat the procedure. The aim is to permit of the P.A. tank condenser being swung through the resonant tuning point without causing the slightest movement of the grid meter. Then, *and not till then*, is perfect neutralisation effected.

If the furnishing of the grid meter should present any difficulties there are two ways which might present a solution of the problem. If one has a plate meter in the high tension lead of the exciting valve, transfer it to the grid circuit of the P.A. valve. The exciting valve may still be tuned with the meter in that position. " Peak " and not " dip " will then be the indication of resonance and it will be found to be much more sensitive than in its former position. Alternatively a low range d.c. voltmeter requiring 20 to 25 milliamperes for full scale deflection (as many of them do) can be used temporarily as a grid meter and will work just as accurately as an expensive r.f. meter. If it is not a " dead beat " instrument, so much the better; a "flick meter " is just what is required in this position.

A Second Method

If the amplifier which is being neutralised is not the final stage of the transmitter (a buffer) a different method can be adopted. First tune all stages to resonance up to and including that to be neutralised. Disconnect the plate voltage of the stage to be neutralised—the final stage high tension not yet having been applied. Then, owing to the fact that the grid circuit of the stage which follows the one being neutralised acts as a diode vacuum voltmeter and so is a very sensitive indicator of R.F. energy, a small grid current reading will be obtained as long as the buffer stage is not neutralised. Therefore the neutralising condenser of the buffer should be adjusted until the grid current disappears entirely, but it is most important to remember to retune the exciting valve (of the stage being neutralised) after each movement of the neutralising condenser.

Finally the neutralisation of a link coupled stage will be described as it presents problems peculiar to this type of coupling in that each adjustment of the neutralising condenser effects not only the tuning of plate circuit of the exciting valve, but also that of the grid circuit of the P.A.

Again the plate voltage is disconnected and the filaments left heated. Tune the plate circuit of the P.A. to a point known to be *off* resonance. With the coupling loop around the centre of the driving stage tank coil and the other loop around the centre of the P.A. grid coil, note the reading of the grid meter. Then tune the grid circuit of the P.A. and the plate circuit of the exciting valve for maximum reading of the grid meter. Tune the plate circuit of the P.A. to a point where the grid meter takes a pronounced dip and set for minimum reading of this meter. Adjust the neutralising condenser for maximum reading of the grid meter.

For each setting of the neutralising condenser the plate circuit of the exciting valve and the grid circuit of the P.A. must be readjusted to bring the grid current back to maximum. The highest reading of grid current during this compensating adjustment is the point of correct neutralisation. Check by swinging the plate condenser through resonance. If the slightest flicker is present, neutralisation has not been effected and the adjustment must be repeated with a different setting of the tap of the H.T. lead on the plate coil.

Radio Society of Northern Ireland

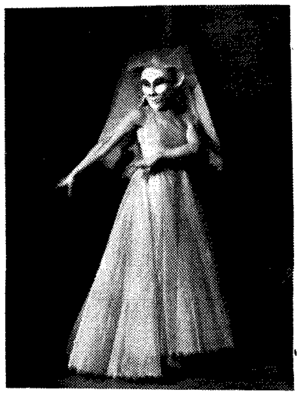
The Society hold their monthly meeting on the first Wednesday of each month in the City of Belfast Y.M.C.A. Radio Club room (GI6YM), Wellington Place, Belfast, and slow morse practice classes are held weekly for the benefit of all members. All who have attended these classes have made great progress.

Information as to the activities of the Society may be obtained by writing direct to the Honorary Secretary, Frank A. Robb (Radio GI6TK), 46 Victoria Avenue, Sydenham, Belfast, N.1.

STUDIO AND SCREEN (*Continued from page* 29

Among the famous broadcasting stars to make their début in television during the month must be mentioned Leslie Holmes and Leslie Sarony, who have attained great popularity as the "Two Leslies" both on the halls and the ordinary radio. They write their own songs and have a distinctive style which fits them admirably for television.

