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Television and SHORT-WAVE WORLD

JULY 1938
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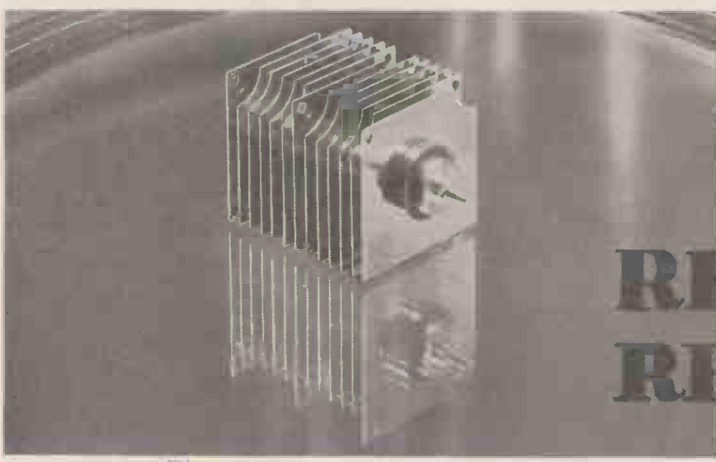

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No. 125 VOL. XI JULY, 1938

TELEVISION and SHORT-WAVE WORLD

Special Features

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AND
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COMMENT OF THE MONTH

Increasing the Range

REPORTS of long-distance reception are constantly coming to hand and there are now few districts within at least a hundred miles of the Alexandra Palace where pictures have not been received. Reception at long-distance has been made possible by special individual efforts of enthusiasts which probably cannot be emulated by the average person who would like to have television. It would seem that the time has come when some research in increasing transmission distance should be done at the transmitting end by the B.B.C. Little is as yet known of the characteristics of ultra-short wave transmission and this is all the more reason why investigation should be made of the possibilities of increasing the transmission range. Increased range would mean many more potential viewers and they would probably be of a class who would be more appreciative of the television service than those who come within the present service area.

There are many possibilities from the transmission side which would be worth investigation; for example, a four-directional beam could be tried, and there seems little reason why the power should not be increased. Beaming would mean less signal strength at close quarters in certain areas, but possibly it would be feasible to have two types of transmission—one for those within the present service area and the other for those more distantly situated. Under present programme arrangements when there is a considerable amount of programme duplication such an arrangement would not be any loss to local viewers who rarely wish to see the same item twice.

The Future of the Large Screen

THE entirely successful demonstrations by the Baird and Scophony companies of large-screen television given under public viewing conditions indicate very clearly that some solution will have to be found to the problem of copyright which at present precludes the giving of shows of this nature to a paying public. Cinema television of topical events has too great a potential future to be restricted in its development by petty restrictions. Also it is a service which the public are entitled to enjoy and one which only television can make possible. It is likely that the average cinema audience would be indifferent to the entertainment side of television as provided by the ordinary programmes and it should therefore be possible to draw a line between entertainment and the showing of topical events in which no question of copyright can arise except as regards the B.B.C.'s claims. The concerns that have spent money and effort in developing large-screen television are entitled to their reward and the public should be able to enjoy the amenities which they have made possible.

A RADIO NEWSPAPER

NEW FACSIMILE APPARATUS FOR THE HOME

AFTER ten years of laboratory research, R.C.A. Victor engineers have produced a simplified radio facsimile system designed to transmit pictures, news bulletins, etc.

Already, seven large radio stations in different parts of the country, most of them owned by newspapers, have placed orders for the new apparatus. These stations are KMJ, Fresno and KFBK, Sacramento, California, both owned by the publishers of the Fresno and Sacramento Bee papers; KHQ, Spokane, Washington; WBEN, owned by the Buffalo Evening News; WTMJ, owned by the Milwaukee Journal; KGW, owned by the Portland Oregonian; and WOR, of the L. Bamberger Company of Newark, N.J.

All these stations have applied to the Federal Communications Commission for permission to carry on their experimental programmes, and several wavelengths have already been assigned. The F.C.C. requires each station to instal a minimum of fifty receiver-printers for each facsimile transmitter. The experimental programmes will determine, among other things, public reaction to facsimile broadcasting as a radio service, the best type of programme material, and the technical requirements for both scanner and receiver.

It is planned to broadcast pictures and text on standard broadcast wavelengths during the early morning hours, between midnight and dawn, so that a complete bulletin will be ready for the user in the morning.

The new facsimile system utilises ordinary white paper, and ordinary carbon paper, at the receiving end. The width of the paper roll on which the facsimile material is printed is $8\frac{1}{2}$ in. The length of each page is 12 in. on a continuous roll. Printing speed is at the rate of three feet of record per hour. A time clock arrangement at the printer-receiver automatically turns the apparatus on and off in accordance with a pre-determined transmission schedule.

Charles J. Young, R.C.A. Victor research engineer, with the simplified radio facsimile receiver-printer he developed for home use. The controls and mechanism are entirely enclosed when in use and need not be touched after they have been properly adjusted. A time clock arrangement automatically turns the apparatus on and off in accordance with the pre-determined transmission schedule, so that it requires no attention.

The Receiver

The facsimile receiver-printer is encased in a wood cabinet measuring only 18 in. by 18 in. by 12 in. All the mechanism and controls are inside so that they cannot be tampered with once they have been properly adjusted. The paper rolls out through a slit in the front of the cabinet. Two designs of facsimile receiver-printers have been developed. One is fairly elaborate and automatically cuts the paper into 12-in. pages and deposits them neatly in a tray. The other is much simpler, and does not cut the paper into strips.

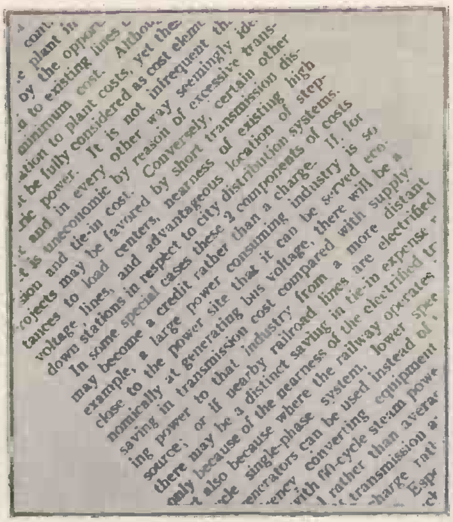
The picture, drawing or text to be transmitted is placed on the roller drum of the "scanner." A beam of light travels horizontally across the page as the drum revolves. The light is reflected and focused on a sensitive photo-electric cell in the various degrees of shading corresponding to the picture. The photo-electric cell transforms the light into electrical impulses which are then transmitted by radio.

The receiver is synchronised to the transmitter-scanner and the signals are picked up exactly as in sound broadcasting. Continuously feeding rolls of ordinary white paper and ordinary carbon paper are led past a metal cylinder drum, on which a single spiral of wire projects a fraction of an inch above the surface. The fluctuations in the intensity of the incoming signals press the paper and carbon together against the spiral to make marks corresponding to the light and shade of the original at the scanner.

The facsimile transmitter scanner. Pictures, text or drawings are placed directly on the roller drum, the speed of which is synchronised with the receiver-printer in the home.

The new simplified facsimile system was developed in the R.C.A. laboratories after years of experiments with many different types of facsimile apparatus, some which were employed for commercial transmission of weather maps and information to ships at sea, and for the transmission of photographs and other material across the Atlantic. The new equipment was developed by Mr. Young and his assistants as the most practicable for home use, because of its extreme simplicity.

The facsimile signals may be heard on the loudspeakers of ordinary wireless sets when broadcast wavelengths are used as high pitched tones of varying intensity.



Two examples of matter transmitted by radio.

TELEVISION'S GREATEST THRILL

THE BAIRD COMPANY SHOW THE DERBY UNDER CINEMA CONDITIONS

THE Derby provided television's greatest broadcast yet. The demonstration staged by the Baird Company at the Tatler Theatre, Charing Cross Road, was a great triumph and apart from the technical achievement it conclusively proved that television has now definitely entered the field of public entertainment. The idea of giving this show at a cinema and under ordinary cinema conditions was an excellent one for it showed exactly what could be done and how an average audience would react.

The screen was, of course, smaller than the ordinary cinema screen (the size was actually 8 ft. by 6 ft.) but it was sufficiently large to be seen clearly from any part of the auditorium. The clarity was wonderful and although it was not possible to pick out individual horses as they were bunched together, it was quite easy to determine the leaders and the remarkable spurt by Bois Roussell was very clear. Television history was certainly made at the Tatler Theatre on Derby Day; it was the day when the dream of television pioneers came true.

Two projectors were installed by the Baird Company at the theatre. Only one was used, however, the other being a standby as is usual in cinema practice. These were placed about fifteen feet in front of the screen right at the front of the auditorium and were tilted so as to project the picture upwards. Projection type cathode-ray tubes are fitted and the entire apparatus is contained in metal cases of approximately three feet cube. These cases are mounted on adjustable tubular iron legs so that the apparatus is of quite a portable character.

The apparent simplicity of the gear is remarkable.

There are very few controls and the interior of the cases containing the time bases, etc., appears no more complicated than any television receiver. The amplifier racks and H.T. supply units were separate from the actual projector, being connected by cables installed under the floor of the front part of the auduitorium. Duplicate H.T. units were available and these were placed in a cellar. The voltage of these is 30,000 and they provide a current of 300 microamps. The transformers and condensers are placed in oil-filled teak tanks supported on porcelain insuluators. The amplifier racks were at the side of the auditorium. The whole installation is convenient and portable, though obviously certain precautions are necessary to prevent any possibility of accident with the high voltage employed.

Crowd scenes are notoriously difficult in screen work, but even so it was possible to pick out several well-known characters. Possibly before the race commenced there was too much panning of the course and crowds; it became rather tedious but once the race started the audience became keyed up with excitement. Here was the race actually as it was taking place and whatever interest one might have of a film show of the same event, there was something very much more in the actuality to which the dramatic finish served to add. No other medium could have provided the same thrill.

We understand that apparatus similar to that installed at the Tatler Theatre will be made available to the film trade for installation in picture theatres. It is proposed to retain the equipment in the Tatler Theatre.

Short-wave listeners know that to obtain the maximum results the most important accessory is the aerial system. The Taeo directional aerial is now available from Messrs. Webbs Radio for only 32s. 6d. It is compassed marked and will give an increase in signal strength of at least 12 db. when it is switched to receive from any particular direction. This type aerial will, before very long, almost certainly become general in use.

LUMINESCENCE—

AND ITS APPLICATION TO TELEVISION

TELEVISION SOCIETY. THIRD KERR MEMORIAL LECTURE

The third Kerr Memorial lecture on "Luminescence and its Application to Television" was delivered by Dr. Leonard Levy, M.A., F.I.C., and D. W. West, Esq., A.C.G.I., at the Institution of Electrical Engineers.

The following is a summary of the lecture, a full report of which appears in the Journal of the Television Society.

IN a paper which we communicated to the Institute of Electrical Engineers two years ago (Levy and West, *Journal Inst. Elec. Eng.*, Vol. 79, July, 1936) we dealt generally with the question of fluorescent screens used in cathode-ray tubes for television and for other purposes. We propose, in this lecture, to discuss in some detail a few of the more interesting phenomena connected with luminescence, but to confine our remarks on the practical problems of cathode luminescence to such changes and developments as have taken place since the date of our former communication.

Spectrum Range

The fluorescence exhibited by some phosphors is substantially monochromatic, whilst in other cases it is spread over a large portion of the visible spectrum. With certain compounds indeed it extends well beyond the visible into the ultra-violet. Zinc silicate and zinc phosphate are good examples of the first class. Their fluorescence is confined to a narrow band and when these substances display phosphorescence, this is of the same wavelength as the fluorescence. On the other hand most tungstates and sulphides fluoresce over one or more wide bands of the spectrum. Thus the fluorescence of cadmium and magnesium tungstates are both substantially white, being only slightly tinted yellow-green and blue respectively. The fluorescence of zinc sulphides is usually composed of bands in the blue and green, and sometimes extending into the yellow, according to the amount of copper phosphorogen employed. Thus it is possible to produce a zinc sulphide with copper phosphorogen of almost any shade from a deep blue to yellow green.

In the case of this type of substance with composite fluorescence, the phosphorescence is often selective, the longer wavelengths being usually more persistent. This causes the phenomenon of blue fluorescing zinc sulphide giving a green or yellow-green phosphorescence, while yellow zinc cadmium sulphides often display a red afterglow. We do not know of any case where the phosphorescence is of shorter wavelength than the fluorescence, although this may appear to be so in the case of mixed phosphors.

Types of Substances

Luminescent substances are of several different types. The type of the most practical importance is perhaps exemplified by the luminescent sulphides, notably zinc and zinc cadmium sulphides. This type of substance has three very well marked characteristics:

(a) The presence of a small trace of impurity, known as a phosphorogen, is essential for their proper functioning. The amount of phosphorogen required varies considerably, the usual amount being about one part in ten or twenty thousand. In certain instances as little as one part in a million produces a well-marked and unmistakeable effect.

Luminescent zinc sulphide prepared in as pure a state as possible exhibits a blue fluorescence with but little phosphorescence. If one part in one million of copper is added, the fluorescence becomes blue-green, and the phosphorescence is considerably increased. These effects are very marked indeed when the proportion of copper is increased to one part in 100,000.

(b) If even very small traces of certain substances, notably some of the heavy metals, are present, the luminescent properties are almost entirely destroyed, or at all events reduced so greatly that the substance loses all practical value. This characteristic is not confined to the type of luminescent substance which requires a phosphorogen, but is general in most luminescent substances. It is, however, by far the most marked in the phosphorogen type.

Comparison of zinc sulphide containing one part in 100,000 of copper with and without addition of one part in 10,000 of iron shows that the latter poisons the fluorescence, greatly reducing its intensity. The phosphorescence is also reduced but not to so great an extent.

(c) The luminescent properties are only displayed when the substance is in crystalline form. It therefore follows that any amorphous precipitate must be heated to convert it into a crystalline form before its luminescent properties are displayed.

It will be appreciated that the first two characteristics entail considerable difficulties in the production of luminescent substances of the greatest efficiency. Owing to the prejudicial effect of very minute traces of certain heavy metals, the conditions under which these substances are produced are more akin to those appertaining to bacteriological practice than those of ordinary chemical processes.

The production of luminescent sulphides is usually effected by precipitation of the sulphide in the highest possible degree of purity, the addition of the necessary amount of phosphorogen together with certain salts which act as fluxes, and a final heating of the amorphous precipitate.

Apparent Colour

The apparent colour of fluorescence depends upon the nature and amount of the extraneous illumination. Fluorescence, which when viewed in nearly total darkness appears white, will assume a tinted appearance if viewed by the light of gas-filled lamps. As modern

(*Continued on page 396*)

MECHANICAL-OPTICAL TELEVISION FOR THE EXPERIMENTER—II

By J. H. Jeffree.

This is the second article on the construction of experimental receivers employing mechanical-optical methods. The purpose of this series is to indicate to experimenters the possibilities of quite simple apparatus and suggest suitable lines of development. The author is a well-known authority who has had very considerable experience in this branch of television.

FIGURES have often been given for the intrinsic brightness of various light sources. Large high-intensity cinema arcs give 50,000 candle-power per sq. cm. or even more, in the centre of the positive crator; small carbon arcs, perhaps 10,000, and half-watt filaments 1,000 or so when normally run, up to a maximum of rather over 2,000 when drastically over-run. They can be run at 1,500 candle power per sq. cm. with reasonably long life, and are the obvious choice for preliminary experiments. Motor headlight bulbs or talkie exciter lamps are convenient forms to use.

The figures for glow discharge tubes are relatively quite low, of the order of 10 to 100 at most. The mid-day sky, or the moon's disc, is of the order of 1. and anything which is not dazzlingly bright when seen against these is little use for high-definition television.

Scanning Systems

Now we can tackle scanning systems. It is a good plan, from the start, to consider line and frame scan separately, though it is possible, of course, to produce them by a single device. Leaving light quantity aside for a moment, consider the general problem of getting 405-line scan movements per 2-frame scans. The first point is, that the timing of the second 202½ line movements must exactly correspond to that of the first 202½, or else, even though interlacing may be perfect, the two interlaced frames may not exactly fit horizontally, and a doubling of vertical lines in the picture will result. To avoid this, it is essential that if there are any appreciable errors in timing of the line scanning movements, they must be identical in each set of 202½ lines.

Apart from this, errors up to several picture details would be quite tolerable if they accumulated gradually from line to line, since only a slight bending of the picture verticals would result. As it is, however, it is clear that we have to rule out any idea of producing the whole set of 405 lines by a single scanning movement, since the second half of the movement, with all its errors, would have to be an identical copy of the first, or else *no* errors greater than, say, half a picture detail, could be tolerated in the line scan. For full definition this is about one-part in 400,000, which is too high a standard of accuracy to aim at.

An alternative is to produce 202½ lines per revolution of the scanner, but then the second 202½ of the complete picture are necessarily half a line displaced horizontally from the first! It is not too difficult, however, to arrange some optical unit, which, by slipping in and out of the beam in alternate fiftieths of a second, can be made to displace the second 202½ lines relative to the first; and if, as is likely, we decide to use a separate scanner to produce the vertical or frame scanning movement, this can easily be made part of its duties. With such an arrangement slight errors in the line scanner will do no serious harm.

A simpler expedient is to cut out alternate frames of 202½ lines altogether, being content with a non-interlaced, 25-frame per second picture. We shall re-return to this later.

A different solution is to make the line scanner one that repeats its movements either for every line

The apparatus shown in the photograph above is probably the simplest type with which any results could be got on the present system of transmission

(example, a vibrating mirror) or for every few lines (example, a speeded up polygon with, say, 12 mirror faces). Then it is less difficult to get the necessary accuracy, and one can aim confidently at having no errors greater than half a detail. We shall consider in later articles some of the possibilities of these methods.

Now, however, let us take a simple arrangement (Figs. 5 and 6) involving yet another expedient for simplifying the problem, namely, that of missing out two lines in three from the transmitted picture, making it the equivalent of 135 lines. This loses light and definition, of course—light because the scanning beam is out of action two-thirds of the time—but it makes construction easier.

Polished steel balls are commercially obtainable,

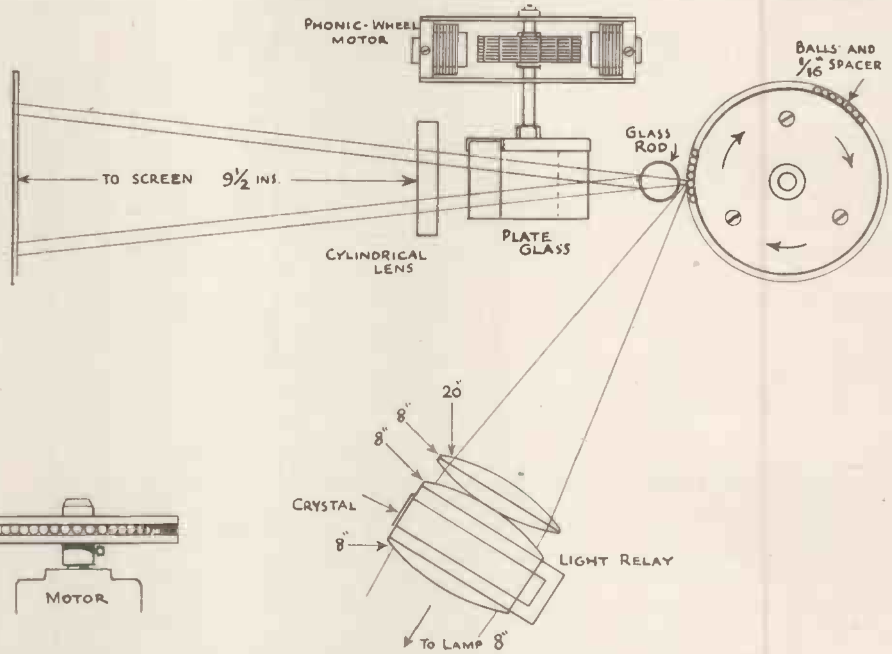
The Supersonic Light Cell

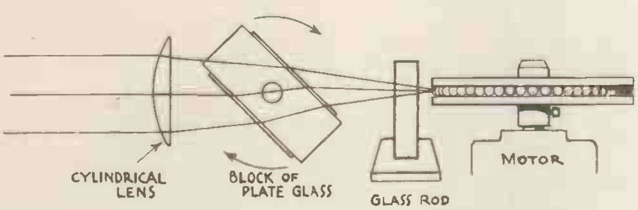
accurate to a given size within fine limits. Sixty-seven of these, one-eighth of an inch in diameter, and a half width spacing member, can be clamped between grooves in two brass discs, to make a scanner for one line in three of the 202½ line frame, with spacing automatically correct enough for our purpose. The only difficulty in construction is to get the grooves just the right diameter—neither too big, when spaces will occur between some of the balls and spoil the accuracy, nor too small, when they will not all fit it! The polished balls act as convex mirrors, and by letting them carry round the image of a train of modulated light details produced in a supersonic wave light relay, we get the basis of an arrangement that can handle a reasonable amount of light.

A second scanner is, of course, needed for the vertical movement, and if it is arranged to correct the horizontal displacement of alternate frames of 67 lines we shall get a 135-line scan. A "simplest possible" arrangement, however, is a piece of plate glass rotating on a horizontal axis, so that when roughly broadside on to the light from the first scanner it causes it to appear displaced slowly upwards as it rotates. This is the first frame of the pair. Then it comes into a more edge-on position to the light, and either obstructs it, or deflects it so far that it does not reach the picture area, in the second frame. Its speed is, therefore, a quarter that of the first scanner, or 12½ revolutions per second, that of the first scanner being 50.

These speeds are such that they can be correctly given, on the *average*, by motors driven from the time-controlled 50-cycle mains; synchronous motors, with rotors having 2 poles and 8 poles respectively, being needed for the first and second scanners. Unfortunately, however, it cannot be assumed that the transmissions are exactly in step with the mains. Variations have occurred in recent months in this connection, and it appears now that while the average frequencies of the synchronising signals are (usually) tied to the mains, there are considerable oscillations around these averages.

It is hoped, later on, to deal with possibilities of direct synchronising of scanners from the signals.





Figs. 5 and 6. These two drawings show a plan and elevation of the simple scanning system. The scanner is of a novel type employing steel balls and an entirely new device for framing and interlacing. All the parts used are of a very simple character and are available.

The Light Cell

A supersonic cell of the simple experimental type* described in the May, 1936 number of this journal can be used with these scanners, using a 10 megacycle crystal and kerosene as liquid, as there described. A 14 mc. crystal is permissible, and a 7 mc. crystal can be used, though it will not give entirely correct results. Simple lenses about 1½ in. diameter are used with it, one, 8 in. in focal length, on the light-source side, and on the other side two or three in contact to give a focal length of 3⅓ in., as nearly as possible; for instance, one of 8 in. focus, which can be balsamed on the cell, on the light-source side, and then two, of 8 in. and 20 in. focus respectively, preferably balsamed together to save light losses, and placed near the one stuck to the cell.

Since the cell has to be horizontal, a shape somewhat as shown by Fig. 7 is necessary, and a simple form of construction, with spacing pieces of bakelite or even seccotined wood, and plate glass sides can be used. Glue rendered permanently soft with a little treacle is well known as a cement for resisting such liquids as kerosene, and can be used to stick the parts together. It is a somewhat tricky business to make quite sure that the whole thing does not leak!

The crystal can have aluminium foil electrodes, as in the articles referred to, and here again a little practice may be needed to stick them nicely to the crystal, and the latter to the opening at the side of the cell.

With the 1½ in. lenses, we can reckon a path length

*The owners of the patents on this cell are Scophony Ltd.

EFFICIENCY CALCULATIONS

for the waves of $3\frac{1}{4}$ cm. to be useful optically, a distance traversed by them, in kerosene, in 1/40,000 of a second. This is a quarter the duration of a line. Therefore, the image of this length of the light cell, in the steel balls of the scanner, must be a quarter as long as the distance they move in one line. The ball diameter corresponds to three lines, two being missed; so one line is $\frac{1}{3} \times \frac{1}{8}$ in. = 0.106 cm.; and one quarter line 0.0265 cm. This settles the distance of the light cell from the balls, which is $8\frac{1}{2}$ cm. approximately (to the width of $1\frac{1}{2}$ cm. will appear as 1/80 cm. approximately. Working, once again, with a simple lens, at f/3, we get width × angle =

$$\frac{1}{80} \times \frac{1}{3} = \frac{1}{240}$$

Product of horizontal and vertical values is

$$\frac{1}{120} \times \frac{1}{240} = \frac{1}{30,000} \text{ (roughly).}$$

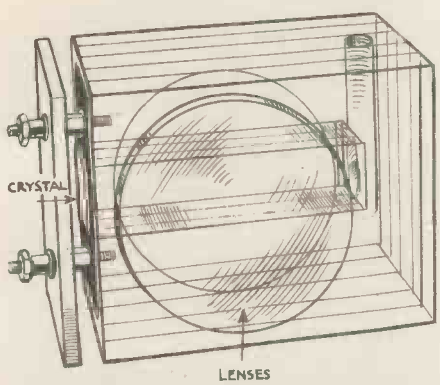
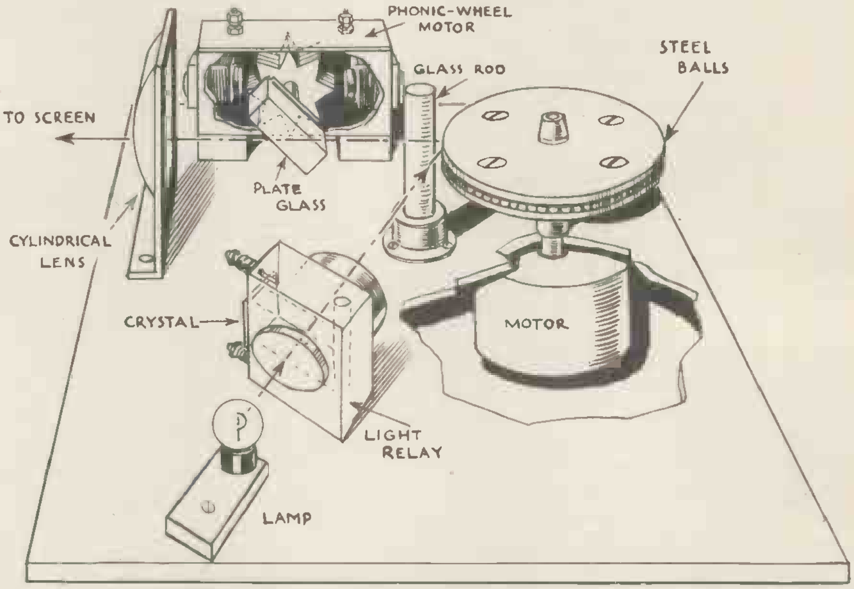


Fig. 7 (above) The supersonic light modulating cell merely consists of a glass sided box capable of holding a liquid with a crystal at one end to which the input from the receiver is applied. The owners of the patent for this type of cell are Scophony Ltd. and it is only permissible to use it experimentally.



The drawing above shows the complete lay-out of a very simple scanning arrangement shown by the photograph on an earlier page.

mean centre of the exit lenses of the cell) when used as in the diagram.

From the above, however, let us now check the light quantity. The image of the light relay in the steel balls is a suitable one, as explained in the preceding article, at which to make light calculations. Assuming the light cell provides enough light (how nearly it does we shall check later) we can expect rays to issue from the 0.0265 cm. long image of it in the steel balls, over a wide angle, since a spherical mirror acts like a lens of very wide aperture indeed. The associated simple lenses, however, which are to project the picture on to a screen, will not work well at a much better aperture than f/3, so this gives the horizontal angel = $\frac{1}{3}$ radian. *Width times angle,* then is (in round figures)

$$1/40 \text{ cm.} \times \tfrac{1}{3} \text{ radian} = 1/120 \text{ (cm.} \times \text{radian)}$$

Now vertically, we might make the line width, as seen in the balls, correct in relation to its length; but, if we are willing to deal with the two directions independently, with cylindrical lenses, there is no reason why we should. It is better to have it as large as possible, to gain light. The light cell is what sets a convenient limit here.

If, as is probable, the available crystal is about 2 cm. diameter, a wave track about $1\frac{1}{2}$ cm. wide can conveniently be made in the liquid. A length of $3\frac{1}{4}$ cm. of this is imaged in the balls as 0.0265 cm., so that a

Losses are those of six glass bodies (including screen) and a steel surface which counts as 4; total 10, with 35 per cent. transmission (from the table). Call it $\frac{1}{3}$.

Light source.—The vertically mounted coiled filament of a motor head-lamp bulb, giving (somewhat over-run) 1,500 candle-power per sq cm.

$$\textit{Light in beam} = \frac{1}{30,000} \times 1,500 \times \frac{1}{3} = \frac{1}{60} \text{ lumens.}$$

We must allow, however, for rejecting two lines in three and one frame in two, so that the average screen illumination is $\frac{1}{360}$ lumen, sufficing for about $\frac{1}{360}$ square metre of ground glass, or, say, an actual picture 2 in. by $1\frac{1}{2}$ in., allowing for the slight extra loss mentioned below.

The 1.06 millimetre movement of the ball images in one line can be projected on a screen a foot away, as a 2 in. line, by a cylindrical lens (L_1) of 6 mm. focus, which may conveniently be a selected piece of glass rod $\frac{1}{3}$ in. diameter, placed rather close to the ring of balls. (The brass discs that hold them must not overlap them unnecessarily.) A stop, on the far side of the rod from the balls, in the form of a vertical slit 2 mm. wide and as long as convenient, limits the aperture to f/3. This rod actually has less aberration than a more conventional form of lens. So much for the line scan.

The Optical System

Then comes the plate glass frame scanner, $1\frac{1}{2}$ in. long, $\frac{3}{4}$ in. wide or more if convenient, and $\frac{3}{8}$ in. thick. Just beyond it, adjusted to focus on the screen is the second cylindrical lens (L2) vertical aperture about four-fifths of an inch, focal length 2 in., axis horizontal. This focuses the line width of $\frac{1}{80}$ cm., as seen in the balls into a width of about $\frac{1}{20}$ cm. = $\frac{1}{50}$ in. on the screen and the apparent shift of the ball images produced by the plate glass, which amounts to just over a centimetre, is reproduced as a vertical scan of an inch and a half. Had we not used this widened line at the steel balls, and cylindrical lenses to correct for it, the second scanner thickness might have been only $\frac{1}{20}$ in.; but by doing so we have gained about 13 fold in light. While not exactly the same as the "split focus" arrangements hitherto used, this is something very similar to them in principle.

The supersonic relay is generally used with a split or stop of some sort to separate the diffracted and undiffracted components of the light. This is dispensed with in the present arrangement, as, with a 10 mc. crystal, the diffracted light goes sufficiently astray to miss the picture area almost completely (and with a 14 mc. crystal still more so). This is part of the reason for focusing the beam obliquely on to the ball scanner (see Fig. 8). The angle should be about 60° off the normal, so that the spread of the first fringes on either side of the central beam, which at $8\frac{1}{2}$ cm. is about $\frac{3}{8}$mm. with a 10-mc. crystal is doubled in projection on the ring of the moving balls, becoming $\pm \frac{3}{4}$ mm. Since the line is only $\pm \frac{1}{2}$ mm., about, the fringes will not enter the picture (except possibly a trace at the edges, which will be hardly noticeable).

The filament image, which is focused on the balls, would be about $\frac{1}{5}$ mm. wide, but is enlarged by lens aberrations to about double. The active aperture of one ball, at f/3, is about $\frac{1}{96}$ in. or $\frac{1}{4}$ mm., since its focal length is a quarter of its diameter or $\frac{E}{32}$ in. Therefore the filament image more than covers this, near the centre of the line, and our light calculation was correct, except that the doubling of the image width due to aberrations means a reduction (though not in practice so great as two to one, owing to the non-uniform nature of the aberrations) in the intensity of the light, which will be of the order of two-thirds of that calculated.

It falls off towards the edges of the picture, where the effective "apertures" of the balls are not fully covered, being, theoretically, down to about half brightness at three-quarters of the way out. If desired, slight de-focusuing of the filament image on the balls can be used to improve this a little, especially with a 14 mc. crystal.

But for the oblique incidence of light on the scanner, this falling off would be very much worse, and could only be cured by considerable de-focusing, with consequent loss of brightness in the centre. The scanner would, in fact, be very wasteful of modulated light. This is a further point that always comes in when dealing with scanning systems, quite apart from their optical efficiency in the narrower sense. An extreme example enables one to appreciate it fully: a simple mirror screw, with 405 laminations, all fully illuminated with moduluated light, only one of which is active at any particular moment! Or most pinhole or slot devices, similarly.

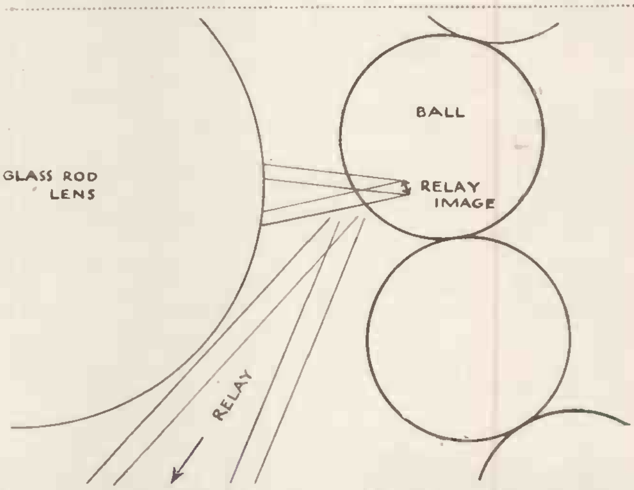


Fig. 8. This drawing shows the incidence of the modulated light on one of the ball units of the scanner.

Ball scanners of the type described are always inherently rather wasteful, even when oblique incidence of the light is used to reduce the waste. Were we, in this case, not missing out two lines in three, a three times larger width would have to be illuminated, giving a wastage ratio of about six instead of the present two as judged spatially. Yet in fact the wastage ratio is still six in the present arrangement, but is made to be two fold (in space) × three fold (in time) by missing out two lines in three! It is hoped, in later articles, to deal with better types, which give more light simply by reducing the amount wasted. The supersonic relay used here provides quite enough for a respectable picture, if it can *nearly all* be got on to the screen all the time!

It will be noted that the undiffracted beam is used, so that increased voltage on the crystal means darker tones on the screen. This must, of course, be remembered in building an oscillator to drive the crystal.

It might be thought that owing to the obliquity of the light falling on the steel balls of the first scanner, definition would suffer. In general, oblique arrangements of this sort are rather liable to be quite hopeless in definition, but it happens that a sphere used in this particular way is satisfactory in that respect. It may also be noted that the distance of the light relay from the scanner is less because of this obliquity, than it would otherwise be, to give correct immobilisation of the several picture elements on the screen.

ANOTHER METHOD OF INTERLACING

HOW THE BARTHELEMY SYSTEM WORKS

In a recently published description of the Eiffel Tower Station mention was made of the French television system which differs radically from the system in use in this country. This article, based on Barthelemy's review in "L'Onde Electrique," present his views on the problems of interlacing and gives details of his methods of overcoming them.

