TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

NEW SERIES

PUBLISHED BY THE PROPRIETORS OF "AMATEUR WIRELESS" AND "WIRELESS MAGAZINE"

JANUARY, 1934

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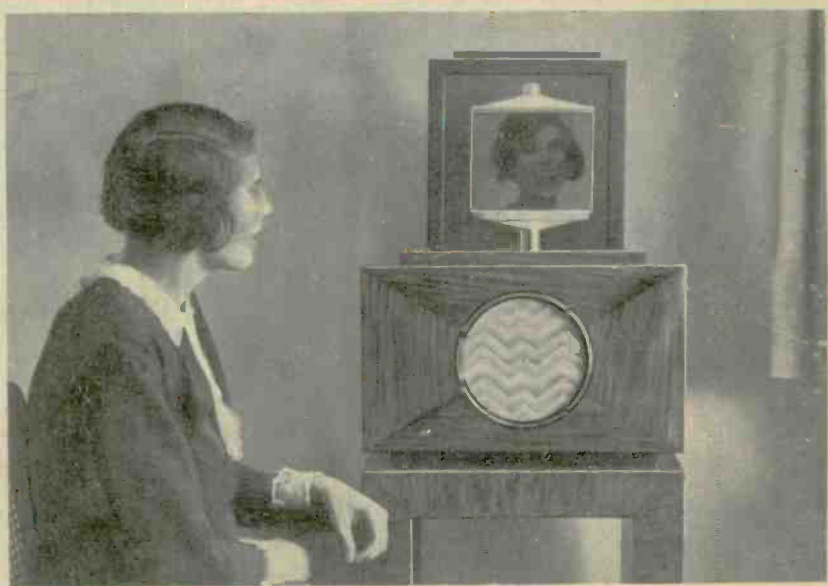

A MIRROR-SCREW RECEIVER

The mirror screw receiver is one of the most efficient of the mechanical type yet produced and it has the further advantage of simplicity. The screw is built up of a number of flat metal plates arranged in the manner of a spiral staircase. The receiver illustrated is the "Texade."

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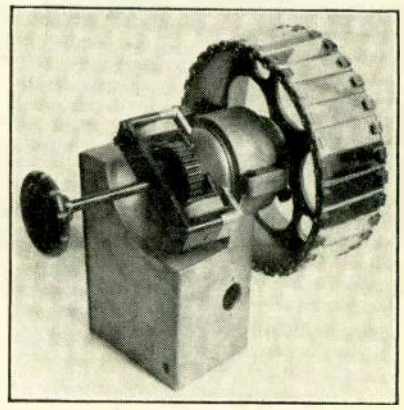

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Motor and synchronising gear only	5	0	0
Mirror Drum with flexible coupling	5	10	0
Grid Cell unit complete with projector lamp	5	0	0
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Variable Resistance		17	6
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Baird Grid-Cell Unit Prices.

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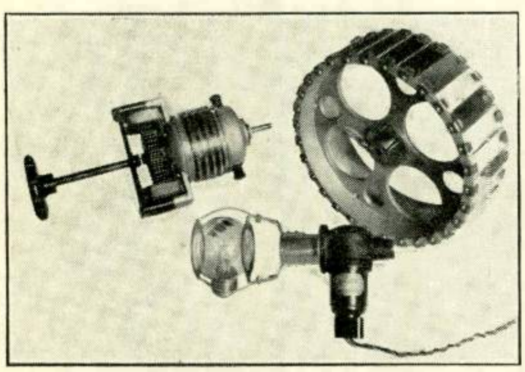
Grid Cell alone, each	2	0	0
Square ended polarising prisms—			
6 mm. aperture, each		17	6
7 mm. aperture ,,	1	2	6
8 mm. aperture ,,	1	7	6
Projection Lamp (12-volt 100-watt) each		12	0
Grid Cell unit complete with prisms, lens, mount and projector lamp, each	5	0	0



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Phone : VICTORIA 7238. **Telegrams : "TELEVISOR, SOWEST, LONDON."** **Phone : TEMPLE BAR 5401.**

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TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

In This Issue

Constructive criticism of the B.B.C.'s policy of television broadcasting by Mr. S. Sagall, Managing Director of Scophony, Ltd.

* * *

The first of a series of informative articles, by G. Parr, on the problems of cathode-ray television.

* * *

Full constructional details of the first mirror-screw receiver for the amateur—a cheap, simple and efficient apparatus for the home-constructor.

* * *

A practical and informative article on the theory of the Kerr cell, by J. C. Wilson.

* * *

First and exclusive pictures of the Scophony receivers.

* * *

Records of latest developments, including the first description of a novel receiving system.

* * *

" Electro-optics "—a comprehensive report of the December lecture given before the Television Society.

* * *

Some considerations on the design of an H.F. stage in a television receiver.

* * *

" Easy-to-understand " instructions for connecting the neon lamp to the wireless set.

TELEVISION

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COMMENT OF THE MONTH

Ourselves.

WITH this issue, TELEVISION passes into the hands of Bernard Jones Publications, Ltd., proprietors of AMATEUR WIRELESS and WIRELESS MAGAZINE, and thus comes under the control of publishers whose sole interests in the past have been devoted to wireless publications and who are therefore in a unique position to direct a journal devoted to a subject which is so closely allied to radio.

The advantage of such an association need not be stressed, but it may be pointed out that a highly trained technical staff and research facilities are now at the disposal of this journal.

Whilst the publication of a separate magazine devoted to television is a new step for the present publishers, there is nothing new whatever in their association with television itself. The Editor and Staff of TELEVISION and its associated technical papers have been present at every outstanding demonstration of television during the last ten years and have kept closely in touch with the whole subject. Indeed, ever since the practicability of television became apparent, AMATEUR WIRELESS has assisted and encouraged its development and this has been a considerable factor in the determination of the publishers to acquire this journal and thus give their energetic assistance to the furthering of a policy which can be summed up in four words " The Development of Television." To this end our energies are pledged and our readers' support is invited.

The B.C.C. Transmissions

WE publish below the latest official statement of the B.B.C. regarding the television transmissions, and refer our readers to the excellent summing up of the position by Mr. S. Sagall on other pages in this issue.

"In September notice was given to Baird Television, Ltd., of the termination on March 31, 1934, of the arrangement under which regular television programmes are transmitted on a medium wavelength using their "30-line" system.

Meanwhile, experimental work is being carried out with high-definition systems transmitted on ultra-short wavelengths. Such systems offer more possibilities of future development than the low-definition systems, although only the latter can be transmitted on medium wavelengths. If, however, the development of high-definition television is not sufficiently stabilised by March 31 to justify regular transmissions by any of the methods tested, then the B.B.C. may continue transmissions, probably twice a week, using the low-definition method on an ordinary broadcast wavelength, with a view to assisting those members of the public who are experimenting in television. These transmissions would depend on future development, with no guaranteed duration."

We may remark that, even assuming that the high-definition experiments are a success from a technical point of view, it is quite improbable that the apparatus required for the reception of these transmissions will be within the reach of any considerable number of people, whereas those participating in the reception of the 30-line transmissions are a steadily increasing section of the listening community, and this would immediately be enlarged were some definite statement of policy forthcoming.

Television *in* 1934

By S. Sagall

Our authoritative contributor is Managing Director of Scophony Limited, and one of the pioneers of commercial television. Scophony Limited is engaged on the development of a novel system of sound and picture communications, based on Mr. G. W. Walton's inventions. Secrecy still surrounds the technical activities of the Scophony laboratory, though some conception of the revolutionary character of the inventions may be gained from the photographs, the first ever to be released by Scophony Limited and placed at the exclusive disposal of "Television."

Mr. S. Sagall, Managing Director of Scophony Ltd.

WRITING this as I do in the last days of 1933, the heading may suggest "prophisus." In television we have had, during the last five or six years, far too many of them. I am accordingly dealing with "realities" and actual achievements.

I feel that the time has arrived when a complete case must be made out for "30-line television," and if convincing, this view must be supported by the full weight of public opinion, before it is too late.

It is my opinion that a great stimulus was given to the development of television in this country by the fact of the B.B.C. establishing, some eighteen months ago, a regular television broadcasting service. The entertainment value of the programmes offered at the commencement of the transmissions was very low, and it was only early this year that a remarkable improvement became apparent. The B.B.C. was the first—at least, as far as Europe is concerned—to make a proper and thorough study of the whole problem of television studio technique and its specialised requirements. The B.B.C. justly deserves the compliments of all those interested in the art, for the part it played in bringing the 30-line transmissions to such a high standard.

Improved Technique

Compare "30-line" pictures as seen a few years ago, even those of twelve months ago, with what is offered now. *What a vast improvement!* One would never have expected that such results could be obtained from what is, *after all*, only a 30-line picture.

This tremendous improvement is, of course, also due to the *greater efficiency of modern television receivers*. The difference between a 30-line picture of a few years ago, the size of a postage stamp, as seen on a Nipkow disc, and a B.B.C. picture received on a Scophony 30-line rotating echelon (size of picture 3½ ins. by 8½ ins.) or on a Baird mirror-drum, is like that between a doll with eyes made to move and a strong healthy infant.

Now, at some time or other, complaints were made by those "ruling the waves" that the public shows very little interest in the television transmissions. Of course, the number of those possessing television receivers was bound to be small, as long as there were no sets on sale. And, naturally, manufacturers would not take the risk of bringing out a receiver until the entertainment value of the picture was amply proved.

A Set Back

I would submit that this stage was reached by the end of the summer 1933. Scophony, Ltd., felt that there was a growing demand for an adequate receiver and made arrangements to place it on the market. About the same time, the Bush Radio receiver became available. It seems, however, most incomprehensible that just *then* (in September, 1933) the B.B.C. should intervene by announcing the possible discontinuation of the 30-line television transmissions. As far as Scophony, Ltd., was concerned, all manufacturing arrangements had to be *suspended*. The latest statement by the B.B.C. leaves the position and everybody concerned very much in the dark, so that, of course, no further progress in the direction of supplying the public with good receivers can be made.

The reasons publicly given by the B.B.C. *in defence* of their attitude—because defence it needs—is that experiments are proceeding on high-definition pictures, which would be so much better, and therefore it would not be worth while to go on with 30-line transmissions.

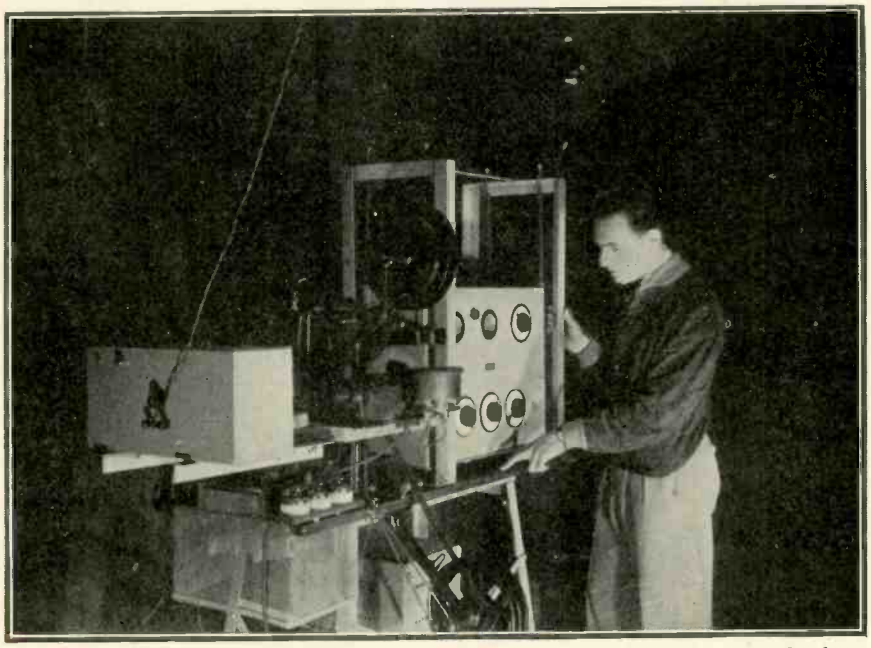
Quite frankly, I consider this attitude of the B.B.C. to be technically *injudicious* and *retrogressive* as far as the interests of television in this country are concerned.

Everybody, even the uninitiated, would appreciate the fact that a 120-line

Mr. G. W. Walton, the inventor of the Scophony system.

THE FIRST SCOPHONY PICTURES

picture is superior to a 30-line picture. Speaking, however, with some measure of intimate knowledge of the problems involved in "putting over" such a high-definition picture, I would say that it would be unjustified optimism to anticipate a *regular* high-definition transmission service, on the lines of the present 30-line transmissions, *in several months' time.*



Scophony high-definition (120 *lines*) *picture and sound transmitter with Mr. J. Sieger of the Scophony laboratory.*

A German Opinion

The German experimenters have shown at the recent (August, 1933) Berlin Radio Exhibition television pictures with a definition of 180 lines. One would have therefore expected that there at least one would find complete unanimity in favour of high-definition pictures. The more interesting it is, therefore, to quote an article published in "Ferntechnische Umschau" of "Der Radio-Haendler," November, 1933, issue, in which a prominent Berlin television scientist, Dr. Skaupy, expresses his regret at the decision of the B.B.C., which seems to him a retardation of the development of television, and not progress.

Referring to the "180 lines" German cathode-ray pictures, Dr. Skaupy says that while the number of picture-lines would be adequate, "there is, apart from the difficulty of transmission with ultra-short waves, and their various disadvantages, also, as known to the experts, the problem of synchronisation, which involves considerable difficulties," and he further points out "that the making of cathode-ray tubes, which would preserve unvaried, over a long period, their small gas contents, which is essential for a sharp concentration of a picture, is not at all easy, and the observers of cathode-ray pictures (as shown at the Berlin Radio Exhibition) were, of course, not aware of the great and enormous trouble involved in their making."

Two Kinds of Transmission

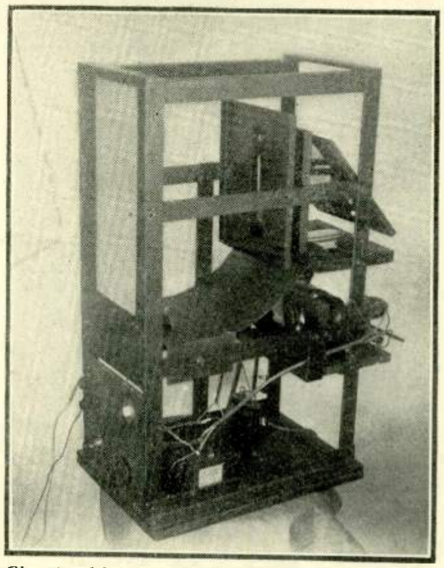
Interestingly enough, Dr. Skaupy arrived at a conclusion which, though always held and on occasions expressed by the writer of the present article, should sound almost like a "heresy" when coming, as it does, from a writer living in a country which at present, as far as publicly demonstratable results go, has more to show in high-definition developments than this country. He suggests that—please note, even in Germany—*there should be two kinds of transmission, one of low-definition pictures*, available for the larger masses and within their reach, owing to comparatively low price of apparatus and ease of handling, and *one of high-definition*, for the reception of which, for some time to come, more expensive and more complicated apparatus, and accordingly with an appeal to a different class of people, would be required. He is of the opinion that the two services may exist *simultaneously for many years to come.*

I completely endorse this view. Though, for instance, the laboratory of Scophony Limited is engaged on the development of high-definition television, which, because it deviates from the normal routine, may bring considerably nearer the day when a comparatively simple and reasonably priced *high-definition* (say, 120 lines, the Berlin Radio Exhibition having shown that even a 90-line mechanical device was superior in definition to a 180-line cathode-ray tube) receiver would be made available for the large masses, a 30-line receiver would undoubtedly for some time to come be much cheaper than a 120-line receiver, and therefore more accessible to the man in the street, and particularly to the technically-minded amateur.

Apart from this, there is the fact that it may be years before the country would be covered with regional short-wave transmitters, radiating television programmes limited more or less to the visual range. *30-line transmissions can, however, be received over comparatively long distances.* (Excellent B.B.C. pictures were received on the Scophony

Small model of 30-line television receiver, employing the Scophony rotating-echelon principle. Actual size of television unit is easily visualised from this picture. The picture shows also the size of the moving part used in this type of receiver, which is held between the fingers of Mr. G. Wikkenhauser of the Scophony laboratory. This model, used with a mercury lamp, is capable of giving a satisfactory projected picture 3½ in. by 8½ in. and the moving part can be driven and synchronised by the output of a small valve.

receiver in Manchester, and quite recently, while in Vienna, I became the recipient of congratulatory appreciation of the quality of the B.B.C. 30-line transmission from the Chief Engineer of a leading telephone firm, who



Chassis of large model of 30-line receiver, employing the Scophony rotating-echelon principle.

receives the London transmissions regularly. (As a matter of fact, a 30-line B.B.C. picture on the Scophony receiver is nearly as good as a 90-line cathode-ray picture.)

Further Improvement Possible

Further, it is very likely that even now the last word regarding *low-definition pictures* has not been said yet. They may be capable of further development on the *present normal wave-lengths*. The B.B.C. may perhaps be well advised to try out on a somewhat shorter wave length than the one at present used, while still remaining within the medium wave lengths' range; an increase of picture definition to, say, 40 and perhaps even 60 *lines* may be quite feasible.