Then we saw Anne Ziegler, the pretty Liverpool girl, who has enjoyed a rocket-ride to fame in ordinary broadcasting. Gillie Potter, the well-known radio comedian, appeared complete with Harrovian straw hat, blazer and bags; and "Hutch" (Leslie A. Hutchinson),



Yolande Proctor wearing the mask of the "White Lady" in the B.B.C. television programmes.

the popular coloured syncopated pianist and vocalist, came over well, as also did the inimitable Sophie Tucker. I was glad also to see that Tex McLeod filled a television date during the month. Tex is no newcomer to television, as he appeared several times in the 30-line programmes, complete with a piece of special rope—he used a black rope for the old programmes—"spinning ropes and yarns."

* * *

So far as the personnel at "Ally Pally" is concerned, there is not much to record this month. Gerald Cock, popular Director of Television, of course, is back again in harness, working extremely hard, and now appears to be much better in health. Productions Manager D. H. Munro is, to use the stock phrase, still "keeping things humming." At the time of writing this, Producer Stephen Thomas is away on special leave for a few weeks producing "Peter Pan" at the Palladium.

Producer Cecil Lewis is still concentrating upon developing the technique of television talks, and I gather he has a number of quite remarkable things up his sleeve, so to speak, for the near futre. He is launching out in the New Year, I hear, with one series of particularly interesting programmes to be broadcast under the general title of the "World of Women." This series will consist of six fortnightly talks illustrating and explaining the activities of women in various professions. I understand the first programme will be in the middle of January.

Included in this new series will be an illustrated talk by Miss Molly McArthur on "Design in the Theatre." Miss Mary Field will talk on "The Secrets of Nature." Dame Laura Knight will give a programme of "Pictures and Pottery." The Motley Sisters will also deal with "Theatre Design," while Elizabeth Denby will discuss the homes of the working classes and explain by word and picture the best arrangements of working-class flats and the like. This series evidently will be attractive.

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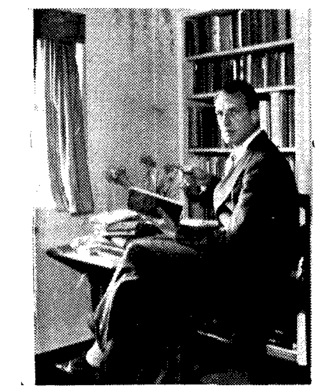
Another of Cecil Lewis's programmes, beginning on January 5, is a series of fortnightly talks by



Cecil Lewis, B.B.C. Television producer, who will be responsible for several important series of illustrated television talks to begin early in January.

Philip Thornton. Mr. Thornton is well known in sound broadcasting, particularly for those interesting gramophone record programmes he broadcast not long ago of strange music picked up in unusual quarters of the world. His idea in these new television programmes, I understand, is to demonstrate the function of each section of a symphony orchestra. I am told that he will treat each instrument in turn, describing its origins and tracing its evolution to the modern counterpart.

Here is an interesting item of news about this programme: It will be the first television series to have a signature tune. I hear that the piece selected is Peter Warlock's " Capriol " suite. Yet another attractive series of talks scheduled for the New Year, which should attract a good deal of attention, will be contributed by Dr. Bentall, who is Assistant Surgeon-in-Chief of the St. John's Ambulance Brigade. This " First Aid " series will comprise six talks dealing with casualties and accidents of all kinds, in the factory, home and on the road, and also will include illustrated instructions regarding gas defence. Dr. Seth-Smith (" The Zoo Man ") is also booked to give his Zoo talks quite frequently in the New Year.

Elise Passavant, who produced the mask dance " White Lady " last month, tells me that she has been assured of further television dates although, at the moment of writing, no actual fixtures have been made.

* * *

A general decision has now been reached that all television talks in future will be cut down to no longer than a quarter of an hour, and in some cases less. Producers previously had a difficult task before them in maintaining sufficient variety in presenting illustrated talks when they had to last longer than this time. In the early weeks of the B.B.C.'s high-definition service talks often ran on to 25 minutes and more, but the general feeling now is that anything more than 10 or 15 minutes is too long if interest is to be sustained.