IT is well known that the difficulty in the operation of interlaced scanning systems is in ensuring the correct spacing of the lines and in maintaining this spacing during successive frames. The problem can be solved by two methods:

(a) By utilising a periodical phase displacement of the line pulse in relation to the frame pulse.

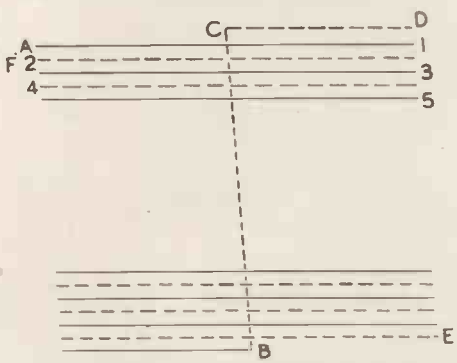


Fig. 1. Diagram explaining the Marconi-E.M.I. system of interlacing.

(b) By making a periodical variation in the amplitude of scan.

The former method has been more favoured by workers in high definition television, as the latter presents several difficulties in practice and it is difficult to ensure stability.

Under the first heading comes the method using odd-line interlacing, such as is used in the Marconi-E.M.I. system. The conventional method of representing this is shown in the figure. The spot starting at A traces the odd lines 1, 3, 5, etc., until "2n + 1" lines have been drawn.

In the middle of the (2n + 1)th line the spot flies back to a point C on a level with the original point A and continues to draw the other half A of the line. Note that the section of the line is above the original line 1 and at a distance equal to half the interval between the two lines of the first frame. When the line pulse operates, the line CD is shifted to F and the second frame 2, 4, 6, etc., is then drawn. At the end of the line E the line and frame pulses occur simultaneously and the spot returns to the commencement A.

The characteristics of this system are that the picture scan is regular in periodicity and amplitude. The line synchronising pulses are also regular in occurrence, but if the beginning of the group of odd lines is in phase with the picture synchronising pulse, that of the even lines is regarded by half a line. Necessarily the number of lines must be odd to give the half line at the end of each frame.

It has been assumed in the above explanation that the duration of the flyback in the frame scan is so short as to be negligible, but this is not the case in practice. If the duration of the travel of the beam from B to C lasts for half a line the interlacing is upset, and it is in this flyback time that one of the difficulties of the system occurs. Since it is impossible to have an instantaneous flyback it is necessary to fix its duration, allowing, if necessary, a whole number of lines for this purpose. It is also necessary to fix the phase of the picture signal in relation to the line signals, as a slight phase displacement between two successive picture signals would alter the composition of the picture. This phase relationship is assured in the Marconi-E.M.I. system by deriving the line and picture pulses from a common oscillator.

Separation of Pulses

Theoretically, a satisfactory way of distinguishing between line and picture pulses would be to make them of different amplitudes, but since the synchronising pulses form part of the total carrier amplitude any increase in pulse would encroach on that part of the carrier available for the vision signal. For this reason frequency separation is usual, the line pulse being steep fronted and the picture signal being longer in duration, even up to 20-30 line signals. These pulses can then be separated by the usual resistance-capacity filter network.

In such a system it is not possible to prevent the line pulses from slightly affecting the picture pulses unless the filtering is elaborate, and in the case of the odd-line scanning that we have just considered there will be an extra pulse (line) every other frame. This may lead to irregularity in the picture pulses and increase the difficulty of keeping exact interlacing. Again, in the E.M.I. system, this is avoided by the use of supplementary pulses which tend to prevent the stability of the scanning being upset by irregular picture pulses.

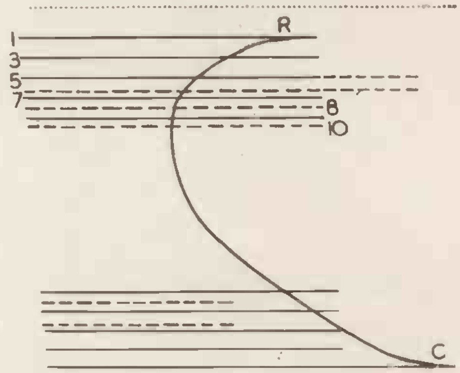


Fig. 2. The Barthelemy system. In this the shifting of the lines takes place in the frame.

Barthelemy's System

In spite of the ingenious solutions to the difficulties of odd-line interlacing, the use of a system depending on flyback time and correct phasing of the synchronising pulses places certain limitations on the circuits which can be used in the reception of the television.

With this in mind another system was investigated which should have rigid phase relationship between the line and frame pulses and which should to a certain extent be independent of flyback time. In this

*T. and S.W.W., May, 1938, p. 261.

system the displacement of the lines is made, not at the beginning or end of the frame, but three or four lines from the commencement. For this reason it has been called "internal displacement" of the scan.

The method is shown in the diagram Fig. 2. The scanning follows the normal practice except for the fact that the spot returns from a point C beyond the end of the last line of the picture, CR being the approximate path of the flyback.

The scan recommences, successive lines being superimposed on the lines of the original frame, as shown by the lines 1, 3, 5, etc.

At the end of line 5 the scanning circuit has become stabilised or, as the phrase is, "lost the memory of previous events," and the formation of the interlace begins. The 5th line is extended for a distance as shown. As the picture scan is operating this will have the effect of causing the next line to be drawn nearer line 5 instead of coinciding with line 7, as it would do normally. This line is in turn extended, and the additional lag in timing causes the next line to fall into place between the lines as shown by 8. The interlacing is now established and continues to within a few lines of the end of the frame.

At the end of the frame the reverse process takes place. The line duration is shortened by shortening the interval between the line pulses, and two successive short lines enable the third to be superimposed on the last lines of the previous frame.

The picture finishes at the same point in each frame and the picture synchronising pulse is always the same. It should be noted that two frames have the same number of line synchronising pulses, which improves the stability of the filter circuits associated with the synchronising separator. Finally, the number of lines can be even, which is an important point from the aspect of mechanical systems. In practice the system has been found stable and the separation of the pulses can be easily effected by ordinary simple circuits.

LUMINESCENCE—AND ITS APPLICATION TO TELEVISION

(*Continued from page* 390.)

television receivers give an image of sufficient brilliance to be viewed in a fully lighted room, this effect is of some practical significance.

In the case of fluorescence excited by cathode radiation, the intensity of the fluorescent light has a considerable bearing upon the colour sensation produced. The difference in colour tints is much more marked at low intensities than at high intensities. At high intensities the colours all tend to become much nearer white or, to put it another way, the spectral band of the emitted light increases in extent.

The thickness of the coating of the screen in a cathode-ray tube exerts an influence on the colour of the fluorescence, due to absorption. With greater thicknesses of screen, the fluorescent light from the blue component is preferentially absorbed, and the tint of the fluorescence becomes yellower.

Voltage and Colour

The voltage applied to the cathode-ray tube exerts quite a noticeable effect on the tint of the resulting fluorescence. This is due to the fact that the response of the different components of the television compound employed does not vary to the same extent with alteration in the voltage applied. At higher voltages there is a tendency for the blue component to increase preferentially in brilliance, so that the tint of the white becomes bluer. As television reception tubes are always operated on a fixed and predetermined voltage, it is easy to arrange for the television compound to give the most desired result at any particular voltage at which it may be employed.

Projection Tubes

The necessity for an image of greater intrinsic brilliancy has put new demands upon the fluorescent materials employed. These are highly satisfactory for all loadings required for ordinary television, and have practically an indefinite life at such loadings. This is, however, not the case at present in projection tubes. The increase of brilliancy required can be obtained by a considerable increase in voltage or by increasing the beam current, or by a combination of both. High voltages have been tried in the case of sulphides with considerable success, but difficulties are experienced due to a lack of secondary emission of electrons, whereby an instability of the resulting image, known as "picture flutter," results. Experiments are at present being carried out to devise suitable methods for increasing secondary emission of sulphides when used in these circumstances. This can obviously be done by increasing the conductivity of the layer. Some improvement can also be effected by special methods of preparation of the sulphides. It cannot, however, be said that finality has yet been obtained, or that an entirely satisfactory product is yet available.

The fluorescent material can be coated on a metallic plate and viewed from the front in a special type of tube. This overcomes the secondary emission difficulty, and also has the advantage that the brilliancy is increased in the ratio 1 : 1.73 (see Levy and West, *Journ. I.E.E.*, 1936). It introduces, however, considerable mechanical difficulties in the construction of the special shape of cathode-ray tube which would be required.

If silicates are employed for projection tubes advantages are not obtained by pushing the voltage too high. With these substances it appears to be desirable to increase the beam current to a greater extent than with sulphides.

SIR JOHN REITH

Considerable surprise was caused by the announcement that the Director General of the British Broadcasting Corporation was to leave to take a position with Imperial Airways.

Sir John has been connected with broadcasting since 1922 when he was appointed General Manager of the British Broadcasting Co., Ltd. In the following year he was made Managing Director and in 1927 Director General of the newly-formed British Broadcasting Corporation.

The appointment of J. C. W. Reith to the British Broadcasting Co., Ltd., in 1922 was unexpected for his previous position was with Wm. Beardmore and Co., Ltd., of Coatbridge. He had, however, had considerable experience of business management.

In his new sphere as full-time Chairman of Imperial Airways at a salary said to be £10,000 per year there is no doubt that his wonderful organising ability will again be put to very important use.

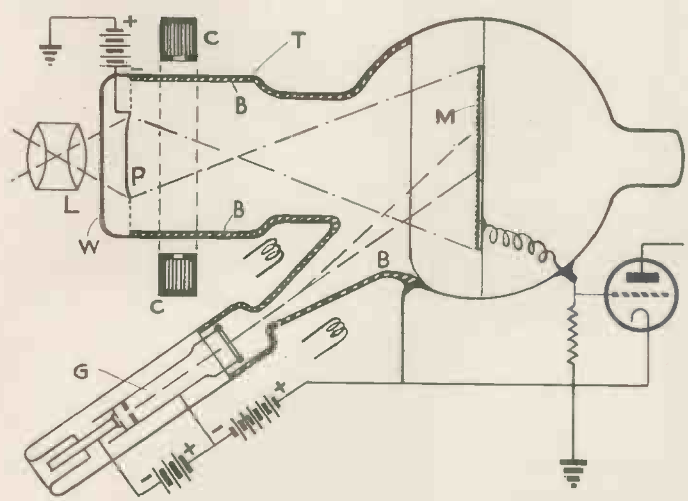
THE LATEST EMITRON CAMERA

In view of the highly successful transmissions of the Derby and other outside events this information on the construction and functioning of the super Emitron camera will be of particular interest. The information was given by J. D. McGee, M.Sc.Ph.D., Research Department of Electrical and Musical Industries, Ltd., in a paper read before the World Radio Convention, Sydney.

THE Super Emitron which is now being used for all outside broadcasts represents a considerable improvement on the old type of standard Emitron. The new type of tube is shown diagrammatically below. A beam of electrons from a conventional electron gun G scans a mosaic M similar to that of a standard Emitron, except that in this case the mosaic elements are not photo-sensitive. In fact, the charge storage electrode may now be a plain sheet of mica backed by a metal signal plate. The optical image is focused by a lens L on to a conducting transparent photo cathode P, which is supported on a thin sheet of transparent material (e.g., glass or mica) situated close to a polished glass window W.

The light liberates photo-electrons from the opposite side of this photo cathode to that on which it falls, these electrons having the same distribution as the light in the optical image. These electrons are accelerated by an electric field between the cathode which is held at about −500 volts, and the metal coating B on the internal walls of the cylindrical glass tube T. This metal coating is an extension of the second anode of the electron gun, and both are held at earth potential.

Encircling the glass neck T is an iron-clad magnetic coil C, which produces a magnetic electron lens and enables the electrons that leave the cathode to be brought to a focus on the surface of the mica mosaic. These electrons liberate several secondary electrons each when they impinge on the mica surface, and these secondary electrons now assume the same role as the photo-electrons that are ejected from the mosaic of the Emitron by light. From this stage onward the mechanism of signal production is essentially the same as that in the standard Emitron.



The super Emitron camera tube shown diagrammatically.

An interesting point to note is that the electron image that is formed on the mosaic surface is rotated through an angle of about 45° relative to the original optical image by the magnetic electron lens. Hence the tube mosaic must be rotated through the same angle about the axis of the electron lens in the same direction to compensate this rotation.

Advantages of the New Type

The super tube has several notable advantages over the standard Emitron. The mosaic is not photo-sensitive and hence its insulation can be kept very high. At the same time, the photo cathode can be made as sensitive as possible without the mosaic insulation being affected. Thus it has been possible by a special technique for preparing the transparent photo cathode to obtain a photo-electric sensitivity of 25μA./lumen in the super Emitron as compared with 10 μA./lumen in the Emitron.

Again each photo-electron, as it impinges on the mosaic liberates probably about five secondary electrons. Thus an amount of light which in the standard Emitron would liberate one photo-electron from the mosaic would be effective in liberating probably 10 to 15 secondary electrons from the mosaic in the super Emitron. It follows that for equal amounts of light in the optical image, the electrostatic charge image built up on the mosaic of the super Emitron and hence the picture signal should be 10 to 15 times greater than in the standard type. In actual tests the super Emitron has proved to be at least ten times as sensitive; that is to say, good pictures can be transmitted of scenes with a maximum brightness of 20 ft. candles, which is about the illumination of an ordinary room.

The Optical System

Owing to the radical change in design of the new tube the optical system can be made much more efficient. The optical image that is thrown on to the photo-cathode is about ¾ in. by 1 in., and the electron image which falls on the mosaic is magnified to the normal size of 4 in. by 5 in. by the electron lens.

Also, the transparent photo cathode can be placed sufficiently close to the window of the tube to accommodate lenses with short back focal lengths. Thus it has been found possible to adopt miniature camera technique and the large range of excellent lenses developed for small cameras. At present an f/1.4, 50 mm. focal-length lens is used. The new tube is particularly suitable for telephoto shots both because of its extra sensitivity and because efficient long focus telephoto lenses can be obtained to suit it.

The colour response of the super Emitron is as good as, if not better than, that of the standard Emitron, while the resolution of fine detail is quite adequate for a 400-line picture.

SOME TELEVISION AERIAL HINTS

FACTORS THAT WILL ENABLE THE GREATEST PICK-UP TO BE OBTAINED

IT is generally known that reception on short waves calls for more care in the installation of the aerial than is the case on medium and long wavelengths. On the ultra-short waves used for television the matter is far more vital. Not only is it necessary to pick up the maximum of signal by using an aerial which resonates at the required frequency, but it is necessary to use a transmission line which itself does not have any pickup and also to employ every means to reduce the amount of electrical interference falling on the aerial.

It would appear from normal short-wave practice that a satisfactory television aerial would consist of two wires each ¼ wavelength long, suspended on end between two masts with a suitable feeder from the centre to the receiver. It is reasonable to expect this to resonate as required and be sensitive from the direction at right angles to its length. However, due to the way in which television signals are transmitted the polarisation is vertical, and ten or more times as much signal is picked up with the same aerial if it is vertical.

Using a Reflector

The efficiency of the television aerial from a particular direction can be increased to 1½ to 2 times its normal figure by fitting a reflector behind it. It is thus usual to find that most proprietary models incorporate this as a matter of course. From the consideration of signal strength alone, reflectors would not be essential for localities within ten or twenty miles of the transmitter, but unfortunately, the very troublesome problem of interference is usually present and it is for this reason that a reflector is of general value. As well as increasing the signal from a certain direction, it reduces any pickup, whether it be signal or interference, from the opposite side of the aerial, and this feature can be made use of in most cases.

By far the most common form of television interference is that due to ignition circuits of vehicles and there is likely to be radiation for hundreds of feet or even yards on the extremely high frequencies used for television.

When the television service commenced it was expected that useful reception would only be obtained for a radius of twenty-five miles from the transmitting station and it must be remembered that consistent reception beyond this distance is not a thing that must be taken for granted until careful tests have definitely proved its practicability.

Importance of Height

There are many characteristics of the ultra-high frequencies which are only vaguely understood, one of them being the laws which govern the field strength at different points more than twenty-five miles away. One fact is clear and that is the higher a television aerial can be placed above the ground and the less the amount of screening between receiver and transmitter, whether this be in the form of hills, trees, buildings, etc., the better. Wooden masts are essential in almost every installation and these are preferably mounted on the top of a building to give increased height unless this means proximity to potential sources of interference.

Interference

Concerning interference, with the exception of cars and special apparatus such as that used in hospitals or in some factories, little trouble is experienced since most of the usual appliances which are noisy on medium and long waves, set up no noise on wavelengths below 10 metres. Electric lifts, neon signs and household appliances rarely affect reception of sound or picture, but needless to say the aerial and the downlead should be kept as clear as possible from these possible sources of interference.

Belling & Lee, Ltd., have designed a particularly neat and inconspicuous type of television aerial. Two drawn brass tubes 5 ft. 4½ in. long are supported vertically one above the other by means of an insulating clamp in the centre. This assembly can be attached to a stand-off arm secured to the side of a house or a mast and therefore the entire aerial is self-supporting without the necessity for a wooden framework.

An Eiffel Tower Television Programme.

THE following is a typical programme of the television transmission from the Eiffel Tower. British readers will note that the majority of the items are musical turns and that there is no film transmission. At present there is no transmission on Wednesdays and Thursdays, and it should be appreciated that the transmissions are still on an experimental basis.

Sound: 7.0 metres.
Vision: 6.25 metres.

Sunday.—3.30-5.30: Mia Slavenska, star dancer. Suzy Gassen and Valerie Mayer, songs. Ryandreis, improvisations.
Y. Leduc in songs from her repertoire of operetta. Germaine Roger, film singer. Mara-Mara, Hindu ballerina, and Vialichevska and Combes, dancers. Claude Doraine, concert artist.

Monday.—3.30-4.30: Theatre and Music Hall: P. Dudan, student ballad singer. Zaid and Zaida, impromptu singers. Claude Duhour, baritone, and "Fog," a comedy (Werner) played by Pierette Caillol and I. Berger.

Tuesday.—3.30-5.0: Matinee for juveniles: M. Louvat, Jugoslav singer. I. Cazanove, juvenile ballad singer. Viviane Regnier, diseuse.
"Feminine faces and foibles," camera interview by Mme. M. Boulanger.
Duprez, dances, followed by a ballet of nine young performers.

Friday.—3.30-4 30: Variety: Tontcheva and Stabelli, songs. I. Clarens, monologue. Belle Ista, classic dancer. Poems by Suzanne Pichon. Dances by Taline.

Saturday.—3.30-4.30: Theatre and impromptu: Ten minutes in Berry—with Jeanne Andrai and Berrichon (songs). Impersonations by Lily-Siou. Gaud Arvor, dancer, and Plic and Ploc, humorists.

BARRIER-LAYER PHOTO-ELECTRIC CELLS

Here are details of a comparatively new type of photo-electric cell which is finding many commercial applications.

INCREASING use is being made of the barrier-layer type of photo-electric cell, the advantage of this kind being that no separate source of

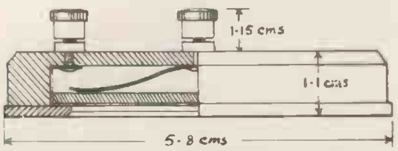


Fig. 1.—Type of cell as used for photometers.

current supply is needed, the photo elements converting light energy directly into electrical energy which makes them eminently suitable for photographic exposure meters, photometers and even for use in the sound heads of talkie apparatus. Tungsram have three types of these

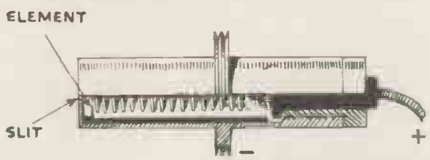


Fig. 2.—Cell for sound head of talkie apparatus.

cells available, two of which are shown by Figs. 1 and 2. The first is intended for use as a photometer and the second for sound heads.

The barrier-layer photo-cell consists of an iron plate on which a thin layer of selenium is deposited as shown by Fig. 3.

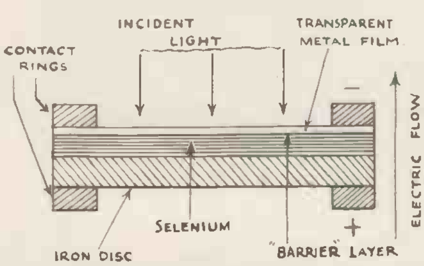


Fig. 3.—Diagram showing construction of barrier-layer cell.

This layer is coated on its outer surface with an extremely thin transparent metal deposit. Incident light passes through this metal deposit and creates a potential difference at the boundary-plane between the selenium and metal electrodes, having the effect of making the transparent metal electrode negative with reference to the iron electrode. If an external circuit is connected across the two electrodes a current will flow when the cell is exposed to light.

The type for use in sound heads (Fig. 2) consists of a very small

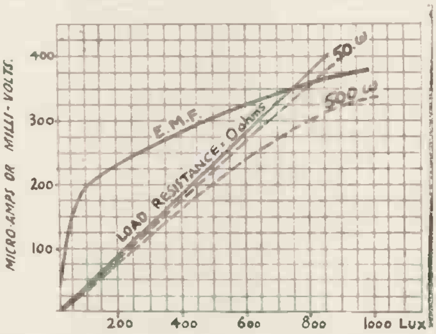


Fig. 4.—Characteristic curve of barrier-layer cell.

plate contained within a tubular housing with a small slit at one end having an area of 5 square millimetres, which allows light to fall upon the surface of the cell.

Characteristics

The photo-voltage and photo-current generated by barrier-type

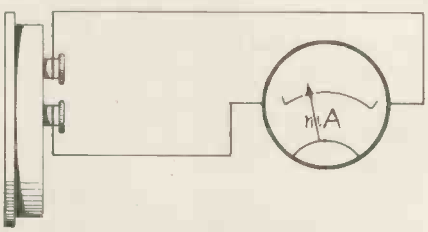


Fig. 5.—Diagram showing construction of photometer.

photo-cells are shown as functions of illumination in Fig. 4. The open circuit voltage rises rapidly at first up to 100 lux., approximately, then rises more slowly and achieves at 1,000 lux., the very high value of 0.4 volt.

The photo-current generated on short circuit (external load = zero ohms), for unit area and illumination is a constant and has the value of 460 γA lumen approximately.

From Fig. 4 it will also be apparent that with a short circuit load, the increase of photo-currrent with illu-

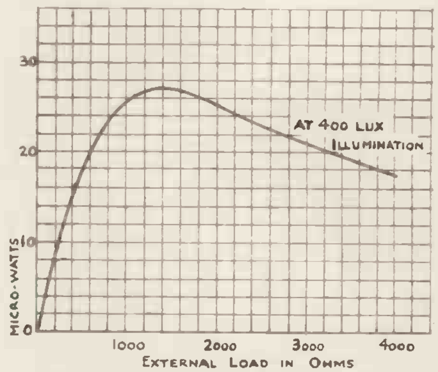


Fig. 6.—Current-illumination curves.

mination is linear up to 1,000 lux; above this value it loses linearity, due to the shunt resistance of the cell increasing. Current-illumination curves for various values of external load resistance are also shown. In view of the high resistance of the cell the deviation from linearity even at 500 ohms loads resistance is very small. As most measuring instruments for this purpose will have a resistance much smaller than 500 ohms, it will be seen that a lux meter constructed according to Fig. 5 will be substantially linear.

Power Output

From Fig. 6 it will be observed that the output in micro-watts is a function of the external load resistance. (This curve is taken on the

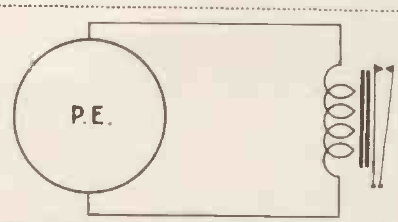


Fig. 7.—A simple light-operated relay.

circular type cell at constant illumination of 400 lux.) The maximum output occurs at 1,400 ohms, this indicating that the cell resistance has a value of approximately 2,000 ohms, the power output at this point being 27 micro-watts. It will be appreciated that in this case, the external load resistance is not equal to the internal shunt resistance of the cell, because its series resistance has to be taken into account. In general,

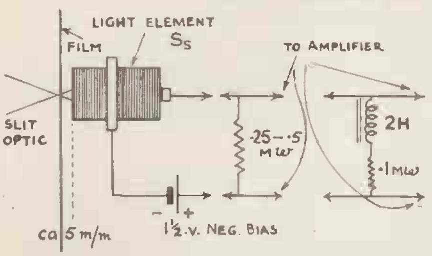


Fig. 8.—Circuit connections of cell used for sound head.

it can be assumed that the maximum output is obtainable if the external resistance is equal to two-thirds of the internal resistance. This is of importance when designing light-operated relay devices.

Fig. 7 shows the extreme simplicity of such a device as a light-operated relay. It will be observed that no batteries are required, the photo-elements converting light energy directly into electrical energy.

Efficiency

It is interesting to note that the conversion of light energy into electrical energy takes place at the remarkably high efficiency of approximately 50 per cent.

The response to fluctuating light decreases with increasing frequency. This is not due to any inherent time lag, but to the increased effect of the shunt capacitance of the cell at high frequencies.

By making the cell sufficiently small this capacitance can be reduced to a very low order. Fig. 8 shows the circuit connections of the type used for sound heads and it will be noticed that a small bias of approximately $1\frac{1}{2}$ volts is applied in opposition to the cell e.m.f. to give increased output.

Colour Sensitivity

Fig. 9 shows the colour sensitivity of the Tungsram "S" type photo-element. The average response of the human eye is also shown, and it will thus be apparent that the Tungsram cell has a wider response band than the human eye, thus making it possible to get an accurate coincidence by the use of filters. For all ordinary white light measurement purposes (such as when using daylight or incandescent lamps), the cells can be used without filters and the results will still be relatively correct. For greater accuracy, however, light filters should be used.

Fatigue

Provided that the entire light sensitive area is uniformly illuminated, the photo elements are not subject to drift or time lag in their response, as their action is purely electronic. However, if the cells are used in a manner other than recommended, for instance, by illuminating only small parts of their light sensitive area (this particularly applies to large cells) an effect akin to fatigue occurs, and it is for this reason that the uniform illumination of the entire light sensitive area is recommended.

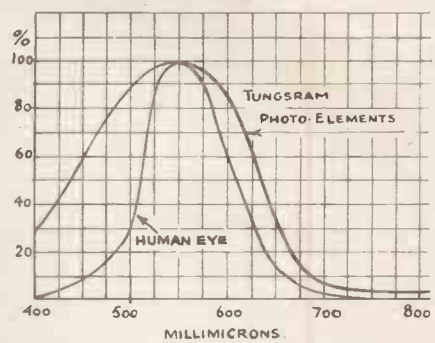


Fig. 9.—Colour sensitivity curve.

If this is not possible, the use of small area cells is advisable.

Variation of sensitivity of different parts of the surface is exceedingly small, and is for normal purposes almost immeasurable. The response to light incident at varying angles to the normal, approximately follows the cosine law, any slight irregularity being due to the varying reflectivity of the lacquer coating. This variation in the reflection constant has been kept as small as possible, consistent with a high degree of translucency. Consequently, these cells may be used for wide angle photometry, such as for measuring street lighting, without any appreciable error.

HIVAC LOW-PRICED C.R. TUBE

A NEW low-priced cathode-ray tube has been introduced by The High Vacuum Valve Co., Ltd. This tube has a 3 in. screen which will be found adequate for all normal observations and measurements.

The electron source of the tube is an indirectly heated cathode which with the control grid and focusing electrode (Anode 1) constitutes an electron gun, which projects a beam of electrons upon the fluorescent screen.

The deflection of the beam is accomplished by two sets of electrostatic plates at right angles to each other. Plates D_2 and D_4 (furthest from the cathode) are tied to anode 2 internally; whilst the free plates D_1 and D_3 are each connected through a 10-megohm resistor to the anode 2 socket, thus maintaining them at essentially the same D.C. potential.

This arrangement ensures that the electron beam is not distorted by D.C. potentials built up on the deflecting plates.

A special feature of the Hivac CR3 is the electronic shield positioned between the horizontal and vertical deflecting plates which eliminates angular distortion or the "Keystoning" effect.

For electromagnetic deflection two coils can be used to control the beam along one axis. The cathode is connected inside the tube to one side of the heater.

Focusing of the light spot produced by the beam is obtained by adjustment of the voltage ratios of anodes 1 and 2 (approximately 5 to 1). Regulation of spot size and intensity may be accomplished by varying anode 2 current and/or voltage.

The Hivac CR3 may be used for the examination of all oscillatory voltages and currents, measurement of loudspeaker characteristics, valve characteristics, intervalve stage gain, measurement of percentage modulation of a transmitter, lining up of I.F. transformers, measurement of L.F. transformer distortion, etc.

Another type is available in which the deflection plates and anode 2 are brought out to independent pins.

A CROWD ALWAYS ASSEMBLES TO WITNESS DEMONSTRATIONS ON BAIRD RECEIVERS.

WHY?

BECAUSE EACH MODEL IN THE RANGE REPRESENTS THE HIGH WATER-MARK OF ACHIEVEMENT.

Among the factors contributing to the first-class performance of all Baird Television receivers are brilliant pictures, freedom from distortion, excellent detail, wide angle of vision, extremely simple operation, high fidelity sound and all-wave radio. Each television receiver incorporates a Baird "Cathovisor" Cathode Ray Tube which has the outstanding advantage of being completely electro-magnetic in operation. These tubes can be supplied separately with the necessary scanning equipment where desired. Apart from manufacturing processes, stringent tests are made for electrical emission, tube characteristics, filament rating, and screen quality, and following normal picture reconstitution under service conditions, every Baird Cathode Ray Tube, on completion, is subjected to a very high external pressure test. Baird "Cathovisor" Cathode Ray Tubes are the ideal solution for high quality television pictures. Write for details.

★ ★ ★

A small section of the daily crowd which assembled at a recent exhibition to see demonstrations on Baird receivers.

★ ★ ★

You have never seen television reception at its best until you have witnessed a Baird set in operation. We shall be pleased to arrange a demonstration with your nearest dealer if your name and address is sent to Dept. "D."

BAIRD TELEVISION LTD.

Lower Sydenham, London, S.E.26

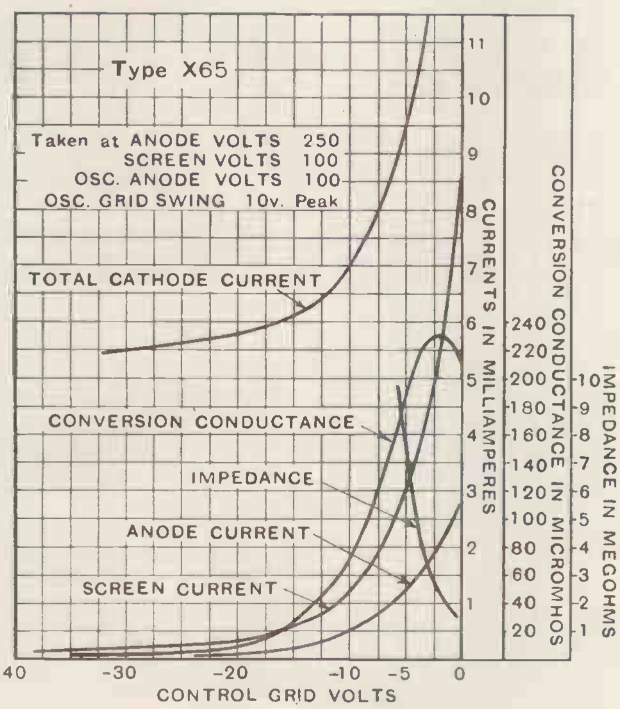
Telephone: HITHER GREEN 4600. *Telegrams:* TELEVISOR, FOREST, LONDON.

OUTSTANDING ON SHORT WAVES

FREQUENCY CHANGER VALVE TYPE X65

Osram valves

MADE IN ENGLAND.



The OSRAM X65 is a Triode Hexode Valve with Indirectly Heated Cathode designed expressly as a frequency changer in super-heterodyne circuits for reception on short and ultra short wave lengths.

Due to the use of 6.3 v. 0.3 amp. filament, type X65 is suitable for use in parallel or series connected heater circuits (A.C. or D.C./A.C. Sets), with other valves in the Osram "International Range."

The OSRAM X65 possesses the following advantages :—

1. *Phenomenally low oscillator frequency drift with bias.*
2. *Negligible change in oscillator frequency with variation in feed supply.*
3. *High Impedance results in maximum conversion gain on short wave-lengths.*
4. *Freedom from "pulling" on short waves.*

CHARACTERISTICS

Heater Volts	6.3
Heater Current	0.3 amp. approx.
Anode Voltage	250 v. max.
Screen Voltage (Eg_2 Eg_4)	100v.
Oscillator Anode Voltage	250 v. applied through 30,000 ohms minimum.
Oscillator Grid Peak Swing (Eg_3)	10 volts
Control Grid Voltage (Eg_1)	—3 volts min.
Conversion Conductance average	225 micromhos at Eg = —3) 0.2 micromhos at Eg = —45) Eg_3 = 10 v. peak.
Conversion Impedance	2.5 megohms.
Total Cathode Current average	11.0 m/A.

INTERELECTRODE CAPACITIES :—

Measured with external valve shield.

Control Grid to all ...	3.5 m.mfd. approx.
Control Grid to Anode	0.12 ,, ,,
Anode to all	5.5 ,, ,,
Oscillator Grid to Osc. Anode	2.0 ,, ,,
Oscillator Anode to all ...	5.5 ,, ,,
Oscillator Grid to all ...	10.4 ,, ,,
Oscillator Grid to Control Grid	0.2 ,, ,,

PRICE EACH 15/-

Unsurpassed from point of view of frequency conversion on short or ultra short wave lengths.

THE OSRAM X65 IS FITTED WITH THE INTERNATIONAL OCTAL BASE

Scannings and Reflections

AMERICA'S FIRST RECEIVER

MANY television receivers have, of course, been built in America, but they have been intended for experimental purposes and not for sale to the general public. The first receiver for sale to the public has now made its appearance and it is priced at approximately £30. It is a very modest affair employing a 3 in. cathode-ray tube with a green screen. The whole design has been kept as simple as possible. It employs 14 valves and has no provision for picking up sound. Television transmissions are not available in America other than those which are being put out for experimental purposes by the various concerns engaged in development. These, however, work to a fairly regular schedule in most cases, so there is quite a good prospect of owners of receivers getting a certain amount of entertainment and it is with this fact in view that this receiver has been put on the market.

TELEVISION AND THE GLASGOW EXHIBITION

Criticism is being made that there is no television display at the Glasgow Exhibition. Of course, it would have been impracticable to reproduce the B.B.C. programmes, but it seems strange that some sort of display on the lines of the South Kensington Museum exhibition with a local transmitter has not been staged, particularly as we are aware that there is very keen interest in television in the Glasgow district. Writing on the Exhibition one critic says: "Television would be a magnet for tens of thousands. It is one of the major discoveries of the century, and it would be a great pity if this splendid Exhibition did not accept a magnificent and profitable opportunity of introducing it to Scotland."