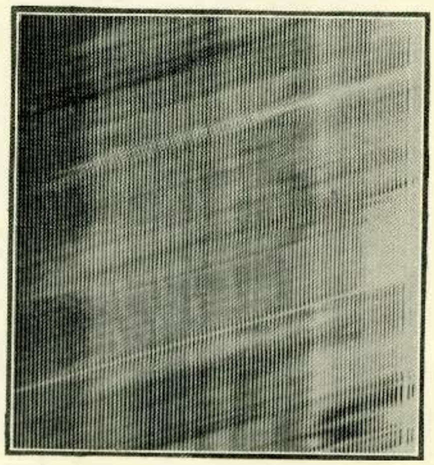
I would therefore submit for the serious consideration of the appropriate technical circles and the B.B.C. as a practical suggestion that for the *next two years at least* the 30-line transmissions should be continued, and that they should be treated as a service *independent* of any progress made on high-definition pictures.

I would further suggest that the facilities for receiving 30-line transmissions should not only *not* be curtailed, but more convenient reception hours should be arranged. The B.B.C. may be well advised to consider the introduction of television during their normal broadcasting hours as a *pictorial illustration* and adjunct to ordinary items in the programmes. For example, the B.B.C. could with ease transmit on the television wave length the picture of the party leader debating the future of the British Empire, of prominent singers, lecturers, etc. The addition of vision in such a way would greatly enhance the value of the sound entertainment offered, and would probably have a greater appeal than the "eleven-o'clock-at-night-half-hour-transmissions."

The Cost

There is one further aspect to be considered. Arguments have been advanced that the B.B.C. may not be justified in spending several thousand pounds per annum out of the wireless licence fees on provision of television programmes for a small number of people. Informal computations bring the number of owners of various kinds of television receivers in this country to between 10,000 to 13,000. I believe, therefore, that television is already paying its own way. But even apart from this, very few subscribers amongst the nearly six million owners of licences would object to the B.B.C. spending in fostering television even five or ten times the amount it now spends.

The development companies and the technical circles are justified in asking



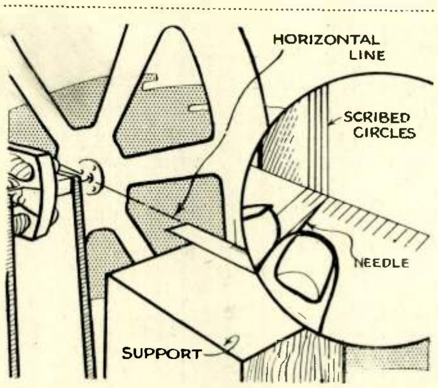
Scophony type of film, based on Mr. G. W. Walton's stixograph invention. This invention is a novel method of pictorial representation, in which the pictorial limits of position and size of details are only in one dimension. This type of film is of great value in all cases, where there is motion of a picture relative to apparatus. It is also of value with animated pictures, as it is a true continuous record. Intermittency of exposure and movement of film is eliminated and the rate of movement of film is one to five mm. per second, compared with the 450 mm. per second of ordinary film.

the B.B.C. for an immediate reconsideration of its attitude and a final, this time clear-cut statement. A positive decision, giving a guaranteed continuation of 30-line pictures for a minimum of two years would enable interested manufacturers to supply the public demand for efficient 30-line sets.

Setting Out a Scanning Disc

AMATEURS who like to make as much of their apparatus as possible will no doubt be interested in the following method of making a scanning disc which was adopted by an enthusiastic reader.

The first procedure was to divide the disc into thirty equal parts, and this was done by first making six divisions by stepping the radius round the circle. Each of these divisions was then divided into five by means of a protractor. Next the disc was permanently mounted on the motor shaft by means of the usual boss. A strip of thin brass was then dug out of the junk box and a line scribed down it about a sixteenth of an inch from one edge, the line being then marked off to the picture width and divided into thirty sections. A centre punch mark was next made at each section, and then the sixteenth of an inch filed off down to the punch marks so that the result was a scale with slight indentations.



This drawing shows how the lines were accurately scribed on the disc.

The sketch will explain the rest of the procedure. The motor was started up, the scale rested on a block of wood and a gramophone needle mounted in a slip of wood held against the revolving disc.

Could be £20 per Magazine

the Neon to Your Wireless Set

... en ... all ... can- ... nent ... ibers of an... w to connect the neon ... eivers to effect vision reception.

In presenting the accompanying pictorial sketches, to illustrate the several suitable systems of connection, no apology, therefore, is necessary.

Before attempting to interpret the different circuit arrangements, it will, perhaps, be best to discuss the simple principles involved.

First of all, the neon-tube is that which supplies the light necessary for the perception of the pictures by the human eye. This light source alone is not sufficient for vision-picture reception, however, as some method of modulating the light—causing it to increase and decrease in brilliancy—is necessary.

The wireless set effects this operation. It picks up minute electrical impulses, which represent the vision-picture transmissions, and when these are applied to the neon-tube they add to and detract from the initial energy which causes the neon to light. Thus the brilliancy of the neon light is varied.

Knowing, now, the *modus operandi* of the essential parts, we can go ahead and determine how best to couple up the apparatus to effect the desired results.

We have already stated that there is an initial energy required to cause the neon to light up. The amount of energy varies a little, but is usually in the neighbourhood of 170 to 200 volts at 30 milliamperes, and is known as the "striking" energy. This amount of energy is not usually available except in the case of mains-operated sets, or those making use of large super-power valves.

(*Continued on foot of page 9.*)

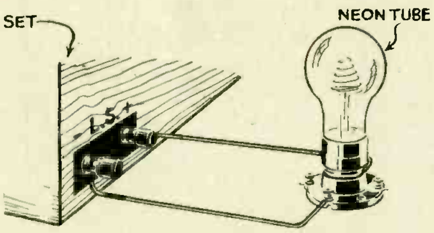


Fig. 1. (left) A circuit suitable when there is ample H.T. voltage.

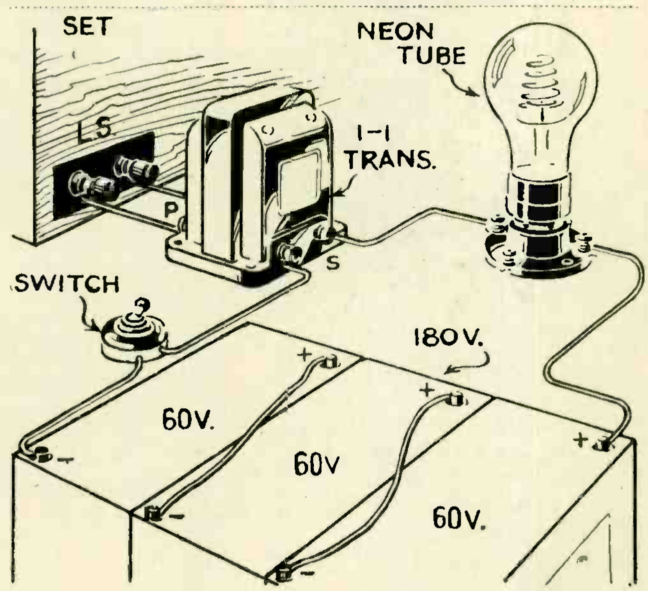


Fig. 3. Using a separate source of H.T. for the neon.

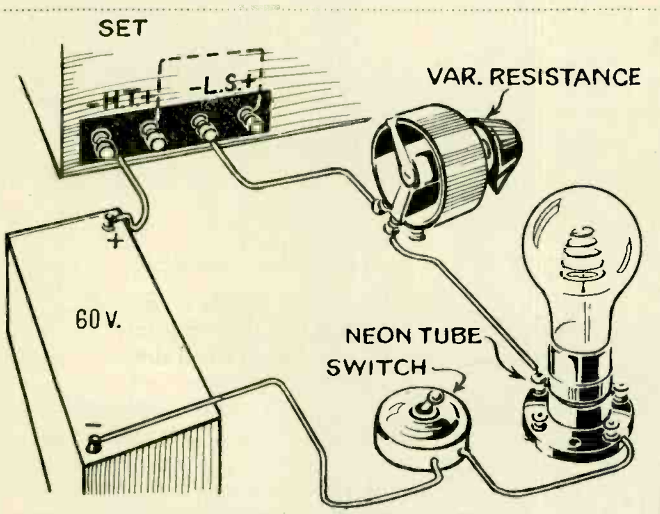


Fig. 2. An arrangement for use when the normal H.T. for the set is not sufficiently high.

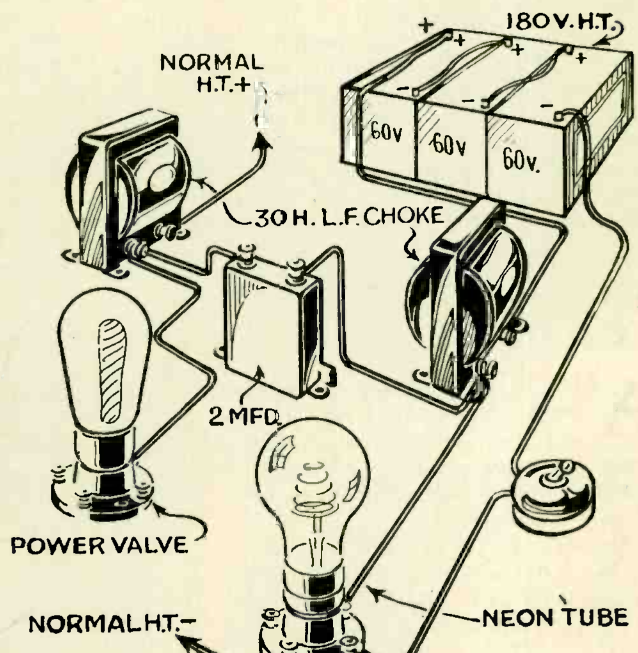
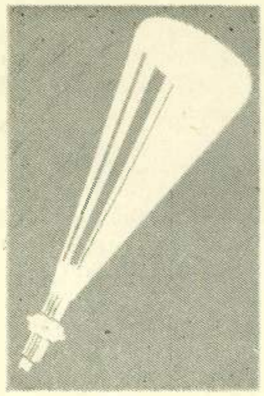


Fig. 4. This is the arrangement when the wireless set has choke output.

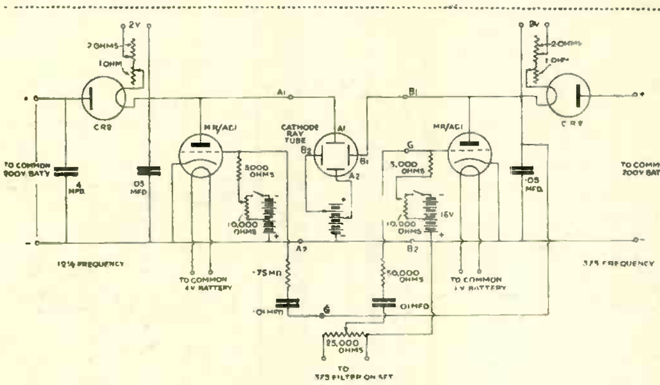


Some Problems in Cathode-ray Television

IN the July issue of TELEVISION an article appeared on the application of the cathode-ray oscillograph to television.

The developments of this new branch of the science are being closely investigated, and this article is a forerunner of a series which will deal in a practical manner with the use of the cathode-ray tube and its associated circuits.

The production of the line screen at the end of a cathode-ray tube is a comparatively simple matter so far as the electrical circuits are concerned, but the technique of producing satisfactory images requires a knowledge of the behaviour of the tube itself and of the various factors which affect the modulation and movement of the beam. A typical double time base circuit is shown by Fig. 1 in which the movement of the beam in the vertical and horizontal directions is actuated by a condenser-resistance combination discharging through a thyratron.



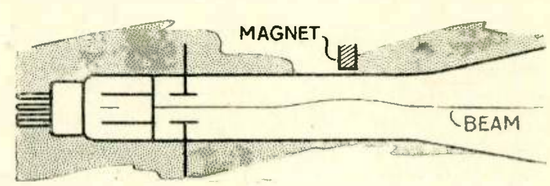


Fig. 1. (left) Circuit diagram showing connections of double time base to the cathode-ray tube.

Fig. 2. (above) Effect of strong magnetic field on the beam.

Interference

It is important to remember that the cathode ray is deflected by both electric and magnetic fields, and the majority of defects in the formation of the screen itself can be traced to magnetic interference from an outside source.

The earth's field is a permanent influence in this respect, weak though it is, but its effect is offset by the fact that it does not vary in magnitude or direction, and hence it can be allowed for by orienting the tube or by applying a slight opposite bias from a weak magnet placed nearby. Another similar source of trouble may arise from the field magnet of a loudspeaker mounted near the tube. This may displace the beam to such an extent that a considerable opposing deflecting force may have to be applied to bring the beam into the centre of the screen.

The use of magnets for centring the beam is not altogether advisable if a strong field is required, since they tend to introduce distortion in themselves, if mounted close to the tube. The drawing of Fig. 2 illustrates the effect of a concentrated magnetic field in the path of travel of the beam, and it will be understood that the linear deflection and response will be upset if the beam is given a " kink " at one point in its travel.

By far the most common source of trouble is the mains transformer associated with A.C. receivers, or even the output transformer. The field surrounding these will give rise to an A.C. ripple, which will be superimposed on the travel of the beam in either the vertical or the horizontal plane, producing a result shown by a typical example in Fig. 3. Here the interference is affecting the vertical travel of the beam and appears as a wavy line at the end of the screen formation.

Another form of interference produces ripples in the lines themselves, and yet a third form produces light and dark bands across the screen, four in number if the A.C. is 50-cycle and the scanning speed is 12½.

This last effect can be turned to advantage in some cases since it enables the correct scanning speed of the horizontal time base to be checked by a stroboscopic method.

It might be wondered that the tube could not be protected against external fields by the use of a steel shield of high permeability, such as Mumetal. This

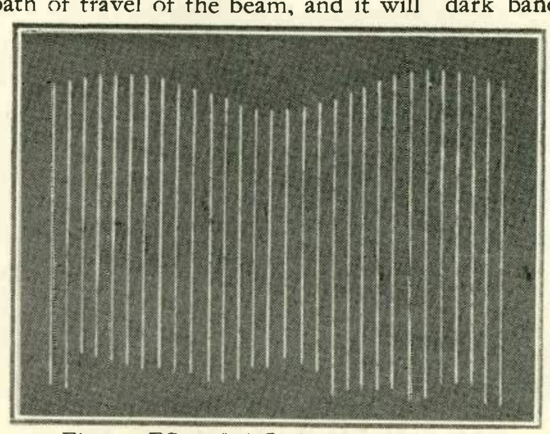


Fig. 3. Effect of A.C. ripple on scanning screen.

is of course possible, but the thickness of metal required adequately to shield the tube is such that the cost is almost prohibitive. There is also the risk that the shield itself may become accidentally magnetised and the remedy become as bad as the disease. On the whole, the best procedure for minimising interference from external fields is to mount the tube on a separate stand connected to the circuit by a multi-core cable. The most convenient mounting is a long box, lined on the inside with thin sheet copper for electrostatic shielding, the copper being connected to the anode of the tube. A further advantage of this arrangement is that the tube can be placed at a distance from the receiver for focussing and modulation adjustments.

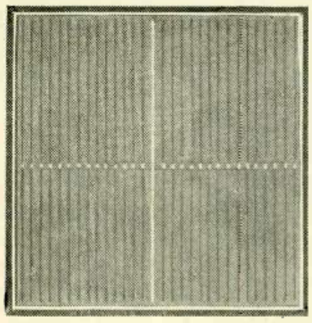


Fig. 4. Illustrating the threshold effect or slowing down of the beam movement at the centre of the screen. The method of obviating this is described in the text.

The best distance for viewing the image at the end of the tube is about 6-10 feet, depending on the size of the image and the detail of the picture, and if the controls are placed at this distance a better idea of the effect of the picture on an audience can be obtained.

The remaining points are principally concerned with the scanning and synchronising circuits, but before considering these there is a peculiarity in the screen produced by the cathode-ray tube which will immediately be noticed by the experimenter at the outset. This is the presence of a bright cross in the centre of the screen stretching for the full length of the screen in both horizontal and vertical directions. The effect is somewhat as shown in Fig. 3 and will clearly spoil the detail of the picture at the centre of the screen.

"Threshold Effect"

The cause of the cross is as follows:

The majority of cathode-ray tubes at present in use in this country are "soft" tubes—*i.e.*, they contain a trace of inert gas. The presence of this gas materially assists in focussing the beam, owing to the production of positive ions by collision with the main electron stream on its way up the tube. These positive ions drift into the main electron stream and form a core which tends to prevent the divergence of electrons from the main body, and thus keeps the beam within the smallest possible diameter.

Where the beam passes between the deflector plates, however, the presence of these positive ions is a disadvantage since at very low deflecting potentials their charge will have to be neutralised before the beam itself can be deflected.

This means that the response of the beam will be definitely less to small potentials than those above, say, 10 volts. On its to-and-fro travel, when the difference in potential between the deflector plates of a pair is very slight, the movement of the beam will slow down, and it will pause for a moment on "dead centre." The effect will be the brightening of the scanning line at this point, and in the line screen a series of bright points will appear as in Fig. 4.

This effect has been variously named "Threshold Effect" or "Origin Distortion," and depends on the amount of gas in the tube as well as on the anode voltage and cathode current.

Since the trouble is an electrostatic one, it does not arise when magnetic coils are used for deflecting the beam, and this is one argument for their use instead of deflector plates.

So far as the threshold effect is concerned in ordinary viewing, it can be obviated by shifting it to one side of the screen by a suitable bias applied to one of the deflector plates. The transverse bright line can be moved to the top or bottom of the picture where its effect is less marked, and the vertical line can be biased to the side.