Exeter and District Radio Society

Meetings of this society's members are held regularly at the Y.M.C.A., High Street, Exeter. A number of lectures have been arranged, details of which can be obtained from the hon. secretary, Mr. W. J. Ching, 9 Sivell Place, Heavitree, Exeter.

The Harco Radio Club

All readers are invited to the meetings of the above society held in the lounge, 124 River Way, Greenwich, every Tuesday at 8 p.m. Members are learning the morse code so that they may soon be in a position to obtain transmitting permits.

A number of interesting lectures have been arranged, details of which can be obtained from the hon. secretary, C. W. Kemp, Esq., at the above address.

"Pentodes for Transmitting"

(Continued from page 56)

(2) Excessive screen current.

(3) Too high a drive required.

The first point is the clearest indication of too high an impedance in the anode circuit. The dip should not exceed 30 per cent. of the total current and when this has been correctly adjusted any excessive screen current and drive power can be attributed to grid bias. With grid leak bias the grid will attempt to adjust itselff fairly near correct value once the anode load has been correctly set.

"A 10-metre Acorn-valve Receiver"

(Continued from page 50)

would be useful to those who are unfamiliar with the ten-metre band. When this band is effective the results are phenomenal. Between 3.15 and 4-15 one Sunday afternoon thirty-two VK, 2s. W and K stations were received. A number of these were on telephony. The average signal strength was well over R8.

On the following Sunday at the same hour the band was completely "dead."

Another common effect is that at times European and semi-local stations only can be heard whereas at other times only extreme DX rolls in.

If the first test draws a blank one should not be discouraged, but try on another day, the 10-metre band generally being of little use after 8 p.m.

General test and line up can be done by using a harmonic of the transmitter crystal stage or the harmonic from the oscillating detector of another short-wave receiver.

The 7-metre television transmission should be available if the location and antenna are at all suitable.

BINDING CARDS AND INDEXES FOR 1936

Binding cases and indexes for the 1936 volume of "Television and Short-Wave World" will be available in the second week of January. The cases are full brown cloth with stiff boards lettered in gold. The price, including the index, is 2/9 post free. Indexes may be obtained separately and the price is 6d. post free. Orders should be addressed—

BERNARD JONES PUBLICATIONS, LTD., CHANSITOR HOUSE, 37/38 CHANCERY LANE, LONDON, W.C.2

and should be accompanied by the remittance.

The International Short-Wave Club

Meetings of this society will in future be held at the new headquarters, 80 Theobalds Road, W.C.1. There is to be a special opening night on January 8, at 8 p.m., to be followed by a new feature.

The society will meet every Friday, at 7 p.m., followed by a lecture at 8.30 p.m., in the new club room, which is within 2-minutes of the Holborn tube station.

Those who wish to join the London Chapter of the I.S.W.C. should write to the hon. secretary, Arthur E. Bear, 100 Adams Gardens Estate, S.E.16. The charge for membership is 5s. per year. The new club room is to be equipped with a short-wave transmitter and receiver in addition to books of reference on short-waves.

Readers in the Brighton area are invited to the opening of the Brighton Chapter at the Brighton Technical College, on Saturday, January 23, at 6.30 p.m. Full details can be obtained from the hon. secretary, at 205 Braeside Avenue, Brighton, 6.

The Ilford and District Radio Society

Those interested in television and ultra-short wave experiments are invited to the meetings of this society, held every Thursday, at 8 p.m., at St. Albans Church Room, Albert Road, Ilford. Full details can be obtained from the hon. secretary, at 44 Trelawney Road, Barkingside, Essex.

Constructors Circle

Additional Members

A. Waters, 36 Spring Street, Bristol, 3: S. R. Oscroft, 4 Hillside Avenue, Off Main Road, Burton Joyce; C. Allenby, Scarborough Road, Rillington, Malton, E. Yorks; M. Shelley, 49 Mintern Street, London, N.1; J. C. Faulkner, Post Box 171, Calcutta, India; E. M. Knackstedt, 33 Hungerford Road, London, N.7; Francis Ross, 6 Alexandra Road, Bedford Park, Chiswick, W.4; A. E. Richardson, Greenways, 430 Kingston Road, Ewell, Surrey.

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