LARGE-SCREEN RECEIVERS TO BE MARKETED

It is announced that Gaumont-British Equipmments, Ltd., are to market large-screen receivers constructed on the lines of that used by the Baird Company for the showing of the Derby and Trooping the Colour transmissions at the Tatler Theatre. Among the invited audiences were many who are engaged in the cinema trade and the excellent results that were obtained stimulated their interest in the entertainment possibilities of television. We understand that many inquiuries have been received together with requests for further demonstrations.

A QUESTIONNAIRE ?

Some time ago the B.B.C. sent out a questionnaire to television viewers, but what response there was to this has never been announced. This first questionnaire was in the nature of a census, but there is now a proposal to consult viewers in the same manner regarding the programmes—in other words to obtain some idea of their likes and dislikes. Very little direct criticism of the programmes has been made to the B.B.C., but it is known that they are not satisfying viewers and that it is the broadcasts of outside events that are regarded as the high-lights of the service.

TELEVISION IN WIGAN

In the plans for a new super cinema which is is proposed to construct at Wigan and for which the site has already been acquired, provision has been made for the installation of Baird large-screen television apparatus.

RECORD LONG-DISTANCE RECEPTION

A television programme from the Alexandra Palace has been received near Middlesbrough, 220 miles away. This is a record distance for consistent reception. The installation, at Ormesby, on the edge of the Cleveland moors, was made by a Middlesbrough firm of radio engineers. The situation is at a high altitude, away from trees and buildings, with no hills intervening between it and the Alexandra Palace transmitting station. A standard receiver was used and a special aerial. Further aerial equipment which it is hoped will provide still better reception is in course of erection.

THE DERBY IN EAST ANGLIA

Our contributor, Mr. S. West, who lives at Beccles, was enabled to see the whole of the Derby transmission on his home-built receiver which is of the same type as that which was described in the October, November and December issues of last year. Mr. West is at all times able to receive the Alexandra Palace transmissions and we believe that he holds the record for really consistent reception at distances exceeding a hundred miles.

THE O.B. AERIAL

The B.B.C. have applied for permission to erect an aerial for the reception of the O.B.'s at Highgate. Difficulty has been experienced in picking up the signals from the O.B. van at the Alexandra Palace, so it is proposed to erect an aerial at Highgate and carry the signals from there to the Palace by means of cable. The application is for the erection of a mast 150 feet high at the corner of Swains Lane and Bisham Gardens in Highgate village. The Works Committee of the St. Pancras Council disapproved the scheme, but it is understood that the proposal is under further consideration.

TELEVISION MONOPOLY

Concern at the "monopoly control of television secured by the B.B.C." was the subject of a motion put to the House of Commons by Mr. De La Bere, M.P. B.B.C. charter revision is urged, "to enable development of television on the screen in places of public amusement in the London area to be dealt with."

DERBY SEEN AT BEXHILL

A party of 15 watched the Derby in Pear Tree Lane, Little Common, Bexhill, a distance of about 70 miles from Alexandra Palace.

"It was as good as seeing a

MORE SCANNINGS . . . .

cinema film of it," Mr. Blackburne, who owns the receiver, said. "It came through remarkably well and one could not help being thrilled by it." Other distant places from which reports of reception have come, are Brighton, Southend, Worthing, Cheltenham, Letchworth, Eastbourne and Malvern.

SCOPHONY HOME RECEIVERS

At the annual general meeting of E. K. Cole, Limited, Mr. W. S. Verrells (Chairman and Managing Director), in the course of his speech, said: "Our engineers are now collaborating with the Scophony engineers on the construction of commercial models of Scophony home receivers, which it is hoped will be available for marketing this autumn. The receiver will give a picture 24 in. by 20 in."

THE EPSOM TELEVISION MAST WRECKED

It was fortunate that the gale which did so much damage at Epsom came after the broadcast, otherwise there might not have been time to replace the special tower which was wrecked. The tower of steel scaffolding was 100 ft. high, guyed by ropes.

One guy rope after another snapped and the tower began to sway about. For a few moments it hovered between the sky and earth, and then with a crash came to the ground.

TIME TUNING

Engineers of the General Electric Co. (U.S.A.) have developed a system of time tuning. Briefly it means that the performance of a radio receiver during every 15-minute interval of a full 24-hour day can be predetermined.

The new development consists of a simple but ingenious radio time control unit which permits the preselection of favourite programmes throughout the entire day and night, on five different stations. The preselector is divided into ninety-six 15-minute time intervals. In practice a user consults radio programmes for the ensuing 24 hours, moves the correct slider-contacts into position—and the automatic control takes complete charge. The cycle will be repeated each day unless further changes are made in the setting. A self-starting electric clock maintains absolute accuracy in automatic operation once it has been set.

PYE, LTD. AND TELEVISION

Mr. C. O. Stanley, Managing Director of Pye, Ltd., speaking on television at the general meeting of the company, said that their experience over the last few months had proved that not only was the present system correct, and the size of the picture correct, but that the marvellous improvement in the programmes was establishing the industry at a much higher rate than was expected a few months ago. It was the opinion of the directors that television in the future would be an even bigger industry than the radio industry.

RADIOLYMPIA TELEVISION CONFERENCE

A meeting was held on June 2 of television receiver manufacturers who are members of The Radio Manufacturers' Association. It is proposed to hold a conference for dealers at Olympia during the period of the Radio Exhibition and the meeting was to consider the arrangements to be made.

It was decided that the conference should be held in the afternoon of Thursday, August 25. Invitations will be extended by the Association to dealers in the service area. The purpose of the conference will be to place before dealers the true position that television is taking in the radio industry; and to bring about an enthusiastic and united presentation of television by every dealer who is in a position to take up the marketing of television receivers.

Detailed plans remain to be worked out, but the co-operation of the B.B.C. is assured and it is hoped that speeches by Sir Stephen Tallents and Sir Noel Ashbridge may be included in the programme.

The proposal was unanimously approved and the sub-committee was authorised to proceed with the detailed arrangements.

THE DEMAND OF THE PROVINCES

Interest in television is growing at a very rapid rate in the provinces and insistent demands are being made in many quarters that now the experimental period may be said to be over provincial centres should receive consideration. It appears that a certain amount of organised agitation is developing and recommendations are being made that M.P's should be approached on the matter. Criticism is being made of the Television Advisory Committee which, it is pointed out, in the course of three years has only issued two public statements.

AMATEUR RADIO IN PITCAIRN

The British amateur station G5BJ in Birmingham is in fairly regular contact with the recently erected station on Pitcairn Island. This station with the call sign of VR6AY is said to be one of the most lonely in the world. A frequency of 14.343 Mc. is used, but whether QSL cards can be obtained is another matter, for a large number of listeners have sent in reports but so far no cards have been received in this country.

However, this is a new station for listeners to hear and the signal strength is quite good on ordinary all-wave type receivers between 6 and 9 a.m.

AMATEURS AND A.R.P.

Although amateur station operators in other countries have been enrolled into a national band for use in emergency, the British Government have not yet defined their attitude in the matter.

The bodies concerned in this country have already offered the services of the 3,000 odd British amateurs, but so far the policy has been not to make use of their services.

However, the fact remains that in time of need there are 3,000 good operators ready for service whose value would be greatly increased if they were to have a little preliminary training.

RADIO IN INDIA

As yet radio manufacturers seem to have ignored the possibilities of India for the sale of radio components and receivers. The market is rapidly growing which is proved by the increasing number of requests for information received from that part of the world by British exporters.

It seems that the time is ripe for some enterprising set or component maker to consider the big potential market in India and to get a good hold on it before the Americans beat us.

. . . . AND MORE REFLECTIONS

Now that the Empire stations are being heard so well all over the world and the short waves offer a considerable amount of entertainment it should be fairly easy to sell low priced communication receivers to those interested in India.

For many, a short-wave receiver is the only way of keeping in touch with events abroad, and now that the Indian Broadcasting Company are erecting a chain of stations, interest in radio will soon awake with a great rush.

The equipment required is similar to that used by British amateurs, so this would give a chance to makers, who complain of the small English market, to kill two birds with one stone.

AERIALS 9 MILES LONG

Special short-wave aerials are being erected by the American A.T. & T. Co. for transmission use to be brought into operation during 1940. These aerials will have a total length of over 9 miles and are of special design and highly directional. It is hoped that these arrays will have sufficient gain over the more conventional arrays to counteract the exceptionally bad conditions on short-waves which experts predict will start in 1940.

The American engineers of the A.T. & T. have found that highly directional arrays do more to increase the power of a station than all normal wattage increases. Amateur transmitters who are limited in power have also discovered that big increases in signal strength can be obtained by using special aerials beamed on one particular spot. No doubt in a few years the old-fashioned omni-directional aerial will be almost unused on short waves.

TELEVISION AND THE COPYRIGHT QUESTION

At the beginning of each televised outside broadcast a warning is given that the programmes are strictly copyright and must not be shown in public. Any doubt as to whether the B.B.C. mean what they say is removed by the fact that in future these announcements will also be made during breaks in the transmission.

The B.B.C. intend to stop all public exhibitions of television which will infringe their copyright. Whether this point of view is right or wrong remains to be seen, but it does seem that the more people are allowed to see some of the special outside broadcasts, such as the Derby, the quicker every one will realise the advantages of the modern vision receiver.

ON THE ULTRA-HIGH FREQUENCIES

It is expected that amateur activity on the ultra-high frequencies will suddenly come to life next year. Owing to the bad period of conditions that are due about 1940 amateurs will find it more and more difficult to maintain long-distance contacts on 20 metres.

This should arouse further interest in the 5-metre band which will not be much affected by the changing conditions. It is hoped that with low power and beam aerials more long distance 5-metre records will be made. At the present time there is every indication of more 5-metre activity for there is a steady sale of transceivers running from batteries which cover 15 to 20 miles without trouble.

ELECTRICAL INDUCTION AS AN AID TO HEARING

For some years enlightened cinemas have had a few of their seats wired to the sound output so that patrons who have difficulty in hearing can plug in a phone and have the speech relayed direct to their ear. The system is not popular, however, since it involves sitting in a specified seat.

An attempt to overcome this defect was demonstrated recently by Messrs. Radio Aid, Ltd., of Duke Street, W.1. With this system a large loop of wire carrying the speech current is run round the whole theatre and anywhere inside this loop the speech current may be picked up by a simple coil of wire and a pair of telephones.

Certain practical difficulties have had to be overcome but the system as demonstrated operated very successfully. Being inexpensive to install it may find its way into theatres where even the normal person may have difficulty in hearing. With this apparatus installed one can rent a telephone detector unit in the same way as a pair of opera glasses.

DRAMATIC EXPERIMENTS

Two interesting dramatic experiments are to be tried during July. On the evening of Wednesday, July 6, the famous trial of Bardell versus Pickwick, from "The Pickwick Papers," by Charles Dickens, will be presented in the Alexandra Palace studio. Bardell against Pickwick will be repeated in the afternoon of July 11.

An attempt at programme serialisation will begin on July 12 when the first of six episodes in the life of Ann and Harold will be presented. These glimpses into the lives of a young London couple and their dog are taken from Louis Goodrich's play which made a successful broadcast series six years ago. Each episode is self-contained, but there is a thread of continuity which should prompt viewers to tune in weekly to follow the adventures of the pair—their first meeting in Hyde Park, their engagement, marriage, life in Bayswater, and their only quarrel

McCarthy A.C./D.C. Communication Receiver

A very interesting receiver has just been produced by McCarthy Radio, Ltd., for the specific use of amateur experimenters. It is very compact, and is suitable for use on A.C. or D.C. mains from 110 volts upwards. It is also built to a rigid tropical specification.

The circuit is made up of a single radio-frequency amplifier, tetrode detector and a triode output valve. It has been designed primarily for use with headphones, but can be modified to use a small loudspeaker. A stand-by switch is embodied, a point which transmitting amateurs will appreciate, while a special system of band spreading has been included.

One of the most important features in this receiver is the use of a separate triode oscillator which has enabled the designers to produce a receiver with perfect regeneration. It also allows the detector to operate most efficiently with an almost constant degree of applied regeneration.

The receiver will operate from 8 metres upwards with 6-pin interchangeable inductors.

The price, complete with five valves and one inductor with a twelve months' guarantee, is nine guineas. Full information on this interesting receiver can be obtained from McCarthy Radio, Ltd., 44a Westbourne Grove, Bayswater, London, W.2.

INCANDESCENT PICTURES— RECENT PROGRESS

By L. S. Kaysie

INCANDESCENT light is sufficiently intense—particularly as compared with the glow of fluorescence—to stand up to considerable enlargement, and its use for projection purposes has considerable promise.

Before a picture can be made visible by incandescent light, the screen must be raised to a temperature, varying from red to white heat. Originally, this involved the use of very high operating potentials (of the order of ten to twenty thousand volts) on the accelerating electrodes of the tube. One of the objects of later improvements is to reduce this voltage to a more reasonable figure.

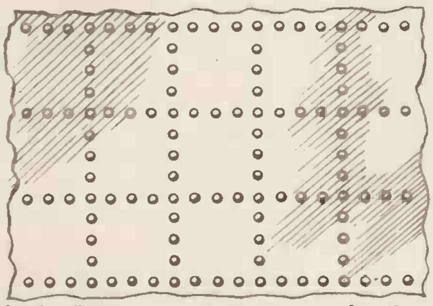


Fig. 1. Incandescent screen with perforations to localise the heat.

The heating of the screen must in the first place be "localised" or confined to the track of the scanning stream, and, in the second place, the variations in temperature must take place very rapidly. Otherwise the whole of the screen would gradually rise to a uniform red or white heat, and all picture detail would be lost. In other words, the screen must respond to the scanning stream of electrons, by developing white heat at a high-light point on the picture, though it must not "hold" this temperature longer than necessary to produce the persistence-of-vision effect. At the same time the white-hot "spot" must not be allowed to "spread" since that would blur the picture.

It has been found that a very thin sheet of tantalum, from three to six microns thick, can be made white-hot at points bombarded by a stream of electrons. A micron, it will be remembered, is only the thousandth part of a millimetre, and in a sheet of this extreme thinness, the cooling effect is so rapid that the incandescence disappears very rapidly.

To localise the heat, and prevent it from "spreading," the screen is pierced by lines of perforations, which, as shown in Fig. 1, divide it into a series of small squares. Since the latter are only connected together by the small parts of metal left between the holes, very little heat can flow from one square to the other.

High voltages are required to operate a tube of the projection type, owing to the amount of work which the electron stream is normally called upon to do in raising the temperature of the screen to the point of incandescence. This can be considerably reduced—and the accelerating voltage cut down— by using an independent heating current to maintain the screen at a temperature just below that at which it begins to glow. Much less energy is then required from the electron stream to raise this "threshold" temperature to the level of incandescence.

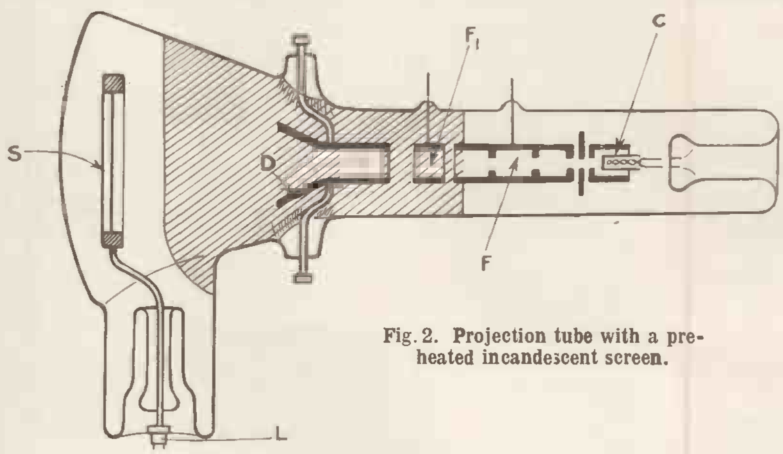


Fig. 2. Projection tube with a pre-heated incandescent screen.

Fig. 2 shows one of the latest types of projection tube in which a perforated screen S, of the kind shown in Fig. 1, is maintained just below the "glow" point by a local current supplied through leads L. The screen is scanned by electrons from the cathode C of the tube, after they have been passed through focusing electrodes F, F1 and deflecting plates D. The size of the screens is about 3 in. by 2 in. with 200 lines used to scan to each frame, the width of each line works out at just under half a millimetre, and this fixes the size of each of the squares, into which the screen is divided by the perforations shown in Fig. 1.

In another up-to-date type of projection tube, the incandescent screen is made of tugsten particles mixed with fine carbon. The two are made into a paste, which is then pressed into the interstices of a very fine mesh of tungsten wire. One advantage of this form of screen it its low thermal conductivity—owing to the presence of the carbon particles. There is accordingly very little tendency for the incandescent effect to "spread" beyond the width of the scanning line. At the same time the composition can be heated to an even higher temperature than pure tungsten, without fusing, so that it produces an intensely-brilliant picture.

The management of the Telephone & Radio Works of the General Electric Co., Ltd., at Coventry, gave a complimentary dinner recently to those of their employees who have completed twenty-one years of service with the company.

More than eighty guests were present, and jointly they represented 2,333 years of service.

Amongst them were seven who joined the company last century, whilst the individual record for long service goes to a member of the staff, who recently completed his fiftieth year with the G.E.C., having joined the firm in February, 1888.

THE RECEIVING AERIAL AND RECEPTION FIDELITY—II.

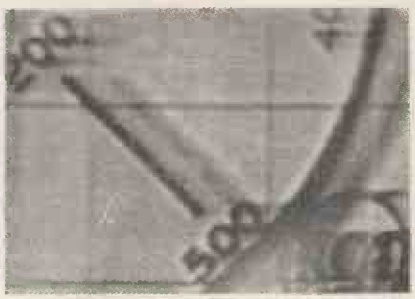
The second part of an abstract from a paper by Stuart W. Seeley of the Licence Laboratory of the Radio Corporation of America. It deals with the effects of interference between direct and reflected signals and the production of double images on the screen.

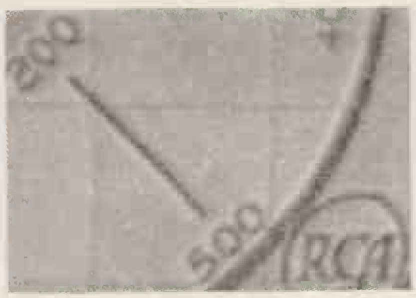
IT is interesting to note that with reflected signals synchronisation of the receiver was seriously impaired. The whole patter moved to the left as though the receiver had synchronised on one of the reflected signals. This was undoubtedly the case due to partial destruction of the true horizontal pulse by the strong, short-delay, out-of-phase reflection.

Fig. 2 was taken with the doublet and transmission line connected normally to the balanced-input terminals of the receiver, and with the doublet adjusted to the position which minimised secondary images. However, it can be seen that this aerial would be entirely unsatisfactory for good reception. Two principal reflections are still apparent. These are displaced by amounts which indicate additional path lengths of 800 ft. and 2,300 ft. A very faint trace of the 3,700 ft. reflection, which is strong in Fig. 1 (June issue), still remains.

The aerial for Fig. 3 was the same as for Fig. 2 except that one end of the doublet was lengthened by adding a three and one-half wavelength wire toward the transmitter. This was supported one-quarter wavelength above a wide copper coping parallel to, and about 150 ft. directly above Fifth Avenue. Resistance termination at the outer end of this aerial had little or no effect on the reproduced image, so Fig. 3 was taken with the far end open. In this case the 2,300 ft. reflection is still faintly visible, but probably represents an acceptable minimum of direct to reflected-signal ratio.

Of a large number of aerials tested, that used for Fig. 3 seems to be the only one which gives acceptable performance for reception at this location. Reflection conditions at this point are unusually severe and do not, by any means, represent the average to be expected. Although objectionable secondary images are picked up by simple half-wave doublets at various locations within the range of the transmitter, there are many more where no reflections are apparent.





Figs. 2, 3 and 4. Section of the cathode-ray tube screen to illustrate the effect of various receiving aerials on reproduction. The receiver was operated with reduced contrast for best photographic results.

Long-wire Aerials and Transmission Lines

The long wire aerial at the Licence Laboratory is necessary only because its directional characteristics improve an adverse direct to reflected-signal ratio. At, or near, the boundaries of the service area of a television transmitter it will sometimes be necessary to use something other than a simple dipole and twisted pair for the aerial system in order to raise the signal well above the receiver hiss level.

The attenuation of the average, close-spaced, open-wire line is about one-tenth of that of twisted pairs. However, if an open-wire line is used, its increased impedance will cause the aerial to operate less efficiently unless the two are connected together in such a manner that the damping of the aerial is about the same as with the lower-impedance line. This can be done by the use of the well-known Y connection which is common in amateur transmitter practice.

It is also necessary for the input impedance of the receiver to be at least approximately matched to the higher-impedance line in order to realise the increased signal level. In some recent tests it was found convenient to have a small residual-inductive component as part of the input impedance at the balanced-input terminals of the receiver. The resistive component of this impedance measured about 100 ohms; therefore, when using a 100-ohm line, two small series condensers (one in each wire) were inserted to cancel the reactance. If, however, the reactance was cancelled by shunt tuning, the input resistance became 500 ohms, which was the impedance of the open-wire line. This made it possible to analyse the behaviour of the two lines without making changes in the receiver input-coupling circuit.

Under some conditions the energy picked up by the two wires of the transmission line acting in parallel may exceed that in the aerial proper. If the entire system, and the receiver input in particular, is well balanced to ground, the signals from this source cannot enter the receiver. If, however, an unbalance does exist, energy from this source may give rise to considerable trouble. This is particularly true if the entire length of line and aerial is of the order of 100 ft. or more. In this case the unwanted signals may be reflected back and forth between the receiver and the outer end of the aerial producing a new image, slightly displaced from the previous one, on each round trip, and thereby obliterating much of the horizontal detail.

The energy loss in twisted-pair lines is usually sufficient so that signals cannot travel in them (back and forth) for a sufficient length of time to cause blurred reproduction before being attenuated below a disturbance level. However, energy travelling on the two wires in parallel is often subjected to much less attenuation and can cause trouble, if lack of balance in the system allows some of it to enter the receiver.

A marked example of this effect was noticed recently. At a particular location, a half-wave doublet and twisted-pair line gave no indication of extraneous reflections, but the signal level (about 800 microvolts) was somewhat too low for a good signal-to-receiver-noise ratio. Therefore, it was decided to instal some type of long-wire aerial and open-wire line as an experiment to determine just how much this could be increased without resorting to means other than those which will be at the disposal of the average serviceman. Existing supports were not available for a rhombic aerial which would have had to extend from the lead-in point in a direction toward the transmitter. Therefore a single-wire, five-wavelength aerial was placed between two tall trees which were on a line about 20 degrees from the direction of the transmitter. The 2 in. spaced transmission line was Y connected to the aerial across a point one-quarter wavelength from the end toward the transmitter. With this arrangement it was realised that the major portion of the received energy would have to travel to the far end of the aerial, be reflected there, and then travel back the entire length before entering the transmission line. Furthermore, the whole system was, of course, unbalanced with respect to ground.

A test of the operation of this aerial showed that it delivered about ten times as much signal voltage to the receiver as the doublet and twisted pair. A large portion of this was due to an increase in height above the old aerial; the rest of it was accounted for by increased aerial and transmission-line efficiency. However, the reproduced image was decidedly poor. The radical loss of horizontal detail which resulted was at first assumed to be due to a too sharply defined resonant characteristic of the aerial proper; however, this proved not to be the case. The cause of the trouble was found to be end-to-end reflection of that energy which flowed down the transmission-line wires in parallel. The distance from the receiver to the outer end of the aerial was about 175 feet. The blurring of the edges of vertical lines extended for a distance which indicated that at least three complete round trips (1,050 ft.) were made over this path by the extraneous signal before it was sufficiently attenuated to be unnoticeable.

The difficulty was corrected by shorting and grounding the transmission line at its bottom end and tapping off a short length of low-impedance line (for a lead-in) at an empirically determined point a few feet above the ground rod. It would normally be expected that a terminating resistor between the shorting bar and the ground connection would be required to prevent reflection of unbalanced signal energy at that point; in this case it was not necessary.

In its final form the aerial delivered somewhat less signal to the receiver than when first tried with a direct connection; but it still gave a 15 db. improvement over the half-wave doublet. This was sufficient to raise the signal well above an acceptable minimum.

Conclusions

Some locations within the service area of a television transmitter will require individual receiving aerial study and design to meet conditions at those locations.

It appears at present that a standard aerial design, or any single preventive of multiple reception, cannot be prescribed for all receiving locations, especially where service from two transmitters in the same area is to be obtained.

Satisfactory performance has been obtained in every case studied, by means described in the paper.

New McGraw-Hill Books

If a census were taken of the average radio engineer's library, it is probably that the majority of the books would be in the McGraw-Hill characteristic green cover. The latest additions to their list of publications are well worth a place on the shelf, as they deal with two important branches of electronics. They are:

"Radio Frequency Electrical Measurements." H. A. Brown. Pp. 377, 179 figs. Price 24s.

"Engineering Electronics." D. G. Fink. Pp. 349, 216 figs, 11 tables. Price 21s.

Radio Frequency Electrical Measurements.

This is the second edition of Prof. Brown's book which was originally published in 1931. So many developments have taken place since its introduction that it may be considered as as a new book and the chapter on measurement of wave-form gives details of some of the latest circuits for oscillographic work.

A long chapter on the measurement of circuit constants (resistance, inductance, power factor, etc.) is followed by one on frequency determination. The measurement of frequency response is dealt with in a later chapter, which gives details of the Clough-Brengle frequency modulator. Aerial and field strength measurements are dealt with at length, and the theory of static and dynamic valve characteristics. In describing the measurements on wave-form the author deals with both the visual apparatus (C.R. tubes) and quantitative methods using harmonic analysers. The final section on modulation and receiver measurements also includes notes on piezo-electric work.

The treatment is mainly theoretical, although a number of practical circuit diagrams are given. The footnote references enable the reader to find more comprehensive information where required, and it is refreshing to note a number of quotations from British technical journals. Some American books seem to be based on extracts from the Proceedings of the I.R.E., but the author shows that a wide range of periodicals has been consulted for the material in the book.

Engineering Electronics.

Mr. Fink is the managing editor of "Electronics," and this fact assures the excellence of this reference book, which should certainly be in the possession of all radio engineers. It is stated that the material formed part of a lecture course delivered to the Westinghouse Lamp Company, and the mathematical theory has been reduced to a minimum.

After dealing with the fundamental properties of the electron and electronic emission, electrons in gases, control of free electrons, the second

(*Continued at foot of page 420*)

THE DERBY TELEVISION BROADCAST

HOW IT WAS DONE

A special article by T. C. Macnamara B.B.C. Engineering Division

For the transmission of the ultra-short wave vision signals to Alexandra Palace an aerial was erected on the roof of the grand stand.

THERE can be little doubt that the television of the Derby captured public interest in a way hitherto unequalled by any broadcast since the start of the television service in this country. This is, perhaps in part, due to the fact that the Derby is more than a mere horse race—it is a national sporting event of unparalleled appeal, the most gripping finish of which was portrayed in marvellous accuracy of detail on the television screen. It must be realised also that the public in general is becoming more accustomed to television, and those who do not actually own receivers are every day afforded more opportunities for viewing.

The degree of actuality reached in this transmission was largely resultant upon the rapid development of television technique which has taken place during the past twelve months, and which affords considerable grounds for satisfaction to those engaged upon this work.

The Transmitting Units

To turn to more technical aspects of this broadcast, three of the vehicles forming the television mobile outside broadcast unit, supplied by the Marconi-E.M.I. Television Co., Ltd., were used. These vehicles are of similar appearance from the outside, but differ widely in the apparatus installed in them.

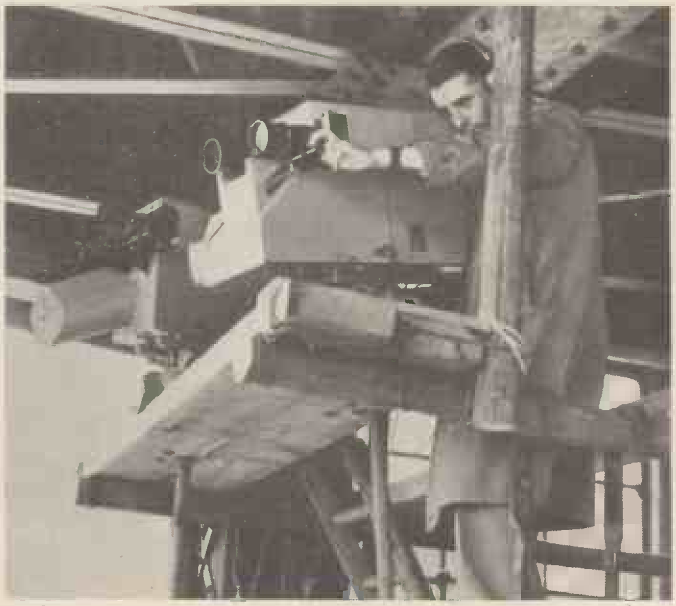
The first is the mobile control room, which contains all the requisite apparatus for the operation of three television cameras and six microphones for reproducing the sound accompanying the visual image.

The vision equipment consists first of duplicate pulse generating gear for supplying the necessary scanning impulses to the cameras and also impulses forming the basis of the synchronising signals.

Secondly, there are three "camera channels," which provide the high-tension and low-tension supplies for the Emitron tubes, and the head amplifiers built into the cameras themselves. The camera channels provide also controls for adjusting and focusing the electron beam used in the process of scanning, and, in addition, means are provided for ensuring uniformity of illumination.

Thirdly, there are two picture channels by means of which the electrical impulses from the cameras are brought into a suitable state for reproduction upon a cathode-ray picture monitor, two of which are provided. The picture channels also render the vision signals suitable for the next stage in their transmission to Alexandra Palace where they are broadcast on the normal wavelength.

The sound from the microphones after being suitably amplified by speech amplifiers of normal type may be sent to Alexandra Palace through the medium of ordinary Post Office



A special erection was provided for two of the cameras to enable long panning shots to be made.

D

HOW THE RACE WAS COVERED

telephone circuits. The vision signals, on the other hand, owing to the great frequency band which they cover, cannot similarly be sent over such great lengths of telephone line.

The Radio Link

A special cable designed for the transmission of vision signals does actually, exist, but the installation is confined to a circular route round the West End of London, and it does not extend to within many miles of Epsom.

In consequence it was necessary to resort to an ultra-short-wave radio link for the conveyance of the vision signals from Epsom to Alexandra Palace, the sender of which is mounted in the second of the mobile unit vehicles and consists of a small radio transmitter capable of delivering a peak power of $1\frac{1}{4}$ kW to the aerial on a wavelength of about $4\frac{1}{2}$ metres.

The radio portion of the transmitter comprises a valve master oscillator and frequency doubler, followed by five stages of high-frequency power amplification, the last two of which employ valves cooled by an air blast. Modulation is effected at the final stage by grid control by means of a modulator which consists of several stages of vision frequency amplification possessing a frequency characteristic sufficiently good for the faithful reproduction of the vision and synchronising signals. Cathode-ray oscilloscopes are provided for waveform monitoring purposes, and are used in conjunction with various controls for the adjustment of the modulation and the ratio of vision to synchronising signals.

The third vehicle contains a stationary petrol engine direct-coupled to a 3-phase 50-cycle alternator which supplies the power required to operate the control room and transmitter apparatus in places, such as Epsom Downs, where no suitable supply mains are available.

Three Cameras

In the case of the Derby broadcast, all three cameras were used, two being mounted on a special platform erected near the top of the grandstand, and the third on the roof of the mobile control room vehicle itself.

Here are the mobile units stationed near the Grand stand.

The first camera was provided with a telephoto lens and commanded a view of the distant start, being able to follow the whole course of the race up to Tattenham Corner. Unfortunately the light became very bad and some rain fell during the time that this camera was in action, so that the visibility was generally poor and this, coupled with the fact that a telephoto lens was used, resulted in the reproduced picture being somewhat dark.

Having rounded Tattenham Corner and entered into the finishing straight, however, the field came into the range of the second camera, which, being equipped with a shorter focus lens, was better able to deal with the low value of illumination, and a superb picture of Bois Roussel's spectacular dash to win was obtained.

The third camera was used to televise scenes from the paddock and from a number of points in the vicinity of the grand stand, and was effective in securing some excellent shots of the crowd waiting in keen anticipation of the great event.

The Emitron camera cables were run down from the camera position to the television vehicles which were drawn up by the side of the grandstand, and the transmitting aerial itself was mounted by means of a light tripod mast 30 feet above the actual roof of the stand. Connection between the transmitter and the aerial was effected by means of a special flexible high-frequency cable which has been developed for this purpose.

An Accident

During the previous day's testing an unfortunate incident occurred which might have seriously prejudiced the chances of a successful broadcast had it happened nearer to the time of the race. A sudden squall of wind of extraordinary violence sprang up and literally blew the transmitting aerial to pieces, despite the fact that it was secured by guy ropes which would normally have been more than adequate to withstand windage stresses. Nothing daunted, however, the outside broadcast engineers hastily erected a new array and repaired the breach in the high-frequency feeder line which had occurred at the same time. Needless to say some qualms were felt as to whether the second aerial might be damaged before the race, but happily the wind moderated, and in consequence the broadcast was carried out without any further hitch.

Reception

The reception of the radio link signal was carried out by means of an aerial surmounting the transmitting mast at Alexandra Palace, the received signals being passed down a high-frequency feeder line to the receiver and thence, after demodulation and suitable amplification to the main radio transmitter. The alternative receiving point at Highgate was also available as a standby.

100 PRACTICAL USES FOR THE PHOTO-ELECTRIC CELL

THE PHOTO-CELL IN INDUSTRY

NEW uses for photo-electric cells are being developed almost daily and there is every indication that in the near future there will be very few industries to which it cannot be applied with advantage. Suitable applications are well worth very careful consideration with a view to development of new manufacturing methods in all branches of industry.

In order to realise what are the possibilities of photo-electric control in modern industry, it is essential to have some knowledge of the chief properties of photo-cells and how they may best be utilised.

A photo-electric cell is essentially an electron tube whose resistance to the passage of the current is determined by the intensity of illumination of the cathode. It is light energy which causes electrons to be ejected from the cathode and as the energy involved in light absorption is very small indeed, it follows that the photo currents will be correspondingly minute (of the order of a few millionths of an ampere).

The minute nature of these currents, however, is not necessarily a disadvantage, because, as the internal resistance of a photo-cell is so very high, a large load resistance, say, a megohm, may be employed, so that the voltage output will be appreciable even for very small quantities of light. For this reason a photo-cell is admirably suited for valve amplification.

The cell load resistance is, of course, put between the grid and cathode of a thermionic valve, so that the minute photo currents result in changes of anode current at least a thousand times as great. In fact, the limiting factor will be the grid-cathode insulation of the valve. Still greater gains are obtainable when a gas-discharge triode is employed either in a simple on-off circuit or in a phase control circuit.