The facility with which the screen can be moved by means of biasing potential applied to the plates is of the greatest possible help, and a simple circuit, showing how the deflector plates can have a small potential applied to them relative to the anode, (Fig. 5.)

Part of the conventional time-base circuit is shown, supplied from 150-300 v. H.T. Across the H.T. battery is connected a high-resistance potentiometer, the slider of which is taken to one of the pair of deflector plates (A_2). A_1, the "live" plate, is connected to the anode of the thyratron. Adjustment of the potential divider puts plate A_2 either at anode potential or above it to the full value of battery voltage. The use of a similar potentiometer for the other pair of plates enables the beam to be moved to any point on the screen.

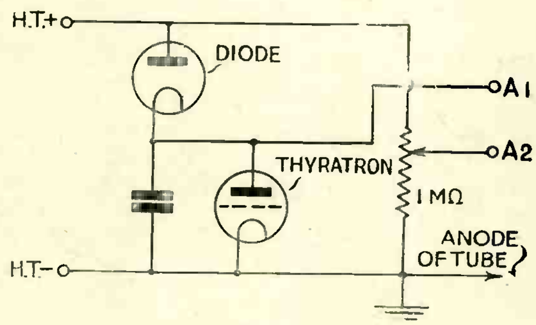


Fig. 5. Bias potentiometer for deflector plates.

Connecting the Neon to Your Wireless Set—*Continued from page 7.*

Fig. 1 shows a system of connections for the neon when there is adequate energy available, as in the case of the types of receiver mentioned above. It is the simplest arrangement possible.

Fig. 2 illustrates how an additional H.T. battery may be adapted to increase the normal H.T. energy available for the working of the neon. Here, a variable resistance, preferably of about 1,000 ohms, permits a very fine degree of adjustment for the operation of the neon. This resistance-control arrangement, by the way, may also be used in conjunction with the two remaining systems of connections.

Fig. 3 indicates a method of using entirely separate batteries for striking the neon—the 1-1 ratio output transformer being employed to isolate the striking energy from that which supplies the receiver.

Fig. 4, theoretically, is identical in effect with Fig. 3, in that it affords a 1-1 coupling device between the set and the neon, as does a transformer. It is of advantage wherever a set already includes a choke-filter output for the loudspeaker. All that is necessary is a further choke, similar in all respects to that normally used for isolating the speaker from the H.T. supply to the receiver, and the appropriate components common to the neon-tube supply.

In each case, it will be observed, the loudspeaker is omitted from the output of the wireless set.

News *from* Abroad

By OUR SPECIAL CORRESPONDENTS

Italy - Rome

NEW TRANSMISSIONS SHORTLY.

Ente Italiano par le Audiziono Radiofoniche informs us that at the moment transmissions of television on 25.4 metres have been discontinued. New tests are expected to commence shortly, but a definite date has not been given.

France - Paris

THE BARTHELEMY SYSTEM.

The well-known television research worker, M. Barthélemy, recently gave a demonstration of his television system at the laboratories of the P.T.T. to M. Laurent-Eynac, the new Minister. M. Laurent-Eynac expressed his satisfaction as to the results achieved, and we understand he issued instructions for regular television transmissions to be commenced in the very near future with the co-operation of the administration of the P.T.T.

There is a general increase of interest in television in France.

United States of America

TWENTY-EIGHT TRANSMITTERS.

Great interest is being taken in television development in the U.S.A., and all leading laboratories are conducting intensive research to establish television as a commercial proposition. Licences for experimental broadcasts have been renewed, including N.B.C. transmissions from New York on 2,750-2,850 kilocycles on a power of 5 kilowatts. Sparkes Withington, of Jackson, Michigan and the Western Television Research Corporation, had their licences renewed by the Federal Radio Commission.

At the moment there are twenty-eight televison transmitters in the United States, transmitting on the following frequency bands :—1,600-1,700 megacycles, 2,000-2,300 megacycles, 2,750-2,850 megacycles, 43-46 megacycles, 60-80 megacycles.

NEW AMERICAN TELEVISION SERVICE.

The Don Lee Television Broadcasting stations W6XS and W6XAO, Los Angeles, announce that from now on there will be transmissions of full-length feature broadcasts of cinema films. This is now part of the regular schedule, and is in addition to the regular transmissions of news-reels and close-ups.

To lessen sideband cutting which has so far been experienced, the Don Lee station W6XS changed on November 1 from 2,150 kilocycles to 2,800 kilocycles.

Dr. B. C. Goldmark, who was formerly in charge of the television research department of Pye Radio, Cambridge, has been appointed head of the research division of the Ray-O-Television Manufacturing Corporation in Long Island City.

ULTRA-SHORT WAVES AND FOG.

In Boston, Mass., U.S.A. it has been found from experience that 56-megacycle transmissions are greatly affected by fog and mist. Whereas in normal weather no appreciable increase of signal strength has been observed with the increase of power, in foggy weather quite an appreciable increase has been observed.

STANDARDS AT WHICH TO AIM.

Mr. W. Hoyt Peck discussed in a recent essay what constitutes perfect detail in television. In his opinion, the television image on 180 lines 18 in. deep will contain all details the human eye can see when this picture is viewed from a distance of 9 ft.

Mr. Peck says : " Television may well copy the use of an illusion of detail, of which the motion picture makes use. When a character is seen in a group of a long shot, the features are more or less formless lights and shades, detail being supplied principally from memory, and from very general impressions." Mr. Peck concludes : " Look for this the next time you go to the movies."

In this connection it is interesting to note that the same opinion is expressed in a recent article published by the research engineer of the Leningrad research department concerning television. It is said that it is useless to attempt to reproduce a perfect image as the human eye will indicate perfection in a picture, when actually it is far from being so.

Television Research in Russia

Television research is extensively carried out in Russia by the Leningrad Electrophysical Institute, and also the Institute of Telemechanics. Experimental transmissions are being carried out from transmitters in Leningrad and Moscow.

Germany

180-LINE TRANSMISSIONS.

It is reported that research workers in Germany are concentrating their efforts on producing a commercial system of television, utilising 180 lines. It is stated that for transmissions on 90 lines all difficulties surrounding technical requirements have been eliminated, but 180 lines have not yet emerged from the laboratory stage. The greatest difficulty at the moment is the modulation of ultra-short waves with 180-line television signal. It is expected that when this difficulty is overcome, the first regular television transmitter will be installed in Berlin.

It is stated that 180 lines constitute the transmission limit on a wavelength of 7 metres. In this connection it is interesting to note that other research workers consider 180 lines to be the maximum number of lines required for satisfactory television service.

It is urged that the authorities concerned concentrate on the type of programmes the public wants, as, so far, this side of television has scarcely been touched upon. Opinion in some quarters is that television programmes will be nearly as important as the technical development of the science.

Hungary

A PROPOSED SERVICE.

The broadcasting authorities had a number of television experiments conducted, and sent their television engineer to Berlin to gather the latest information as to the possibilities of television broadcasting.

Regular transmissions do not yet take place, and no definite dates can be given, but great interest is attached to television, and it is hoped to start transmissions in the near future.

The First Mirror-Screw Receiver for the Amateur

Full constructional details of one of the most efficient receivers of the mechanical type which has so far been evolved.

Some Advantages of the Mirror Screw

Compactness; the image-forming screw is identical with the size of the image.

High optical efficiency providing bright pictures with small power.

Durable construction with little likelihood of later adjustment being necessary.

Very little strip effect.

IT is generally conceded that the mirror-screw receiver is one of the most efficient that has ever been designed. Moreover, it is one of the simplest, with the further advantage that it can be operated with quite small power; in fact, the output from almost any medium-power three-valve set will be adequate, the actual power required being from 1 to 1½ watts. It thus comes within the same class as the disc receiver so far as power requirements and simplicity are concerned, but it is infinitely better than the disc type because it is much more compact and the general efficiency is greater.

Hitherto the mirror-screw receiver has not been available to the amateur on account of several reasons, but no difficulty will be experienced in the construction of the machine about to be described, and all the parts are readily obtainable.

The photographs will show that essentially the receiver consists of three parts—the mirror screw, the motor and the neon lamp. The mirror-screw is comprised of a number of flat metal plates with polished edges, and these are to be built up into spiral formation and clamped on a special holder which is then mounted on a steel shaft. No difficulty will be experienced in building the screw, but detailed instructions respecting this will be given later.

It will be seen that the screw is mounted independently of the motor and is driven by a rubber belt. This belt acts as a mechanical filter and prevents any small variations of motor speed being transmitted to the screw; it also permits of a compact layout and the use of practically any motor.

Very little need be said about the actual construction, for apart from the cabinet this is merely a matter of screwing the motor and the bearings for the mirror spindle in position. Ready built cabinets are available from Messrs. Peto Scott, Ltd., but if preferred this can be made from the details given. All the necessary dimensions are given for the positioning of the patts, and this will be further simplified if the large scale blueprint which is available at the price of 1s. be obtained.

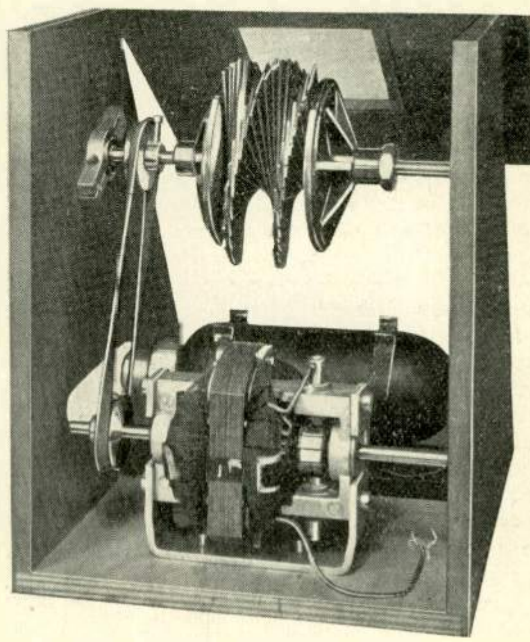
The Light Source

As the mirror screw does not project, a line of light is necessary which is viewed subjectively (via the reflecting edge of the mirror plates). This line of light is easily obtained from the ordinary flat-plate lamp used with disc-type television receivers, and is easily obtainable if the amateur does not already possess one.

If this lamp is turned so that only the edge is viewed, a brilliant line of light is seen. This line is masked off to .048 in. for the length of the glass bulb with strips of lantern slide binding. The remainder is coated with black paint or covered with tinfoil (this helps to increase the light efficiency).

The lamp is clipped in the holder and is placed temporarily close to the motor. It will be noticed that the light emerging from the slit is of strip formation, but fairly wide. The lamp being easily rotatable in the clips, the direction of the beam can be controlled.

It is, of course, directed to the mirror on the front panel of the chassis, and



This is a rear view of the miror-screw receiver with the outer case removed. The simple construction is apparent from this photograph.

from there it is reflected to the edges of the mirrors on the screw, and is rendered visible on each edge in turn as a spot. The lamp should be so turned that the strip of light falls in line with the axis of the screw.

With the type of lamp and simple layout used, the top and bottom of the picture is not rendered at the same brilliance as the centre. This can, of course, be corrected by a concave cylindrical mirror instead of one of the plane type or a cylindrical lens can be interposed between the lamp and mirror.

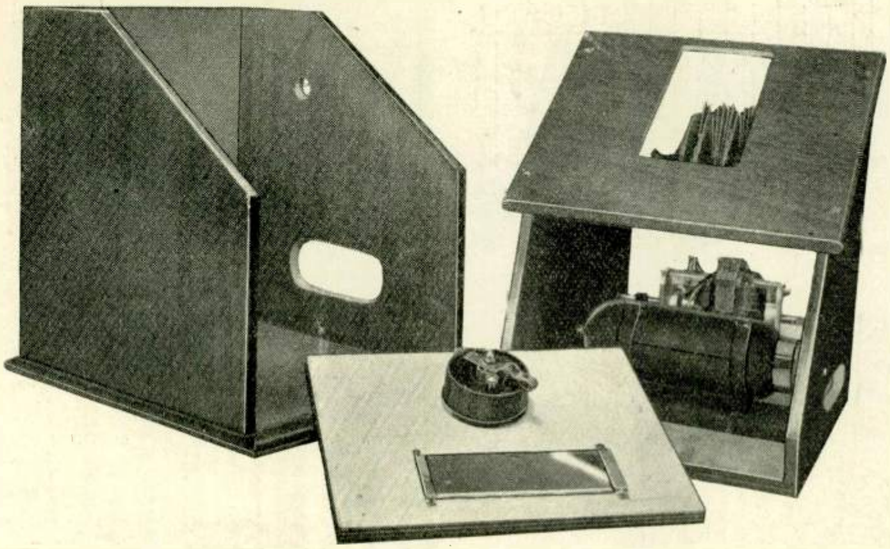
It is important to note that the mirror screw should revolve in the opposite direction to that usual with a mirror drum—*i.e.*, the screw should travel downwards when viewed.

In order to obtain a ratio of 7-3 for the B.B.C. transmissions, the distance of the lamp from the screw via the mirror is adjusted so that the synchronising line appears either at the top or bottom. It will follow that other ratios are possible by alteration of this distance, which is not very critical. For instance, the German transmissions on 1,600 metres are of the 30-line 3-4 type viewed horizontally. It is only necessary, therefore, to place the lamp nearer and 3-4 ratio is possible. It is also necessary to reverse the direction of rotation for this transmission.

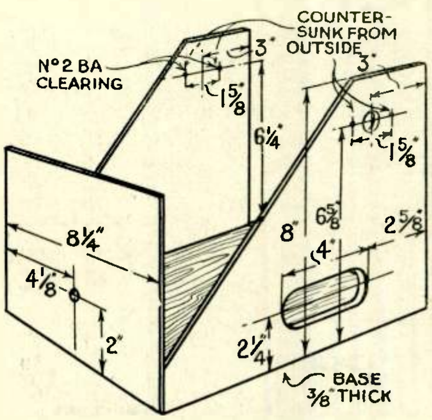
The parts for the screw are available, and the adjustment of the assembly is a fairly simple matter. It should be noted that adjustment in one plane only is required, and that is the angular separation. This adjustment gives the separation of the spots correctly to give the horizontal scan.

To assemble and adjust the screw first obtain a board 2 ft. square and screw a block of wood 3 in. square to the centre. This has a vertical hole slightly under ¼ in. into which is pressed the screw spindle so that it is tightly gripped. From this centre scribe the largest circle possible on the baseboard and divide the circumference into thirty equal parts. This should be carried out carefully.

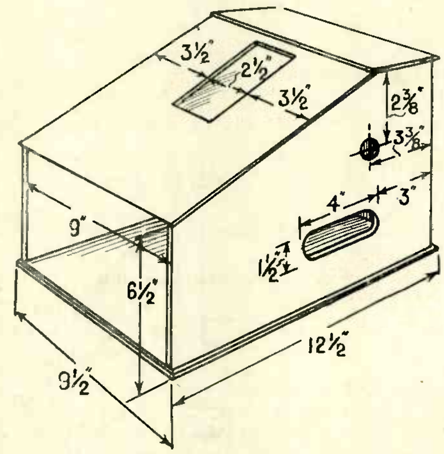
Mount the lamp in a holder on the baseboard so that the beam falls on the screw at the axis and in line with the spindle.



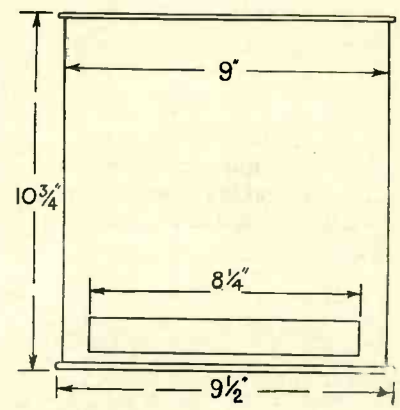
The various parts of which the receiver consists are shown here ; note the reflecting mirror on the back of the front panel.



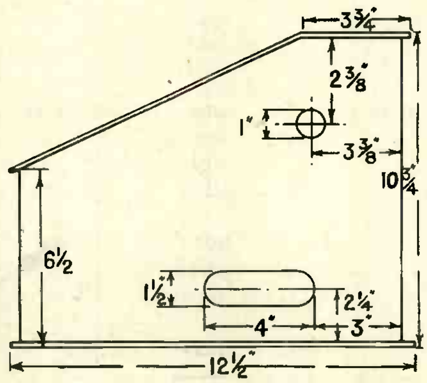
Details of the chassis.



The complete cabinet.



The back of the cabinet.

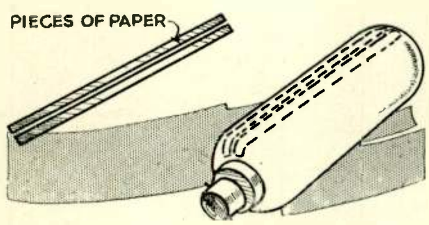


Side elevation of the cabinet.

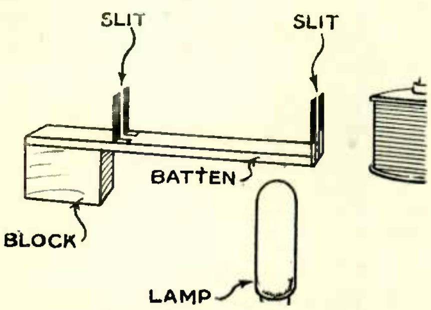
Next arrange two slits on a batten as shown so that a spot is seen reflected on a mirror edge from the lamp. Before adjusting, an arm is fixed to the mirror screw base ; the arm is free to revolve on the fixed spindle at one end, and the other end is provided with an oversize hole for a woodscrew ; in this end is forced a needle to act as a pointer (see illustration). A woodscrew (with washer) is inserted at A.

The needle is placed so as to coincide with one of the radial divisions on the baseboard and with the woodscrew and washer at A the arm is fixed to the baseboard. As the hole A is large, accurate setting of pointer can be made. All the plates should now be threaded on the carrier and the end plate made finger tight so that the mirror plates can be just moved.

Starting with the bottom mirror strip, the spot from the lamp is picked up in the slits. Fix in this position

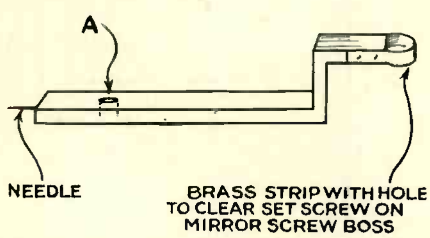


The lamp is covered with paper to provide the strip of light.



A check of the screw adjustment is made with a lamp.

with a little Durofix cement (obtainable from multiple stores) at the ends and the base, taking care not to allow any to get on to the mirror edges. The

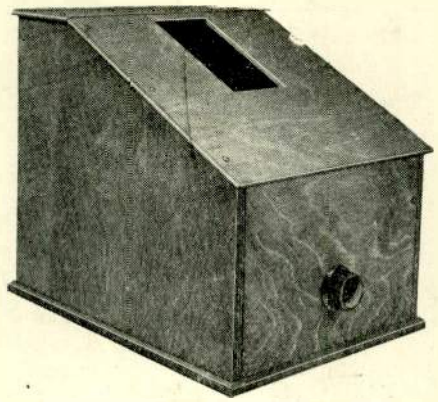


The indicating device for fitting the mirrors.

mirror strip can be held in contact by two small bulldog clips. Durofix dries rapidly, and in a few minutes the next mirror can be positioned. Rotate the screw by the arm clockwise so that the pointer is opposite the next radial line and screw to the baseboard. The next strip is moved so that the spot is again picked up in the slits, and so on.

If desired, each mirror can be put on the carrier and adjusted separately, and this may be found easier. When completed, the top end plate is screwed up and locked.

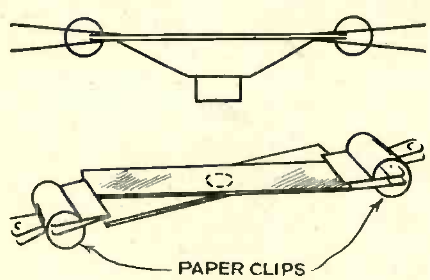
The cabinet has a hole at the side,



The complete receiver is particularly compact and neat.

PARTS REQUIRED

Woodwork and lamp clip belt.
Metal motor holder (Peto Scott).
Motor type B.M.1 (Mervyn).
Parts used in screw (Mervyn).
Spindle and ball bearings (Mervyn)
Pulleys, resistance and mirror (Mervyn).
Neon lamp Osglim flat plate (G.E.C., H. C. Sanders and Peto Scott, Mervyn, etc.).
Suitable synchronising gear if required (H. C. Sanders & Co.).

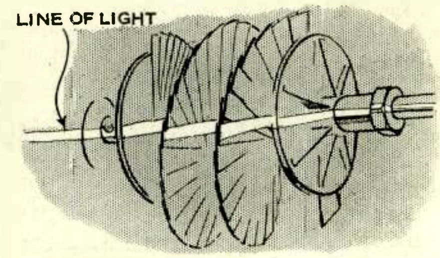


The mirrors are held temporarily in position with paper clips.

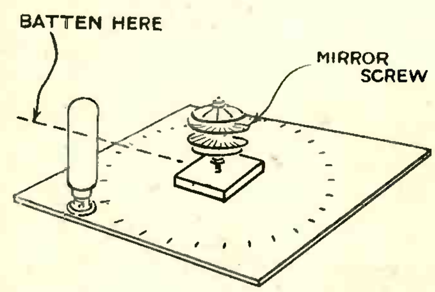
and in this can be seen the ribs of the end plates. These are eight in number, and if viewed by light from 50-cycle A.C. mains these will appear stationary at 750 r.p.m.

The slot at the bottom is to enable the lamp to be moved, and also the connection to be made to it by a bayonet holder.

A variable resistance is shown on the front panel, and this is used for speed control; but a coarse speed adjustment is obtained by another fixed resistance in series, the value of this depending on the mains supply and motor used.

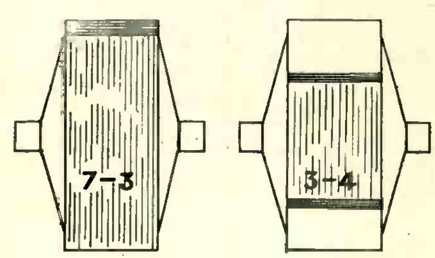


The strip of light should fall in line with the mirror axis.



The mirrors of the screw can be set as shown above.

A receiver of this type can be operated under practically the same conditions as a disc receiver, which means that the power required is small. On



Showing how the picture ratio can be altered with the mirror screw.

another page in this issue instructions are given for connecting the neon lamp to the wireless set, and these will apply in the case of this receiver as well as the disc type, so no difficulty should be experienced in the operation.

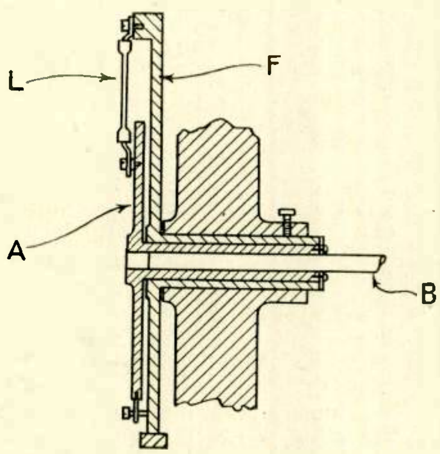
In a later issue it is intended to describe the fitting of synchronising gear, but as this is accessory to the present apparatus it can be added without alteration to the design; also readers may be assured that excellent results are obtainable by hand control.

Patents *and* Progress

A Record of Recent Developments

Synchronizing Apparatus
(Patent No. 399154.)

To prevent a scanning disc or drum from "hunting" about its correct phase position, it is driven from the motor through an elastic link *L* of india rubber or similar material. One end is screwed to a flange *A* on the driving shaft *B*, and the other end is screwed to an extension of a flange *F*, which is concentric with the driving shaft *B* and may be the scanning disc itself. Provided the length of the elastic link *L* is large compared with



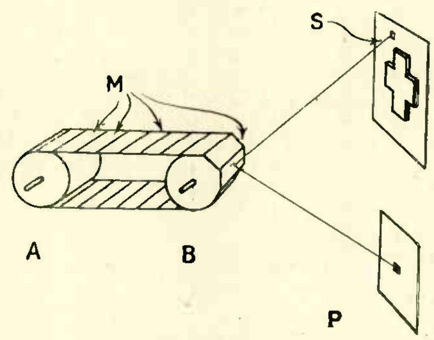
A mechanical coupling to prevent a scanning disc or drum "hunting."

the radius of the outer flange, the driving torque increases very rapidly with the displacement of the disc from its correct position.—(*C. L. Richards* and *Baird Television Ltd.*)

Scanning Drums
(Patent No. 399552.)

In a scanning drum the larger the number of mirror elements, the better, though in practice a limit is set partly by manufacturing difficulties, and partly by the fact that the angular displacement of each mirror decreases as the number of elements increases.

These difficulties are, to some extent, overcome by the arrangement shown, in which the mirror-elements *M* are mounted on an endless band which passes over two pulleys, *A*, *B*, of comparatively small radius. Light from the picture *P* to be televised (or from a scanning aperture in reception) is projected on to each mirror in turn as it passes over the pulley *B*. Because of the small diameter of this pulley, the change of angle of the mirror in its

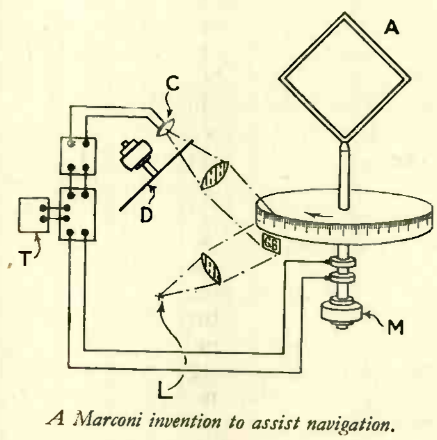


A substitute for the mirror drum: the mirrors are mounted on an endlessband.

forward motion is correspondingly large. It therefore sweeps the reflected ray of light over a longer path on the viewing screen *S*, than is the case with the ordinary type of mirror drum having a comparatively large diameter. —(*J. L. Baird* and *Baird Television Ltd.*)

Assisting the Navigator
(Patent No. 400279.)

The wireless beacon enables a mariner to get his bearings at sea in



A Marconi invention to assist navigation.

foggy weather when it is not possible to use the ordinary aids to navigation. There are various schemes for getting this information across to the navigating officer, some more simple than others, but they all demand a certain amount of care and skill in operation, particularly in judging the critical point of maximum or minimum signal-strength, which gives the key to the desired information. Also in most cases it is necessary for the operator to know the morse signalling code.

By means of television the ship's bearings relative to the beacon station, can be indicated in the form of a picture or image of a compass card. This conveys the desired information directly to the navigation officer whether or not he is a skilled wireless operator.

At the transmitting station a directional aerial *A*, shown as a frame, is mounted on the same spindle as a scale marked in degrees (or a compass card). The aerial and attached scale are rotated at a constant speed by a motor *M*. A lamp *L* is focused on the scale just above the letters GB, and the reflected light is passed through a scanning disc *D*, on to a photo-electric cell *C* forming part of a television transmitter *T*. The result is that a highly concentrated beam of energy sweeps round the horizon carrying with it an ever-changing compass reading and a constant representation of the identification letters GB. Wherever the ship may be located it will receive only that part of the scale which indicates the bearing of the ship relatively to the beacon station. Synchronising signals for the television receiver are simultaneously radiated from a separate omnidirectional aerial so as to control all receivers within range.—(*J. P. Bowen* and *Marconi's Wireless Telegraph Co., Ltd.*)

An "Iconoscope" Improvement
(Patent No. 399654.)

In the Iconoscope type of transmitter, the ordinary single photo-electric cell, used for converting light into electricity, is replaced by a "mosaic" of cells. This consists of a very large number of silver globules deposited on a sheet of mica which forms the anode of the cathode-ray tube. The picture to be transmitted

(*Continued on page 30*)

The Eye *in* Television

By J. H. Reyner, B.Sc., A.M.I.E.E.

TELEVISION as an entertainment is undoubtedly nearer than it has been for some years. The recent technical progress has brought high definition television within the bounds of practical politics, and the introduction of really good quality pictures will probably take most people by surprise.

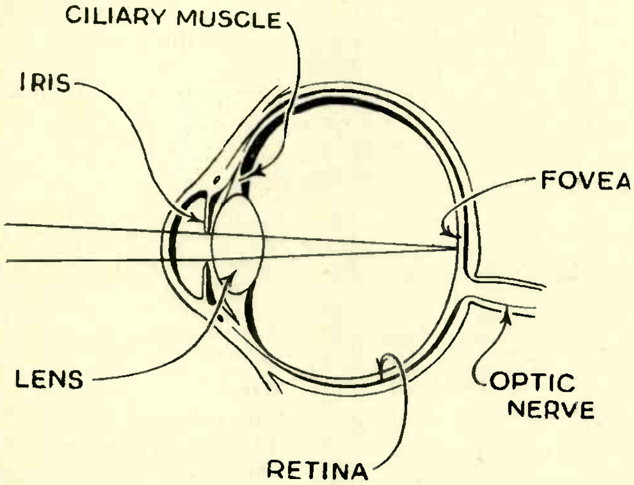


Fig. 1. A diagram showing the various parts of the eye.

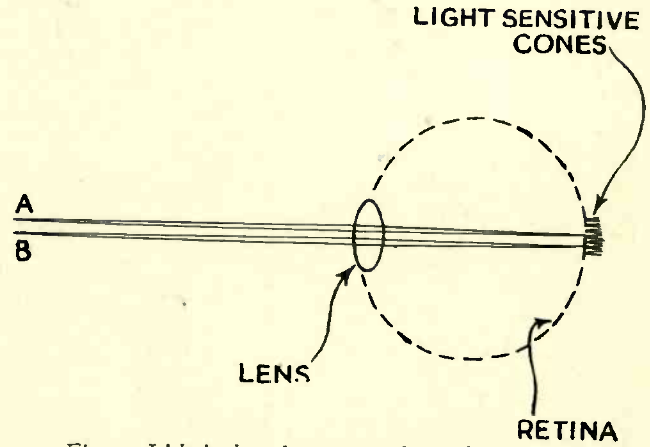


Fig. 2. Light is shown here entering the eye from two points and producing two images on the retina

Let us consider what is involved in the production of high grade pictures. In broadcasting we have realised for a long time that the relative perfection attainable depends very largely on the human ear, and research shows that this organ is a most accommodating one. While a true vibration corresponding to a certain sound may be very complex, we know that the ear will be satisfied with quite a poor imitation and will fill in much of the deficiencies by imagination.

The Eye As a Camera

The eye is unfortunately much more critical. It demands a much higher standard of performance before it will be satisfied. Moreover, we are already accustomed to reproductions of scenes in the form of photographs or cinematographs in which the standard is so high that the task of the television engineer is made still more difficult. Let us therefore analyse the mechanism of the eye and endeavour to estimate the requirements for perfect detail and how closely we can approach this ideal in practice.

It is convenient to regard the eye as a form of camera. In the front of the eyeball is a lens made of special transparent tissue. It is oval in section, as shown in Fig. 1, and the actual shape can be altered by the ciliary muscle to suit the different requirements. This operation is quite instinctive, and probably most people are quite unaware that any such action is taking place. The effect is that the focus of the lens is altered so that the rays of light entering the eye from the scene in view are all accurately focussed on to the retina.

This is a sensitive surface at the back of the eye and takes the place of the photographic film or plate in an ordinary camera. The mechanism by which the necessary intelligence is conveyed to the brain is rather interesting. The whole of the retina is composed of millions of tiny cells which are sensitive to light. When any light falls on these cells a chemical change takes place proportional to the intensity of the light, and this change is communicated to the brain by the optic nerve. On the removal of the light the substance changes back to its normal state, but it is interesting to note that it does not do so at once, there being a small delay in the action so that the eye continues to see the object for a small fraction of time after the light has been removed.

Persistence of Vision

This phenomenon of persistence is most important. Without it there could be no television (nor, for that matter, any cinematography) because both processes depend upon the presentation of a series of pictures, one after the other. In the cinema, in particular, there is a period in between the pictures during which there is no light on the screen at all, but if the rate at which the pictures follow one another is sufficiently fast the persistence of vision entirely bridges the gap and the eye is not conscious of the change.

Now, one of the most important features of the eye in relation to television is its ability to distinguish detail, and we gain much useful information by considering the exact mechanism of the eye in this respect. The most sensitive portion of the eye as regards detail is that in the very centre of the retina where the small light-sensitive cells or cones, as they are called, are extremely closely packed. A little thought will show that the closer these cones are together the greater is the ability to distinguish detail.

Consider two adjacent points, one light and the other dark. Rays of light will enter the eye from these two points, as shown in Fig. 2, and will focus themselves on two spots on the retina next to one another. Suppose that the distance between these points exactly corresponds to the distance between two of the cones. One cone will be affected by the light and will communicate this intelligence to the brain. The next cone will not be affected because practically no light is falling on it, since it corresponds to the dark point. Thus the brain can distinguish between the two points, and say that one is light and the other dark.

A similar effect occurs if the distance between the two points on the retina is *greater* than the distance between the light sensitive cones. In this case we have a group of two or three cones in between the particular cones on which the light rays focus, and the intelligence is conveyed to the brain as before. If, however, the distance between the two points is *less* than the distance between the cones, then the eye begins to fail. The particular cone will receive a small amount of light and a small amount of dark, and the only intelligence conveyed to the brain is that there is some light coming from that particular area, but that is all.

Limit of Detail

Hence there is a quite clearly defined limit to the closeness at which details can be distinguished. This limit is ultimately determined by the distance apart of the cones in the retina, and since the retina is at a fixed distance from the eye lens, our limit is one of an angle rather than an actual distance, this being known as the angle of resolution.

This means that the farther away, the more apart two points have to be before they are distinguishable. If you make two lines in black ink on a card $\frac{1}{8}$ in. apart, (Fig. 3) and you hold this card a foot from your eye, you can quite easily distinguish the two marks as separate marks. If you place the card 20 to 25 feet away, you will find that you cannot distinguish the two marks, but you can only see one blackish blurr. It does not even look as black as it did when it was close to the eye for the reason already given, that light rays from the black marks and the surrounding white portions are all falling together on one particular light-sensitive cone, which therefore only registers the average value of the light received.

Visual Acuity

Visual acuity (ability to distinguish detail) is more marked for objects in the centre of one's field of view where the light rays focus on the centre portion of the retina. Around the edges of vision the acuity is much less, due to the fact that the cones are much more widely separated. Most people do not realise this in practice because if one wishes to concentrate attention on any one object one naturally turns the head or the eye so that that particular object comes in the centre of the field of view; but if you think it out you will realise that you cannot see details anything like as well at the side of your field of vision.