There are two types of photo-cell—the vacuum and the gas-filled. If the cell contains a minute quantity of gas a great increase of sensitivity is obtained. A few hundredths of a millimetre of a rare inert gas is employed, and as a result of the ionisation of the gas molecules by collision with the photo electrons the minute primary current is increased five to ten-fold. But for devices in which proportionality of current to light are essential, it is desirable to employ either a vacuum cell or else a gas-filled cell with a small load resistance.

Photo current commences to flow as soon as the cathode is illuminated. With gas-filled cells there is a slight time lag before the full gain is realised, but this is hardly noticeable for frequencies up to 10,000 cycles per second and in normal industrial applications, the response of a photo-electric device may be regarded as instantaneous; any time lag may be attributed to the associated mechanical relay and switch gear involved.

A very valuable property of photo-cells is their selective spectral sensitivity. The colour response of modern photo-cells usually differs widely from that of the eye. Furthermore, individual cells will vary in their colour sensitivities. This selectivity may be taken advantage of in several ways. For example, a pair of cells of different responses (intensified if necessary by coloured screens) can be used as a colour matching device.

The photo-cell will also respond to infra-red radiation, and it is easily possible, therefore, to construct control or alarm devices operating with " invisible " light.

From what has been said it is evident that the fundamental light control unit will embody:—

(1) A sensitive photo-electric cell.
(2) A thermionic amplifier.
(3) The requisite relay or indicating equipment.

A. C. Cossor, Ltd., have compiled a list of a hundred applications of the versatile light cell which are already in commercial use. This list is given below but it is not claimed that it is complete. The grouping, Messrs. Cossor state, is only approximate but the list provides an excellent idea of typical applications. It may be remarked that suggestions for further uses will be welcomed.

Light-operated Switches

1. Switching on street lamps at dusk.
2. Illumination control in schoolrooms, offices, etc.
3. Iceberg or ship detection through fog.
4. Automatic photography of wild animals or burglars.
5. Lighting jewellers' shops by police torch.
6. Lighting displays in shop windows by passers-by.
7. Automatic door opening for waitresses.
8. Customer indicator in shops.
9. Opening doors or gates for trucks.
10. Opening garage doors by headlights of car.

Counting Devices, etc.

1. Production articles on moving conveyor.
2. Beats of master clock.
3. One way counting of traffic
4. High speed counting (cigarettes, etc.)
5. Sorting and counting over and undersize articles
6. Items on printed cards.
7. Analysis of statistics on punched cards.
8. Day and night counting of animals.
9. Checking coupons in packets of chocolates, etc.
10. Rejection of unlabelled tins.

Alarms and Signals

1. Infra-red burglar alarm.
2. Invisible jewel protection.
3. Smoke alarms.
4. Fire alarms.
5. Alarms against trespassers.
6. Boiler guage level alarm.
7. Water hardness alarm.
8. Crack detector in polished surfaces.
9. Breakage indicator in paper mills.
10. Noxious gas detector.

Safety and Control Devices

1. Power press protection.
2. Prevention of lifts moving before gates are shut.
3. Remote control of dangerous processes.
4. Automatic water purification.
5. Limit switch for motor travel.
6. Low pressure water gauge.
7. Aligning parts of swing bridges.
8. Reversing rolls in steel mills.
9. Voltage regulation.
10. Full and empty hoppers detected.

Transport

1. Stopping underground trains in correct position.
2. Speed measurement.
3. Train operated signals.
4. Roadside advertisements lit up by car lights.
5. Headlights dimmed or dipped by approaching car.
6. Cars overtaking, warn lorry drivers.
7. Pedestrian operated crossings.
8. Traffic density control in tunnels.
9. People on escalators (speed control).
10. Headroom alarm for bridges or tunnels.

Colour Differentiation

1. Temperature measurements (Pyrometry).
2. Colour matching of solutions.
3. Seed sorting by colour.
4. Lamp efficiency measurement.
5. Matching false teeth.
6. Detection of unripe fruit at canning depot.
7. Egg sorting by colour.
8. Colour matching (Bakelite products).
9. Stamp checking on letters.
10. Automatic butt welding.

Measurement

1. Piston displacement (Engine Indicator).
2. Photographic exposure meter.
3. Calipering steel balls.
4. Projectile velocities.
5. Checking resistance values.
6. Automatic weighing.
7. Light transmission of frosted bulbs.
8. Control of master clock.
9. Foot candle meter.
10. Talking clock (TIM).

Entertainment

1. Sound films.
2. Television.
3. Film gramophone.
4. Pin tables.
5. Shooting galleries.
6. Cinema air conditioning.
7. Automatic drinking fountain.
8. Studying speed of golf club swings.
9. Timing of races and speed trials.
10. Automatic photography of finish of races.

Scientific Apparatus

1. Stellar photometry.
2. Eclipse measurements.
3. Cloud chamber control.
4. Wind tunnel pressure control.
5. Ultra-violet dose meter.
6. Precise temperature control with thermo-couple.
7. Daylight recording.
8. Analysis of curves for mathematical equations.
9. Spectro photometry.
10. Secret signalling by infra-red radiation.

Miscellaneous Industrial Applications

1. Synchronizing conveyors.
2. Register control for textiles or paper.
3. Photo engraving.
4. Densitometry in photography.
5. Calibration of shutter timing of cameras.
6. Calibration of vibrator frequency.
7. Register control in bag making.
8. Gloss meter for paper manufacture.
9. Picture and facsimile transmission.
10. Turbidity control in chemicals.

MECHANICAL TELEVISION PROVES ITSELF

ANYONE who in the past has had any doubts as to the ultimate practicability of high-definition mechanical-optical television would have had their doubts removed had they been able to witness the Scophony demonstration of the Trooping of the Colour, which was given on the premises of Derry & Toms, Ltd., High Street, Kensington.

The picture size was six feet by five-and-a-half feet, which as yet does not approach cinema standard, but it was sufficiently large for viewing in comfort by an audience of approximately three hundred. The quality, however, was a near approach to cinema standard and there can be no doubt of the utility of this apparatus for public viewing.

With the exception of about half-a-dozen momentary occasions during the whole period of the transmission, which lasted an hour and a quarter, the picture remained perfectly steady and when a frame partly slipped it locked in again almost immediately, without, we understand, any sort of manual control.

The picture was very bright and the only criticism that we have to make is that with this type of apparatus the viewing angle is somewhat small so that the picture if viewed from the side of the auditorium anywhere near the front, appears dark and a considerable amount of definition is lost. This point is a factor which will have to be taken into account in public installations unless means are discovered of mitigating the effect. It would be better to provide screens cutting off near side views, rather than create the impression that the picture lacks brilliancy and detail.

The Scophony Receiver

Back projection was employed with about a ten-foot throw, a shrouded hood of dark cloth on a light wooden framework being used to cut out any extraneous light. The hall itself was not in perfect darkness and was, in fact, very considerably lighter than the average cinema.

The entire apparatus occupies a space of roughly twelve feet square at the back of the screen. A cinema arc is employed which is a separate unit. The scanners and associated optical apparatus are mounted on a cast iron pedestal which is bolted to the floor. The amplifier is contained in a vertical rack entirely separate from the rest of the gear.

In the previous week Scophony, Ltd., also gave a demonstration of the Derby transmission, and during the preliminary tests, made a few days before, difficulty was experienced in getting sufficient pick-up with the aerial that was installed on the roof. Various aerial positions were tried and ultimately it was found that there was considerable screening from a large metal crane which was being used in the erection of a near-by building. Later the aerial was transferred to a tower on the roof of an adjacent building and in this position it provided ample signal strength.

We understand that Scophony, Ltd., are now satisfied with the performance of both their home and public receivers and that arrangements are well forward for going into production. It is expected that the home receiver will be available for sale to the public at the time of the Radio exhibition.

On the occasion of the Trooping the Colour broadcast the B.B.C. engineers used two super-Emitron cameras on the roof of the Horse Guards building, which gave views of the entire parade. A third camera, placed near the Whitehall entrance of the Parade ground, provided intimate glimpses of the King at the saluting base and of the troops as they passed.

Telegossip

A Causerie of Fact, Comment and Criticism

As an average listener to the sound programmes as well as a viewer, I have been struck with the fact that very rarely is there any mention of television in ordinary broadcasting and yet the B.B.C. finds plenty of opportunity to interpolate little publicity puffs about their official organ *The Radio Times*. Why should there not be a little television publicity? The absolute lack of it, except on those occasions when it is quite unavoidable, leads one inevitably to think that strong opposition to television still exists at Broadcasting House. It is no secret, of course, that in the past this opposition did exist, but if it is still there it needs rooting out. Large sums of money have and are being spent on television and it is incumbent on the B.B.C. as a body to do all that is possible to further its development.

What amount of liaison there is between Broadcasting House and Alexandra Palace it is difficult to determine, but there seems precious little, for many of the sound transmissions could originate from the television studio and if properly put over ordinary listeners would not suffer in any way. The proposal to televise the variety broadcasts was scotched chiefly on the flimsy excuse that the cameras would interfere with the view of the audience. The main object of these stage variety shows is, or should be, broadcasting and not free entertainment to a few hundred people who are only present by courtesy and to provide a *clacque*.

Aircraft and Interference

Living on a route that is taken by aeroplanes at fairly frequent intervals, I have been interested in the correspondence which has appeared on the subject of interference. In my experience of observation made during the last few weeks the phenomena are interesting but detract but very little from any possible enjoyment of the programmes. In no case has the ordinary ignition interference been as bad as that experienced when a car passes the house and the fading that has taken place has only been such as slightly to reduce the brightness of the picture. I should mention that I am well within the service area (about twenty miles) and get a strong signal, but the effect is so slight that I cannot imagine that aircraft can be seriously detrimental at considerably greater distances. The ignition interference from a plane is usually what may be described as clear cut, that is, each splash of light is clearly defined, whereas many cars will slash the picture to bits and render it totally unrecognisable.

The Home-built Receiver

I recently decided to build a receiver at home. My main object in doing so was because I felt that it would be the surest way of learning the most about television receivers—and I have not been disappointed. First I satisfied myself by witnessing demonstrations that really first-class results were possible with the home-built article, and secondly, that the work was within my ability. Now that the job is done I can say that the work is quite as easy as that entailed in building an ordinary wireless set—but there is a lot more of it.

There came the day when it was ready for checking and testing. Each wire and connection was carefully gone over and checked with the diagrams. Two errors were discovered and with these rectified it seemed certain that all was in order.

But not a sound could be got from the receiver when tested with phones in the orthodox way, and not a glimmer of light appeared on the screen of the tube when the time base was tested. A second rather quick checking of the wiring did not reveal any further error and I began to think that building a television receiver was not so simple as it seemed and felt somewhat concerned. However, to cut a long story short—and it did take a considerable time—a third check resulted in one of the H.T. connections being found missing. It was its very obviousness that had caused it to be overlooked. With this trouble put right there was no difficulty in tuning in the signal and a little further adjustment made it clear that some sort of result in the way of a picture would be obtained so far as the vision unit was concerned.

No troubles were experienced with the power packs, but there did remain the time base. Here I was dealing with something with which I had no previous experience whatever. Valves and tube were glowing but there was nothing on the screen. Actually, as it proved afterwards, the spot was there but it was off the screen due to the use of a wrong value resistance—but the trouble took some finding.

Finally, with time base and receiver working it was felt that a picture would be obtained and it was—but it was negative, and all the adjustments that I could make would not put it positive! On this matter I sought advice and was told that in all probability it was due to too great a signal input. This was reduced to a minimum, but still the picture remained negative. Finally, I got an intuition that caused me to look at the connections of the diodes in the vision receiver. Yes, they were wrongly connected and evidently the fault had been overlooked because of the small differences in the positions of the pins of these tiny valves.

My troubles were at an end now and there was no difficulty in trimming the receiver for the best pictures. One minor difficulty occurred after the receiver had been installed in a cabinet: there was a dry joint somewhere and the set went dead. By this time, however, I had obtained sufficient experience to locate the trouble almost immediately. The receiver now gives very fine pictures and it is rarely necessary to touch the controls.

Reliability

When television receivers were first introduced, even the makers had some misgivings regarding their degree of reliability, and the amount of servicing they would require was a factor which was taken into account when the original prices were fixed. Time has proved, however, that receivers very seldom cause trouble. I know of one Baird receiver which has been in use practically every day for nearly two years and it has never had a replacement of either tube, valve or component.

The reason for this reliability is, I think, that on the whole the workmanship is better than that which is put into the average radio set; it must be if the performance is to come up to a high standard and it must be remembered that anything less would be very apparent, for the eye is not so tolerant of faults as the ear.

OUTSIDE TELEVISION BROADCASTS

By T. C. Macnamara and D. C. Birkinshaw, M.A.

PART II. THE LONDON TELEVISION SERVICE

The second and concluding instalment of an abstract from a paper read before the Institution of Electrical Engineers. The first part of this paper was published in the June issue.

IN order that outside events may be included in the television field a mobile television unit has been formed which in effect provides the same facilities for vision and sound as are available at the main station at Alexandra Palace, although of necessity somewhat limited in scope.

Every effort has been made to construct the mobile unit in the most transportable form possible, so that the minimum of time is required for moving it to site and setting it to work. Rapid mobility is felt to be an essential of a unit of this type, as lacking this quality much of the topicality of the outside-broadcast transmissions will be inevitably lost, and their value thereby greatly reduced.

At present, setting up the equipment for an outside broadcast takes a comparatively long time, perhaps a day or even longer. This is considered to be far too long, and every effort is being made to arrive at a design of all equipment including the smallest accessories such that the process of setting up for transmission can be accomplished in an hour or even less.

Travelling Studio Equipment

The travelling control room, which, as has been stated, is brought into use in cases where it is required to televise events taking place at points remote from Alexandra Palace, consists of a large motor vehicle, 27 ft. 6 in. long, 7 ft. 6 in. wide, and 10 ft. 8 in. in height, fitted with a closed body of special design.

Inside the vehicle body is mounted all the apparatus required to operate three Emitron cameras and six microphones. The cameras, which when the vehicle is in motion are carried in specially sprung cradles to protect the fragile tubes from the effect of road shocks, are in all respects similar to those for studio purposes.

When the vehicle reaches the site of the broadcast the cameras are taken out to appropriate positions, being connected to the apparatus by multi-core cables similar to those used in the studio and each of a total length of 1,000 ft.

Provision is made on the vehicle for carrying 600 ft. of this cable on drums which are lowered through the rear doors of the body by means of a winch mechanism which enables them to be deposited on a hand-truck and so easily transported to the required point. After use, the drums are raised into the vehicle by reversing the operation of the winch.

The apparatus contained in the vehicle consists of all essential portions of the control-room scanning and amplifying equipment, and includes duplicate sets of pulse-generating equipment either of which can be brought into action in the event of failure of the other.

Provision is made for fading from any one camera to another, or for the superimposition of the outputs from two or all three cameras. Two cathode-ray vision monitors are provided, one for the purpose of viewing the transmission actually taking place, and the other for previewing the picture emanating from the camera to which it is next proposed to fade.

The outputs of the six microphones are connected to a six-way fading mixer, so that any microphone or combination of microphones may be chosen as dictated by the requirements of the programme being transmitted. Duplicate speech amplifiers are provided and are equipped with a logarithmic volume indicator and a monitoring loudspeaker. The speech amplifiers are designed to deliver to a Post Office land line a signal of appropriate level for transmission to Alexandra Palace.

The whole of the equipment is made up in the form of flat-fronted panel units mounted in 7 ft. racks which extend down both sides of the body, with a central gangway for the operating personnel.

The mobile television control room used for outside broadcasts.

The rear of the racks is not accessible from the interior of the body, and to overcome the resultant difficulty of access to apparatus a particular form of body construction has been adopted. The sides of the body have been made to open over the greater part of the length in the form of flaps. The top half of the bodywork is formed of flaps opening upwards and the lower half of flaps opening downwards. The lower flaps are retained in the horizontal position by means of chains, and they form platforms on which those manipulating the apparatus from the rear may stand at a convenient height.

All the equipment is mains-operated, consuming a total of about 5 Kw, and is adopted to operate from either single-phase or 3-phase 50-cycle supply mains over the range of voltages normally encountered.

In the absence of supply mains the mobile control room unit may be operated from a petrol-driven generator. The chassis is of the 4-wheel, 45 h.p. 6-cylinder

AERIAL HEIGHT AND TOPOGRAPHICAL FEATURES

petrol-driven type, and in the fully loaded condition weighs approximately 9 tons.

Travelling Vision Transmitter and Power Unit

Conveying the sound signals to Alexandra Palace presents no difficulties, as use can be made of Post Office line circuits in the usual manner, but the vision signals present a serious problem. At the present moment it is not possible successfully to transmit television signals through the medium of ordinary landline circuits of appreciable length, and while special television circuits exist their scope is limited at present, and many events of interest take place in localities far removed from these special circuits.

In circumstances such as these, other means for linking the mobile control room with Alexandra Palace must be adopted, and to this end a second mobile unit comprising an ultra-short-wave radio transmitter has been constructed.

This unit is mounted in a second vehicle of precisely similar construction to that for the mobile control room, as previously described.

The transmitter is built into two sheet steel cubicles, which are disposed either side of the centre line of the vehicle body and are carried by means of resilient bushings upon transverse bearers affixed to the main chassis members of the vehicle.

The transmitter is designed to operate at a frequency in the region of 64 mc./sec. and delivers to the aerial a power of 1,000 watts at peak picture-white modulation.

The radio-frequency portion of the installation consists of a valve master oscillator operating at 32 mc./sec. having a frequency stability of 1 part in 5,000. This is followed by one doubler stage, and five stages of neutralised push-pull radio-frequency amplification, modulation being by grid control on the final stage.

All valves are of the air-cooled type throughout, and in the case of the final and penultimate stages consist of small water-cooled valves designed for working at these frequencies, modified for air cooling by having intimately affixed to their anodes a type of copper honeycomb, through the cells of which air is rapidly forced. Heat generated by the dissipation of energy in the valves is thus removed, without the use of cooling water, the presence of which would be inconvenient in a mobile vehicle.

The modulating equipment is designed on the same lines as that installed as part of the Alexandra Palace vision transmitter, but, of course, on a reduced scale, air-cooled valves being used throughout. The whole equipment is designed to pass, with a minimum of loss at the high frequencies, the wide frequency band required, and to transmit a signal having exactly similar characteristics to that radiated from the main vision transmitter.

The output of the transmitter is adapted to feed the aerial either through a balanced open-wire feeder of about 500 ohms characteristic impedance, or, alternatively, by means of a co-axial high-frequency cable of 110 ohms characteristic impedance.

The first type of aerial used consisted of a two-stacked balanced series phase array adapted to emit a vertically polarised wave and having marked directional properties. This aerial was constructed on a Jarrahwood frame, approximately 18 ft. long by 12 ft. high, which was slung between two 30 ft. transportable wooden masts with tripod bases, both the masts and the aerial frame being capable of being dismantled into component parts of such size as to make transport possible.

It will be noted that in the interests of portability the height of the transmitting aerial was kept low, an action which was held to be justifiable on the following grounds.

Evidence showed that good-reception conditions could be obtained using a high transmitting aerial in conjunction with a comparatively low receiving aerial, and it is generally conceded that the converse must in theory apply. Consequently it was felt that if a very high aerial could be installed at the receiving point, a comparatively low aerial could be used with the transmitter, with manifest advantages from the point of view of rapid erection and dismantling.

In practice, rather variable results were obtained with the low series phase aerial, as it was found that from some outside broadcast sites a good signal strength giving a satisfactory signal/noise ratio was received at Alexandra Palace, whereas from others the results were very poor. For example, from Wimbledon a field strength of approximately 2mV/m. was obtained, whereas from Hatfield Aerodrome whence an attempt was made to relay the start of the King's Cup Air Race, a very low signal strength of the order 250 μV. per metre only was obtained, which gave an insufficiently good ratio of signal to noise to maintain synchronism of the picture. The actual length of the radio link path was 11½ miles in the case of Wimbledon, and 13 miles in the case of Hatfield, and there clearly is not sufficient difference in these distances to account for the widely divergent field strengths obtained

Some attempt was made to determine the factor influencing this divergence, and inspection of the topographical features of the intervening country revealed that in the case of Wimbledon, while the actual height of the site above sea-level was not great, being of the order 100 ft., the transmitting aerial stood effectively on the summit of the highest ground in the district and a very marked falling away of the ground occurred immediately, there being no high ground in the path of the wave for a number of miles.

In the case of the Hatfield site, on the other hand, the transmitting aerial stood on fairly level ground, there being no falling away in the direction of the receiving point. There was in fact a certain amount of rather higher ground between the transmitter and the receiver, fairly close to the transmitting aerial, and it could only be assumed that this had the effect of introducing local attenuation, which resulted in the weak signal strength to which previous reference has been made.

The question of a suitable support for a higher aerial has received a good deal of attention, and numerous proposals have been considered.

Attention was turned to the fireman's ladder, a highly specialised and well-developed form of structure which

TRANSMISSION VIA CABLE

already exists and which is ideally suited to the purpose in view, in that it combines extreme portability with ease and rapidity of erection.

Designs have therefore been drawn up for a lightened form of wooden extensible ladder carried on a motor chassis which will form a rigid base for the aerial mast when the latter is erected.

Mobile Power Unit

A third vehicle of similar construction to those containing the mobile control and transmitting apparatus houses a petrol-driven engine-generator set capable of supplying power for both the other units, thus making the mobile outside-broadcast equipment independent of supply mains in places where these are not available or unsuitable.

The engine is of the 6-cylinder omnibus-propulsion type and develops 120 b.h.p. at 2,2000 r.p.m. It is direct-coupled to a 3-phase 415-volt 50-cycle alternator operated at 1,000 r.p.m., at which speed the engine is adjusted to develop 50/55 b.h.p., giving a maximum electrical output of approximately 30 kW.

Radio Link Receiver at Alexandra Palace

The receiver takes the form of a 10-stage superheterodyne using an intermediate frequency of 7 mc/sec. and is provided with automatic volume control and indicating instruments, including an oscilloscope for observing the received signal wave-form. No amplification is used at the original frequency (prior to the frequency changer), but three stages of vision-frequency amplification are introduced after the second detector, arrangements being made that the output shall contain the full D.C. component of the signal.

The output is thus in the usual form of vision + synchronising signals, which is applied to the vision transmitter without the introduction of any further impulses or signals. It is taken to a suitable point in the control room, where, by means of relays, the input to the vision transmitter can be rapidly changed over from the output of the local studio apparatus to the output of the receiver. A rapid change-over is essential, as it is necessary to change from locally-generated synchronising signals to those coming by radio from the distance point, and a complete cessation of synchronising impulses to the transmitter would cause serious overloads if maintained for an appreciable space of time.

Television Transmission over Cables

Attention in this country, as well as in others, has for some time been directed towards the transmission of television signals through line circuits, not only for the purpose of linking up outside broadcast transmission but also to permit ultimately of a simultaneous broadcast of a television programme from a number of widely-separated radio stations.

In general, the types of circuits under consideration have fallen in three main categories:—

(a) Unbalanced co-axial cables designed for multi-channel telephony and/or television.

(b) Balanced-pair low-capacitance cables primarily designed for television.

(c) Normal telephone circuits.

As regards (a), experiments are in progress by the Post Office Engineering Department to determine the requisite conditions for satisfactory operation on a long route of cable of this type, with particular reference to the co-axial circuits already existing between London, Birmingham, and Manchester, intended for multi-channel telephony.

As regards (b), a network of this type of cable, supplied by the Marconi-E.M.I. Television Co. to the Post Office, has been installed round the centre of London. This route embraces numerous points of interest, including the site of many national functions as well as places of entertainment such as theatres, etc., and proceeds via Broadcasting House to Alexandra Palace. Tapping points are provided at frequent intervals along the whole cable route.

All signals originating on this circuit are led into a repeater station at Broadcasting House, where equalization and phase correction takes place, after which the signals are amplified and directed to Alexandra Palace, where further equalisation and amplification is necessary before they are applied to the vision transmitter.

As regards (c), the British Broadcasting Corporation has carried out certain experiments on short lengths of ordinary telephone circuit with the particular object of using such circuits as extensions to the balanced television cable where distances of one or two miles only are involved.

Preliminary investigations on these lines have been made to determine the suitability of ordinary dry-core paper-insulated cables for the transmission of frequencies in the vision range. The primary constants vary, not only with the physical dimensions of the pair concerned, but also with its disposition relative to the other conductors in the cable. The iterative impedances of pairs measured vary between 75 and 140 ohms.

Measurements made on short lengths of cable indicate that where small-gauge conductors are concerned the high-frequency value of inductance is reached below 200 kc., which means that at frequencies above this value the frequency phase characteristic is linear, apart from a secondary effect of attenuation which becomes apparent at the higher frequencies. For the limiting lengths of circuit contemplated, it is possible to obtain the phase characteristic up to 200 kc. by open-circuit and short-circuit impedance measurements. The phase distortion introduced by the attenuation correcting networks has to be compensated, but as the required correction can be easisly calculated, this presents no difficulty.

A problem which requires special attention is the connection of the balanced circuit to an unbalanced amplifier at the low-level end of the circuit, as the longitudinal currents normally present in the cable pair must be much attenuated before they are effective in the unbalanced input of the amplifier. A specially-designed shielded repeating coil was included in a circuit of suitable constants, and was found to transmit frequencies in the range 50 cycles per sec. to 2.2 mc./sec. with small attenuation and phase distortion.

With this arrangement of terminal apparatus, the noise level on the 1.2-mile section of cable was better than 50 db. below the equalised signal.

RECENT TELEVISION DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

Specially Compiled for this Journal

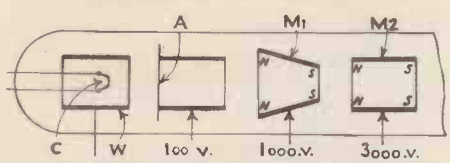
Patentees: Zeiss Ikon Akt :: E. Michaelis :: Soc. Anon Franco-Belge D'Electricite :: Marconi's Wireless Telegraph Co. Ltd. and L. M. Myers :: H. G. Lubszynski :: V. Zeitline, A. Zeitland and V. Kliatchko :: The General Electric Co. Ltd. and A. Bloch :: Radio-akt D. S. Loewe

Focusing the Beam

(Patent No. 478,410.)

THE focusing electrodes of a cathode-ray tube are made of permanently-magnetised metal, so that the electron-optical control-field is partly electric and partly magnetic. As shown in the figure the electrons emitted from the cathode C are directed by the Wehnelt cylinder W to pass through the aperture A of an accelerating anode.

From here the stream passes in succession through two cylindrical



Tube with permanent magnet focusing electrodes. Patent No. 478,410.

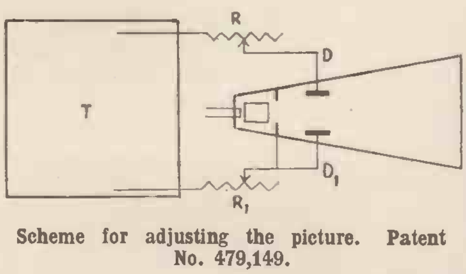
electrodes M1, M2, which are permanently magnetised as indicated by the polarity N.S. to produce an intervening magnetic field. At the same time they carry a graded biasing-voltage which creates an electrostatic field. The resultant "lens" system is therefore partly magnetic and partly electric, and is produced without having to use magnetic windings mounted outside the glass stem of the tube.—*Zeiss. Ikon Akt.*

Adjusting the Picture

(Patent No. 479,149.)

Variable resistances R, R1 are inserted in the leads from the time-base circuit T to the deflecting-plates D, D1 of a cathode-ray receiver, and serve either for varying the size of the picture, or for centring it properly on the fluorescent screen. This method of adjustment does not react upon the time-base circuits, nor cause distortion of the saw-toothed waves.

The resistances are ganged together so as to ensure that the length and breadth of the picture is always maintained at the correct standard ratio. For centring purposes, adjustment is effected by varying the two resistances in opposite directions, i.e., as one is increased the other is decreased.—*E. Michaelis.*



Scheme for adjusting the picture. Patent No. 479,149.

Scanning Systems

(Patent No. 480,859.)

Two pairs of deflecting plates are set at right angles to each other, and co-operate with a fifth plate which is formed with a central aperture to allow the passage of a stream of electrons. If the voltages on the deflecting plates are equal, the electrons moving in a straight line through the centre of an aperture will not be affected, but all others will be forced to diverge in different directions.

The position of the "neutral line" can be shifted closer to, or further from either of the deflecting plates by varying the biasing voltage applied to them, and in this way it can be used to scan the whole surface of the fluorescent screen of the cathode-ray tube.

The arrangement overcomes the usual difficulty of obtaining a "point source," and of keeping the electrons in a clear-cut pencil over a considerable distance.—*Soc. Anon Franco-Belge D'Electricite.*

Incandescent Pictures

(Patent No. 481,434.)

To secure greater brilliance, it has been proposed to replace the ordinary fluorescent screen of a cathode-ray tube by a thin metal plate, which is heated to varying degrees of incandescence by the bombardment of the scanning stream, and so throws up the picture in glowing colours. One of the problems in this type of apparatus arises from the fact that, no matter how thin the incandescent screen is made, it displays a certain "lag" due to heat inertia.

To overcome this difficulty, the screen is sprayed during the intervals between successive impacts of the scanning stream, with secondary electrons which serve to keep its surface at a temperature just below the glow point. The response of the metal screen to signal-forming impulses then becomes practically instantaneous.—*Marconi's Wireless Telegraph Co., Ltd.,* and *L. M. Myers.*

Television by Secondary Emission

(Patent No. 471,563.)

An electrode coated with a compound of nickel and uranyl nitrate is found to possess the peculiar property of liberating a more copious supply of secondary electrons after it has first been bombarded by primary electrons travelling at a comparatively low speed. The effect is utilised to increase the strength of the signals produced by a transmitter of the cathode-ray type.

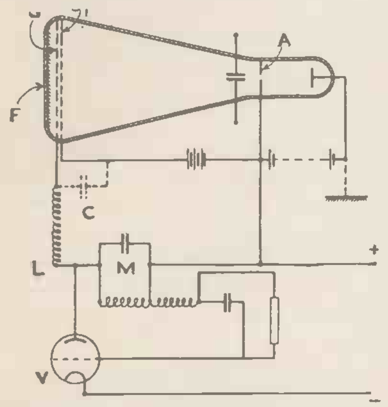
The picture to be televised is first projected on to a transparent photo-sensitive electrode, and the resulting stream of electrons is focused, as a beam, on to the specially-prepared nickel screen, which is mounted at the far end of the tube. This simply prepares the nickel screen for a more intense bombardment by a second electron stream which is supplied from the usual gun or cathode of the tube.

The second stream releases a very copious supply of secondary electrons from the nickel screen, and these are used to produce the outgoing signals. The specially-coated screen in effect plays the part of the well-known "mosaic-cell" type of electrode, though it possesses the advantage of having a plane and unbroken surface.—*H. G. Lubszynski.*

Low-voltage C.R. Tubes

(Patent No. 481,917.)

The cathode-ray tube shown in the figure will receive television signals when operated from D.C. mains, or from a battery supplying from 100 to 200 volts. Two "open" grids G, G1 are placed close to the fluorescent screen F, the grid G1 being positively biased, relative to the anode A, so that it serves to accelerate the electron stream. The other grid G is connected by a coil L and through the series capacity between the grids G and G1 (represented by



Low-voltage cathode-ray tube. Patent No. 481,917.

the dotted-line condenser C) to a tuned circuit M in the output of an oscillating valve V.

Owing to the large inductance of L and the small capacity of C, high voltages are set up between the two grids. Each positive half-cycle of the voltage serves to increase the velocity with which the electron stream strikes against the fluorescent screen. Because of this controlling action, the incoming signals can be applied to the grid of the valve V, instead of to the grid of the cathode-ray tube.—*V. Zeitline, A. Zeitline,* and *V. Kliatchko.*

Viewing Screens

(Patent No. 483,841.)

The picture produced on a fluorescent screen, when viewed by daylight, or in a lighted room, tends to be "blurred" by the surrounding illumination as diffused from the surface of the screen. This indirect light not only reduces the contrast-value of the picture tones, but also prevents the shadows of the picture from showing dead black.

By way of remedy, the end of the cathode-ray tube on which the screen is mounted is surrounded by an opaque shield or tube with a blackened internal surface. In addition a "grey" glass plate is interposed between the fluorescent screen and the eye of the observer. The "grey" plate absorbs more of the "diffused" light than it does of the light coming direct from the picture; its place may be taken by a partially-reflecting sheet of glass set at 45° to the line of sight.—*The General Electric Co., Ltd.,* and *A. Bloch.*

Summary of Other Television Patents

(Patent No. 480,673.)

Construction and mounting of a single-mirror scanning device moving simultaneously both at the line and frame frequency.—*W. H. Priess.*

(Patent No. 480,946.)

Method of depositing the photo-electric material on a cathode-ray screen of the mosaic-cell type.—*L. Klatzow.*

(Patent No. 480,997.)

Forming the small apertures in a scanning disc of the kind in which they are arranged to include several turns of a spiral.—*The General Electric Co., Ltd., D. C. Espley, H. W. B. Gardner* and *W. O. Russell.*

(Patent No. 481,549.)

Preventing the formation of stray fields likely to distort the path of the stream passing through a cathode-ray tube.—*Standard Telephones and Cables, Ltd.*

(Patent No. 468,294.)

Rotating-disc scanner designed to give a higher definition at the centre of the picture than at the outside or marginal parts.—*J. G. S. Arathoon.*

(Patent No. 469,488.)

Electron multiplier of the secondary-emission type in which a back-coupling link is provided between two or more of the target electrodes.—*Marconi's Wireless Telegraph Co., Ltd.*

(Patent No. 469,558.)

Screen of variable transparency for use in a cathode-ray receiver for projecting large-sized pictures.—*M. Aarman.*

(Patent No. 475,032.)

Film television system with provision for ensuring accurate register between successive sets of interlaced scanning lines.— *G. E. Condliffe.*

(Patent. No. 475,046.)

Preventing disturbances due to the sudden cessation of high-frequency synchronising impulses.—*Baird Television, Ltd., L. R. Merdler,* and *A. H. Gilbert.*

(Patent No. 475,473.)

Preventing interference or "false brightness" effects in a television transmitter of the Iconoscope type.—*Telefunken Ges. fur drahtlose Telegraphie m.b.h.*

(Patent No. 475,539.)

Magnetic deflecting systems for distortionless scanning in a cathode-ray tube.—*Fernseh Akt.*

(Patent No. 475,582.)

Composition of fluorescent materials for giving an approximately "white" light.—*S. T. Henderson.*

(Patent No. 475,735.)

Cam-controlled device for ensuring an easy "balance" when opening and closing the lid of a television cabinet.—*Baird Television, Ltd.,* and *E. J. Treasure.*

(Patent No. 478,840.)

Light-cell for scanning in which the medium is subjected to high-frequency mechanical vibrations and acts as a diffraction grating to reflected or transmitted rays.—*E. Traub.*

(Patent No. 479,471.)

Means for regulating the degree of deflection applied to the electron stream of a cathode-ray tube.—*Fernseh Akt.*

(Patent No. 479,458.)

Compensating for the distortion which occurs when televising a scene from a rapidly-moving object such as an aeroplane in flight.—*Baird Television, Ltd., T. M. C. Lance* and *B. B. Austin.*

(Patent No. 480,073.)