Fig. 3. If this diagram be viewed from a distance the two lines will be indistinguishable as being separate.

In the centre of the retina—the region known as the *fovea*—the cones are about .003 mm. apart, and since the focal length of the eye is about 22 mm. this corresponds to an angle of about 28 seconds of arc—*i.e.*, about $\frac{1}{120}$ degree. This represents the angle of resolution for objects in the centre of the field of view *under normal lighting conditions*. But in television we are dealing with a much reduced illumination, and the effect of this is to reduce the visual acuity, because the iris expands to admit more light.

Fig. 4. The "grain" of 120-line scanning. If this picture be held about 3 ft. away the detail will appear perfect and at this distance the eye could not distinguish more if it were present.

The iris is a circular diaphragm over the lens which automatically adjusts itself to admit the optimum amount of light. In strong light the iris contracts to leave a very small aperture for the light to enter the eye. In dim light the iris expands to its full aperture of $\frac{1}{4}$ in. or more to admit all the light possible, but in doing so the focussing power of the eye lens is reduced. Readers who have experimented with photography will know that with a large aperture lens a soft focus effect is obtained, really sharp focussing only being possible with a small aperture.

In the same way the eye, under conditions of poor light, cannot distinguish so much detail, and experiments made by the Kodak Co. under the conditions obtaining in an average cinema indicate the angle of resolution as being about twice the daylight value —*i.e.*, about 1-50th to 1-60th of a degree. With television the visual acuity is probably still less, but the figure quoted will serve as a convenient standard.

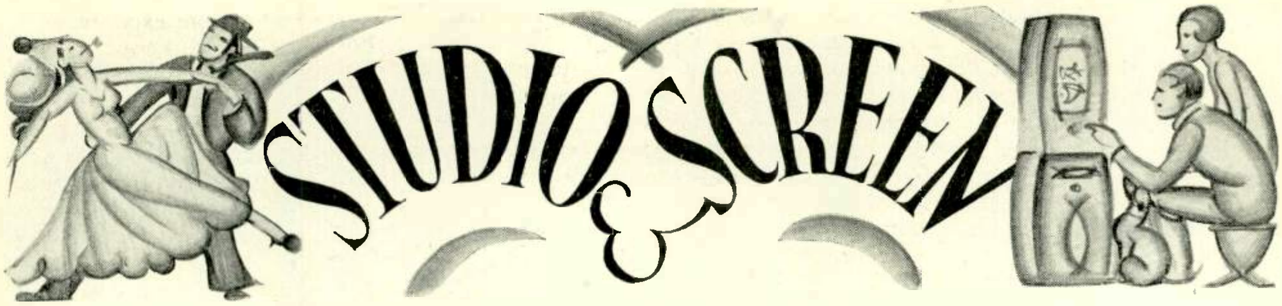
Let us consider a picture 2 in. high and $2\frac{3}{4}$ in. wide, at a distance of 20 in. The closest distance which can be distinguished under such conditions is about .0057 in. If we assume horizontal scanning, this requires 2 .0057= 350 lines. This is still some way in advance of modern technique, but it must be remembered that this represents *perfect* detail. We know that although the eye is relatively unaccommodating, it will accept coarser detail than this.

The Circle of Confusion

The home cinema affords proof of this fact. The size of a typical 16 mm. frame is 10.5 by 7.6 mm. We know that the various points do not focus sharply, but have a finite size which is known as the *circle of confusion*, and is usually taken as about .05 mm. This corresponds to 150 lines, which is quite feasible. In fact, experimental cathode-ray television has been carried out on 180 and 200 lines in many quarters. Hence modern television is approaching a state with which the eye will be well pleased if not completely satisfied.

One final point is worth remembering. Since the visual acuity of the eye is determined in terms of an angle, it follows that the farther away one is from the picture the better is the detail, or, alternatively, the less the number of lines necessary to provide a given degree of definition. As an example, it is easy to show, from the figures already given, that a 30-line image $3\frac{1}{2}$ in. high and $1\frac{1}{2}$ in. wide viewed at a distance of 14 ft. gives perfect detail. In other words, even if the detail were made better, the eye could not appreciate any improvement at this distance.

The moral, therefore, is do not get too close to your pictures particularly with low-definition reproduction.



REVIEWS OF THE PROGRAMMES AND RECEPTION REPORTS

AS technique improves, artists present a more human appearance in the studio. Make-up has been modified now that lighting is more precise, and a soubrette no longer looks grotesque as she stands in the dazzling shaft of light. Her eyebrows are not so thickly blackened and her lips are not so full of paint.

In the earlier days when pictures were cruder, I failed to recognise a friend through her coating of grease; that could not happen to-day.

Current fashion prescribes a nose lightly shaded in pale blue on either side, eyebrows thinly emphasised in black, eyelashes beaded with mascaro and lips touched with blue. Formidable as this sounds, the effect is not unpleasant in the twilight of the studio, and is not unnatural even when lit by the beam from the projector.

Twelve months ago the same artist would have appeared with the pallor of a ghost, the black eyes of a pugilist and the mouth of a coon. The refinement is made possible by additional photo-electric cells and experience which has taught the engineers just where to place them to secure the best results.

* * *

Those who receive the television programmes are familiar with the stairs used for revue and other spectacles. Twelve feet long, the staircase is usually placed against the backscreen facing the projector. For the pantomime it is being shown in a new position. Placed across the studio with canvas pinned to the side which is normally invisible, we see Cinderella tripping up to quit the ball and leaving her slipper behind. The staircase is a useful prop, but I had begun to tire of it; then the producer added castors and used it as a trolley. Here is a fresh variation.

* * *

Once or twice recently the picture has not been up to standard, and when the pipers of the Scots Guards were in the studio their image disappeared altogether for a few seconds. The cause is still uncertain. Lookers-in may have blamed their sets.

A report referring to the programme on December 18 which has been received says: Considering fading was noticeable, the picture at times almost disappearing, whilst at other times the contrast of light and shade was very strong.

Although she has taught many Spanish dancers who have been seen in the studio, Elsa Brunelleschi was making her first appearance. In her gypsy dance the picture seemed rather dim at first, but this was intentional, and the light improved as she mounted the stairs and caught the rays of the "sun."

* * *

Technically, the outstanding feature in "Cinderella" on December 27 was a slick fade from a property pumpkin in the studio to a coach and horses drawn in black and white on a card in the miniature transmitter. The fairy godmother taps the pumpkin with her wand and the vehicle arrives at the trot. Like the cinema, television lends itself to an optical trick.

* * *

The small transmitter is now being used for larger drawings which are slowly pushed through the frame as a slide is pushed through the light of a magic lantern. In this way the drawing is scanned in sections, a develop-

IN THE STUDIO AT BROADCASTING HOUSE

THE ARTIST IS MISS JANE CARR

ment which gives greater scope to the draughtsman.

In contrast to the process in the main studio, the projector of the small instrument is fixed, and it is the object being televised which has to move.

* * *

Alanova was at Broadcasting House watching the picture while Agnes de Mille was dancing. It was a striking performance, and afterwards Alanova remarked that better perspective was obtained for dancing in television long-shots than was possible on the screen, which confirms Adeline Genée's opinion, given after her world farewell in the studio, that the film is not a suitable medium for ballet work.

* * *

Some ingenious arrangements of toys were seen in the seasonal toyland programmes during Christmas week. Yvette as a doll and E. Kelland-Espinosa as a golliwog mingled with Teddy bears, penguins and trains from a London store. The golliwog came to life when Father Christmas had wound him up, and we discovered that the big doll could sing.

* * *

The year ends with the news that the B.B.C. is to continue these 30-line programmes after the end of March, probably on two nights each week. So there is no reason for lookers-in to fear that they will have to scrap their apparatus. Although research is concentrated on ultra-short-wave systems, I believe that 30-line visors in use to-day will be needed for a long time to come. Meanwhile plans are being discussed for a new television studio to replace B.B. in the basement at Broadcasting House, which was originally designed for use by a dance band. This development is important, as it implies that the B.B.C. has not lost faith in studio work, though film is being used for research.

Early in the New Year the E.M.I. system of film transmission will be installed for ultra-short-wave experiments at Broadcasting House.

The photograph shows a scene in a Broadcasting House studio during the production of a television revue. Harry Pepper and John Watt directing the production.

Shabalevsky and Nina Baronova in Jeux d'Enfants.

* * *

Olive Groves, popular radio soprano; Anna Dusé, in her Infanta dance again; and Kassen, the Russian singer, were booked for December 29. A new dance act by Ray and Geoffrey Espinosa is down for New Year's Day, when Anona Winn and Dimitri Vetter will also be seen and heard.

Harold Stearn, a lieder singer was recommended by Delysia, besides Hermione Daneborough, classical dancer from the Vic-Wells Company, and Aranka von Major, who sings in the "Café Colette."

Jack Browning has found a new dancing partner in Marjorie Stevens, and they are down for performance on January 3 with Louise Maxim, conjuring and juggling, and Betty Bolton, our old friend.

Comedy on January 5 will be entrusted to Arthur Askey. His songs and patter were amusing last time.

A Letchworth reader writes: Last night (Dec. 11) reception was better than it has been for a long time. I was able to see every item except the first one. This was my fault as I forgot to allow for the motor to warm up. I generally use cathode-ray equipment although I can obtain quite good pictures on a 20 in. Mervyn disc and a small Osglim indicator neon. Brookmans Park is about twenty-five miles from here, so I do not experience any trouble from fading.

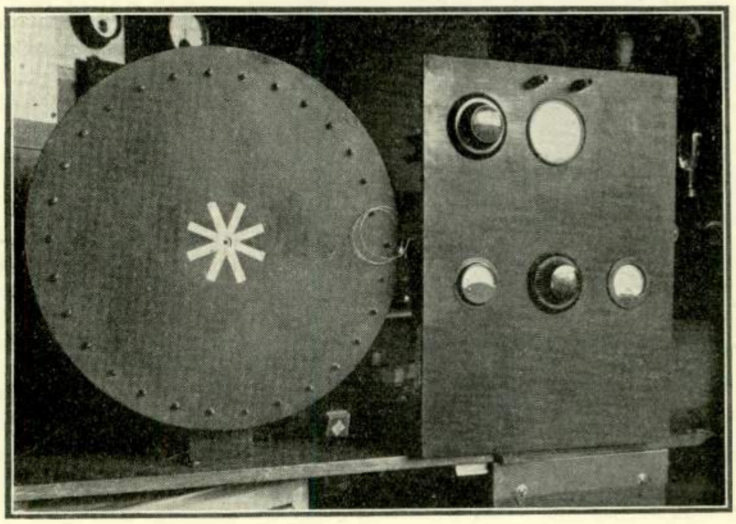
A Novel Receiving System

By E. L. Gardiner, B.Sc., F.T.S.

Here are the first published details of a novel system of reception which is now undergoing experimental tests.

It is interesting that the Nipkow scanning disc, probably the very earliest device used for successful television, remains to this day the most widely used scanning device for receivers. This can be attributed to its several very good features, prominent amongst which are the high accuracy of the scanning obtainable, the low cost, simplicity and relative ease of synchronisation of a good disc. In fact the disc has only one serious drawback, unfortunately a very vital one, which is the poorness of the illumination which it gives when used for systems employing any considerable number of scanning lines. Whereas in the case of 30-line television a disc image may be bright enough for good direct viewing, it cannot be made bright enough for satisfactory projection on to a large screen even when the best light sources so far known are employed behind it.

This disability of poor illumination becomes rapidly more serious when a larger number of scanning lines are employed, until at 120 lines for example the image is hardly bright enough for really satisfactory direct viewing. The rapid falling off in brightness is partly due to the increasing smallness of the holes, but it is also bound up with the question of the very inefficient utilisation of the available light source, which has to be diffused over the whole of the image area on the disc, or made large in area as in the case of a plate-type neon tube.



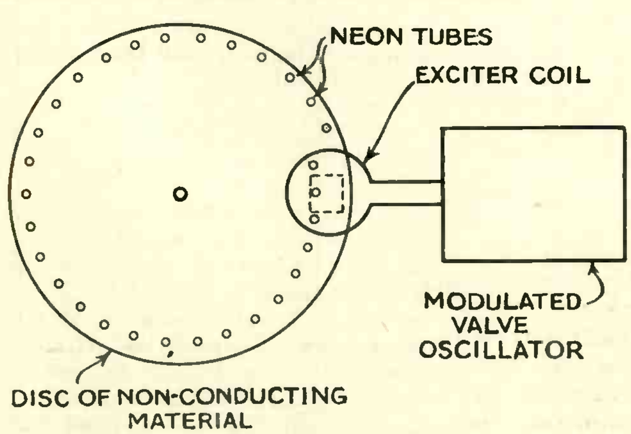
This is the first experimental model of the novel receiver; note the miniature neons inserted in the disc.

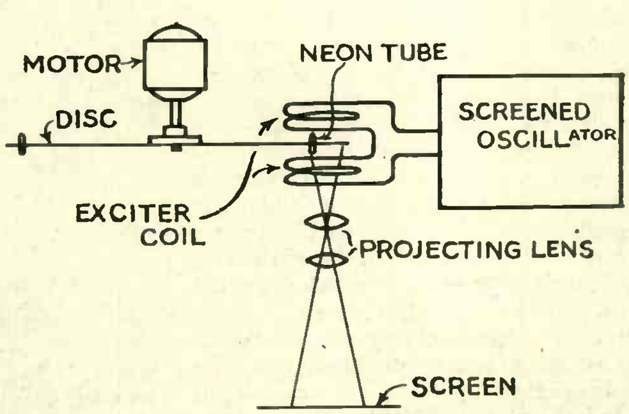
Only a minute portion of the total light is being employed to form the image at any instant; in the case of 30-line television this fraction is of the order of one-twentieth per cent. For 120-line working, however, it becomes as low as one three-hundredth per cent. or less, causing a terribly low efficiency.

Increasing Light Efficiency

It is largely because of this deficiency of the original disc that other scanning devices, such as the mirror drum, have come into increasing use. Most of these methods are characterised by the fact that nearly the whole light from the light source used is being employed during the whole period of scanning, resulting in a greatly increased brilliance and permitting of screen projection. They are also better suited to the use of light sources of high intrinsic brilliance, such as the crater tube or Kerr cell.

An interesting system invented by the writer is at present undergoing development in the Wilson Laboratories, which is able to do away very largely with this main defect in the disc





These two drawings show the schematic arrangement of the new receiver in elevation and plan. In the plan view the optical system is indicated.

as a television receiver, whilst retaining its good features; it also makes it suitable for screen projection on a more competitive basis with the newer systems.

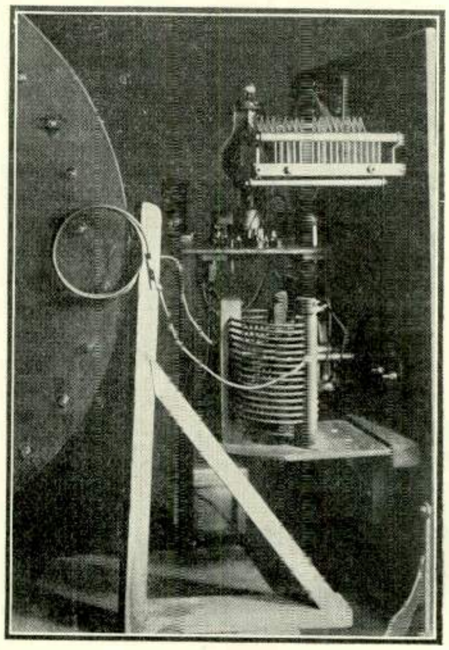
The essence of the system is the use of separate light sources in place of each hole of the usual disc; a very old idea in itself, but one which has not been applied with any success in the past owing to the crudeness of the methods used.

Discs have been made at various times in which ordinary electric lamps were used in place of the conventional holes, operated in their correct order by means of some form of commutator which rotated with the disc and connected the right lamp into circuit with the television signal currents at the required moment. Whilst filament lamps are obviously of little use for this purpose, owing to their sluggish response to changes of current, some results might be obtained from modern gas-discharge lamps were it not for the many troubles introduced by the commutator, a device which is almost incapable of giving perfect and consistent connection at high speed. necessary in television. There are other defects in such a system for a large number of lines which are sufficiently obvious to show its impracticability as a commercial receiver; there are, for example, the cost and complexity of the commutating mechanism, the cost of the many lamps, and the great difficulty of providing a number of lamps containing electrodes which have identical electrical characteristics, and which will remain of sufficiently identical brilliance after long use.

No Electrical Connections

The system about to be described, however, overcomes these difficulties completely. In the first place the lamps used at the present stage of development contain no electrodes, and have no external connections whatever. Also no mechanical commutating device is used. The lamps simply consist of very small glass tubes containing neon or a suitable gas mixture at low pressure, and they are cemented through the holes of the disc with their long axes parallel to the spindle of the disc. One end of each tube is blown of clear glass, and carries a suitable square or hexagonal diaphragm. Such tubes are small, light, and cheap, and if filled with gas at the same time, have practically identical characteristics.

The lamps are caused to glow by the action of a high-frequency field, provided by a valve oscillator modulated with the television signal. Their brightness is thus a function of the signal at any instant. This is effected by the periphery of the disc on which



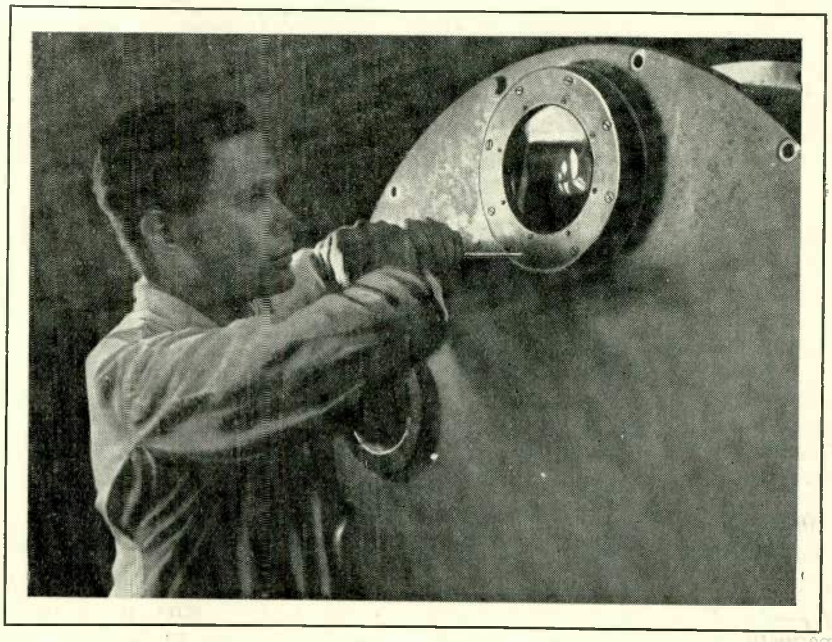
Here is a close-up showing the coil in which the high-frequency field is produced.

the image is to be formed and on which the tubes are placed passing between the turns of an inductance carrying the radio-frequency current; thus the tubes are excited without any metallic contact with the disc, and therefore without friction or irregular contact.

A very important feature of the arrangement is that only the tube which is contributing to the image at any instant is within the field and glowing, all others (except, possibly, those adjacent to it) being extinguished, and moving rapidly through the cold air. Hence in the case of 30-line working, each tube has a period nearly thirty times that for which it is alight in which to cool off before it is again called upon to glow.

The absence of electrodes within the tubes make them capable of withstanding high temperature without sputtering or damage, and hence high brilliance can be obtained which is still further increased by the fact that owing to the efficient cooling the tubes can be run while in motion at a brilliance which would destroy them if applied for more than a few seconds to a single stationary tube. These factors make for good illumination, and while it is not yet known to what extent the brightness of the tubes can be increased by suitable design and the use of a very strong field, preliminary work indicates that projection on to quite large screens will be possible.

Those readers who are interested in this development of disc working will have an opportunity of seeing the research model of the system at the exhibition of the Physical and Optical Society, which opens shortly after the publication of this journal. It is hoped to describe future progress in a month or two.



The scanning disc used in the German daylight transmitting system.

THE TELEVISION ENGINEER

THE THEORY OF THE KERR CELL

This is the third of a series of articles on the action of the Kerr Cell. In this, the author, J. C. Wilson, discusses the interaction of electricity and light.

WE now come to the consideration of the interaction of electric phenomena and light. Nearly a hundred years ago, when Faraday was pursuing his researches into electromagnetic action, he chose for examination a feature of a ray of light which is extremely sensitive to observation : namely, its state of polarisation. His apparatus was, by modern standards, exceedingly crude and, after many experiments, in his diary he had to write " no effect." (It is instructive to notice the strength of his conviction that an effect of the kind he was looking for existed : a favourite expression of his after an experiment which, with more delicate apparatus, would have yielded a result is : " Think it ought to have done.")

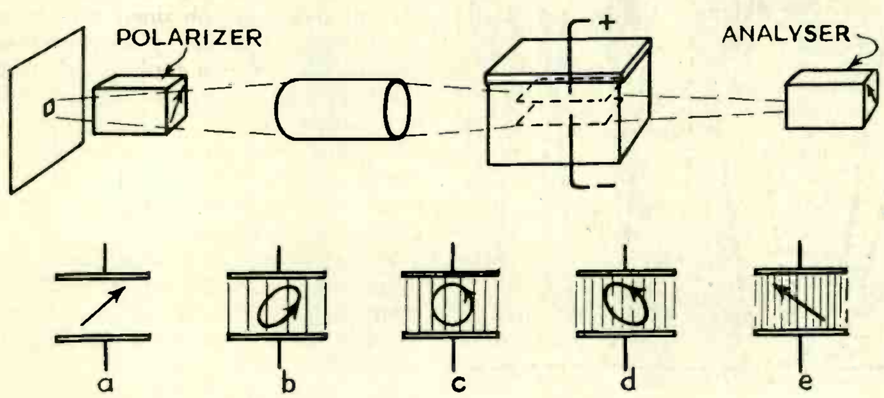


Fig. 1. A diagram showing the effect of polarisation.

On September 13, 1845, his persistence was rewarded : on passing a ray of plane-polarised light through a block of heavy glass (lead borosilicate) situated between opposite poles of an electro-magnet, so that magnetic lines of force traversed the glass in the same direction as the light, he found that the plane of polarisation of the light was deviated slightly when current was sent through the electro-magnet coils. His comment is pithy : " This fact will most likely prove exceedingly fertile."

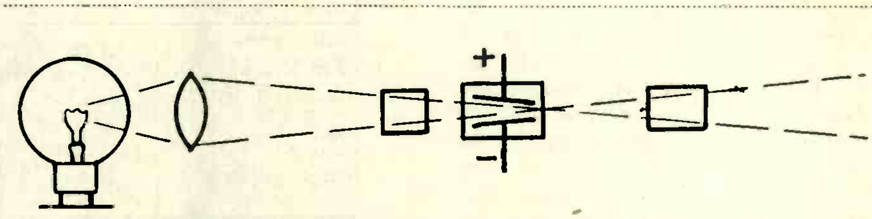


Fig. 2. Slightly increased sensitivity may be obtained by the arrangement shown here.

Rotation of the Plane of Polarisation

This deviation or *rotation of the plane of polarisation* of light in media under magnetic stress is termed Faraday's effect ; it may be observed in media and under conditions somewhat different from those with which Faraday himself first saw it. For example, if a ray of plane-polarised light, proceeding from a Nicol or other similar device, be passed through a cylindrical vessel, surrounded by a coil of wire, and containing carbon disulphide (which is a clear, yellowish, evil-smelling liquid at ordinary temperatures) so that the light passes down the axis of cylinder and coil, a second Nicol can be set to absorb or " extinguish " all the emergent light.

This setting will, however, not be correct for total extinction when a current is passed through the coil, and the second Nicol will have to be twisted slightly, by an amount varying with the strength of the current, completely to absorb all the emergent light. If, on the other hand, the second Nicol is set, with no current in the coil, to pass the light from the first and left in that position, then it will no longer pass it at all, and the strength of the transmitted light will vary, when a current is passed. This system was proposed as a light-modulating device for television in 1884 by Paul Nipkow, whose name is associated with the scanning disc.

For convenience in reference, the initial Nicol or other polarising device is termed the *polariser* and the second the *analyser* in an optical system of the kind just described.

The Kerr Effect

About thirty years later an effect of a totally different character, arising from the action of electric force on media through which light is passed, was discovered by Professor Kerr. An arrangement for observing this effect might consist of an analyser and polariser, between which is placed a glass vessel containing a medium such as carbon disulphide. In the liquid are immersed two parallel metal plates a short distance apart, so that the light from the polariser can pass between them.

If the analyser is set to extinguish all the light coming from the polariser, and then an electric potential difference is created between the plates, light will pass through the analyser again, provided that the plates are correctly oriented with respect to the plane in which the light issuing from the polariser is polarised. This effect, known as the *Kerr electrostatic effect* or *Kerr effect*, differs radically from the Faraday effect in that no new position of the analyser can be found in which the light is again completely extinguished, and we must now proceed to investigate the nature of this difference.

When a liquid such as carbon disulphide or nitro-benzene is subjected to electric stress (that is, when electrodes immersed in the liquid are connected to opposite poles of a source of electro-motive force), the molecules of which it is composed behave as though they formed part of a crystalline substance like Iceland spar: that is to say, the liquid assumes some of the properties of a doubly-refracting or *bi-refringent* medium. A ray of light entering such a stressed liquid splits into two components, one of which travels faster through the liquid than the other, although since both components travel in the same path, they cannot be seen as separate beams.

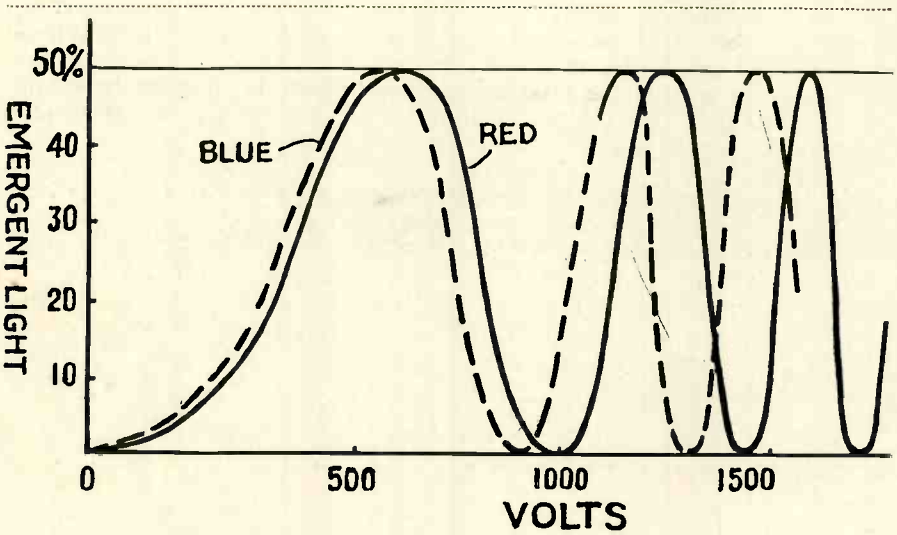


Fig. 3. The theoretical characteristics of the Kerr cell.

Each component is polarised, and the planes of polarisation of the two components are at right angles.

Now when a ray of plane-polarised light enters a stressed liquid along a direction at right angles to the stress, the plane of polarisation being at 45° to the direction of the electric lines of force, the ***component vibration*** (a term of which the meaning was explained in our first article) polarised in a plane containing the direction of the line of force separates out: it is $\sqrt{\frac{1}{2}}$ or 0.7071 of the intensity of the original beam.

Another component vibration, polarised in a plane at right angles to that of the first component, and of the same magnitude as the other, also separates, and no ray polarised in the original sense is left to pass through the liquid. If these two components travelled through the liquid with equal velocities, then they would combine again, at emergence, to form a beam of the original intensity, polarised in the original plane, so that no net effect would be observed. However, they do not travel with exactly the same velocity, but one loses a little on the other so that on emergence their vibrations are slightly out of phase, yielding, instead of *plane*-polarised light, elliptically polarised light.

The analyser can pass only light polarised in one plane; in the case of elliptically polarised light becoming incident upon it, therefore, there is no position into which it can be turned so that *no* light gets through it (as would be the case with plane-polarised light incident on it), but there is a position in which least light gets through—*i.e.*, when the plane of polarisation passed by the analyser coincides with the minor axis of the ellipse representing the elliptically polarised light coming from the liquid.

The diagram, Fig. 1, will help to make this clear.

A very simple optical system, consisting of a polarising device, polarising light in the plane indicated by the arrow on its end-face, a lens, a glass vessel containing, for example, nitro-benzene, immersed in which are two parallel opposing plates, and an analysing device permitting only that light to pass which is polarised in the plane indicated by the arrow on its end-face (that is, light polarised in a plane at right angles to that of the light proceeding from the polariser). From what has been said in the preceding articles, it will be clear that normally no light will be passed by the analyser, for all the light reaching it is polarised in precisely the wrong plane.

Suppose (*a*) is a diagrammatic representation of the state of polarisation of the light coming out of the cell when no potential difference exists between the plates. The state of polarisation will change to elliptical polarisation as shown at (*b*) when electrostatic lines of force traverse the medium between the plates; as the potential difference between them increases, more and more lines are added, until a point is reached, represented at (*c*) when the light is circularly polarised, and in this state the analyser could be turned around the axis of the beam without changing the intensity of the light emerging from it.

Further increase in potential produces elliptical polarisation again with the major axis of the ellipse canted in a different direction as shown at (*d*), and finally a maximum is reached when *all* the light is passed by the analyser, since the ellipse contracts again into a straight line representing plane polarisation, but in a plane at right angles to that in which it was originally polarised on leaving the polariser.

How important it is in designing a television receiver to understand the real nature of the Kerr effect will be obvious from the distinction which has now been drawn between this and the Faraday effect or rotation-of-plane-of-polarisation. Yet again and again we have read quite eminent authorities' descriptions of the Kerr effect in which it has been wrongly stated to depend upon rotation.

Substance.	*Kerr Constant.*	*Colour.*	*Specific Resistance, ohm/cm³.*	*Dielectric Constant.*
Nitro-benzene—				
Commercial ...	22×10^{-6}	Yellow	5×10^{7}	36.4
Best Purified ...	41×10^{-6}	Slightly yellowish	1×10^{10}	38.4
Meta Nitro-toluene	1.43×10^{-4}	—	—	29.3
Carbon Bisulphide	—	Nearly colourless	—	2.62

Kerr Effect in Liquids

We must now turn to an investigation of the conditions under which the Kerr effect is best developed in liquid media: first of all, we give a list of the

(*Continued on page* 37.)

THE TELEVISION ENGINEER

Picture Shapes and Scanning Lines

By Robert Desmond.

Standardisation of picture ratio is a matter needing early settlement. This article explains the various considerations upon which a decision depends.

In the reproduction of any scene the resulting picture has always to be fitted into some mask or shape. Nearly always a rectangular shape is chosen. Very few circular and oval masks are used, excepting perhaps by the profes-

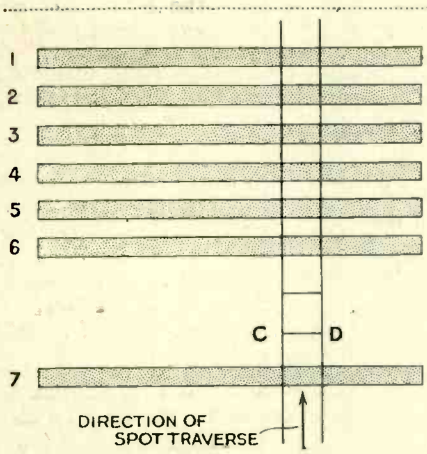


Fig. 1. This diagram shows how detail may be lost.

sional photographer of some twenty years ago. This fact is rather surprising, as if you question any of your friends as to what shape of scene their eyes seem to view, they will generally agree that it is an oval in a horizontal direction, which is to be expected when one considers the "layout" of the human eyes. In spite of what our eyes may or may not frame a scene by, the rectangular mask is predominant.

In mechanical reproductions certain standard shapes or sizes have been adopted for commercial reasons. Of all the shapes that are available, however, four have withstood the test of time to a far greater extent than any others, the ratio of their sides being 1 : 1.3 to 1.4.

Having decided on a picture shape one then has to decide whether it is better to have the greater length in the vertical or horizontal direction. In nearly all reproductions the mask can be turned to suit the subject but where the greatest number of scenes are reproduced as in cinematography the ratio 1 : 1.165 is fixed to give a breadth greater than the height, the actual size being 2.1×1.8 centimetres on the film. (These figures are for the "talkie" picture of today.) In the days of the silent film the mask was 4×3 which was very pleasing for outdoor subjects but a single "close-up" of a face or single figure of a person had a considerable amount of wasted picture area on either side and great care had to be taken not to include anything that would detract the eye from the main object. In the early days of motion pictures many sizes of films were used but it was quickly realized that standardisation had to take place and viewed generally the choice seems to have been well made.

Many Complications

History seems to be going to repeat itself with television, but in addition to various picture ratios there is the further complication of the number of scanning lines and the direction in which they scan the picture area. As in the film industry, however, standardisation must come with television before any real commercial advance is made. But what standards will be adopted? From past experience one comes to the conclusion that something of the order of the 1 : 1.3 picture ratio seems to have the strongest claim with the special advantage of linking television with the film.

While the adoption of a picture shape is relatively simple, the number of scanning lines is a most difficult problem, as on the number of lines depends the amount of detail reproduced.

Theoretically it can be shown that any television picture requires frequencies from zero to infinity for perfect reproduction. Luckily, in practice one can work with a frequency band of which the lowest frequency is that of picture speed and the highest about 12 per cent. below the first zero frequency. The term "zero frequency" perhaps is new to readers and should be explained. It is obtained by multiplying the number of times the linear length of a square spot divides into the breadth and height of the area scanned by the picture speed. For example in the case of the thirty line picture radiated by the B.B.C. one has 30 (breadth) $\times 70$ (height) $\times 12.5$ (picture speed) $=$ 26,250 cycles.

Physically the first zero frequency never exists as a fundamental. In

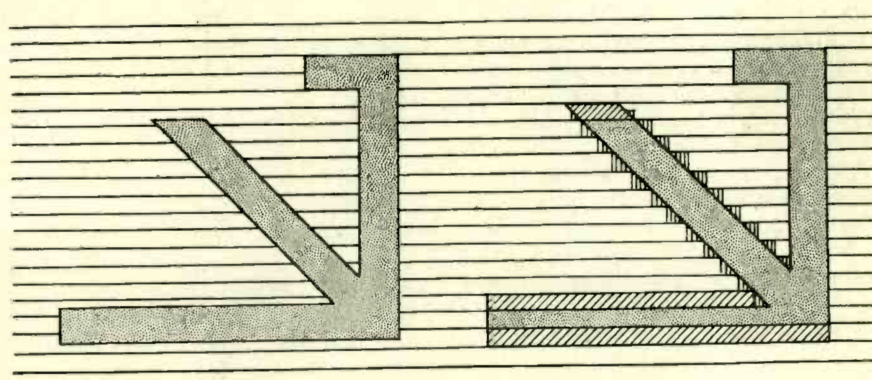


Fig. 2. These two figures show a transmitted object and the received reproduction respectively. Portions of the latter are distorted due to the process of scanning.