Cathode-ray tube with magnetic focusing coil mounted inside the glass tube.—*Farnsworth Television Incorporated.*

(Patent No. 480,263.)

Electron multiplier in which one at least of the secondary-emission electrodes is pervious to the stream.—*Baird Television, Ltd., V. Jones* and *T. M. C. Lance.*

(Patent No. 480,532.)

Method for producing synchronising impulses when televising from a motion-picture film by a rotating-disc scanner.—*British Thomson-Houston Co., Ltd.,* and *S. R. Eade.*

(Patent No. 481,659.)

Method of modulating the electron stream of a cathode-ray tube without affecting the focusing.—*V. Zeitline, A. Zeitline* and *V. Kliatchko.*

(Patent No. 481,792.)

Producing clear-cut synchronising impulses from a rotating-disc scanner.—*The General Electric Co., Ltd.,* and *D. C. Espley.*

PROBLEMS IN TELEVISION RECEIVER CONSTRUCTION—AND THEIR SOLUTIONS

Here is a selection of queries relating to television receiver construction on matters with which readers have experienced difficulties.

Q. I have constructed the Low-Cost Televisor, and whilst the time base and the C.R. tube equipment are operating satisfactorily, I am experiencing trouble with the vision section.

When this section was first completed, it functioned satisfactorily, although I was unable to hear the shrill whistle due to the line sync. pulses. Now, however, it will only receive signals of lower frequency which I assume are picked up by the I.F. section.

A. It is fairly certain that the fault is in the oscillator section and the assumption that the signals heard are picked up by the I.F. stages is correct.

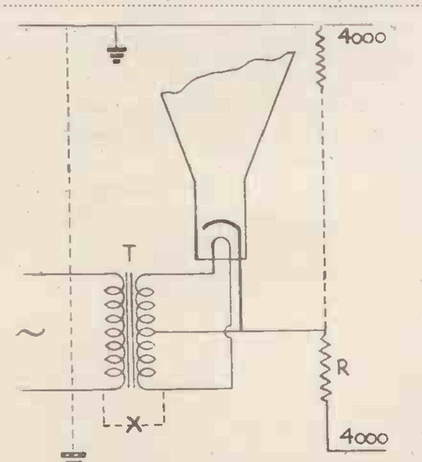
Possibly due to the failure of a by-pass condenser in this section the triode-hexode valve H.T. is short circuited. Alternatively, closer coupling of the oscillator coils may be required. Finally there is the possibility that the X41 valve has developed a fault.

The inability to hear the shrill whistle due to the line sync. pulses indicates that the receiver was incorrectly tuned when the initial tests were made.

Q. On the transformer I have there is no centre tapping for the 4 v. 8 a. and the 2 v. 1.5 a. windings.

In the diagrams you show these as connected to the 5 and 6-way sockets. What connections shall I make for this transformer assuming that I can use it?

A. The heater winding for the time base valves should be centre tapped. No doubt, however, it will be satisfactory to employ a 30-ohm potentiometer (humdinger) across the winding



The voltage existing across X is 4,000. With the 6-way plug withdrawn this circuit is removed.

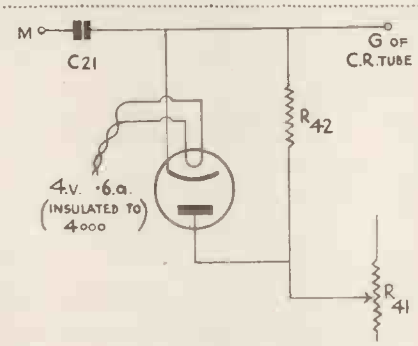
and use the slider of this as the centre tap.

For the tube heater winding it will be satisfactory to connect the cathode to one side of the heater winding. It is important to note that the insulation of this winding must be capable of withstanding the full C.R. tube voltage to frame.

Q. I have built the Low-Cost Televisor described by you, but I am experiencing some trouble with the power unit.

Upon switching on, the C.R. tube screen is momentarily illuminated, but there is an intermittent flashing and sparking at the terminals of the tube heater winding. I cannot see any mistake in the wiring of the unit and I have put the tube heater lead through sleeving. It runs along the base of the chassis in places. I am now afraid to switch on again.

A. It seems probable that the transformer is faulty, although there is the



An insulation problem.

possibility that the measure of insulation you have provided for the tube heater and cathode leads is inadequate. Ensure that the leads are kept well clear of the chassis and provide large clearance holes where they pass through.

These leads should be well insulated with two or more layers of systoflex progressively increasing in bore.

Having done this you can switch on once more with the tube removed. Switch off again immediately if there is any indication that the short circuit is still present, in which event you should send the transformer to the makers for testing.

Later this correspondent again wrote. He had carried out the tests recommended and found the short circuit was still present. He found, however, that with the 6-way plug removed, the short circuit disappeared and is puzzled to account for this.

He now asks why the tube heater winding must be insulated for 4,000v. and why the removal of the 6-way plug cures the short circuit.

If the diagram shown here is studied it is obvious that the 4,000 volts negative terminal is common to the heater winding through the low resistance R. The 4,000v. positive terminal is earthed and there is thus a potential difference of 4,000 volts across the transformer T as indicated by the dotted line. When the 6-way plug is removed, however, this circuit also is removed and the short circuit disappears.

Q. Please inform me in what part of the circuit the D.C. restoring valve is included, also please show how it is connected. You state in your instructions for including refinements that an improvement is effected for the gain control arrangement when the resistances R7 and R11 are returned to the slider of R3 and not to earth, but in the circuit the slider of R3 is already connected to earth.

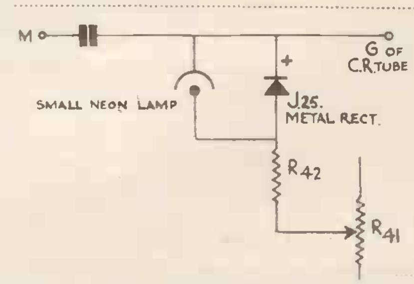
A. The D.C. restoring diode is connected across the grid resistance R42 in the C.R. tube network. The correct connections are shown by the diagram reproduced here. Great care must be taken to ensure that the entire restoring device is insulated to withstand the full tube voltage to chassis. The heater winding for the diode restorer will also need to be insulated for the full voltage from frame and other windings.

For convenience in the theoretical circuit the slider of the gain control R3 was shown connected to chassis. In the actual receiver the connections to R3 are reversed, i.e., one end of it is taken to chassis. It is then a simple matter to connect R7 and R11 to the slider, when the gain control will be effective for all three R.F. stages.

Q. Will you please tell me how I can restore the D.C. component using a metal rectifier?

A. Details of a method of restoring the D.C. component with a metal rectifier that is very satisfactory were given in the December, 1937, issue.

This shows an arrangement that is



Using a metal rectifier to restore the D.C. component.

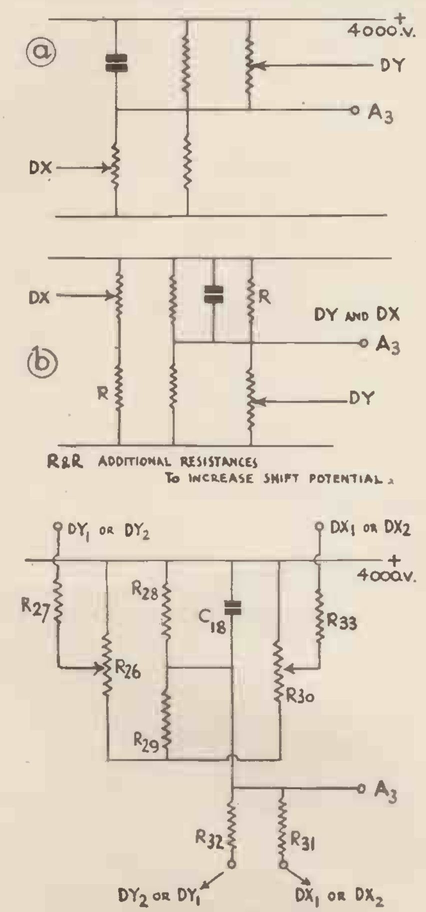
suitable when modulation is applied to both the grid and first anode of the C.R. tube. Type J.25 Westinghouse rectifiers are used; small neon lamps connected across the rectifiers serve as safety devices by absorbing excessive voltage surges.

A single rectifier can also be used in the manner indicated by the diagram shown. The arrangement works very well and if the resistance R42 is retained in series with the metal rectifier, the small neon protecting device is not required.

The value of R42 may be somewhat reduced with advantage.

Q. I have constructed the Low-Cost Televisor, but unfortunately it will not work properly. The synchronism is poor, both for frame and line, and I get a negative picture all the time with a bright band down one side. I am also unable to get the picture to occupy the full screen although the raster does.

A. Firstly there is the remote possibility that the negative picture is caused by excessive tube modulation but, if it is possible to make out the greater part of the picture, this is not the case. The first thing to do is to ascertain that modulation is obtained



Some time base problems

from the " M " terminal of the junction board.

It would perhaps be possible to get a negative picture of sorts if modulation is incorrectly obtained, say from the S.L. or the S.F. terminals.

If this is found to be in order then it is almost certain that the diode valve V8 in the diagram on P.587 October issue is incorrectly wired. A reversed picture is obtained when the cathode and the anode connections are reversed. Note that the anode of the diode goes to the grid of V9 and is also connected to earth through R33 and C37.

The picture being negative would render the sync. pulses white, hence the white border. The sync. pulses would also have a very much greater amplitude because the diode V10 would be unable to discriminate effectively and this will account for the reduced picture size as compared to the raster. It should be borne in mind that the picture will always be somewhat smaller than the raster as a certain percentage of the picture area is used to provide synchronism.

Q. I have constructed the Low-cost Televisor and this is working very satisfactorily. Picture quality and definition is as good if not better than that of many commercial receivers which I have seen.

Unfortunately, however, I cannot centre the picture ; it is approximately 1 in. out of centre and the shift control is at the extent of its travel.

A. Whilst the constants of the shift potentials network should permit the raster to be centred correctly for the majority of cases, for those isolated instances where this does not prove to be the case, it will be necessary to make some change either in value of the constants of the shift potentials network or to the actual arrangement of the resistance.

The diagram reproduced shows the arrangement employed for the original receiver. It is seen that the X1 and Y2 deflector plates are connected to the sliders of the shift potentiometers.

The effect of removing these two leads and replacing them with the X2 and Y1 plates may first be tried. The X1 and the Y2 plates are, of course, reconnected through the high resistances to the 3rd anode.

If this does not effect a cure the values of the potentiometers R26 and R30 may be increased. The most economical manner in which to effect this is by including a fixed resistance in series at the opposite end to that for which direction the additional shift potential is required.

It is important to appreciate that the value for the complete resistance across which the shift potential is obtained is mainly governed by the values assigned to the pots. R26 and R30 as these resistances are in parallel; there is therefore little object in increasing the values of R28 and R 29 as this querist suggested.

Alternately a study will reveal a number of combinations for the network which will result in providing additional shift voltages. The diagrams (a) and (b) indicate two such arrangements.

Q. I am unable to obtain a raster on the screen of the C.R. tube, although I am certain that everything is functioning as it should. With the brilliance control turned full on there is brief illumination of the screen upon first switching on and I am wondering if the value for R42 is too large.

A. You do not indicate what grid voltage is recommended for the particular tube which you have, but we suggest that you reduce the value of R40 until the bias is correct for your tube. It is not unusual for certain tubes to require a cathode resistor having a total resistance of only 50,000 ohms. The resistance R42 should not have any effect on the raster brilliance. It simply serves to complete the grid circuit, whilst preventing short circuiting of the modulation voltage. You can short circuit it if you wish whilst conducting initial tests. This short circuit must be removed, of course, when picture modulation is applied.

" New McGraw-Hill Books "

(*Continued from page* 408)

part of the book is devoted to electron tubes.

The chapter on gas-filled tubes is particulaurly valuable as increasing interest is being taken in the control of circuits by grid-controlled relays. Mention is made of the new cold-cathode relay developed by the Western Electric Co. " Electronic Sources of Light " deals with discharge lamps of the hot and cold cathode types, and the final chapter in this section describes the cathode-ray tube.

In Part III, headed " Electron Tube Applications," we find the theory of the circuit and the elementary theory of radio circuits described before details are given of the application to industrial problems. It is a pity that so much space should have been devoted to what may be found in most radio engineering text-books, and the majority of Mr. Fink's readers would probably prefer more applications and less theory. Only 24 pages out of 300 odd are devoted to industrial applications, and the complete bibliography at the end of each chapter does not compensate altogether for the compression of the material. On the other hand, the description of the fundamental properties of the electron and its control are excellent and are well worth the acquisition of the book for reference. At 21s. it represents good value for money.

A 1-V-1 Battery-operated Receiver

By Kenneth Jowers

We hope that this design of a very modern 3-valve receiver will meet the requirements of all those amateurs who still feel that battery-operated straight receivers are best for general use.

AFTER attending numerous amateur meetings in various parts of the country, I came to the conclusion that, generally speaking, the most popular type of receiver is still a small battery-operated one, with two or three valves. There are, of course, many difficulties and bad features about this type of receiver, but despite this, the low noise level, ease of control, simple C.W. operation and general sensitivity, make a well-designed tuned radio frequency receiver a most suitable choice for amateur use.

The biggest defect seems to be lack of selectivity, closely followed by rough regeneration control systems, but if these two points can either be overcome or minimised, the three valve receiver will be able to give a very good account of itself under normal operating conditions.

As my local Q.R.A. is an excellent one for test purposes, I decided to build a battery-operated receiver that would work well, even though I have three local stations quite close.

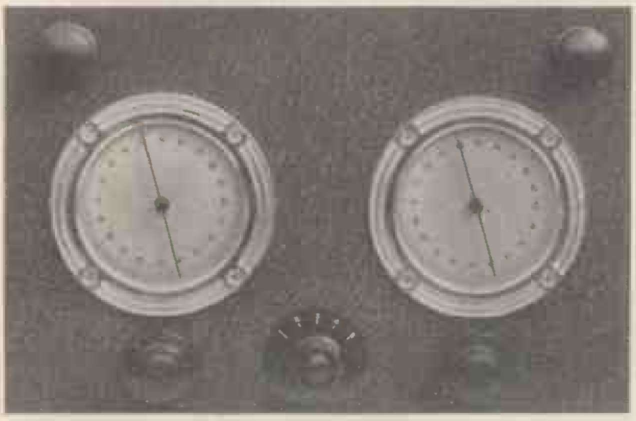
Trap Circuits

At first I was rather under the impression that no matter how good the design, no straight receiver would take care of the terrific blanketing caused by even low-power phone transmitters. After a chat with LA1G, of Oslo, I decided to elaborate an idea that he has had in operation for some years, that is to embody a trap circuit, to take care of the local powerful transmitters.

I had already embodied this scheme in a Tobe receiver in order to permit of satisfactory duplex working, but had not considered the scheme suitable for band switching in a straight receiver.

Several months ago, a 1-V-1 receiver was constructed employing a 4-band wave trap circuit, which eventually proved most satisfactory. It could be tuned so as to reduce the amount of spread caused by local powerful stations, such as would be experienced in towns like Coventry and Birmingham and was sufficiently effective to permit of reception of weak signals with a local station of a similar frequency.

As regards the receiver itself, the design was moderately satisfactory, but nothing out of the ordinary run of a TRF receiver and no noticeable improvement could be made, mainly because of valve limitations.



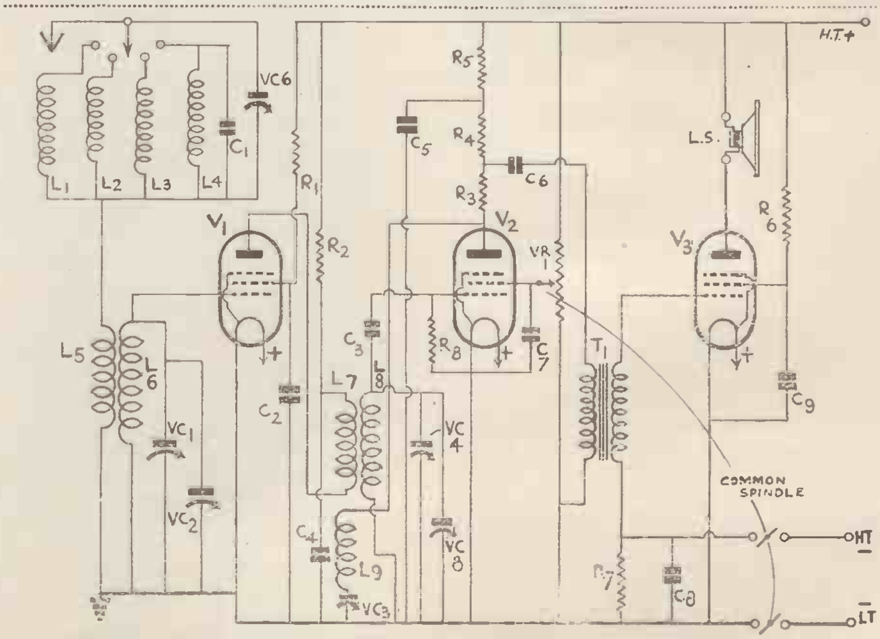
The appearance of this receiver is exceedingly good, while the tuning dials used have a very smooth slow-motiondrive arrangement. The switch in the centre is for the wave trap circuit.

Two New Valves

However, just recently the Tungsram Company introduced a pair of valves which from the characteristics looked as though they had been made to order for the particular set I had in mind. These two valves were the SP2D and VP2D, both being battery pentodes of a highly efficient type. They both have two important features, that of having the control grid connection brought out to the top cap so greatly reducing the grid input capacity and improving their value for really short-wave work.

The use of these two valves enabled me to obtain vastly improved sensitivity on all short wavelengths and to have an even more marked improvement below 20 metres. The losses in the circuit were also considerably less for the grid connection is taken directly to the fixed plates of the tuning condensers by means of an extremely short lead. This also improved the L/C ratio which is a most important factor, particularly on the 10-metre band.

These valves, however, did not, on their own, overcome the difficulty of rough regeneration, so that further work had to be done on improving the efficiency of the detector circuit. The ultimate design was to have a fixed grid base pentode as a leaky grid detector with a semi-capacity control reaction circuit. Actually reaction was, in the



How the wave trap circuit is embodied can be seen from this theoretical circuit. L.F bias is obtained automatically.

Smooth Regeneration

first instance, controlled by means of a pre-set variable condenser with a slot in the top of the control spindle so that it could be adjusted by means of a screw-driver. The amount of regeneration was then finally controlled by varying the voltage applied to the screen of the pentode.

This arrangement worked excellently, smooth regeneration being obtainable down to 9 metres. However, owing to the very high impedance of the pentode detector valve, I had to dispense with the conventional transformer coupling method owing to the fact that the impedance of the transformer primary is far to low as compared with the impedance of the valve. This trouble was overcome by using a parallel fed circuit combining the advantages of resistance capacity and transformer coupling.

Detector Gain

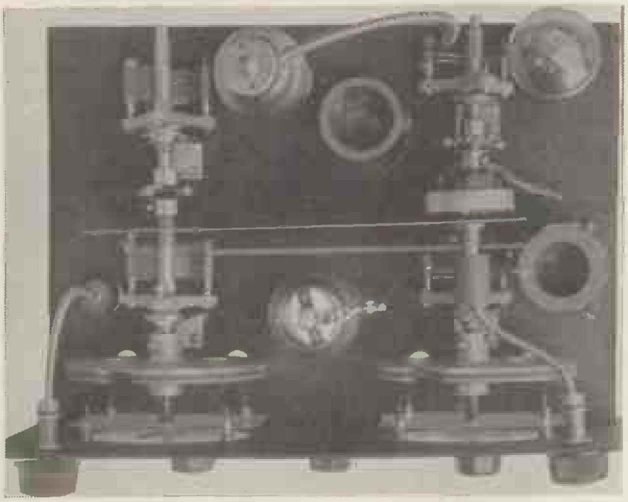
I found that a resistance of 75,000 ohms enabled me to obtain a reasonable amount of gain in the detector circuit without having to use an excessively high HT voltage. A 100,000-ohm resistor gave considerably more gain, but meant using a minimum of 150 volts HT.

This arrangement was quite satisfactory as regards regeneration control and overall gain, but as soon as the first two troubles were overcome a third took their place. This was the discovery of dead spots on certain sections of the frequency spectrum. Radio frequency chokes which were known to be quite satisfactory, for some reason or other caused dead spots in the tuning range which could only be overcome by experimenting with every individual receiver, so that this could not be tolerated in a set to be built by a large number of amateurs who would expect to obtain 100 per cent. efficiency without any trouble at all. Ultimately I decided to use a system which readers may have noticed I have often used in the past, with great success, that is to have a 10,000-ohm resistance in the anode of the detector valve in place of the normal radio-frequency choke.

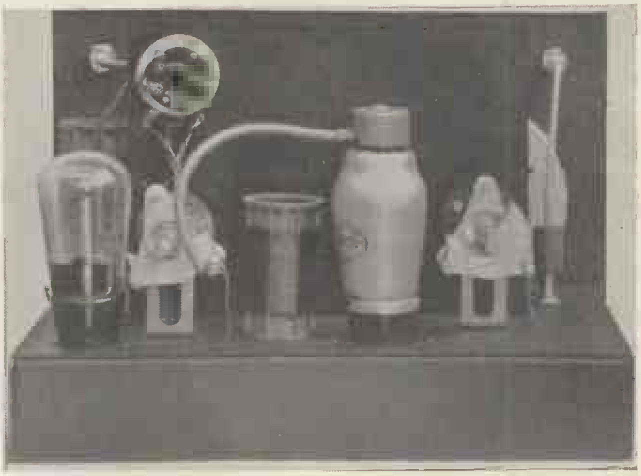
With this arrangement everything was quite satisfactory, for it will be noticed by referring to the theoretical circuit that I have omitted the radio-frequency choke from the anode circuit of V1 in favour of a tuned transformer circuit. This system operates most satisfactorily down to under 10 metres and has the great advantage that should it be necessary the primary winding L7 can be reduced in inductance so as to give increased selectivity.

The Final Circuit

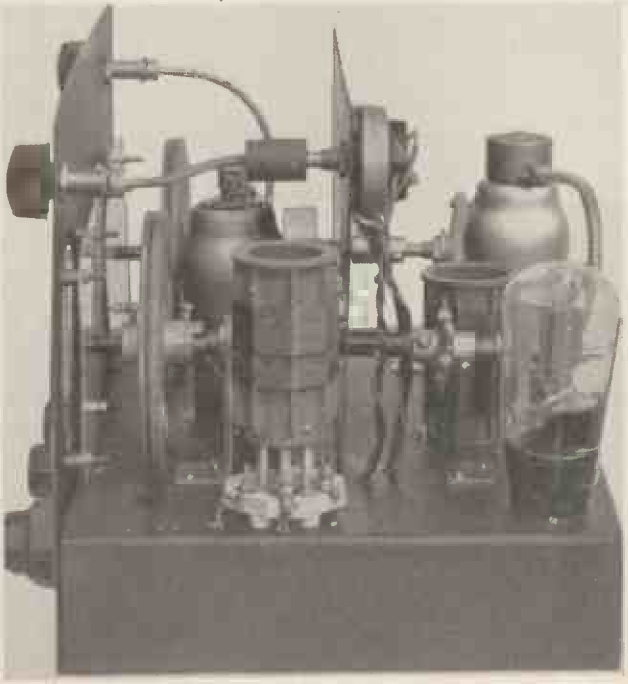
At this stage it is well worth examining the theoretical circuit of the receiver. Ignore for a moment the wave-trap circuit. It will be seen that the first valve, the VP2D pentode is operated as a straightforward radio-frequency amplifier. In the grid circuit is the aerial coupling coil L5 which is loosely coupled to the actual grid coil L6. Across L6 is VC1, a band-setting condenser of 50-mmfd. which is ganged to VC4. The additional condensers VC2 and VC3, both of which have capacities of 15-mmfd., are also ganged together for band-spreading purposes. As both of these two sets of condensers are fitted with slow-motion drives tuning is



This plan view shows the lay-out of the components, particularly how the flexible couplers are used.



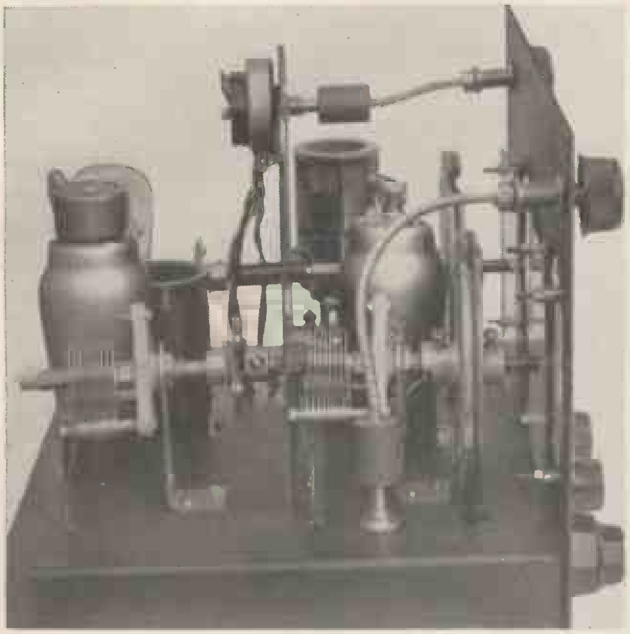
The detector and audio stages are shown in this illustration which was taken when the receiver was being used on 160 metres.



A good idea as to the general construction is obtainable from this view, which shows the aerial coil and output pentode valve.

9-metres Upwards

quite simple, while there is sufficient band spread to permit of reasonably accurate calibration. However, if the receiver is to be used primarily on the higher frequencies, then VC2 and VC3 can be modified so as to have a very small total capacity, so providing a



This is the opposite end of the receiver showing the flexible coupler going to VC6 which tunes to wave trap circuit.

much greater band spread. One variable plate and one fixed plate triple or quadruple spaced can be used to advantage on the 10-metre band.

Screen voltage for V1 is obtained from the main supply of 120-volts by means of a dropping resistance R1, which has a value of 250,000-ohms. This is approximately the correct value and need not be altered even should the HT supply be increased to 150 volts. The tuned transformer circuit is also straightforward, but the primary circuit is de-coupled by means of R2 and C4 which are 1,000 ohms and 2 mfd. respectively.

The secondary winding L8 is identical with the L6 circuit, but also in the grid side is connected the condenser C2 and from grid to earth the leak which has a value of 5 megohms. These values are correct for the SP2D valve and should not be modified in any circumstances. As previously explained the screen voltage for the detector valve is variable in order to provide a smooth regeneration control and a variable potentiometer, having a total resistance of 250,000 ohms is required. This resistance will pass sufficient screen current without causing an excessive drain on the high-tension battery.

Quite a reasonable gain is obtained in the audio stage by parallel feeding the AF4 transformer. This, it will be noticed, has one side of the primary connected to earth, while one side of the secondary goes to HT negative instead of earth, in order to provide automatic bias by virtue of the current flow across R7.

Although the output pentode valve recommended will work with the suppressor grid connected directly to HT I noticed that when headphones were used the current consumed was higher than necessary owing to the fact that there was a higher voltage on the screen than on the anode. This was caused by the resistance of the headphones on the anode circuit. However, to take care of this point I have included in series with the suppressor grid a resistance of 4,000-ohms which is by-passed to LT negative by means of a .1-mfd. condenser.

A point of considerable interest and a feature which is not normally included in a simple receiver of this kind is the special four-band trap circuit. Messrs. Peto-Scott have made up for me four coils which when tuned with a .00018-mfd. condenser will cover the four most important amateur bands. L4, however, which is for 160 metres has connected permanently across it, the condenser C1 which has a capacity of .0001-mfd. Unless this condenser is used it will mean winding a coil of considerably higher inductance. The switching circuit, however, is arranged so that this condenser is only required on the 160-metre band, the other coils resonating on 20, 40 and 80 metres when tuned by VC6.

Constructors will find that despite a good degree of selectivity the average three-valve receiver is quite incapable of withstanding the blanketing effect of high power local amateur stations. However, by switching in a trap resonating on the correct amateur band the offending station can be reduced in volume to a negligible quantity, while the amount of spread can also be reduced to a more reasonable amount. As with a high capacity tuning condenser, such as VC6 these inductances, L1, L2, L3 and L4 cover a reasonably wide band width they can be used when there is interference between stations on the short-wave commercial channels, and I have found that when trying to sort out some of the commercial broadcasters on

(*Continued on page 446*).

Components for
A 1-V-1 BATTERY OPERATED RECEIVER

CHASSIS AND PANEL.
1—Steel chassis 12 in. × 9 in. × 4 in. finished black. (Peto-Scott).
1—Panel 12 in. × 8 in. 16 gauge steel finished black (Peto-Scott).
1—Screen 10 in. × 6 in. 16 gauge steel finished black (Peto-Scott).

COILS.
1—Set type 932 4-pin tuning 9 metres upwards (Eddystone).
1—Set type 959 6-pin coils (Eddystone).

CONDENSERS, FIXED.
1—.0002-mfd. type 690W (C1) (Dubilier).
1—.0001-mfd. type 690W (C2) (Dubilier).
1—2.0-mfd. type BB (C3) (Dubilier).
1—2.0-mfd. type BB (C4) (Dubilier).
1—.0001-mfd. type 690W (C5) (Dubilier).
1—.01-mfd. type 691 (C6) (Dubilier).
1—.01-mfd. type 691 (C7) (Dubilier).
1—50-mfd. type 50 volt 3004 (C8) (Dubilier).
1—.1-mfd. type 4603/S (C9) (Dubilier).

CONDENSERS, VARIABLE.
1—50-mmfd. (VC1) (B.T.S.).
1—15-mmfd. (VC2) (B.T.S.).
1—15-mmfd. (VC3) (B.T.S.).
1—50-mmfd. (VC4) (B.T.S.).
1—65-mmfd. type 978 (VC5) (Eddystone).
1—180-mmfd. type 942/180 (VC6) (Eddystone).

DIALS.
2—Disc type slow motion (B.T.S.).

EXTENSION OUTFITS.
2—Flexible extension cables (Eddystone).
2—Couplers type 1009 (Eddystone).

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

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

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

JACKS.
1—Insulated closed circuit jack (Bulgin).

PLUGS, TERMINAL, ETC.
2—Valve cap connectors Type 26 (Clix).
1—3 socket strip type D (Clix).

RESISTANCES, FIXED.
1—.25-megohms 1 watt type (R1) (Erie).
1—1,000-ohm 1 watt type (R2) (Erie).
1—10,000-ohm 1 watt type (R3) (Erie).
1—75,000-ohm 1 watt type (R4) (Erie).
1—25,000-ohm 1 watt type (R5) (Erie).
1—4,000-ohm 1 watt type (R6) (Erie).
1—400-ohm 1 watt type (R7) (Erie).
1—5-megohms ½ watt type (R8) (Erie).

RESISTANCE, VARIABLE.
1—250,000-ohm potentiometer with two point switch (VRI) (Erie).

SWITCH.
1—Low capacity 5-way switch with extension rod (B.T.S.).

TRANSFORMER, INTER-VALVE.
1—1-3.5 ratio type AF4 (T1) (Ferranti).

VALVES.
1—VP2D (V1) (Tungsram).
1—SP2D (V2) (Tungsram).
1—PEN220 (V3) (Mazda).

WAVE TRAP COILS.
1—Set 4 wave band trap coils (Peto-Scott).

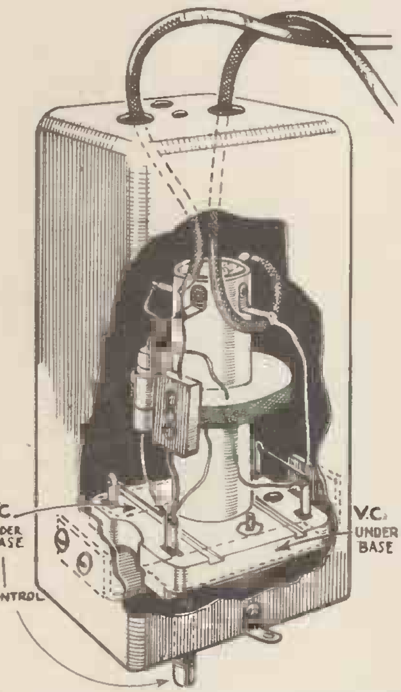
A complete kit of components or a ready wired receiver can be obtained from the Peto-Scott Co.

Building A Beat-frequency Oscillator

By E. J. Pickard, G6VA

Constructors with commercial all-wave receivers without provision for C.W. operation will find this B.F.O. unit a most satisfactory accessory.

As I come into contact with a large number of transmitting amateurs, and an even larger number of enthusiastic short-wave listeners, I am able to tell just what sort of gadgets are particularly required. It has surprised me to find that a very big percentage of those interested in short waves are still using receivers which do not include a beat-frequency oscillator.



The tuning circuit with its associated condensers and resistors are mounted in a can as shown in this illustration.

These remarks do, of course, apply more definitely to the short-wave listening amateur rather than to the active transmitting amateur, but the fact remains that a reliable beat-frequency oscillator is a component very badly wanted at the present time.

As the British set manufacturers are improving the design of their all-wave receivers, more and more of this type of BCL receiver are being used. Very few of these sets make provision for a B.F.O., so for this reason I have built up a small unit which can be used with any receiver, so making it suitable for efficient CW operation.

Two Units

The B.F.O. unit consists of two sections. The tuning coil and its associated condensers and the valve with its conventional resistance network.

Fortunately, I have a home-made winding machine, so that I can make my own layer wound coils, but an ordinary solenoid is quite satisfactory provided it tunes to the frequency of the I.F. transformers used in the B.C.L. receiver.

The illustration, on this page, gives a very good idea as to the construction of this tuning circuit. This part consists of a paxolin former of 1 in. diameter, and $2\frac{1}{2}$ in. total length. On this is mounted either the layer wound or solenoid coil which will tune to about 460 kc. This former is mounted directly on top of the ceramic base, which forms part of the two tuning condensers.

This double condenser can be obtained from Cyldon, and as supplied by the makers each condenser has a capacity of 30-mmfd.. One of these condensers is used as the pitch control, but the adjusting screw must be removed and its place taken by a 2 in. length of 4-BA studding, or else a piece of copper rod with a short length of screwed section. This rod can then be fitted with a knob so that it can be adjusted through the panel. The second condenser needs increasing in size until it has a maximum capacity of about .0005-mfd. This value is not very important, and I suggest that you increase the number of plates by about 5 times with, of course, the necessary mica spacing pieces and then use this condenser as a pre-set merely to bring the circuit more or less to the correct frequency.

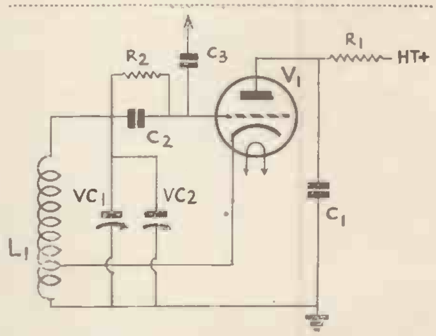
It will be appreciated, of course, that the B.F.O. unit has to be tuned to approximately 1,000 cycles either below or above the frequency of the I.F. transformers in the receiver, in order to produce the requisite 1,000 cycle note.