Fig. 1 we have a series of black and white lines of equal depth separated by white spaces of a depth equal to that of the black lines. Now if these alternate black and white areas are scanned by a spot whose depth is equal to one black and one white line together, it will be clearly seen that after the side of the spot *CD* has passed the lower edge of the sixth black line no change will take place in the value of the light in the spot till the side *CD* has left the bottom edge of the first black line (the spot is travelling upwards), and the pattern of the six lines will appear on the receiving screen as a mass whose tone value will be in the middle of the scale of tone values.

From the above it must not be thought that it is impossible to transmit detail such as the black line No. 7 which is the same depth as the lines above it. If this line was the breadth of the picture it would produce a fundamental frequency of 375 in the Baird system but if we had 70 such lines equally spaced across the picture the fundamental frequency would be 26,250 the zero frequency.

Scanning Lines and Definition

It is generally assumed that an increase of scanning lines give better definition, but this is not always the case as will be shown. If the number of lines were doubled in the present picture ratio the first zero frequency would be $140 \times 60 \times 12.5 = 105{,}000$ c.p.s., but if on the other hand the picture was square, the zero frequency becomes 45,000, while if the picture had a 1 : 2 ratio the spot travelling across the shortest dimension gives us $60 \times 30 \times 12.5 = 12{,}500$ cycles which is less than half the present 30-line picture at present being broadcast. From the above it will be obvious that when deciding on the number of lines to be used in a picture the amount of detail they will transmit will depend first on the picture ratio and secondly on what direction the picture, if other than square shaped, is scanned.

In this country the television picture which is broadcast is scanned vertically, while without exception, to the writer's knowledge, horizontal scanning is used elsewhere. It is not perhaps realized that there is always more detail reproduced in the direction of spot traverse than that of strip traverse. This is obvious when one realizes that in the direction of spot traverse the spot may occupy an all but infinite number of positions, while that of the line may only be a definite amount. Furthermore the spot traverse can be considerably improved by certain electrical networks which the television engineer terms aperture correction.

On the left-hand side of Fig. 2 we have a pattern before being televised while on the right is the same pattern as reproduced in a receiver. It will be noticed how the pattern which runs parallel with the scanning lines and does not fit them exactly is distorted, while those that do fit are reproduced correctly. That part of the design which is at right angles to the scanning line is reproduced correctly by virtue of the sliding spot with the addition of correcting networks and the diagonal part reproduced with a form of distortion which causes a saw-like appearance. Incidentally readers who get this saw-like edge to similar lines in their visors may be interested to know that their receiving apparatus is passing the higher frequency components of the signal.

Many people often express adverse criticism on the shape of Mr. Baird's first picture. The choice, however, is well made. When the first practical half tone television was achieved only a face and a little of the neck were attempted and the 3×7 picture ratio fitted such a subject admirably. As the essential detail of a face lies in the horizontal direction it is best scanned at right-angles, hence vertical scanning, while the limit of thirty lines was made by the sensitivity of the photo-electric cell and the desire to keep the frequency band within reasonable limits to commence with.

Standardisation Essential

Standardisation of the picture in the future must come to ensure the commercial success of television as it had to in the film industry. Undoubtedly the shape will follow that of the cinema, especially as all the high-density television pictures of today are reproduced from film pictures; nor must it be overlooked that film interests control quite a few television laboratories.

As to the number of lines, anything from thirty to three hundred have been suggested. The writer suggests that the modest figure of a hundred and twenty will be the optimum number for quite a long time. Such a number will give very fair reproduction of an object whose linear dimension in the direction of line traverse is $\frac{1}{50}$th of the linear measurement of the whole picture in the same direction, while in certain cases $\frac{1}{100}$th may be similarly reproduced.

It would be very nice to be able to reproduce all that one can see by careful inspection of a cinema film, but is such perfection really necessary? If you watch a movie programme rather more carefully than usual you will at once realize that it is very rarely necessary to see detail finer than that which has an area bounded by $\frac{1}{50}$th of the breadth and height of the picture in order to interpret all that the producer intended. It is no argument to say that because one can see the detailed markings of, say, a sparrow at the bottom of one's garden some twenty yards away as well as seeing the whole of the garden at the same time that therefore television must have the same resolving power; even the cinema would not attempt such a "shot." Of course, the eye only sees very little of the total picture area recorded in anything like fine detail and as in presenting a scene in the cinema picture, those responsible fill the picture area adequately with what they want to "put over" so a similar course would be followed in television.

With regard to the direction of scanning, that of horizontal appears to suit best the greatest number of scenes with the exception of the human face. As already shown, detail at right angles to spot traverse reproduces best and undoubtedly if a square picture was alternatively scanned horizontally and vertically the greatest amount of detail would be transmitted for a given number of lines. Unfortunately such a system of scanning would tend to increase flicker for a given number of picture scans per second.

While on the subject of flicker the problem is of rather greater magnitude than in cinematography owing to the nature of the television picture. It has been shown that to eliminate flicker entirely in a well lighted picture, forty-eight pictures per second will be necessary. The television engineer, however, has great hopes that such picture speeds will not be necessary and that the effect known as "after-glow" of fluorescent substances will help to solve the problem.

The Miraco Kit

TELEVISION FOR THE HOME-CONSTRUCTOR

> **BRIEF SPECIFICATION**
>
> Makers: Grafton Radio Company, Limited.
>
> Model: The Miraco Kits to the design of C. P. Hall.
>
> Price: £18 18s.
>
> Valve Combination: Two screen-grid high-frequency stages, diode tetrode second detector, pentode output, full-wave valve rectifier.
>
> Type: Table cabinet.
>
> Remarks: This is one of the first complete television kits that is within the financial and technical reach of the home constructor.

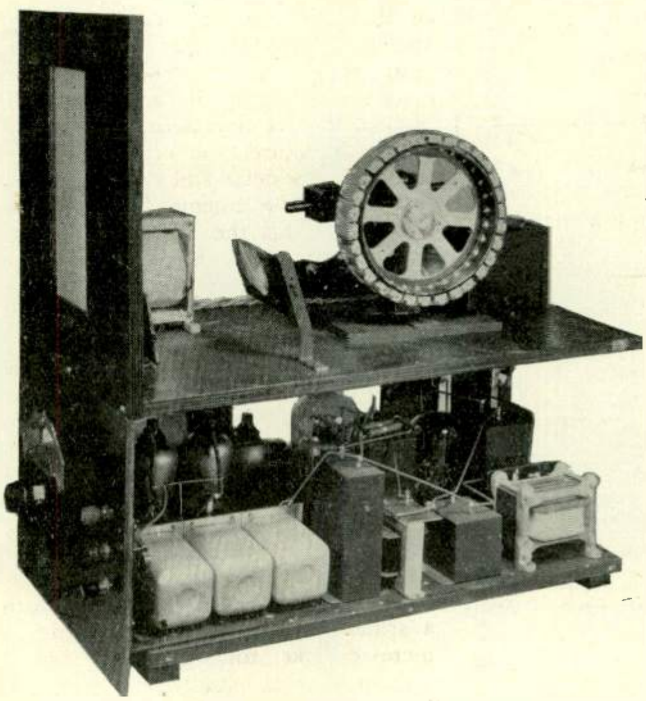
ALTHOUGH the prices of television components have dropped very considerably during the last few months, few readers know that it is now possible to buy a *complete* kit of components, including valves, for a high-class mirror-drum television receiver for £18 18s.

Grafton Radio, Ltd., have just introduced their Miraco kit, designed by C. P. Hall, a well-known contributor to TELEVISION, which does enable the home constructor to receive the B.B.C. television transmissions with excellent quality.

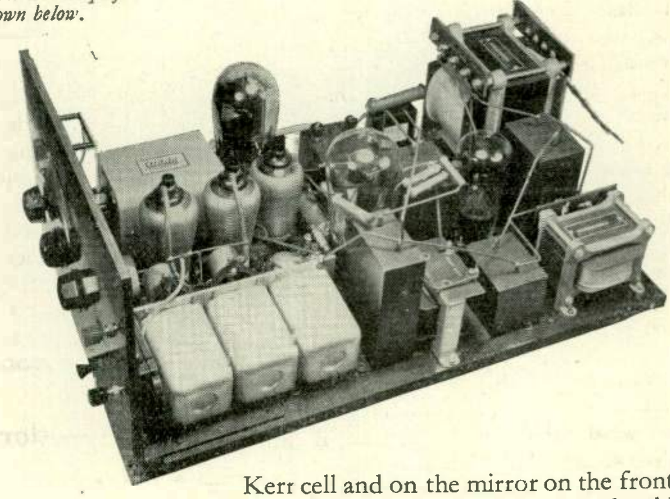
This kit of parts is capable of being assembled by anyone with a few tools at his disposal. It is supplied in two parts, the first comprising a very up-to-date mirror-drum visor with an optical system as a separate unit; and the second the radio receiver, which embodies all the most modern ideas. The tuning is comparatively sharp, but not sufficiently so as to cause frequency cut-off and consequently bad pictures. It consists of two high-frequency amplifying stages, using screen-grid valves, a combined diode detector and screen-grid low-frequency amplifier with a pentode output valve giving thirteen watts. The whole receiver is entirely A.C. mains operated, quite free from hum and extremely compact.

The optical section is mounted directly above the vision receiver. It utilises a mirror-drum scanner of conventional design with a Kerr cell and 100-watt projection lamp. The drum is supplied already assembled and adjusted so that the difficult part of the equipment is already done for you. The most inexperienced amateur cannot fail to obtain satisfactory results with this simple equipment. Blueprints are supplied so that both the sound receiver and the optical portion can be assembled without difficulty; the wiring is shown on the full-size blueprint.

It is quite an easy matter to test out this equipment We suggest that you go about it in the following way:



The picture on the left shows the mirror-drum scanner with Kerr cell and projection lamp, and the vision receiver ready for placing in the cabinet. A photograph of the receiver and amplifier is shown below.



Connect a 2-microfarad condenser in series with the loudspeaker and couple it to the output terminals marked 2 and 3. The other two terminals marked 4 and 5 should be shorted together. The tuning condensers should be adjusted until you hear the local station with the volume control about three-quarters of the way on. The main tuning condenser is supplied with trimmers. These should then be adjusted until you obtain the maximum signal strength. As these trimmers are rather sensitive, the best position will be found by ear quite simply.

Then tune the radio receiver to the National programme on 261 metres, from which the television broadcasts are sent out. The condenser and loudspeaker should then be disconnected, and the Kerr cell terminals on the optical unit connected to the two terminals 2 and 3. The two terminals on the synchroniser should be joined to terminals 4 and 5 on the receiver, which should now be uncoupled.

Switch on the receiver and lamp, and you will see a yellow beam through the Kerr cell and on the mirror on the front of the optical unit. The screen should be pulled forward on the slide about 6 in., and the mirror then adjusted so that the reflected beam passes through the lens on to the mirror drum from whence it is reflected to the screen. Then revolve the drum, taking care not to handle the mirrors, which would spoil the picture-definition and adjust the forward mirror very finely until the thirty lines scan the screen. The

(*Continued at foot of next page.*)

An Experimenter's Notes

An Amplifier Test

PLAYING round with a cathode-ray receiver the other day I made an interesting discovery. Owing to the limited hours in which television is available at the moment, one gets into the habit of testing any changes in the circuit on ordinary broadcast music or speech. Music, of course, is better because it is made up of more or less sustained notes, and if your cathode-ray tube is already building up a series of 30 lines, the modulation of these lines by the music will cause them to go light and dark in patches, and the result is a series of constantly changing but still well defined patterns.

The definition of these patterns is some guide to the manner in which the outfit is performing, and I was rather troubled by a somewhat faint but nevertheless clearly defined pattern which appeared to be present as a background the whole time. The pattern was a very fine one, giving the lines an appearance of watered silk. I spent a little time looking round for troubles in the receiver, but when I thought about it, it was clear that a pattern of this nature could only be produced by a very high oscillation.

This gave me the clue. I was listening to the music on a pair of headphones and looking at the pattern at the same time. The background to which I have referred was produced by a very high-pitched heterodyne whistle (11,000 cycles) between London Regional and Muhlacker which was quite inaudible on my headphones. I replaced them by another pair which I knew had better characteristics, and the whistle at once became audible, although only just because it was extremely high and practically at the limit of audibility. Yet the cathode-ray tube was showing it up beautifully, indicating that my amplifier was working really well from a television point of view. Also it throws an interesting sidelight on the extremely high frequencies which must be handled satisfactorily by a television amplifier if the detail is to be portrayed satisfactorily.

BAIRD TELEVISION, LTD.—CHANGE OF ADDRESS.

Baird Television, Ltd., inform us that the administration office of this Company has been removed to 58, Victoria Street, London, S.W.1. Telephone, Victoria 7238.

The Miraco Kit.

(*Continued from preceding page*)

receiver volume control should then be turned up gradually until black lines and patterns appear on the screen. If by any chance orange colours appear, the volume control should be turned down a little, otherwise the Kerr cell may be damaged.

About five minutes before the television broadcasts start, switch on the motor to let it warm up, otherwise the speed may be irregular for the first few minutes. Take care that you do not switch on the lamp, or the Kerr cell may get hot and deteriorate. The resistance that controls the speed of the motor should be adjusted until you obtain the illusion that the spokes of the drum are stationary against the glow of the neon lamp. When the television broadcast signals appear the synchroniser will automatically adjust and regulate the speed of the drum.

The whole equipment looks very complicated, but let us assure you that it is far from being so. It has been designed so that the home constructor has little or no difficulty in obtaining television reception. The blueprint and constructional details have been so clearly worded that we feel sure the merest novice will be able to boast that he has made his own television receiver.

Think of what it will mean to you later in the year when the B.B.C. start broadcasting illustrated news bulletins. At the moment the programmes are extremely good. Some of the vaudeville items are of the highest standard.

The Constructors' Circle

Additional Members

BOYLE, GEORGE, 20, Sandford Road, East Ham, E.6.

REYNOLDS, H., 3, Oak Street, Blackwood, Mon.

BALDWIN, A. R., Spring Hill, Nailsworth, Glos.

COOK, N., 8, Orange Street, Canterbury.

ARTER, DOUGLAS, The Nest, Warren Avenue, Charlton.

The Television Society

The next meeting of the Television Society will be held on January 17, 1934, at 7 p.m., at University College, W.C., the subject being Cathode-ray Television, with a demonstration. Particulars of the Society and proposal forms can be had on application to the members' Hon. Secretary, J. J. Denton, 25, Lisburne Road, N.W.3.

Television Lectures

A series of twelve lectures will be given by J. J. Denton (Fellow Brit. Radio Inst., Hon. Sec. Television Society) on Fridays from 7.30 to 9.30 p.m. at Morley College, 61, Westminster Bridge Road, S.E.1, commencing January 1. The fee is only 4s. 6d. for the whole course, and the lectures will be illustrated by experiments, lantern slides and demonstrations.

Television Conference in Moscow

An All-Union conference on television is taking place in Moscow. The conference is dealing with future research work to be carried out in television and the production of transmitters and receivers by the Soviet electrical industry. Mr. Shostakovich, of the Commissariat for Posts and Telegraphs, who has returned from a trip to the United States, is reporting on the progress made in television in foreign countries.

Selectivity *or* Frequency Response?

In this article S. RUTHERFORD WILKINS discusses a method of retaining the higher frequencies so necessary to television reception, and at the same time avoiding interference from neighbouring transmitters.

THE design of a television receiver and that of a broadcast receiver differ considerably as regards the high frequency amplifier.

In a broadcast receiver, selectivity is the main consideration, but with the tuning system arranged to give a high degree of selectivity, a considerable attenuation of frequencies above 5,000 cycles is inevitable. This is not a very serious fault in a broadcast receiver, as with most speakers reproduction of these higher frequencies is very poor.

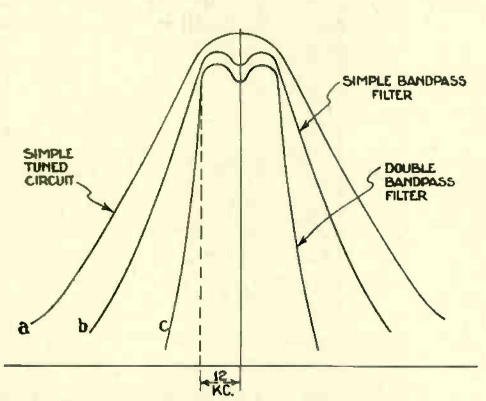


Fig. 1. Curves showing the relative frequency bands passed by various types of tuning circuits.