The grid condenser and leak are mounted on the coil former, as shown in the illustration, so that this part of the circuit is quite self-contained and can be mounted directly inside the screening can. This screening can should be fitted with two lugs for mounting on the panel in such a way that the control knob on the small condenser protrudes through the panel.

One lead comes from the grid side of the grid condenser, through the top of the can and is taken directly to the grid of a 6C5 triode valve. The second connection is taken from the tap on the coil to the cathode of the 6C5, while the outer metal covering of this connection can be used for earthing purposes. The coil side of the grid condenser is connected to a small capacity, the free side of which can be taken either to the anode lead on the I.F. transformer, or the diode lead on the second detector. This capacity must be a very small one, not exceeding 3-mfd. It can easily be made up of a very short length of twisted wire. The grid condenser has a capacity of .00025-mfd. and is of the postage stamp mica type. The grid resistor has a value of 100,000 ohms, the anode resistor 25,000-ohms, and the anode to chassis by-pass condenser a capacity of .01-mfd.

This complete B.F.O. unit can be constructed on a small metal chassis and used either externally, or if there is sufficient space as a part of the main receiver. It can be left connected in circuit merely having a switch to the anode feed so that the H.T. can be cut off from the 6C5. The heater connections can be left permanently connected so that the B.F.O. unit can be brought into use instantaneously.

Constructors should not have any difficulty in obtaining satisfactory results with this B.F.O., and the only two points of interest are the capacity between the B.F.O. and the main receiver and the position for the cathode tap. If the capacity used for coupling is excessive, this will cause a very high noise level, so reducing possibility of picking up weak signals. If the capacity is too small, which is rather unlikely, the B.F.O. will not operate satisfactorily on strong signals. With a solenoid coil the cathode tap should be seven or eight turns up towards the grid end from the earthy end, but this point can be determined by experiment.



This is the circuit for the complete B.F.O. unit which can be mounted in a metal container or on a breadboard if it is more convenient.

I have made arrangements with Messrs. Webbs Radio to make up some of these B.F.O. units, and they are going to charge 12s. 6d. for the completed unit in the can. This does not, of course, include the cost of the valve and its associated components.

With the Amateurs

Some interesting details regarding long distance communication on low power are given in this article while news of the Radio Societies has also been included.

By G5ZJ

ONE of the very important events of the past month and as far as many amateurs are concerned the most important event has been the Annual National Field Day organised by the Radio Society of Great Britain. Portable stations were erected in many areas and this year it is anticipated that several records have been broken, for there has been a decided change in the type of amateur who has been participating in this contest.

Instead of hastily erected hay-wire stations, which were inclined to break down on the slightest provocation, there has been enormous enthusiasm and amateurs loaned their prized equipment for use on the Field Day.

Many stations were equipped with the latest type of communication receiver, such as the RME and HRO, all running from rotary converters, while the transmitters were generally of a highly efficient type.

A good example of an efficient N.F.D. station operated under the call sign of G2HWP. Notice the receiver used by this station.

It is, of course, rather too early to obtain any definite information as to who will come out on top, but the North London and the District 8 amateurs seem to have done extremely well.

To give some idea of the type of portable station that is now being used for N.F.D. on this page will be found a photograph of the Blackburn Group of the R.S.G.B. This station with the call-sign of G2HWP was operating on 160 metres. At the key can be seen Mr. Whalley, G2HW, who is assisted by G6BH. Also in this photograph is the Honorary Secretary of the Group, Mr. J. Bolton, 2CRM.

A station that has been doing very well during the last six months is G5NA. He has been licensed since October, 1937, and operates from his excellent QRA at Finchley. This station uses 10 watts on 20 and 40 metres, using both phone and C.W. and has a most imposing rack built transmitter. This consists of a type 42 regenerative crystal oscillator which is link coupled to a switching circuit, so that it can be used to drive either a 40-metre power amplifier or a frequency doubler. The frequency doubler consists of two 42's in a push-pull circuit, which are in turn link coupled to the 20-metre PA.

With this arrangement, G5NA can have a crystal oscillator-power amplifier on 20 metres. Both PA's are choke modulated by a 6L6 tetrode, which is in turn fed by a two-stage pre-amplifier from a moving coil microphone.

Switching has also been arranged so that the antenna tuning circuit can be switched from valve to valve as required, and although a complicated switching circuit is necessary the antennas can be changed over or the transmitter taken from one band to another in about 15 seconds.

The antenna system consists of a 40-metre Zepp run east and west which has proved entirely satisfactory for DX work includes VK and VE contacts on telephone.

G6QM

Another very interesting station is that of G6QM, who was first licensed in July, 1935. I have worked him myself very many times on 160 metre phone, and, of course, at my local QRA he puts in a really solid R9 signal. However, when that band began to become rather congested G6QM changed over to 7 and 14 mc. This station operates on D.C. mains which is rather a drawback and the maximum input on D.C. mains is 10 watts. This has now been increased to 25 watts by means of a rotary converter.

The line up is a 6V6 Tritet crystal oscillator, capacity coupled to a 6L6, triode connected and of course neutralised, which is in turn link coupled to the final stage, which is a 4033A.

Power supply arrangements are rather complicated, for there is A.C. for the valve heaters, and 400-450-volts A.C. rectified for the final anode, but the crystal oscillator and sub-amplifier are fed from D.C. mains. In the speech amplifier modulator circuit there is a 6C6, RC coupled to a 6C6, triode connected, which is in turn transformer coupled to a pair of 6B5's which anode modulate the 4033A.

On 160 metres the antenna is a 66-foot Marconi with earth connection, while on 40 metres a 66 feet Hertz is link coupled to the final stage. A 33-foot end fed Zepp with 16-foot feeders connected to a 72 ohm line has proved to be most satisfactory on 20 metres. This aerial is North and South, so that it puts a broadside beam more or less into America. When on 5 metres, a half-wave aerial is used with a single valve long line transmitter, but for the time being G6QM is inoperative on the ultra-high frequencies.

The D.C. Receiver

At the present time, the receiver is a National NC81X which has proved to be very satisfactory, and as a matter of interest this set is extremely satisfactory on D.C. mains.

I seem to have spent most of the past month testing 5-metre equipment in the open air, which is very suitable for this time of the year, or examining some of the new equipment which those manufacturers interested in Ham radio are producing with great rapidity.

Some interesting results were obtained during a very local 5-metre field day when G2HK, G5MG, G8MX, G2CG and myself spent a perfectly good Sunday clambering over high hills and prickly bushes trying to erect aerials at the highest possible spot. We were testing three of the new two-valve transceivers which Messrs. Premier Supply Stores have just produced and despite the fact that the total HT supply was only a 120 volt battery, we really did obtain some very good results. Signals were maintained from a point near Letchworth to a high hill just outside Luton in Bedfordshire, a distance of 12 to 14 miles. The reports at both ends were R9. A transmitter located near the golf course at Royston Heath maintained regular communication with the second receiver which was mobile and went to Croydon in Hertfordshire, a distance of only about 6 or 7 miles, but communication was maintained irrespective of the aerial height or the location. From tests I have made since it looks as if these transcievers should

Two Low-powered Amateur Stations

have a range of about 20 miles without very much difficulty providing a satisfactory aerial system is employed. Considering that they only cost £10 complete with everything, handset, aerial, battery, etc., they seem to be quite a good investment.

On July 3 G5MG, G2HK and myself are going to erect a station on top of a water tower which is about 70 to 80 feet high and located in North Hertfordshire. We propose to use a 50-watt transmitter with a rotating beam antenna, with one of the new RME 510X's for reception. We hope to make quite a number of comparatively DX contacts and are going to take some transceivers with us as well, in order to see just how far these little instruments will cover. Any reports on signals using the call sign G5MG, G2HK or G5ZJ will be appreciated.

Mazda have produced a very interesting number of valves during this season. These will probably all be ready and in general use before the exhibition this year. An AC6/PEN has just been designed and this is a beam power amplifier, designed in the first instance for use in the output stage of a time base for magnetic scanning. This valve has the anode on the top of the bulb so that it should be very satisfactory for use as a crystal oscillator. With 300 volts on the anode, 200 volts on the screen the self-bias resistance is 110 ohms. The mutual conductance of this valve is 8.5 mA. per volt, while the peak anode watts is 18.

Here is G5NA operating his transmitter which is described in this article.

Another new Mazda valve is the SP/41, which is a screened pentode of small dimensions and fitted with a British octal base. The input loss of this valve is extremey low at 45 Mc. is approximately ⅓rd of the AC/SP3, so that the SP/41 should be very satisfactory on ultra-short waves. It has a 4.0-volt heater and with 250 volts on anode and screen has a slope of 8.4 mA. per volt. The input loss under these conditions at 45 Mc. is approximately 2,300 ohms.

Another valve in the British octal range is the HL41 which again is of small physical dimensions, and is suitable for use in the first stage of low-frequency amplifiers. With 250 volts on the anode and a load of 50,000 ohms, the anode current is approximately 2.2 mA., while the RMS output voltage for 2½ per cent. total harmonic distortion is 47 volts. This valve has an A.C. resistance of 10,300 ohms and a slope of 3.4 giving an amplification factor of approximately 35.

I noticed two very interesting books on sale at Webb's Radio, which amateurs will find of considerable value. The original Antenna Handbook has proved very popular in this country, but this is now obsolete since the 1938 version has become available.

This book includes a wealth of practical information and some extremely interesting hitherto unprinted information on radiation angles. There is also a special chapter devoted to W8JK beams and similar antenna arrays suitable for amateur use. The chapter devoted to aerial coupling systems is particularly complete, while amateurs who are not getting out as well as they might or think they should, are advised to read the chapter on Directive Properties of Antennas. This book is price 3s. 6d. post free.

For those who need a manual covering every phase of short-wave transmitting or receiving and the design of equipment of every kind connected with it should remember that the 1938 edition of the Jones Radio Handbook contains all this information. This is priced at 7s., but is a book that will last a considerable time without dating for the information contained is of a very up-to-date nature. This book can also be obtained from Webbs Radio.

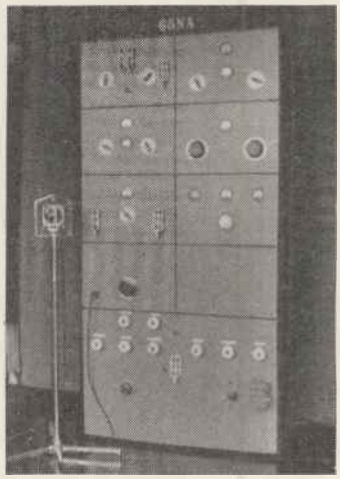
This station of G6QM is operated off D.C. mains with a rotary convertor.

A Variable Crystal Holder

There seems to be quite a revival in interest in variable crystal holders. I noticed on the counter at Webbs that they had one of the new Nationals which cost 36s., but should be suitable for use with any type of crystal. Quite a wide frequency variation can be obtained when this holder is used with an 80-metre crystal.

The Southend and District Radio Society held a very successful field-day on June 26, when there was a large attendance of amateurs from Essex and the surrounding counties. A number of the Ilford and District Radio Society members attended, while DX members included some of the Murphy Radio Society. A direction finding contest was staged and the hidden transmitter with the call sign G5QK was operated on 160 metres and was ultimately located at Laindon some 9½ miles from the start.

A low-power contest organised by Southend members of the R.S.G.B. brought to light some interesting facts.



G5NA has built a most impressive station in the short time he has been licenced.

The winner contacted 72 stations in 12 countries, while members between them worked no less than 18 different countries. Stations were in operation for a period of about one week and used the 20 and 40 metre amateur bands. At no time was the input more than 2 or 3 watts for one of the qualifications was the use of a standard 120 volt battery. The winner was G2SO, with G2LC second, and G5XI third.

A society that has been very active is the Dollis Hill Radio Communication Group, the honorary secretary of which is Mr. E. Eldridge, of 79 Oxgate Gardens, N.W.2. This Society has a total membership of 53 and fortnightly meetings are held at Braintcroft Schools, Warren Road, Cricklewood, at 8.15 every other Tuesday starting from May 31. Readers in that area are invited to write to the honorary secretary for further information.

A 15-watt C.W. Transmitter

There is no need for simple amateur built transmitting equipment to be hay-wire and to operate inefficiently. This simple transmitter which has been designed primarily for C.W. operation but can also be used for phone work, has a very high degree of efficiency, looks commercial in appearance and is at the moment being used by the designer G2HK on the 40-metre band.

FROM experiments I have made it seems that the most outstanding valve for use as a crystal oscillator is the 6L6G tetrode which, despite its troubles when first introduced, is now absolutely foolproof.

When used with a 40-metre crystal, an appreciable output can be obtained on 10 metres, so that with two valves a very nice 10 to 15-watt transmitter can be made to cover three wave bands. There are absolutely no difficulties with the 6L6G providing the correct circuit is used, and the correct voltages are applied.

The meters shown are optional for if constructors wish to save expense one meter can be made to monitor the whole transmitter. The 802 valve is completely screened.

Simple Modulation

As I am quite sure that with an efficient transmitter long distances can be covered with 10 watts, I have chosen as an output valve an 802 pentode which will stand input of 15 watts at 500 volts and requires only a very slight drive to provide maximum R.F. output. At the same time, when it is modulated in the suppressive grid the audio power required is only a few hundred milliwatts.

With this particular transmitter I have worked quite a large number of American phone stations on 20 metres, and when I have mentioned that the input was only 15 watts it has never been believed. However, the fact remains that the aerial used was a good one, the transmitter puts into the aerial the last watt of R.F. and, consequently, reports are better than one would expect.

There does, however, seem to be a tendency to assume that for long-distance working, high power is essential, and although I have proved this to be a fallacy, very few amateurs hold the ssme point of view as I do.

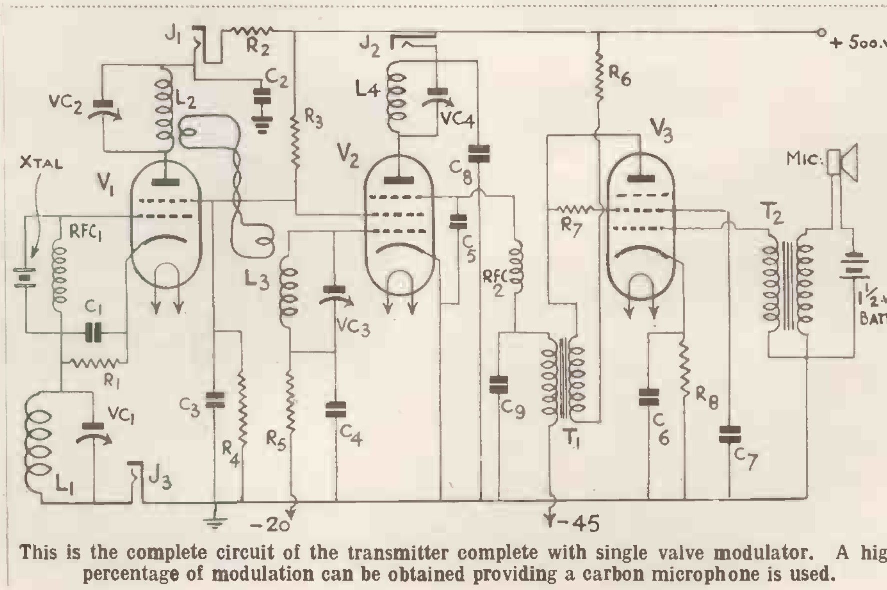
Far too many amateurs think more in terms of watts input, rather than watts output, and I have seen a number of high power transmitters, using 60 to 70 watts input, that give far less R.F. output than I can obtain from my standard 25-watt transmitter.

It is all a matter of using the correct type of valves, obtaining sufficient drive and having the exact L/C ratio. All these small points have been borne in mind with the design of this simple transmitter, and I feel quite confident that if it is made exactly to specification, and used with a suitable aerial, erected in the correct direction, then the user will be able to obtain satisfactory reports from long distances.

At the present time when so many amateurs are complaining about the bad conditions and have migrated to the lower frequency bands I have been able to maintain consistent contacts with all six Continents. In fact, the so-called bad conditions have turned out to be a blessing in disguise, for it has reduced the QRM, enabling lower power stations to get out when normally they would be completely wiped out by the multitude of stations that generally operate on the high-frequency bands.

Refer a moment to the illustration on this page of the completed transmitter. A simple bent chassis is used with most of the components out of sight. The three controls, which can be seen from the front, are VC2 on the left, VC3 in the centre, and VC4 on the right. All of these condensers are bushed off from the metal chassis by means of strips of Trolitul which are extremely low loss and make excellent condenser mounts. The two switches shown are a refinement which I have only just embodied, and are in the anode circuits of V1 and V2. The two jacks are also in series with these switches, so that one meter will read the anode current of all the valves.

The cathode condenser, VC1, which has a capacity of .00016-mfd., is of the pre-set type which I have modified and fitted with a spindle. It is mounted on the under side of the chassis and the spindle comes through the top of the chassis to the control knob alongside



This is the complete circuit of the transmitter complete with single valve modulator. A high percentage of modulation can be obtained providing a carbon microphone is used.

Coil Construction

L1. As this condenser only needs tuning very occasionally, I considered it quite unnecessary for it to be mounted on the panel which would mean an additional length of $3\frac{1}{2}$ in..

The circuit gives all the information required about the component values used. V1 is a 6L6G, the crystal is connected between grid and cathode, and is shunted by means of an R.F. choke. In series with the cathode and the chassis is the bias resistor R1, which has a value of 300-ohms and the cathode coil L1, which is shunted byVC1. If the cathode circuit is earthed on the right side of J3, this jack can be used for a keying arrangement which operates most satisfactorily. There should also be a condenser across R1 which has a capacity of .01-mfd. This condenser is of the tubular type.

Two valve holders mounted on the back of the chassis are for the high and low voltage supplies. The crystal is mounted in a standard five pin valve holder. In addition, the coil holders with the exception of the final stage are not ceramic but of special hard bakelite.

It is most important to obtain the correct screen voltage, and with 500 volts applied a resistance network consisting of R3 having a value of 10,000-ohms with a 15-watt rating and R4 of 30,000-ohms also with a 15-watt rating will approximately provide the correct screen voltage for both the 6L6 and the 802 valves. The mid-point of this resistance network is by-passed to chassis by means of C3, which has a capacity of .01-mfd.

In the anode circuit of V1 is the normal anode coil L2, tuned by VC2, which has a capacity of .00016 mfd. and is double spaced. There is no need to make the link coil of L2 an integral part, for this can be added after the circuit has been checked. It consists, however, of a single turn of rubber-covered wire around both L2 and L3. The top end of L2 has the usual by-pass condenser of .002 mfd., while in series with the H.T. feed is R2 having a value of 5,000 ohms with a 3-watt rating and either J1 or an 0-100 m/A meter as required.

Coil Data

That is the whole of the crystal oscillator circuit, but before going on to the power amplifier here are the necessary coil data. Coil L1 is not required on 40 metres, and it is so arranged that VC1 can be short circuited in its maximum position. On 20 metres, however, L1 consists of seven turns of 20-gauge wire, slightly spaced. L2 on 40 metres should be 16-turns of 20-gauge wire, spaced according to the threading on the former. On 10 metres L1 is 7-turns slightly spaced, and L2 4-turns spaced according to the threading on the former, and both coils being of 16-gauge wire. The link coil, in every case, is one turn around L2, and occasionally two turns around L3 if additional drive is required.

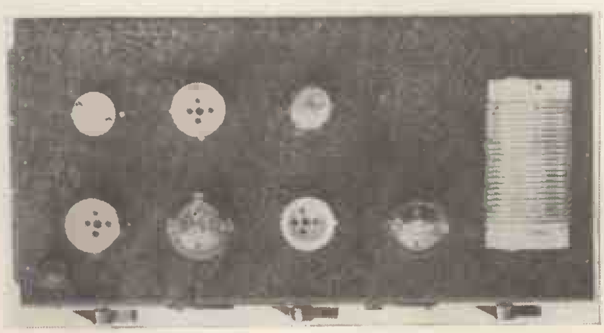
The P.A. Stage

Next comes the design of the power amplifier stage. The 802 valve is a standard pentode which will operate satisfactorily up to 30 Mc., and with 55 per cent. of its rating up to 60 Mc. It has a 6.3-volt heater at a current of 0.8 amp., and has a maximum theoretical anode dissipation of 10-watts. For class-C telegraphy, however, it can be run at 500-volts at 45 mA. and it provides a carrier power of 16 watts. When used for suppressor grid modulation it will stand 500-volts on the anode up to 25 mA. anode current and a screen current of 28 mA. These are rather unusual features. The approximate D.C. grid current for such conditions is 4.5 mA and compared with 2 mA. for class-C telegraphy service and requires a grid driving power of .5 watt, as compared with .25 watt for class-C telegraphy.

These figures will serve as a guide to how to use the 802. However, in actual practice the following additional figures will probably be of interest. Off tune, the 802 when biased 45 volts negatively, will take about 60 mA. When tuned to resonance this will drop down to slightly under 10 mA., and when actually feeding into the aerial should be adjusted to provide correct wattage but never higher than about 25 mA. While on the subject of voltages, etc., the 6L6G takes approximately 100 mA. off tune, 25 mA at minimum dip, and 50 mA. when driving the 802.

The circuit used for the 802 is quite straightforward, and the grid circuit is a straight coil tuned by VC3, which has a capacity of .00016 mfd. The earthy end of these two components is not actually grounded except through condenser C4. The grid resistor R5 having a value of 10,000 ohms, would on its own provide a certain amount of automatic bias, but I have found that an additional battery bias of about 20 volts is required.

The screen voltage is, of course, obtained through the resistance network R3, R4, while the suppressor grid is used for modulation purposes. It will be noted that the suppressor grid goes through an R.F. choke to the secondary of T1, this transformer having a ratio of 1/1. The other end of this secondary is taken to approximately 45-volts of negative bias. For telegraphy working when, of course, no modulation is needed, the suppressor grid is biased positively by approximately 40 to 50 volts.



This plan view gives a good indication of the lay-out. In the left hand bottom corner can be seen the cathode condenser VC1.

In the anode circuit of V2 is the conventional tank coil L4, with its asso-

Building the Modulator

ciated condenser VC4. This coil, on 40-metres, is made up of 16-turns of 16-gauge wire on the ceramic former. Spacing is automatically made correct by means of the threading on the former. For 20 metres only 9 turns of 16-gauge wire are required, and 5 turns on 10 metres. The grid coil is, of course, wound on the standard $1\frac{1}{2}$ in. plug-in former, and is made up of 16 turns on 40 metres, 7 turns on 20 metres and 4-turns on 10-metres, the wire used in every case being 20 gauge.

It is most important that the suppressor grid circuit be efficiently by-passed. For this reason it will be noticed that the actual suppressor grid is shunted to earth by means of C5, having a capacity of .002-mfd., while the junction of RFC2 and the secondary of T1 is by-passed to earth by C9, which has the very small capacity of .0001 mfd.

The Modulator

That completes the actual oscillator amplifier section of the transmitter, and all that is left is the single stage modulator for those who prefer to have provision for telephony. If, on the other hand, the transmitter is to be used solely for C.W. operation on three bands, then the modulator can be ignored, providing the suppressor grid has 45-volts positive applied to it.

The modulator consists of a high-gain carbon microphone energised by a small $1\frac{1}{2}$-volt dry cell feeding into the primary of T2, a microphone transformer having a ratio of 1/35. The secondary of this goes across the grid-earth circuit of V3, which is a normal low-frequency pentode. This valve obtains its screen voltage from the 500-volt supply by means of a 2,000-ohm resistor R7. The anode voltage is also reduced by means of R6, which has a value of 5,000 ohms with a 3-watt ratio.

The audio output from the 42 pentode is fed into T1, which has its secondary in the suppressor grid of the 802. There is sufficient output from the microphone circuit to drive the 42 to give more than enough audio output for maximum permissible suppressor grid modulation.

Cathode bias is used in this circuit, and the resistor has a value of 400 ohms and to obtain reasonably good quality is by-passed by C6 an electrolytic condenser having a capacity of 25 mfd.

Operating

Operation should not cause any difficulty, but I strongly advise constructors, particularly those who have not had much experience of transmitting equipment, to start on the 40-metre band. L1 and VC1 are out of circuit on this band, while the link coils between L2 and L3 can be removed. Have the mA. meter in series with the anode of V1 and when this is mis-tuned it will take a very high current, as previously explained. Quickly tune VC2 until this current drops to the lowest possible value. If constructors should have a loop lamp available, if this is held near to L2 it will light up very brilliantly.

Then wind one turn around L2 and L3 and connect the two links together by means of a twisted pair line. Connect a mA. meter in series with R5 and tune VC3 until current of 4 to 5 mA. is obtained. As the links have been put on after VC2 has been adjusted, this will probably make it necessary for VC2 to be re-tuned, and this should be done very carefully until the maximum current is obtained in the grid circuit.

Next, tune VC4 until the minimum current is obtained. This will also cause a very slight drop in grid current, but this is perfectly permissible. With L4 tuned to resonance, the transmitter is ready to put on the air. However, connect the loop lamp around L4 and speak into the microphone, and should the percentage of modulation be sufficient the brilliancy of the lamp will vary according to the depth of the modulation.

Any of the normal coupling circuits can be embodied, whilst conventional aerial systems are quite satisfactory. I do, however, strongly advise constructors to use a link coupled circuit, for this greatly improves the selectivity of the transmitter and reduces possible interference to broadcast listeners.

This transmitter is now in use at my QRA, and I shall be glad to show it to any amateurs who are interested.

The P.O. Permit

A final point to be remembered is that in no circumstances can this transmitter be built unless a Post Office Licence is first obtained. Full details of this licence can be obtained from the office of the Engineer-in-Chief, Radio Division, Armour House, Aldersgate, Street, E.C.1.

Components for A 15-WATT TRANSMITTER FOR C.W.

CHASSIS.
1—Steel finished black 15 × 9 × 4 ins. (Premier).

COIL FORMS.
3—4-pin threaded type (Premier).
1—Ceramic type (Raymart).

CRYSTAL.
1—7 mc. crystal with enclosed holder (Valpey-Webbs Radio).

CONDENSERS, FIXED.
1—.01-mfd. type 500-volt tubular (C1) (Dubilier)
1—.002-mfd. type 500-volt tubular (C2) (Dubilier).
1—.01-mfd. type 500-volt tubular (C3) (Dubilier)
1—.002-mfd type 500-volt tubular (C4) (Dubilier)
1—.002-mfd type 500-volt tubular (C5) (Dubilier)
1—25-mfd. type 25-volt (C6) (Dubilier).
1—.1-mfd type 500-volt paper (C7) (Dubilier).
1—.002-mfd type 500 volt tubular (C8) (Dubilier)
1—.00001-mfd. type air spaced (C9) (Bulgin).

CONDENSERS, VARIABLE.
1—.00016-mfd. type pre-set (VC1) (Premier).
1—.00016-mfd. type TR0160T (VC2) (Premier).
1—.00016-mfd. type TR0160T (VC3) (Premier).
1—.00016-mfd. type TR0160T (VC4) (Premier).

CHOKES, HIGH FREQUENCY.
2—Type 1011 (Eddystone).

DIALS.
3—$3\frac{1}{2}$-in. dials with pointers (Premier).

HOLDERS, VALVES.
5—5-pin type chassis less terminals (Clix).
1—5-pin type American chassis less terminals (Clix).
1—6-pin type American chassis less terminals (Clix).
1—7-pin type American chassis less terminals (Clix).
1—8-pin type octal (Clix).

JACKS.
2—Insulated closed circuit jacks with plugs (Peto-Scott).

METERS.
2—0-100 m/A. type E66M (Sifam).

RESISTANCES, FIXED.
1—300-ohm type 1-watt (R1) (Erie).
1—5,000-ohm type 3-watt (R2) (Erie).
1—10,000-ohm type 15-watt (R3) (Premier).
1—30,000-ohm type 15-watt (R4) (Premier).
1—10,000-ohm type 15-watt (R5) (Premier).
1—5,000-ohm type 3-watt (R6) (Erie).
1—2,000-ohm type 1-watt (R7) (Erie).
1—400-ohm type 2-watt (R8) (Erie).

SUNDRIES.
$\frac{1}{4}$—lb. 14-gauge tinned copper wire (Webbs Radio).
$\frac{1}{2}$—lb. 16-gauge tinned copper wire (Webbs Radio).
6—doz. 6BA bolts with nuts and washers (Premier).
1—Transverse current microphone with stand (Leslie Dixon).

SWITCHES.
2—Type S80T (Bulgin).

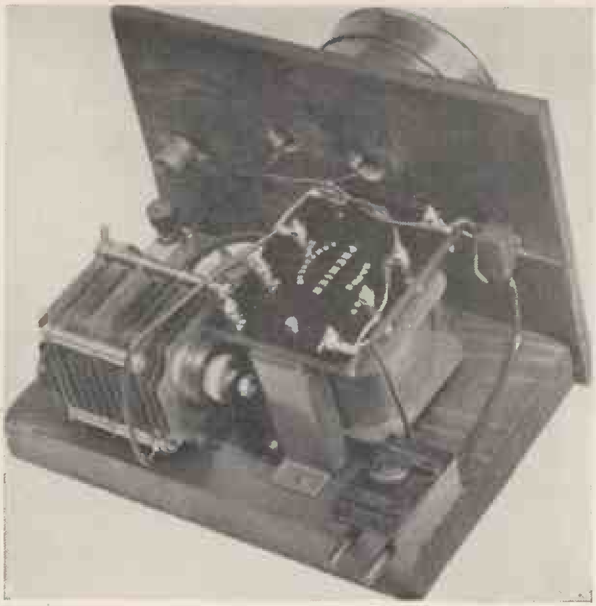
TRANSFORMERS.
1—Type microphone Cat. No. LF35 (Bulgin).
1—Type intervalve Cat. No. OPM1 (Ferranti).

VALVES.
1—6L6G (Tungsram).
1—Type 802 (Raytheon).
1—Type 42 (Tungsram).

WE have made arrangements for complete kits or wired transmitters to be obtained from Messrs. Premier Supply Stores and these can be demonstrated at the Ham shop at 165, Lower Clapton Road, E.5.

The Dublin Radio Society.

The last general meeting of the Dublin Branch of the National Radio Society was held on June 1 when it was decided to become self-supporting and re-name the Society the Irish Amateur Radio Society with headquarters at 18 David's Terrace, North Circular Road, Dublin. Any Irish readers who are within reasonable distance of Dublin are invited to write to the Honorary Secretary, J. Butler, at 92 South Circular Road, Portobello, Dublin.



In this illustration can be seen the special transformer, the Westinghouse metal rectifier and the other small components. A wooden baseboard is quite satisfactory while the mains fuses are combined in the plug.

An Inexpensive Battery Charger

This simple charger is very cheap to build and will take care of 2, 4, or 6-volt cells. The components are quite straightforward while the construction and operation are fully described in this article.

MOST amateurs use an accumulator in either the microphone head amplifier or in a small radio receiver. As these wet cells are little used, they are inclined to be overlooked and generally run down at the most inopportune moment.

We have had considerable trouble in this respect for several accumulators are generally in use on test equipment and it is difficult to keep track on all of them, particularly when some are only used on rare occasions.

To overcome this trouble we have built a small trickle charger which has proved to be quite satisfactory and noiseless in operation. During the period it has been in use it has kept all accumulators satisfactorily charged. The charger has been arranged so that three 2-volt cells can be charged at once or alternatively, one 6-volter, one 4-volter, two 2-volters or a single 2-volt cell. It will be noticed that the unit consists of a transformer with a tapped secondary, a 6-volt 1-ampere rectifier of the Westinghouse metal type, and a regulating resistance.

Three Outputs

A few other incidental components are quite normal and can be varied if required. The secondary of the mains transformer gives three outputs, these being 11 volts, 9 volts and 7.5 volts which are terminated in three insulated sockets.

When 11 volts are applied to the rectifier, the output is approximately 6 volts; with the voltage input to the rectifier cut down to 9 volts the charger gives only 4 volts output which is still further reduced to 2 volts with an A.C. input of 7.5 volts.

It should be noticed that a resistance is incorporated in the circuit and connected in the D.C. side of the rectifier. In this position it will limit the current which will flow in the event of a battery being accidentally connected with the wrong polarity. This resistance is essential as it is the only means of regulating the charging current, so in no circumstances should it be omitted.

It should be realised that the current flowing through a battery on charge is dependent on the resistance of the battery and the difference between the battery voltage and the applied voltage. So due to the very low resistance of the battery any slight variation in applied voltage will make a very great difference to the current flowing.

A resistance having a value many times greater than the battery resistance connected in series with the battery will have the effect of taking up these variations in charging rate. In this particular unit the resistance has a theoretical value of 1.75 ohms which has been obtained by using one of the old-fashioned type baseboard mounting filament resistances which is adjusted until the correct value has been obtained. As the average total value of these resistors is around 6 ohms 1.75 ohms should not be hard to determine.

The circuit diagram on this page gives all the connections, but make sure that the rectifier is correctly connected as regards polarity.

Four soldering tag connections are provided, two of these are marked positive and negative, the other two merely with an alternating current sign.

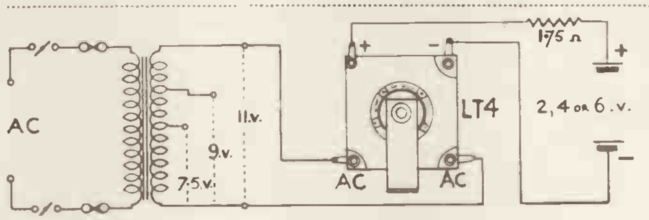
It will only take the average amateur about an hour to build this charger for it is quite straightforward and uses a wooden panel and baseboard so there are no awkward holes to cut in metal.

However, some constructors may care to use a metal frame with a protecting cover, but this is a matter of personal taste.

Arrangements must be made, however, for good ventilation of the rectifier, while no acid from the batteries should be allowed to touch the rectifier unit. In the original model we have used a double-fuse holder and a two-way terminal block in the primary circuit of the transformer. An additional feature is the use of a neon indicator to show when the A.C. mains are connected to the primary of the transformer.

As the charger is noiseless it is quite an easy matter to leave it on indefinitely

(*Continued on page* 446)



A single or a number of cells can be charged with this unit as fully explained in the text.

Components for AN INEXPENSIVE BATTERY CHARGER.

BASEBOARD AND PANEL.
1—Wooden baseboard 6 × 6 × ½ in.
1—Wooden panel 6 × 6 × ¼ in.

FUSE AND HOLDER.
1—Double type F.14 with 1A fuses(Bulgin)

METER.
1—0-2.5 A (Galpin).

NEON INDICATOR.
1—½-watt indicator neon tube (G.E.C.).

PLUGS, TERMINALS, ETC.
3—Insulated sockets type 11 (Clix).
1—Insulated plug type solid (Clix)
2—Two-way terminal strips (Bulgin).

RECTIFIER.
1—Type LT4 (Westinghouse).

RESISTANCE.
1—Pre-set type 2-ohm (Premier Supply Stores).

TRANSFORMER, LOW TENSION.
1—Special type to give 7.5, 9 and 11 volts at 1A (Premier Supply Stores).

We have made arrangements with Messrs. Premier Supply Stores to supply this charger to specification.

Metal valves are used in the two stages following the microphone but they are interchangeable with the glass types.

A 6L6G Speech Amplifier and Modulator

This simple modulator uses the low voltage high current circuit, so reducing the cost of the components. It gives high quality reproduction and has been designed by GI8TS for use at his station.

WHILE the transmitting amateur who intends seriously to interest himself in telephony working generally resorts to plate modulation, many others, for financial reasons, still use one of the many grid modulation methods. There is, however, no doubt that plate or Heising modulation is superior to any other systems as regards quality and relative efficiency.

Unfortunately, plate modulation calls for a very much greater audio output for a given input power than would be required by any of the grid systems.

High, undistorted audio output can be obtained in various ways; either by using a large output valve, with a comparatively high anode voltage depending on the output required, or by using two small output triode or tetrodes in push-pull. This system will provide approximately 2½ times the power output it is possible to obtain from one valve in class A. For example, a pair of small 3-watt triodes with an H.T. supply of 250 volts will give about 7 watts of pure audio in class A push-pull.

This is certainly a cheaper method of obtaining relatively high output than by using a large triode with its normal high anode voltage. As most amateurs are either licensed for 25 watts, or intend ultimately to use this power input, I have designed this amplifier to provide sufficient audio to modulate 25 watts input with the lowest possible cost. For this reason a pair of valves have been used in class A which, with only 250 volts H.T., still give a maximum undistorted output of at least 14 watts.

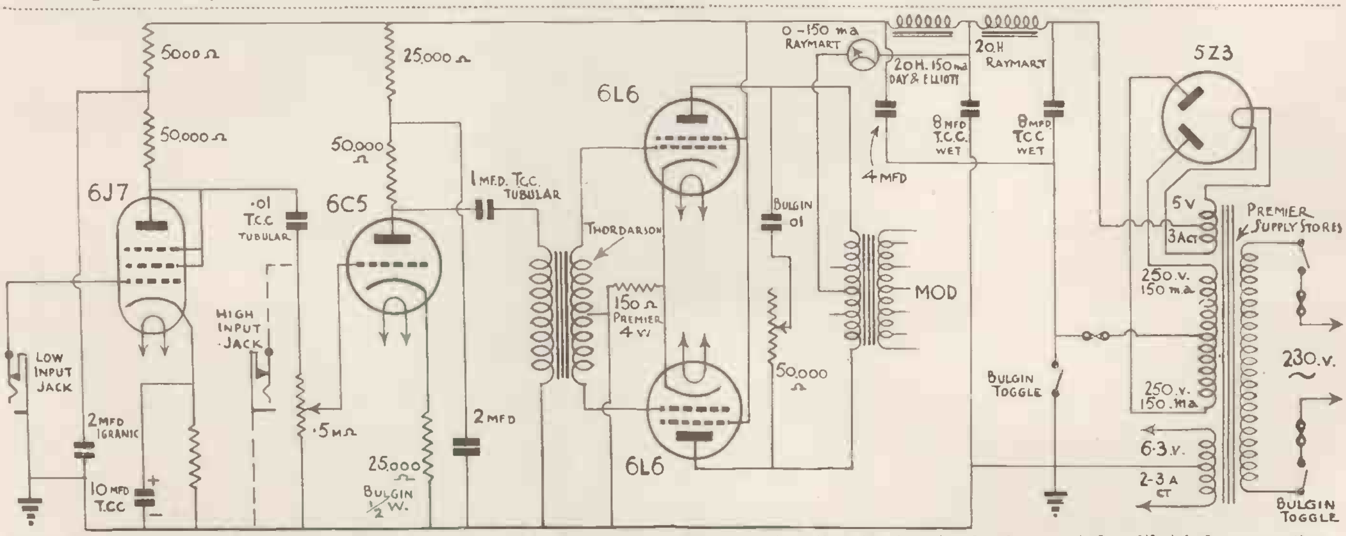
For this reason I have used the beam power tetrodes of the American 6L6 type, which are interchangeable with the British Hivac AC/Pa and Marconi or Osram KT66. With these valves, exceedingly fine quality is obtained without the audio power dropping below a minimum of 14 watts. Additionally, as the maximum voltage is only 250, there is a considerable saving in component costs, particularly in the power pack section.

The Circuit

As can be seen from the theoretical diagram, the amplifier consists of a 6J7 pentode resistance coupled to a 6C5 triode, which is in turn transformer coupled to the two 6L6's. By including two jacks, provision has been made for connecting the microphone or pick-up to either the H.F. pentode or triode valve, depending on the relative voltage output of the instrument used.

For a transverse current microphone with no pre-amplifier stage, enough gain will be obtained to drive the amplifier to its full output when the microphone is connected directly to the grid of the 6J7. Alternatively, if less gain is required, the first valve can be connected as a triode, that is with the anode, suppressor and screening grids connected together.

Maximum results are obtained from the input stage, by using an anode resistance of 250,000 ohms and a screen dropping resistor of one megohm the whole of the circuit is being de-coupled by a 50,000-ohm resistor and a 2-mfd condenser. If, on the other hand, a triode circuit is used, then the anode resistance need only be of 50,000-ohms with a de-coupling resistor of 5,000-ohms.

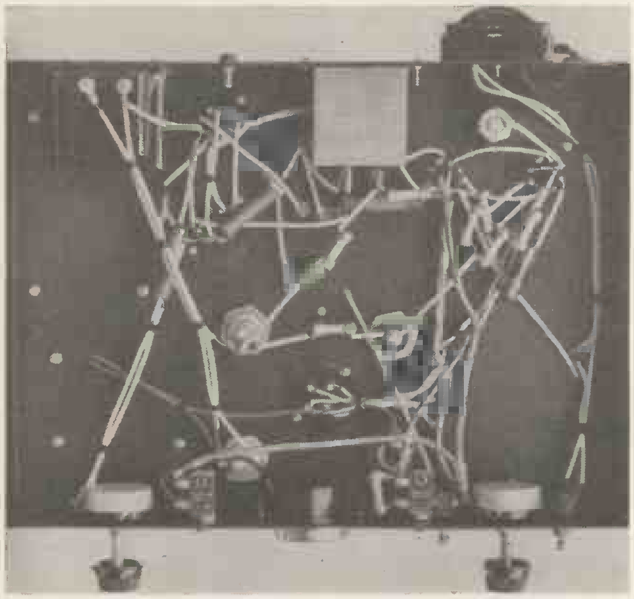


Only five valves are used in the complete circuit which includes the rectifier. Notice that the input valve is a pentode with triode connections.

Low Hum Level

Grid bias for this first valve is obtained by means of a cathode resistor having a value of 1,500-ohms, by-passed by a 10-mfd. condenser.

In the second stage utilising a 6C5 triode, the coupling between stages consists of a .01-mfd. condenser, plus a



How the components are laid out can be clearly seen from this sub-chassis illustration

.5-megohm variable potentiometer which serves as a volume control for either microphone or pick-up in either stage. The anode resistance for the 6C5 is 50,000 ohms, with a 25,000-ohm decoupling resistance and 2-mfd. by-pass condenser.

A high value bias resistance is required in this circuit and should be approximately 2,500 ohms. If extra base response is required this resistor should be by-passed by a condenser of 2-mfd. capacity.

In order to retain the high inductance of the inter-valve transformer, a parallel fed circuit with a coupling condenser of 1.0 mfd. is used, this also enables one side of the transformer primary to be connected directly to earth, as there is no D.C. voltage applied to it. This transformer has a centre tap secondary and a ratio of 1/3.5/1, and is similar to the Ferranti AF5C. Bias for the tetrodes is obtained from the voltage drop across a 150-ohm resistor in the common cathode connection.

The output of the 6L6 valves is connected across a Varimatch modulation transformer which also has a tone correction circuit in parallel with it, made up of a 50,000-ohm variable resistor, and a .01-tubular condenser. No shunt condenser is shown across the cathode resistor for this was inclined to introduce a little base boom, but should any reader need further base response a condenser of 25-mfd should be connected across this resistor.

Power Unit

The next portion of the circuit deals with the power supply. A special mains transformer was wound for me having the following secondaries. One giving 270-0-270 volts at 150 mA., and two filament secondaries giving 6.3 and 5 volts. Also, as the current taken exceeds the 120 mA., a 250-mA. rectifier has been used.

In order to obtain complete smoothing and freedom from hum, special attention was given to the filter circuit. This consists of two 20 Hy. smoothing chokes, the first by-passed by two 8-mfd. condensers, and the second by a 4-mfd. condenser. This has completely removed all traces of ripple and, as the second choke merely feeds the drive stages, there is really no need for this to be of the same current rating as the first choke which has to supply all four valves. However, as the variation in cost is so small, this is really a matter of personal choice.

The mA. meter is connected in the 6L6 anode circuit and reads the current flow in that circuit and not the total consumption of the entire amplifier.

Further refinements consist of a 250 mA. fuse and switch, both of which are connected in the mid-point of the high voltage secondary winder. This switch is particularly useful for stand-by operation, for the modulator can be put out of circuit without cutting off the filament supply.

The plan view of the amplifier quite clearly shows the lay-out of the components on the top of the chassis. Approximately one-half is taken up by the power supply and the other half by the valves and the driver and modulation transformers.

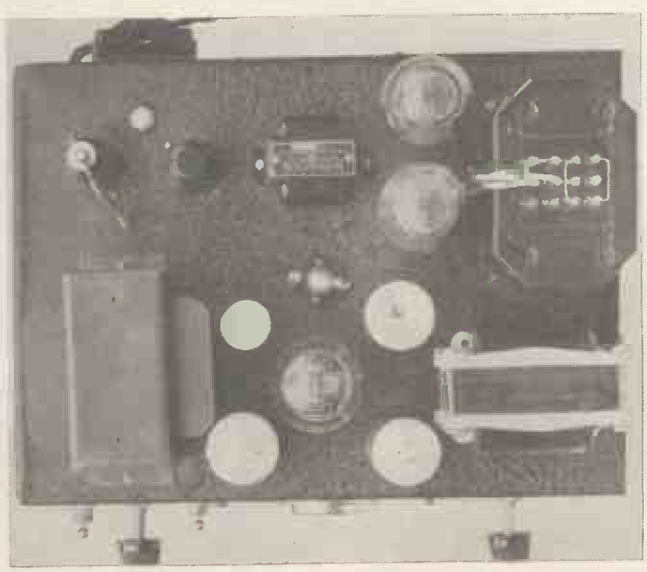
Before mounting the three transformers, holes for their flexible connections must be made in the chassis. The various controls, and the jacks and chassis, while on the opposite lip a half-meter are mounted on one lip of the inch hole must be made to take the bush for the mains cable.

Very few connecting wires come above the chassis, being mainly to the output transformer primary, the first smoothing choke and the top grid connection to the 6J7.

The potentiometers have dead spindles and so do not require bushing from the chassis. Also make quite sure when wiring up the jacks that the connection nearest to the chassis goes to earth, otherwise a grid chassis short circuit will result. An earthing plug has been provided but the chassis must be very well cleaned in order that this may make satisfactory contact.

The underside of the chassis is quite straightforward. Actually, only two components are bolted down, these

(*Continued on page* 441)



All of the components that are mounted on the top of the chassis are shown in this illustration.

The Short-wave Radio World

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

AUTOMATIC FREQUENCY CONTROL

SOME interesting A.F.C. circuits have been developed by the Raytheon Production Corp. of America of which many have been produced so that they can be built into amateur built receivers.

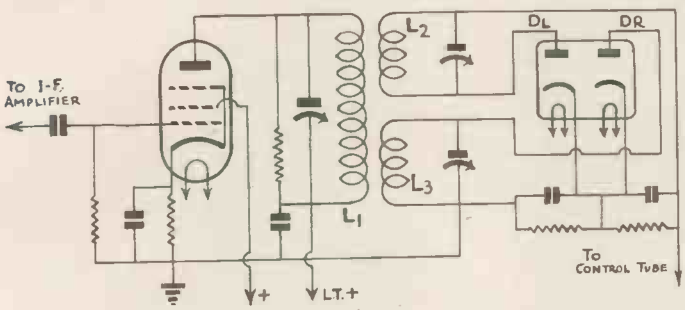


Fig. 1. A frequency discriminator of the simplest type.

Fig. 1 shows a frequency discriminator circuit of the simplest kind. The primary, L1, is tuned to the intermediate frequency of the receiver and is loosely coupled to the secondaries L2 and L3, which are tuned to frequencies spaced equally above and below the intermediate frequency. The voltages across L2 and L3 are applied to a double diode as shown in Fig. 1. The D.C. output voltage of this rectifier is the A.F.C. voltage and is equal to the difference between the voltages developed by each diode. When the I.F. signal is on the centre frequency the voltages applied to the diodes are equal, the D.C. output voltages are equal so no resultant A.F.C. voltage is developed.

If the I.F. frequency changes towards the resonant frequency of L2, more voltage will be applied to diode DL, than to the other diode, DL will develop more D.C. voltage than DR and the resultant A.F.C. voltage will be negative with respect to earth.

In a like manner, if the I.F. frequency changes towards the resonant frequency of L3 the resultant A.F.C. voltage will be positive with respect to earth.

Another circuit is shown in Fig. 2 which does not depend on side circuits tuned below and above the I.F. frequency. In this circuit the primary L1 and the secondary L2 are both tuned to the intermediate frequency of the receiver and are loosely coupled.

The operation of the circuit depends on the fact that at the resonant frequency the primary voltage, Ep and the secondary voltage Es, are 90 degrees out-of-phase and on the fact that the phase angle varies as the frequency changes. The circuit is arranged so that the voltage E1 applied to one diode is the vector sum of the primary voltage and one-half of the secondary voltage, and the voltage E2, applied to the other diode is the vector sum of the primary voltage and the other half of the secondary voltage.

As in Fig. 1 the resultant A.F.C. voltage is the difference between the D.C. voltages developed by each diode. Vector diagram A in Fig. 2 shows the relation of the several voltages when the applied voltage is at the resonant frequency. Since the voltages E1 and E2 which are applied to the diodes are equal no resultant A.F.C. voltage is developed.

If the applied voltage changes in frequency the phase relations may be shown in vector diagram B. The voltage E2 applied to diode DR will be greater than the voltage E1 applied to the other diode. DR will develop more D.C. voltage than DL and the resultant A.F.C. voltage will positive with respect to earth.

Should the frequency change in the opposite direction E1 will be greater than E2 and the resultant A.F.C. voltage will be negative with respect to earth.

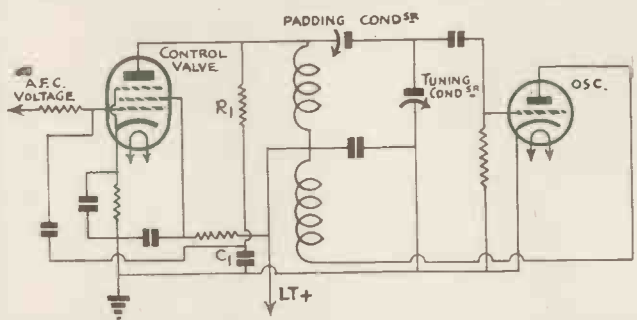


Fig. 3. The out-of-phase voltage in this arrangement is obtained from the condenser C1.

Fig. 3 shows a control circuit which controls the oscillator frequency in accordance with the D.C. voltage developed by the discriminator. The anode of the control valve is coupled to the oscillator anode coil and a voltage approximately 90 degrees out-of-phase with the voltage across the oscillator anode coil is applied to the grid.

In Fig. 3 this out-of-phase voltage is obtained from condenser C1, which is in series with resistor R1, across the anode coil. In practice the resistance of R1, is made much greater than the reactance of C1, and the current through C1 is practically in phase with the voltage across the anode coil.

The voltage across C1 is therefore practically 90 degrees out-of-phase with the tank coil voltage. The anode circuit of the control valve then acts like an inductance across the anode coil. The value of this effective inductance depends on the bias on the grid of the control valve. As the bias of the control valve is determined by the A.F.C. voltage generated by this discriminator

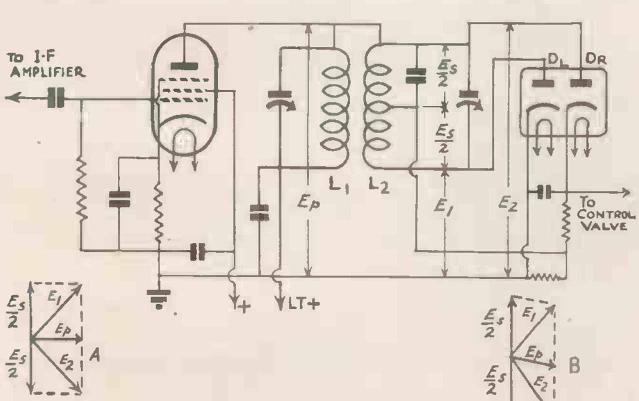


Fig. 2. An interesting A.F.C. circuit of a type popular in this country.

A D.C. Tx. :: 10-metre Converter

the control valve tends to maintain the oscillator at the proper frequency.

All of these circuits are quite easy to follow and the average constructor with a good technical knowledge should be

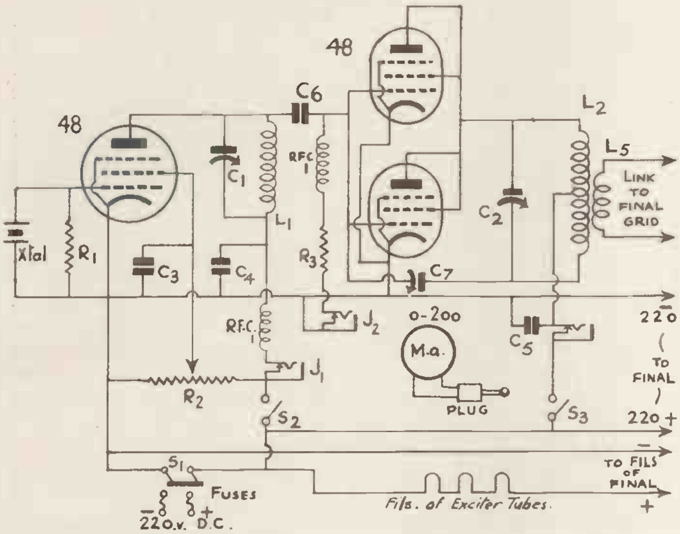


Fig. 4. This interesting D.C. transmitter circuit is suitable for an input of 50 watts.

able to make use of them without difficulty.

A TRANSMITTER FOR D.C.

Amateurs who only have a D.C. supply are always in trouble when it comes to building a new transmitter with an input of much over 10 watts.

The use of modern valves has, of course, helped a little for the 25L6 tetrodes are quite good on low voltages, but even so a transmitter for say 50 watts has always been a problem.

W5BDB has designed a rig, which he published in QST, which will stand a comfortable 50 watts input. The circuit is shown in Fig. 4 with the final amplifier in Fig. 5.

The exciter consists of a 48 pentode in a straight circuit with both filament and anode circuits run straight from the D.C. supply. This oscillator is capacity coupled to a pair of 48's in parallel which obtain bias by means of a 1,000 ohm resistor in the grid circuit.

These three valves have 30-volt heaters so that when connected in series with the four valves in the final stage there is a voltage drop of 210 volts which is just about right for use with the average D.C. supply. If used on 250 volt mains then a small resistance will be required in order to keep the voltage down to the correct level.

With a 40-metre crystal the 48 C.O. will drive the 48 doublers very fully on 20 metres so providing ample drive for the push-pull parallel 48's in the final. It was noticed that the arrangement was more satisfactory when the crystal oscillator was used normally instead of as a crystal oscillator-cum-frequency multiplier.

The values for the components in the exciter circuit are as follows :—

C1, C2 .0001-mfd.
C3, C4, C5 .01-mfd.
C6 50-mmfd.
C7 25-mmfd.
R1 5,000 one watt.
R2 2,500 ohm variable.
R3 1,000 ohm.
S1 D.P.S.T. switch.
S2, S3, S.P.S.T. switch.

Three coils are needed in the exciter section and these are all home wound to the following dimensions. L1 is made up of 15 turns of 18 gauge wire to a length of 1 in. with a diameter of 1½ in.

Next comes L2, the anode coil in the doubler stage. For 40-metre operation use 15 turns of 18 gauge wound to a length of 1 in. with a diameter of 1½ in. On 20 metres wind on 10 turns of the same gauge wire to a length of 1 in. and the same diameter.

The link winding between stages should be about two or three turns wound over the centre of L2. The correct number of turns has to be found by experiment in order to obtain the proper drive. Use fairly heavy gauge rubber covered wire of the solid type for this link coil.

In Fig. 5 can be seen the arrangement for the final amplifier which uses four

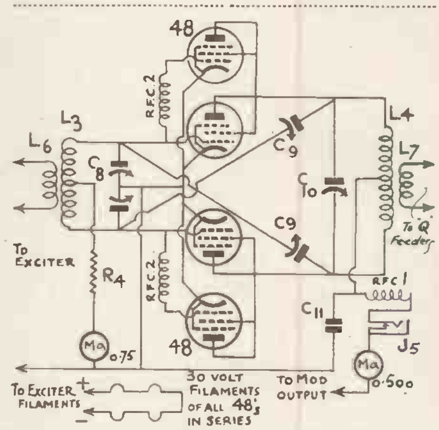


Fig. 5. This type of output circuit is quite easy to operate if precautions are taken as explained in the text.

valves of the 48 type. The circuit is a simple one with bias again obtained automatically by means of a grid resistor of 400 ohms. This resistor must be of the 10 watt type for a heavy grid current flows in this circuit.

Both sets of valves must be carefully balanced and neutralised in order to obtain docile operation. The split-stator

(Continued on page 446).

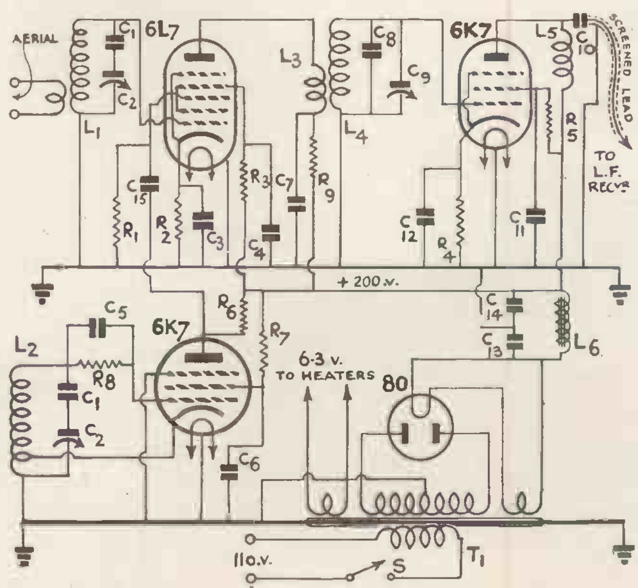


Fig. 6. For those interested in ultra-short wave reception this converter is about the best possible.

The 6L7 as an R.F. Amplifier

In this article engineers of The Radio Corporation of America show how to use the 6L7 as an R.F. amplifier and discuss the advantages of this type of valve over the normal tetrode or pentode.

ALTHOUGH the primary use of the 6L7 is as a mixer valve in super-heterodyne receivers, this valve can be used advantageously as an R.F. or I.F. amplifier. The 6L7, an all-metal type, includes a heater, a cathode, five grids, and a plate. Two of the five grids are control grids, two are screens, and one is a suppressor, which is internally connected to the cathode. The signal is applied to control grid G_1, which has a remote cut-off characteristic; the other control grid (G_3), interposed between the two screens, is biased negatively, and has a sharp cut-off characteristic.

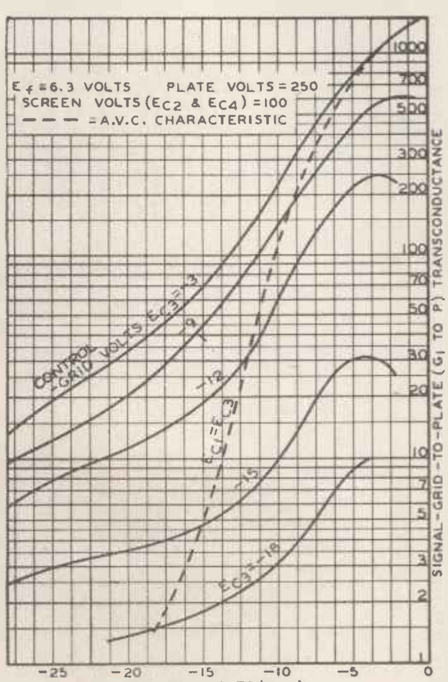
When the pentode type of remote cut-off valve now in general use is under the control of the A.V.C. system, relatively large signals can be handled without introducing modulation distortion and cross modulation effects. As the carrier voltage applied to such a valve increases, the transconductance, and hence the gain, decreases, because of the action of the A.V.C. system. When the carrier voltage is large enough, further increases in carrier voltage are offset by the decrease in gain due to the A.V.C. system; the overall response of the receiver is then substantially independent of further increases in carrier voltage. The A.V.C. voltage at which the response begins to become independent of carrier strength depends on the number and type of valves under the control of the A.V.C. system. A curve which shows the relation between audio output and carrier input voltage describes the A.V.C. characteristic of a receiver up to the point at which overloading occurs.

The usual A.V.C. characteristic rises at first sharply with increases in carrier voltage and then flattens out with further increases in carrier voltage. For the remote cut-off type of R.F. pentode now in use, the region in which the A.V.C. characteristic begins to flatten can occur at a reasonable low carrier voltage in a receiver of nominal sensitivity. The flat portion of the curve, however, may not be sufficiently horizontal to prevent overloading of the audio system when a strong local station is tuned in. Furthermore, an A.V.C. characteristic that rises too rapidly cannot satisfactorily compensate for fading.

It is not desirable to have a horizontal A.V.C. characteristic if tuning the receiver to the carrier frequency is to be simple. When a receiver having a perfectly flat A.V.C. characteristic is tuned slightly off resonance, a tuning indicator which is operated from the A.F. diode will not show a change in signal strength.

The A.V.C. characteristic of a receiver can be improved by increasing the number of valves under the control of the A.V.C system or by amplifying the A.V.C. voltage before applying it to the controlled tubes. These expedients, however, because they increase the cost of the receiver, cannot always be employed. The use of one or more type 6L7 valves offers a good solution for the problem of obtaining a desirable A.V.C. characteristic at limited cost.

When the 6L7 is used as an R.F. or I.F. amplifier, the signal should be fed to G_1; the A.V.C. voltage should be applied to both control grids (G_1 and G_3) in order to reduce the transconductance of the tube to a minimum with a small A.V.C. voltage. Referring to the dotted curve, it may be seen that approximately 15 volts of A.V.C. voltage is required for a G_1-P transconductance (g_{m1}) of 5 microhms when $E_{c1} = E_{c3}$. This should be compared to the 40 volts necessary for $g_m = 10$ microhms for a typical remote cut-off pentode. Cut-off at a correspondingly low voltage may be obtained, of course, by merely using a valve having a single sharp cut-off control grid, such as the 6J7; but the use of such a valve will result in severe modulation distortion and cross modulation effect, especially with large input signals. An examination of the transconductance curves shows that a comparatively large signal can be applied to the No. 1 control grid of a 6L7 before distortion due to the curvature of the characteristic becomes appreciable. The 6L7 as an R.F. or I.F. amplifier, therefore, has the A.V.C. characteristic heretofore peculiar only to sharp cut-off tubes and at the same time retains the remote cut-off features of the super-control valve.



The transconductance curves for the 6L7 valve.

The 6L7 can be employed in receivers developing more than 15 volts of A.V.C. voltage. In this case, the A.V.C. resistor can be tapped at the point necessary to furnish 15 volts to both control grids of each 6L7; additional A.V.C. voltage may then be distributed to the remaining amplifier and mixing valves.

It is not necessary that the same A.V.C. voltage be applied to both control grids of the 6L7. The voltage applied to G_3 may be a fraction of that applied to G_1 when a less rapid change in gain with A.V.C. voltage is desired. Thus, an unequal distribution of voltage on the control grids of one or more 6L7 valves is effective in realising a desired A.V.C. characteristic. Referring to the curve, it is seen that the dotted line shows the most rapid change in gain with A.V.C. voltage; this occurs when $E_{c1} = E_{c3}$. The solid curves show the change in gain with A.V.C. voltage when G_3 has the fixed biases shown. The change in transconductance for any ratio (R) of E_{c3} to E_{c1} can be determined

(Continued on page 447)

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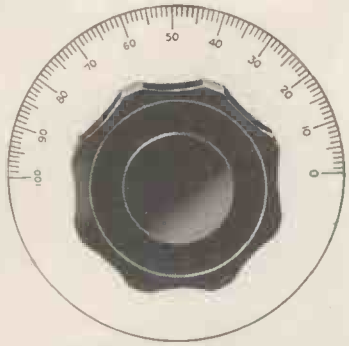

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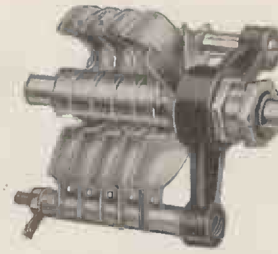

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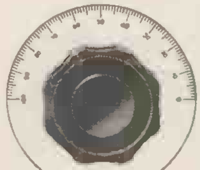

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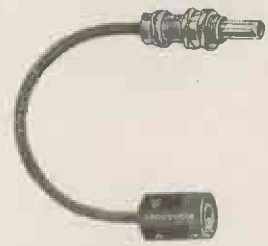

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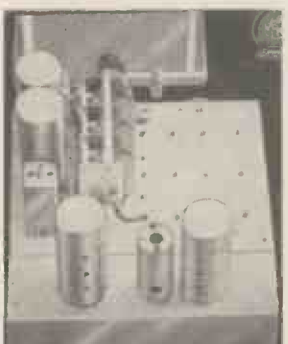

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A High- and Low-voltage Continuity Tester

This interesting tester has been designed by the engineering staff of Messrs. Murphy Radio Ltd., to whom we are indebted for this information. Arrangements have been made for a complete set of components or a completed instrument to be obtained from any Murphy agent.

A direct reading meter is used while the various ranges are brought into circuit by means of a multi contact switch.

CONTINUITY testing is one of the most frequently used means of fault finding with radio equipment, and in some form or another is generally called upon for the final location of the majority of faults.

The apparatus employed for this sort of work takes many forms from the rather crude flash lamp and dry battery, simple ohm meters, again operated by a dry battery, to high voltage ohm meters and self contained meggers.

Broadly speaking, continuity test gear falls into two divisions; high voltage—where the applied voltage is 200 volts and upwards, and low voltage—utilising 1½ to 30 volts.

Although apparatus of both classes is sufficiently familiar to advanced experimenters this type of apparatus is not so generally used as might be expected by the average radio man.

Since practically all experimenters possess some sort of ohm meter of a type usually embodied in a multiple test set, this article shows the special functions of the instrument using the higher voltages and it also points out that continuity testing is not just a simple matter of reading off a resistance value in ohms. While the measuring ranges of two instruments, one from each class, may widely overlap, the same components may give very different results on the two, so that it may truthfully be said that although both types come under the general heading of continuity testers each has its own function to perform in radio fault finding.

The two following practical examples should serve to emphasise this point :—

On a low voltage instrument an output transformer read open circuit; on a high voltage ohm meter the correct reading for the transformer was obtained. The high voltage test in this instance sealed the break in the wire and if this test had been used alone the transformer would not have been judged faulty.

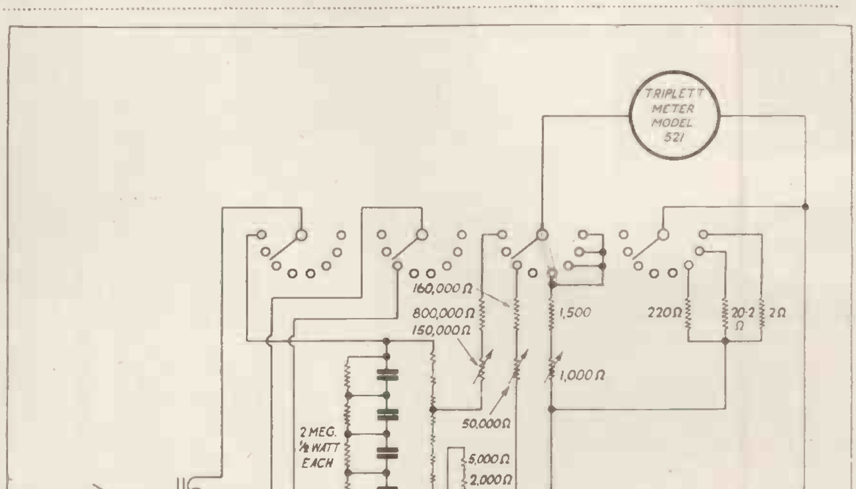
In the second instance a certain fault in a receiver gave rise to suspicion of a defective oscillator coil. On low voltage tests the coil gave the correct reading and was therefore replaced. As the symptoms were still present in the set, the coil was again removed and tested on a high voltage ohm meter and this check showed an open circuit. A check with the low voltage ohm meter, however, still gave the correct resistance showing that the break was only noticeable under high voltage.

Condensers with intermittent short circuit can usually be checked only by means of a high voltage test, as it is obviously of little use applying 1½ volts to a condenser which is only breaking down momentarily under a peak pressure of something like its maximum working voltage.

A safe general rule when testing is to use a voltage of approximately the rated value, as it can be safely left to the designer to ensure that the actual working voltage of components in a receiver is below this figure and if the component withstands this test it may safely be passed as satisfactory.

Where voltages of 500 to 1,000 are used a continuity tester is able to check the quality of insulation. Two types are available for this purpose—the megger and the high voltage ohm meter. Both have their advantages, the megger being a convenient self-contained instrument, but rather above the pocket of the average experimenter, while the high voltage ohm meter is to be preferred for general work. It can also be constructed from components which are quite easily obtainable cr may be on hand.

Faults due to insulation breakdown, or more particularly to leakage, are fortunately not every day occurrences. But when they do occur the symptoms are likely to be extremely puzzling. For



Here is the circuit diagram of the continuity tester with the majority of the component values. A 0-1 mA meter can be used in place of the meter less suggested as explained in the text.

.05 Ohm to 25 Megohms

this type of fault finding an insulation tester is essential. This is particularly important with television apparatus where a very big percentage of the components are of the special high voltage type.

The construction of apparatus of this sort is quite simple and the cost is comparatively low. This instrument is both a low and high voltage tester. The lowest range leads down to .05 of an ohm and is therefore capable of measuring switch contact resistance, short wave coils, and output transformer secondaries to quote but a few examples. The highest range will read up to 25 megohms by utilising the 1,000-volt supply.

The actual ranges are .05-50, .5-500, 5-5,000, 50-50,000, 5,000-5 megohms, .05-25 megohms. Each range is selected by a switch and the values are read directly from the meter.

The circuit diagram shown is more or less self-explanatory with an 0.5 milliammeter as the heart of the instrument. In the three highest ranges series connection is used, while the lower resistance scales are obtained by use of shunts and a two volt accumulator.

Any good 0-1 milliammeter may be used as long as it has a total resistance of approximately 100 ohms. If it is lower than this value a resistance must be connected in series with the meter to increase the total resistance to 100 ohms.

Standard components have been used where ever possible and this accounts for the bank of electrolytic condensers used in preference to one high voltage condenser. This also applies to the number of carbon resistances recommended where one specially recommended resistance of high voltage may have been used.

Constructional Details

The chassis is made of 16 gauge alluminium, and the dimensions are 9 in. long by 7 in. wide by 1½ in. high. Care must be taken to ensure that the cases of three electrolytic condensers are well insulated from the chassis. The low value resistances should be mounted on bakelite panels, the high potential end of each potentiometer being kept away from the chassis. All wiring carrying high potentials must be well insulated in systoflex, while rubber grommets must be used where it is necessary to take these wires to the chassis.

If the meter shunts are purchased ready made, this would be an advantage for a calibration chart can be obtained for a small charge from Messrs. Murphy Radio via any of their official dealers. If on the other hand, constructors intend to make their own shunts, the following gauge wire should be used.

Eureka wire is essential and should be 22 gauge for the 2 ohm shunt, 36 gauge for the 20.2 ohm shunt, and 45 gauge for the 220 ohm shunt. Alternatively, quite good shunts can be manufactured by unwinding the wire from old type filament rheostats. The common types have resistances of 5 to 6 ohms and 20 to 30 ohms.

To calibrate the meter with these or other home-made shunts, the following procedure should be adopted:—

Make sure the accumulator is charged, adjust the meter pointer to zero reading, turn range switch to range 1 and short the test prods together. Adjust meter to 1 milliampere by the zero ohm adjustment. Insert a known 2 ohm resistance capable of carrying 1 ampere between the test prods and adjust the 2 ohm shunt until the meter reads .5 mA. Range 1 is then correctly calibrated. The connection should, of course, be soldered to ensure permanent accuracy of the shunt.

Identical operation for the two remaining low ranges should be carried out using known resistances of 20 ohms and 200 ohms.

Any of these components required can be obtained from registered Murphy dealers, while should constructors wish to purchase a completed instrument it can be obtained from the same source.

The fixed condensers are of the 4 mfd. type suitable for 500 volt working, the resistors used are all marked, while the special mains transformer has a secondary giving a filament winding for the MU2 and also 1,000 volts at about 10 mA. The special four gang 8-point switch can be obtained from T. H. Walters, Limited, while a cabinet 12 in. wide, 13 in. high and 9 in. deep is available from Messrs. Peto-Scott, Limited.

Simplified Volume Expansion

This article by **F. E. Henderson** *explains the advantages of automatic contrast expansion and the reasons for its inclusion in amplifiers designed to provide faithful reproduction, particularly from gramophone records.*

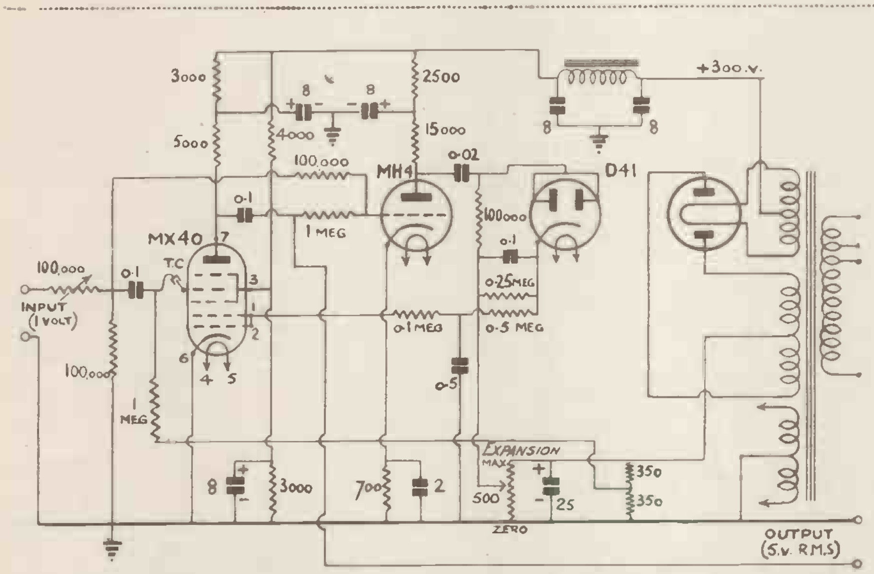
It is well known that in making gramophone disc recordings it is often necessary to compress the range of sound in order to accommodate the size of the disc for commercial purposes. Thus, in recording a full orchestra the range of sound as heard in the concert hall is such that the louder passages often require to be reduced in the recording, which has the result of making the difference between the loud and the soft passages sound less during the play-back than they were in the original.

While this degree of compression is not always constant, and does not appear at all in some cases, yet some expansion of the contrast between the loud and the soft passages often produces a very pleasing result to the ear when playing certain records.

Such contrast expansion, or volume expansion as it is sometimes called, is obviously only applicable to electrical reproduction, and various means have been used to produce this effect. It is thought, then, that some description of a method which will introduce this automatic contrast expansion in the electrical playing of gramophone records will be of interest.

In the first place it must be clear that the same degree of expansion is not suited to all records, and therefore an expander must be used intelligently by the listener, the degree of expansion being adjustable to suit the particular record being played. Thus, it will probably be found that the reproduction of a full orchestra will be rendered considerably more realistic when the difference between the loud and soft passages is increased—a comparison between the playing of a given record of this type both with and without contrast expansion being most noticeable.

On the other hand speech or vocal records do not lend themselves so much to contrast expansion, and for such records the expansion should be much reduced or cut out. Dance records, which are usually played at a more or less constant level, would probably not be improved by a contrast expander.



A typical amplifier embodying volume expansion, using a Heptode, triode, double diode and rectifier.

Reducing Surface Noise

There is another aspect which is often considered an advantage of automatic contrast expansion; this is that, intelligently applied, the surface noise or needle scratch may be very much minimised without having resort to the older methods of drastic top cut which reduces the high frequency response and ruins the brilliance of reproduction. Played in the ordinary way a very quiet passage, or a pause in the music, is only heard to the accompaniment of a more or less scratching noise varying according to the make and type of record. This scratching noise remains sensibly constant and is not noticed on the louder passages.

When a contrast expansion circuit is used this automatically cuts down the amplification according to the input from the record, so that on very soft passages and during pauses in the music the scratch almost entirely disappears. Naturally, the scratch is amplified by the contrast expander on loud passages but is usually lost under cover of the music at such times and is not objectionable.

This reduction of needle scratch on quiet passages adds realism to the playing of a gramophone record because immediately the needle reaches the end of the playing passage the surface noise also to a large extent disappears.

In using a contrast expansion circuit certain precautions must be observed, but before dealing with these a typical circuit which has been shown to give exceedingly good results will be described.

There have been many circuits developed which will alter the gain of an amplifier in direct proportion to its input; possibly the simplest is the use of a flashlamp or flashlamp bridge in the output. This, simple though it appears, has, however, the disadvantage that it gives very little expansion and is non-linear in action, giving an exaggerated effect on the loudest notes and insufficient expansion on the less loud passages.

Other forms using valves may introduce serious distortion, and the problem is therefore to use a circuit which will not introduce distortion into the amplifier chain and will at the same time increase the amplification in linear proportion to the voltage input. Such a circuit is shown in the figure, and makes use of a heptode valve as the variable gain valve. The variability in gain is afforded by applying a negative bias to the inner grids G_1 G_2, which increases the impedance of the valve and reduces its effective amplification. Removal of this negative bias will restore the normal amplification of the valve.

In the circuit shown the basic principle is that the signal is applied in two directions: the first to the control grid of the heptode, and secondly to an amplifier whose output is rectified by a diode. On no signal the G_1 G_2 of the heptode are automatically biased negatively by means of a resistance in series with the H.T. negative lead. This resistance is also arranged to carry the rectified current of the diode, so that as the signal is applied some of it is applied to the heptode grid and some of it after amplification is rectified by the diode. The rectified voltage is arranged to be applied also across the G_1 G_2 bias resistance of the heptode in opposition, so that the stronger the rectified voltage the more is the negative voltage applied to G_1 G_2 neutralised until, ultimately, on a very strong signal this negative voltage is entirely removed and the heptode is allowed to

(*Continued on page 448*)

Matching the Modulator

"A 6L6G Speech Amplifier and Modulator"

(*Continued from page* 432

being the small low-frequency choke and the 2-mfd. condenser.

Notice how the valve holders have been placed in such a way that short grid connections are possible. This makes a very big difference to the ultimate hum level. All small components such as resistors and tubular condensers are supported in the wiring.

It is also important that the electrolytic condenser in the bias circuit is correctly connected as regards polarity. The negative side of this condenser must be joined to chassis. Connections from the jacks and volume control slider are also made with screen cable, which has to be earthed at both ends in order to completely remove hum from this part of the circuit.

A special modulation transformer has been included, for without this the amplifier is quite unsatisfactory. It is of little use having sufficient audio power unless it is possible accurately to transfer it into the final stage of the transmitter. This is only possible if the impedance of the modulation valves and the impedance of the transmitting valves under working conditions are correctly matched. Distortion and under-modulation are always bound to occur when there is any percentage of mis-match in the final stage.

By the introduction of a multi-ratio transformer, possibilities of mis-match are reduced to a minimum. The Vari-match unit specified is capable of modulating any power amplifier stage with a working impedance of between 300 and 21,000-ohms.

The impedance of the 6L6's is approximately 5,000-ohms with an anode voltage of 250, and for correct matching the anodes should be connected to terminals 2 and 5, using terminals 3 and 4 connected together for use as a centre tap to the H.T. line, via the meter.

The secondary connections, of course, depend on the impedance of the amplifier valve or valves, and the correct terminals can very quickly be determined by reference to the table supplied with the transformer. The secondary of the Vari-match unit is designed to carry the full class C plate current.

For those who wish to use this amplifier for public address work it is a good plan to have a transformer with a 5,000-ohm primary and a secondary to suit the loudspeaker to be used.

Components for A 6L6G SPEECH AMPLIFIER AND MODULATOR.

CHASSIS AND PANEL
1—Steel chassis 17½ by 14 by 3 ins., finished black (Peto-Scott).

CONDENSERS, FIXED.
2—2-mfd. type BB (Dubilier).
1—1.0-mfd. type tubular (T.C.C.).
1—.01-mfd. type tubular (Bulgin).
2—8-mfd. type electrolytic (T.C.C.).
1—4-mfd. type electrolytic (T.C.C.).
1—10-mfd. type 25 volt working (T.C.C.).
1—.01 mfd. tubular (T.C.C.)

CHOKES, LOW-FREQUENCY.
1—20 Hy. 150 mA. (Raymart).
1—20 Hy. 150 mA. (Day and Elliott).

FUSE HOLDER.
1—Type F5 Fuseholder (Bulgin).

HOLDERS, VALVE.
4—8-pin type octal less terminals (Clix).
1—4-pin type American less terminals (Clix).

METER.
1—0-150 mA. type Beede (Premier Supply Stores).

MICROPHONE.
1—type Astatic crystal (Webb's Radio).

RESISTANCES, FIXED.
1—1,500-ohm type ½-watt (Bulgin).
2—50,000-ohm type 1-watt (Erie)
1—5,000-ohm type 1-watt (Erie).
1—25,000-ohm type 1-watt (Erie).
1—2,500-ohm type 1-watt (Erie).
1—150-ohm 4-watt (Premier).

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

SWITCHES.
1—Type 280 (Bulgin).
1—Type S123 (Bulgin).

SUNDRIES.
2—Jacks type J2 (Bulgin).
2—Plugs type P1 (Bulgin).

TRANSFORMER, INTERVALVE.
1—Type 6789 driver for 6L6G (Thordarson-Raymart).

TRANSFORMER, OUTPUT.
1—Varimatch type VM1 (Day and Elliott).

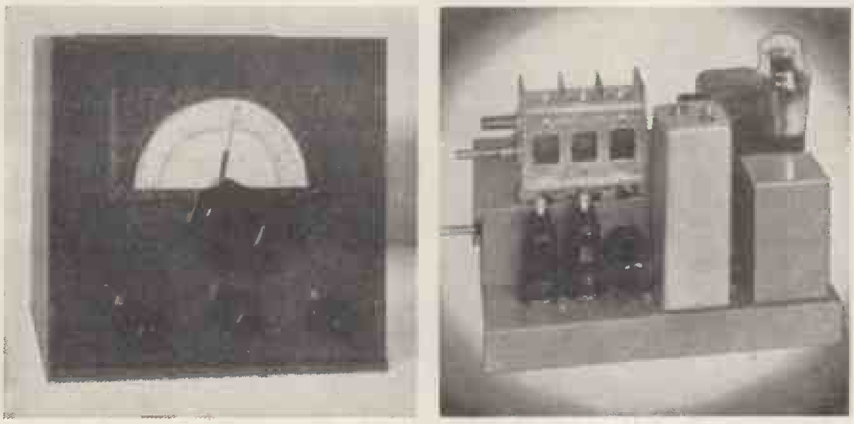
TRANSFORMER, MAINS
1—Special type to give :—
250-0-250 V, 120 m/A
5V, 3A, 6.3V, 3A, (Premier Supply Stores).

VALVES
1—6J7 (Tunsgram).
1—6C5 (Tunsgram).
2—6L6 or AC/Qa (Day and Elliott or Hivac).

New Amateur Receivers

We are glad to be able to give the first information on the R.M.E. Frequency Expander which has just arrived in this country. It should prove extremely popular amongst ultra-high frequency enthusiasts. We also discuss the new Sky Buddy Receiver.

AT last the new R.M.E. Frequency Expander, which has been promised for such a long time, has arrived in this country. We have just seen one of the first models, which can be obtained from Messrs. A.C.S., Ltd., of Bromley. This new Frequency Expander, the 510X, is designed to work in front of the well-known R.M.E.-69 receiver to extend the frequency range



This illustration gives a very good idea as to the construction of the R.M.E. frequency expander. It is similar in appearance to the DB-20 but includes four valves.

to 70 Mc. The range of the 510X is actually 27.8 Mc. to 70 Mc. in three channels with the equivalent of 21-in. of linear travel.

Sensitivity

It is difficult to give a sensitivity figure for a converter of this kind, but to give some idea as to what users may expect when it is operated in conjunction with the R.M.E. receiver it has a sensitivity of better than 1 microvolt over its entire range.

Very few of the available commercial all-wave receivers have a sensitivity anywhere near this figure at 5 metres, and this has been realised by the R.M.E. Company, who found it better to use a separate converter rather than to have an all-wave R.M.E., the design of which would present very considerable difficulty.

In appearance, the converter is identical with the DB-20 pre-selector. However, it embodies no less than four valves and its own power supply. The valve line-up is a 6K7-radio frequency amplifier, transformer coupled to a 6L7 1st detector. The high-frequency oscillator is a 6C5 leaky grid triode arrangement, while the fourth valve is the conventional 80 rectifier. Provision has been made for doublet input, which is essential on these ultra-high frequencies and for a special impedance matching output unit having a secondary impedance of 300-ohms. This enables the expander to be used with a direct connection to the R.M.E.-69 without mismatch.

The tuning dial is accurately calibrated in frequencies on the same lines as the DB-20, so that users will not have any difficulty in locating the various ultra-high frequency bands.

As this converter is suitable for use in front of almost any receiver, and is a completely self-contained unit with a highly efficient RF stage, it presents an easy solution to satisfactory ultra-high frequency working. It has an image frequency ratio of 750 to 1 at 60 Mc., 2,750 to 1 at 45 Mc., and 10,000 to 1 at 39 Mc. Readers who have ideas about picking up television sound programmes at long distances will find the 510X frequency expander most suitable for that purpose. The price is £13 15s.

New radio showrooms of the A.C.S. Company have now been opened at 16 Grays Inn Road, London, W.C.1, where readers can obtain a demonstration of this and other short-wave equipment.

The Hallicrafter Sky Buddy

Although amateurs are rather inclined to associate the title of communication receiver with an instrument embodying a large number of valves and, of course, being sold at a high price, the Hallicrafters have produced what they term an Amateur Communication receiver which, although not up to the standard of the multi-valvers, will give a very good account of itself in the hands of those who want to obtain the best results on short waves with the very minimum cost.

The new Sky Buddy, Model S.19, has already become very popular in this country during the short time it has been available. It is a 5-valve, three band super-het covering 540 kc to 18.4 Mc. with separate coils on each band. The main tuning dial is calibrated in kilocycles on band 1 and megocycles on bands 2 and 3, while a new improved mechanical band spreading system is perfectly satisfactory when used on the congested amateur frequencies.

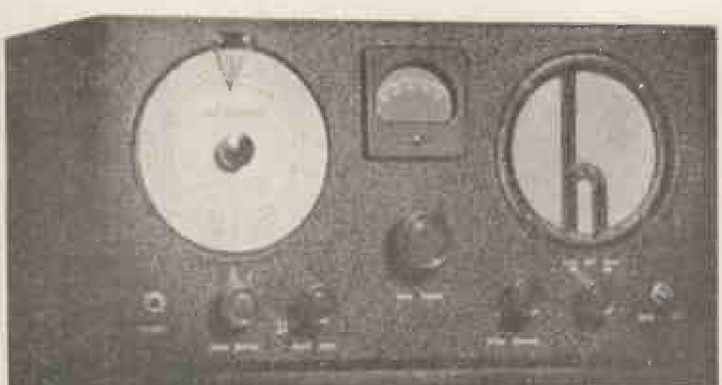
The valve line-up is a 6K8 first detector-mixer, a 6L7 IF amplifier and beat-frequency oscillator, 6Q7 second detector AVC control valve and first audio amplifier, 6K6 audio output valve and 80 rectifier. This gives the equivalent of 9 single valves, for the 6K8 fulfils two functions, that of first detector and oscillator, the 6L7 that of IF amplifier and beat-frequency oscillator, and the 6Q7 as a diode second detector, diode AVC control valve and triode first audio stage.

A headphone jack is mounted on the panel, which is arranged so that no DC current flows through the winding, also when the phone plug is inserted the loudspeaker is automatically disconnected.

The transmitting amateur will appreciate the fact that stand-by switch is included, which cuts off the H.T. supply while provision has been made for either a doublet aerial or for a Marconi aerial with earth connections.

The beat-frequency oscillator circuit is semi-tuned, and is arranged so that

(*Continued on page* 446)



The Sky Buddy Receiver although only using five valves has a performance equivalent to a nine stage receiver.

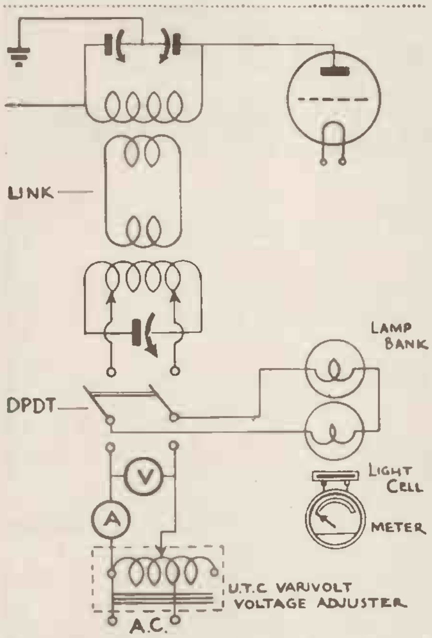
Hints and Tips for Amateurs

By G5ZJ

Several new ideas which are suitable for amateur use have been gathered together in this article.

Checking Radio Frequency Power

IN order to tell whether a transmitter is operating efficiently, one of the most important factors is the amount



This comparative method of checking R.F. power is a simple method that is most useful to the amateur.

of R.F. developed as compared with the D.C. input. To check this to any degree of accuracy, is rather difficult and calls for expensive measuring equipment, but some simple tests can be made by means of the circuit shown in Fig. 1.

The operation of this circuit is briefly as follows:—A dummy load is coupled to the tank circuit of the amplifier under test, and the values of capacity coupling and the number of lamps adjusted to obtain maximum output from the amplifier.

The brilliancy of the lamp bank is then either noted by eye or measured with an illumination meter. A suitable meter is that supplied for photographic work or one can be made up quite quickly with the aid of one of the new Tungsram photo-electric elements which gives a very high current output for a given amount of illumination.

Then switch the lamps back to 250 volt 50-cycle mains and adjust the voltage to obtain the same degree of brilliancy as was obtained from the transmitter. Since the lamp is practically non-inductive the error will be small enough to be neglected for the purpose of this test. The power output of the amplifier under test may be considered as the 50-cycle power necessary to obtain the same brilliancy from the bank of lamps when fed by either 50 cycle mains or the R.F. from the transmitter. P = I x E at 50 cycles.

The Class C Amplifier

This type of amplifier must have ample excitation and be so adjusted as to be linear when the anode voltage is varied from zero to twice the operating potential. In other words the anode current should vary directly as the anode current over the entire range.

This condition is usually obtained when the bias is equal to between two and two and half times cut off and with correspondingly high excitation. The capacity in the tank circuit of such an amplifier should be somewhat greater than for CW operation, but the value depends on the frequency in use, anode voltage and anode current.

The following formula will give the approximate value of capacity to be used for single-ended grid neutralised amplifiers on CW, for phone operating multiply by two, for split tank coils, divide by four and for anode neutralised amplifiers use one quarter of these values.

The formula is $C = \frac{2,600,000}{f \times Rb}$

where C = capacity in mmfd. f = frequency in Mc. and Rb = the anode load resistance.

Amplifiers used as frequency doublers are essentially of the distortion type. In order to produce maximum harmonic output, these amplifiers are operated with high bias and plenty of excitation. Usually the pentode is superior to other types of valves for this purpose for it requires a comparatively small amount of drive. If a triode valve is used then the impedance should be reasonably high, in excess of 10,000 ohms, with a slope of approximately 2.5 mA. per volt.

Conversion of Power to dB Level

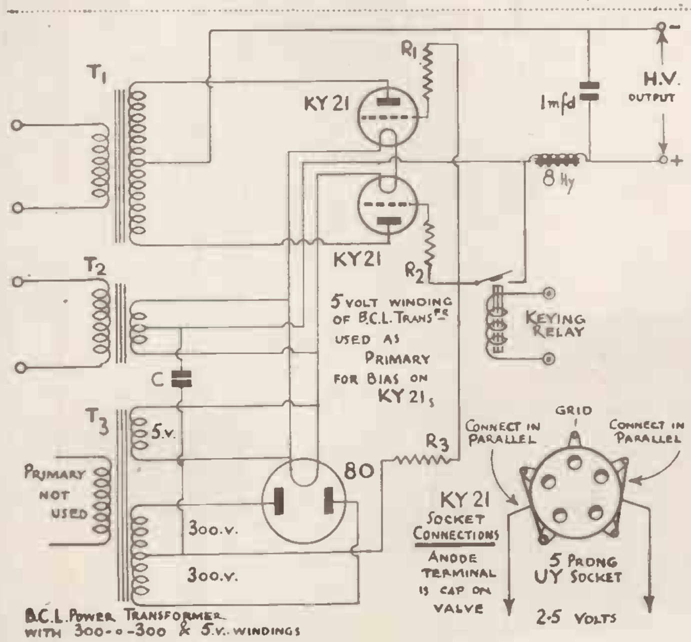
As amateurs well know the standard of electrical energy comparison is the decibel which has been based on a reference level of o-db at a power level of .006 watts. This means that energy level greater than .006 watt are plus dB compared to a reference level and energy levels less than .006 watt are minus dB compared to reference level.

It is also assumed that 6-dB are equivalent to one R strength and as it takes approximately four times the carrier power to enable a 6-dB rise to be obtained, amateurs will probably appreciate more fully the difference between an R8 and R9 report.

A Keying Rectifier

A new valve recently produced in California is the KY21 Eimac mercury vapour grid control rectifier. The control electrode prevents any flow of

(Continued on page 447)



For the C.W. man the keying rectifier offers a new system of clickless keying which has great possibilities. The valves and other equipment needed are now available in this country.

"A 1-V-1 Battery-operated Receiver"

(continued from page 423)

the 40 metre bands that the L2 trap circuit was most useful.

The switch embodied which is of the 5-point Yaxley type brings into circuit as required any one of the four coils. When switched to the fifth position, the aerial is connected to the top end of L5 through VC6.

In order to reduce the amount of panel space taken up, I have made use of, for the first time, the new Eddystone flexible couplers, which can be used to drive almost any component up to an angle of 90 degrees. By using these couplers the condenser can be mounted on the chassis, and controlled from the panel, which is a most satisfactory arrangement. Similarly with the screen voltage control which is mounted on the dividing screen. This is operated from the panel, even though it is 2 in. out of true, by means of another flexible connector. The two switches which are in series with the HT and LT supply are an integral part of this control so that volume is reduced to zero at a point just before the receiver is switched off.

All Wavelengths

I have used this set on wavelengths of between 9 and 175 metres, being primarily interested in amateur band reception, but standard Eddystone coils are available to cover wavelengths up to 2,000 metres. The selectivity with such coils on the higher wavelengths is not too good, although colonial listeners will find it quite satisfactory for reception of European broadcaster.

The regeneration control is quite straightforward in operation. Condenser VC5 is pre-set adjusted so that the receiver is just oscillating after which the receiver is brought in and out of oscillation by merely varying VR1.

The complete chassis with the dials and condensers already mounted can be obtained from Messrs. Peto-Scott, who built the original chassis for me, while they are also making arrangements to supply a kit of components.

"An Inexpensive Battery Charger"

(continued from page 430)

so to prevent this, we strongly suggest that constructors connect an Osram half-watt neon indicator on the transformer side of the switches. This half-watt indicator gives quite a bright light despite the low current consumed.

Here are some hints on operation :—If a 2-volt cell is to be charged, use a 7.5 volt tapping on the transformer secondary and connect the accumulator across the two output terminals with the correct polarity.

When charging two 2-volt cells, connect the negative side of one cell to the positive side of the other. This leaves a positive terminal on one cell and a negative cell on the other which should be correctly connected across the charger.

The same method of connection applies when using three cells connected in series, but this is the maximum number that can be charged at once. If, however, six 2-volt accumulators are to be charged, they should be connected in series parallel so that the total voltage is 6 volts, but then the charging rate will only be .5 ampere.

In no circumstances should the charging rate exceed one ampere otherwise this will cause damage to the rectifier unit. Constructors will find that by decreasing the value of series resistance that this charging rate can be increased. In order to prevent overcharging, we have obtained from Messrs. Galpin an inexpensive amp.-meter which reads up to 2.5 amperes so that the 1-amp. position is in the centre of the meter.

Providing the accumulators are kept well filled with distilled water to a point slightly above the top of the plates and that corrosion is prevented by keeping the terminals clean and covered with a film of vaseline the average modern accumulator should last indefinitely.

Much more accurate readings can be obtained with test equipment when the accumulators are kept fully charged, while every listener knows that the short-wave receiver will only give maximum results when the accumulator registers the full 2 volts on load.

"The Short-wave Radio World"

(Continued from page 434)

condenser in the grid circuit is essential for this reason.

Constructors will find the following values correct for use on 40 and 20 metres.

C8 two section 50-mmfd.
C9 25-mmfd.
C10 100-mmfd.
C11 .002-mfd.
R4 400-ohm 10-watt.

The coil L3 for 40-metre operation needs 30 turns of 18 gauge wire wound to a length of 1½ in. with a diameter of 1½ in. The same coil for 20 metres should consist of 16 turns with all other constants equal to the 40 metre coil.

On 40 metres L4 is made up of 26 turns of 14 gauge wound to a length of 2½ in. and a diameter of 2 in. This coil on 20 metres 10 turns with all other constants the same.

This transmitter has been designed for phone operation and the designer suggests a speech amplifier and modulator with the following valve line-up. The input valve a 6J7 with a 6C5 and two 6C5's in push-pull driving a pair of 6L6G's in push-pull.

An amplifier of this kind will give sufficient audio to modulate a 50-watt carrier and can be all D.C. operated. Although the filament currents with the valves suggested are not all equal they can be equalised by means of shunt resistors.

AN EFFECTIVE 10-METRE CONVERTER

A design of considerable interest is published in *Radio* and is the work of W8GNJ. It consists of a four valve converter using a 6L7 mixer valve with a 6K7 as the high-frequency oscillator. So far so good, but instead of connecting the output of this section to the input of the normal radio set the designer has also included a complete I.F. stage of the correct frequency so that all is needed to complete the unit is the second detector and audio stage.

The idea of this is to make sure that the converter is correctly connected to the proper input load which cannot always be done with commercial receivers. It also helps to reduce the noise level, a trouble very hard to overcome in short-wave converters.

The fourth valve is the rectifier in the power pack section so that the unit is quite self-contained. A frequency of 2,000 Kc. was chosen for the I.F. amplifier so as to give stability, freedom from noise and also allow the unit to be connected in front of a receiver designed only for amateur bands should the operator wish to do so.

It is suggested that the converter be used with a doublet antenna in order to reduce the interference from motor cars which were found to be very bad indeed owing to the high degree of sensitivity.

As the converter is only for one band operation it is also suggested that the coils be wound with 14 gauge wire and soldered directly into circuit across the condensers.

Recent designs of short-wave converters have indicated that this method of reception can be as good as with a modern super-het short-wave receiver with its high cost.

"New Amateur Receivers"

(Continued from page 442)

the pitch of the note can be varied to suit individual requirements. Also, immediately the B.F.O. is switched into circuit, the A.V.C. is disconnected, so making it impossible to have automatic volume control when receiving C.W.

The I.F. selectivity is perfectly satisfactory due to the use of one iron-cored I.F. transformer, and while image interference is noticeable, the ratio is good for a receiver without a pre-R.F. stage.

This instrument, complete with valves, built-in loudspeaker and all accessories, is priced at £9, and readers can obtain demonstrations from Messrs. Webbs Radio, Ltd., 14 Soho Street, London, W.1.

"The 6L7 as an R.F. Amplifier."

(*Continued from page* 436).

from Fig. 1 by joining the points of intersection of E_{c1} and $E_{c3} = RE_{c1}$

Since the transconductance of the 6L7 can be reduced to 5 microhms with 15 volts of A.V.C. voltage, and since the 6L7 is capable of responding to comparatively strong signals with little distortion, this valve may be employed successfully as the I.F. amplifier valve in a receiver having only one stage of I.F. Such a receiver can be made to have a fairly flat A.V.C. characteristic and respond to strong local stations without introducing excessive distortion.

"Hints and Tips for Amateurs."

(*Continued from page* 444).

current through the valve until negative potential on the grid reaches a certain minimum critical value. The grid will not regain control until after the voltage existing between filament and anode has reached an approximate zero. If the grid remains slightly negative in respect of the cathode, and it is not sufficient to prevent the passage of anode current, it will be found that the anode current does not start over the initial portion of the cycle.

These characteristics make possible the use of the grid controlled rectifier as both the rectifier and the power controlled tube. The KY21 permits of the control of 5-kilowatts of power (3,500 volts at 1,500 mA.) at the highest possible speeds found in manually keyed transmitters. The control power required is negligible and can either be supplied by D.C. or tone.

Properly used the grid controlled rectifier practically eliminates key clicks.

A suitable circuit is shown by Fig. 2 on page 444. The grid controlled valves are prevented from conducting by means of a bias voltage obtained from a small power unit consisting of a BCL transformer, a type 80 rectifier and a .5-mfd. filter condenser.

In order to utilise commercial transformers without the expense of special insulation between the windings, the whole transformer is isolated from earth by insulating the transformer for anode voltage from the metal chassis.

The 250-volt primary is not used as the energising voltage is obtained from the already well insulated secondary of the filament transformer. The 80 rectifier valve is heated by voltage taken directly from the same windings. If a 2½-volt filament transformer is used, an 82 valve can be substituted.

The relay which short circuits the bias voltage must have its armature insulated for the total anode voltage to earth.

A suitable relay is the Ward-Leonnard type 507-516 which Messrs. Webb's Radio have obtained specially for this circuit.

The bias voltage necessary is about 100 or so, although there is no objection to using up to 300 volts.

"Simplified Volume Expansion"

(*Continued from page* 440)

amplify to the full. The amplified voltage is applied through a resistance capacity coupling to the main power amplifier where it can be handled in the normal manner.

It will be observed from the diagram that the rectified output from the diode is applied to the slider of a potentiometer which is the G_1 C_2 bias resistance. By adjustment of this slider varying degrees from zero to maximum contrast expansion may be obtained, zero expansion being when the slider is at the earthed end of this potentiometer. A small fixed negative bias for the heptode is provided by tapping off the G_1 G_2 bias resistance, as shown.

A point about this circuit is that no negative bias is applied to any of the control grids in the amplifying chain which would give rise to distortion. It will also be seen that part of the input is applied through a one megohm resistance to the output of the expander unit. It is found that this small injection of input voltage serves to maintain the contrast expansion linear so that the loudest and less loud passages get expanded to the correct relative degree.

With the circuit given a pick-up output of approximately one volt is assumed, such as is given by a piezo electric crystal pick-up. For pick-ups which give an output less than this, such as needle armature types, it is advisable to increase the amplification before the diode rectifier, which can be done either by substituting a step-up transformer instead of the resistance coupling shown, or by adding another stage of R.C. amplification with another triode. Failure to do this with a low output pick-up will result in insufficient expansion, and disappointment.

It is also advisable to include a series resistance with high voltage pick-ups of the piezo electric type, as shown.

In employing a Contrast Expander Unit certain precautions must be observed and these are as follow:

(1) It is important that the unit obtains its H.T. from a source separate from that of the main amplifier as the H.T. negative is not in this case at earth potential. A separate rectifier valve is therefore required for the Contrast Expansion Unit. Alternatively, if the same H.T. supply is used, the chassis of the unit must not be allowed to make electrical contact with the main amplifier—that is either chassis may be earthed, but not both.

(2) To obtain the results required it is important that the volume control should *not* be between the pick-up and the Contrast Expansion Amplifier. Audio frequency volume control must be obtained at the input to the main amplifier, immediately after contrast expansion.

(3) In order to avoid distortion on the loud passages it is strongly recommended that a high power output stage be used in the main amplifier, such as that afforded by two power triodes in push-pull. Failure to have a good output stage feeding the loudspeaker will result in harsh reproduction when the amplifier is fully expanded.

(4) As stated above, do not expect that the Contrast Expander can be set at a fixed position for every record. This should be adjusted to suit individual requirements. It may be necessary to adjust the main volume control at the same time as the degree of setting of the contrast expansion potentiometer.

The circuit shown is arranged to give an output of approximately 5 volts r.m.s. for an input of one volt to the heptode grid, and the main amplifier should, therefore, be designed to accept this input on the first valve without distortion. Any normal medium impedance triode will do this satisfactorily.

Amateur television receiver constructors who require cabinets to house their receivers should get into touch with Samson Radio, of 4 Praed Street, Paddington. This firm have a number of very fine surplus cabinets at a remarkably low price.

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