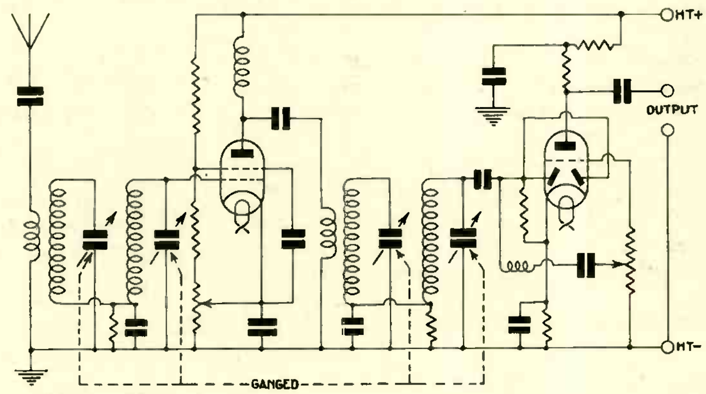


Fig. 2. Experimental circuit of double bandpass high-frequency stage for television reception.

Wide Frequency Band

The range of frequencies required for good picture reproduction is much greater, however, as the degree of definition of the picture depends on the frequency range of the modulation. In the new multi-line short-wave transmission the highest modulation frequency transmitted runs into hundreds of kilocycles and corresponds, in fact, to the frequency band of the longer broadcast wavelengths. Such modulations frequencies obviously would be impossible when the transmissions themselves are taking place on broadcast wavelengths.

As a matter of fact, the frequency band is limited to 10,000 cycles with the 30-line transmissions which are radiated from the London National transmitter, and if the full frequency band is properly received the resulting picture has quite a good definition.

In order to avoid attenuation of these higher frequencies, it has been usual to design a receiver with one or two stages of high frequency amplification with flatly tuned circuits. Admittedly, if the tuning is flat enough, very little attention of sidebands up to 10 kilocycles will result. In order to achieve this, however, the skirt of the tuning peak will be so wide that interference from stations as far removed as 80 or 100 kilocycles will be noticed.

Selectivity of Tuning Circuits

It is as essential in television as in radio to avoid appreciable interference from neighbouring broadcasting stations, otherwise unwanted modulation will be present with consequent distortion of the image. Thus a television receiver has to have the two rather opposing properties of reasonably high selectivity and a frequency response up to 10 kilocycles.

The solution that immediately springs to one's mind is to employ bandpass tuning. Unfortunately, however, most modern bandpass coils are designed to give approximately 8-9 kilocycles separation at the peak of the tuning curve. This means that, apart from all other sources of loss, there will be definite attenuation above 8,000 cycles in the low frequency modulation output.

In order to achieve a uniform response up to 10,000 cycles, it is really necessary to have bandpass filters with a peak separation of 12 kilocycles. This can be quite easily accomplished by slightly altering the value of the coupling between the two circuits of the bandpass filter.

If capacity coupling is employed, it is only really necessary slightly to decrease the value of the coupling condenser.

With an input filter of this description it would be quite possible to obtain a uniform low frequency output from the set up to 10 kilocycles, provided that the other tuning circuits were fairly flat.

Unfortunately, a simple bandpass filter, although better than a single circuit arrangement, does not give a tuning curve with really steep sides (see Fig. 1). For instance, a bandpass filter designed to give a peak separation of 12 kilocycles would pass quite appreciable interference from a broadcast transmitter separated 30-40 kilocycles from the one being received.

The Ideal Bandpass Filter

The ideal bandpass filter, of course, would be one that has the same separation at the bottom of its response curve as at the top.

The goodness of a filter from this point of view depends on the number of circuits included in it. For instance, a 12 kilocycle bandpass filter with four tuned circuits would give a very much steeper response curve than the more common type with two circuits only. Unfortunately, it would be expensive as well as impracticable to include such a filter as this in a simple receiver. Practically the same effect could be achieved, however, by two two-circuit filters, one on the input to the high-frequency valve and the other in the anode circuit of the valve.

Double Bandpass Tuning

For instance, a receiver with one efficient high-frequency stage and double 12 kilocycle bandpass tuning could be relied upon to give adequate low-frequency response at 10,000 cycles and at the same time should obviate serious interference between stations separated by 15-20 kilocycles. Although this is not an extremely high degree of selectivity, it should be quite sufficient to enable the National programme to be received quite free of interference on a set with a single H.F. stage.

Having designed an efficient high-frequency stage for our set, the next problem is the rectifier.

Any form of retroaction would be useless as, besides introducing distortion, it would upset the matching of the bandpass filter immediately preceding it. Power-grid, or power anode-bend rectification, would give excellent results if carefully adjusted, but from the point of view of simplicity and freedom from distortion anode rectification is undoubtedly superior.

Use can then be made of one of the new double-diode-triode valves, to perform the dual function of rectifier and first L.F. amplifier.

A circuit showing the high-frequency and detector stages of a set on these lines is shown by Fig. 2.

It will be noticed that the diode is tapped down the secondary coil of the second bandpass filter to reduce the load on this coil and prevent mis-matching.

The output from the triode should now be taken to an amplifier of suitable frequency characteristic, the number of valves in the amplifier being dependent on the type of visor in use. For instance, if a mirror-drum apparatus is being used, the amplifier will have to be capable of producing 5 watts undistorted output with at least 500 volts high-tension. If a cathode-ray receiver is in use, however, the output from the duo-diode-triode should be enough to modulate the picture.

In any case, the design of a suitable amplifier is quite straightforward, and a high-frequency amplifier designed on the lines detailed above should give a suitable output.

EUROPEAN TRANSMISSIONS

Transmitter.	*Wavelength.*	*Power.*	*No. of Lines.*	*No. of Frames. Second.*	*Picture Ratio.*	*Transmission Times. G.M.T.*	*Remarks.*
Baird U.S.W. from Crystal Palace	6.055 m.		30			Various	
B.B.C. U.S.W. from Broadcasting House	7.75 m.		120			Various	
Berlin ...	1,635 m. (183.5 kc.)	60 kw.	30	12.5	3-4	Tuesdays, 8.5 to 9 a.m. Thursdays, 12.45 to 1.45 p.m. Saturdays, 8.5 to 9.45 a.m.	
Berlin, U.S.W.	6.985 m. (42,950 mg.)	4 kw.	90	25	5-6	Daily, 9 to 10 a.m., excluding Sundays and holidays. Occasionally 1 to 2 p.m. and 8 to 9 p.m.	
Leningrad, R.V. 53	857.1 m. (350 kc.)	100 kw.	30	12½	3-4	Irregular.	
London National	261.6 m. (11.47 kc.)	50 kw.	30	12½	7-3	Mondays, Tuesdays, Wednesdays and Fridays, 11 to 11.30 p.m.	
Moscow ...	1,000 m. (300 kc.)	100 kw.				Every other day (uneven dates in December), 9.15 to 10 p.m.	Telecinema transmissions.
Rome ...	80 m. (3,750 kc.) 25.4 m. (11,810 kc.)	9 kw. 9 kw.	60	20	4-3	Discontinued at present.	Commencing again soon. Special announcement will be made.

PLACE AN ORDER WITH YOUR NEWSAGENT FOR "TELEVISION" TO BE DELIVERED EACH MONTH

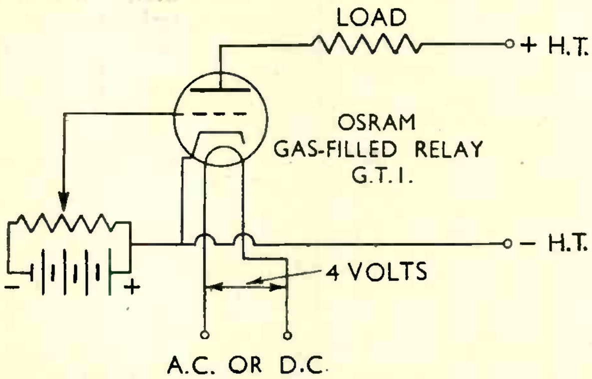
A VALVE RELAY

—And Some Typical Applications

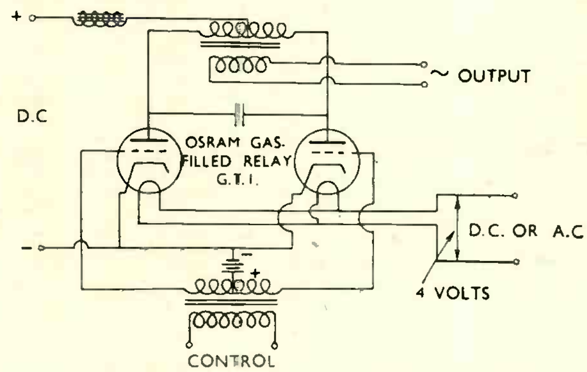
The gas-filled relay has become an essential part of the modern Cathode-ray television equipment. Here are some useful facts concerning the Osram mercury-vapour tube.

THE Osram gas-filled relay type G.T.1 is a gas-discharge valve consisting of a cathode, anode and grid in a mercury-vapour filled bulb.

The electron emission is obtained from a coated cathode indirectly heated by a 5.2 watt heater which it encloses. This has the advantage, in combination with the standard heater rating of 4 volts, that the filament may be heated from a transformer common to other indirectly-heated valves if desired. Under normal operating conditions the bulb is filled with a blue glow, due to ionisation of the mercury vapour. When the discharge is in progress the voltage drop across the gas-filled relay remains constant at about 15 volts, independent of the load.

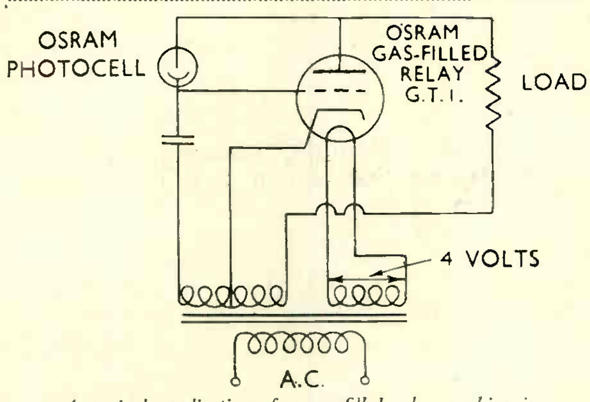


The gas-discharge tube used as a simple relay with D.C. anode voltage and D.C. grid control.



An inverter circuit—D.C. to A.C. with D.C. anode voltage and A.C. grid control.

One important point in the operation of the tube is that the cathode should be allowed time to attain its full operating temperature (at least 1 minute) before the anode voltage is applied. Failure to observe this precaution will result in permanent damage to the cathode. For the first time of switching on a greater cathode heating time (5 minutes) should be allowed in order to ensure correct distribution of the mercury in the bulb.



A typical application of a gas-filled relay working in conjunction with a photo cell.

The function of the grid in the Osram gas-filled relay is to control the anode voltage at which the discharge commences. A negative voltage applied to the grid will prevent the discharge being established, its minimum value depending upon the applied anode voltage and the "grid control ratio." In the case of the type G.T.1 gas-filled relay this ratio is approximately 25: that is, for example, a negative grid voltage of 10 will suffice to withhold the discharge up to an anode voltage of 250 (the discharge in any case not commencing under 15 volts).

The moderately low value of control ratio avoids a highly critical operating condition. The actual grid control ratio depends on the temperature of the surrounding air and of the gas-filled relay. A reduction in temperature will increase the control ratio—*i.e.*, for a given anode voltage a smaller negative grid voltage suffices to withhold the discharge. After the discharge commences the grid exercises no further control and the anode current may in general only be stopped by breaking the anode circuit or reducing the anode voltage to a condition below the ionisation voltage—normally about 15 volts.

The time required for the grid to regain control, while the discharge is off, is extremely small, a fraction of a milli-second.

It is important to note that when the anode current is once started its value is limited only by the external impedance in the anode circuit. To avoid injury to the valve it is essential that anode current shall not exceed the rated peak value of 0.6 ampere. To this end a suitable resistance, or other current limiting device, must always be included in the anode circuit. For example, in the case of a resistance load, if the D.C. voltage is 200, and a 15-volt drop in the gas-filled relay is allowed for, this resistance may be obtained as follows :—

Maximum permissible peak current —0.6 amp.

Volts drop required across resistance —185.

Resistance $\frac{185}{.6}$=308 ohms.

For A.C. voltages the anode resistance must be calculated for the peak value of the voltage—*i.e.*,

$\sqrt{2}\times$R.M.S. value.

Thus, if the A.C. voltage is 200

$$\text{Resistance} = \frac{(\sqrt{2}\times 200)-15}{.6} = 448 \text{ ohm}$$

If a tungsten filament lamp is connected in the anode circuit, it should be noted that the cold resistance of such a lamp is about one-fourteenth of the resistance when hot, and consequently an excessively heavy current will flow when first switching on before the tungsten filament becomes hot.

It is advisable to operate with a resistance (about 10,000 ohms) in series with the grid to limit the grid current for positive grid voltages. This resistance does not appreciably affect control when the grid is negative. With A.C. anode voltage and A.C. grid control, continuous control of anode current, from zero to maximum load currents, may be obtained by variation in phase angle between anode and grid voltages. This is of considerable importance in all cases where continuous control is required.

PATENTS AND PROGRESS—*Continued from page 14*

is projected directly on to the "mosaic" surface, where it is immediately converted into an equivalent "electrical" picture, the high lights setting-up large electrical charges and the low lights small electrical charges. At this stage the picture is scanned by the cathode ray and the small cell-condensers are discharged as a series of varying currents.

In order to allow the picture to be projected on to the "mosaic" from outside the cell, the anode of the cathode-ray tube must be set at an angle to its usual position. Unfortunately this means that it is partly foreshortened with respect to the cathode ray, a fact which is liable to produce a certain amount of distortion. To prevent this the picture is projected on to the mosaic of cells through a special system of lenses which slightly distorts the picture in the reverse sense to that previously described, the result being that one deformation offsets the other, and so produces a true image at the receiving end. —(*Electrical and Musical Industries Ltd.* and *W. D. Wright.*)

Other Television Patents

(Patent No. 399469.)

Velocity-modulated television system in which the deflecting potentials for the cathode-ray tube are derived from a condenser controlled by thermionic valves.—(*W. R. Bullimore* and *L. H. Bedford.*)

(Patent No. 399694.)

Dynatron valve used as a television modulator.—(*Marconi's Wireless Telegraph Co. Ltd.*)

(Patent No. 400062.)

Magnetising coils for focussing the electron jet in a cathode ray tube.—(*Telefunken Co.*)

(Patent No. 400453.)

Cathode-ray tube for television in which a "throttling" diaphragm is placed in front of the cathode to control the stream.—(*Telefunken Co.*)

(Patent No. 400610.)

Synchronising systems for television in which a driving motor is automatically checked from running out of time.—(*Marconi's Wireless Telegraph Co. Ltd., H. M. Dowsett,* and *L. E. Q. Walker.*)

THE SCOPHONY SYSTEM

The Editor is accorded the first press demonstration and an examination of the apparatus.

IN photography the word "kodak" has become synonymous with simplicity. It would appear that the word "Scophony" may come to have the same meaning in television, for surely no mechanical television apparatus could be more simple or require less power for its operation than that which has this appellation. The simplicity, however, is in the complete apparatus ; the principle and construction are extremely complicated, the latter embodying a great deal of fine optical work.

We are not at liberty to disclose the actual details yet, beyond saying that the principal unit in the apparatus is a revolving echelon which in the small model weighs but a few ounces and, being perfectly balanced, requires negligible power to drive. There are no other moving parts whatever.

At present a line mercury vapour lamp is being employed as the illuminant, but other sources of illumination are equally suitable. This type of lamp requires the minimum amount of power for its operation, and this, combined with the high efficiency of the echelon, accounts for the extremely small power required to operate the Scophony receiver.

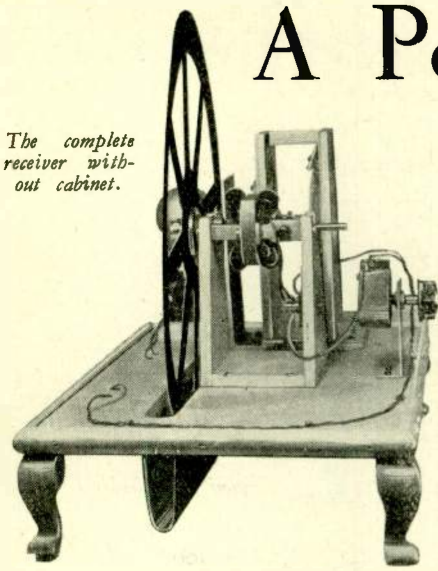
Photographs on other pages in this issue show the two types of receiver demonstrated. One, it will be observed, is but little larger than a hand camera, and yet it will project pictures 3½ in. by 8½ in. The extremely small size of the echelon scanning device which is used with this receiver will also be apparent from this photograph.

The other receiver is the standard instrument, and this is built into a metal framework ; the simplicity of this is also apparent from a photograph. At the demonstration witnessed the results were about the equal of those obtained with high-class mirror-drum apparatus, but with the added advantage that there was an almost complete absence of scanning-line demarcation. Also it must be remembered that the input was less than ordinarily used for mirror-drum reproduction. The lighting of the picture was all that could be desired.

The reason why this apparatus is not available to the public is explained by Mr. Sagall on another page. Examination of the Scophony receiver makes it quite evident that it is a type which can only be manufactured commercially and, if the price is to be kept to the low figure intended, on a large scale.

The Scophony system lends itself equally well to high and low-definition transmissions. Fully illustrated details will be given in an early issue of this journal.—H. C.

A Popular Disc Receiver



The complete receiver without cabinet.

THE photographs and drawings on this page show a simple disc receiver which has attained very great popularity. Originally it was described in our sister journal *Amateur Wireless*, and it is felt that brief particulars will be appreciated by readers of TELEVISION who are desirous of making up a receiver of this type.

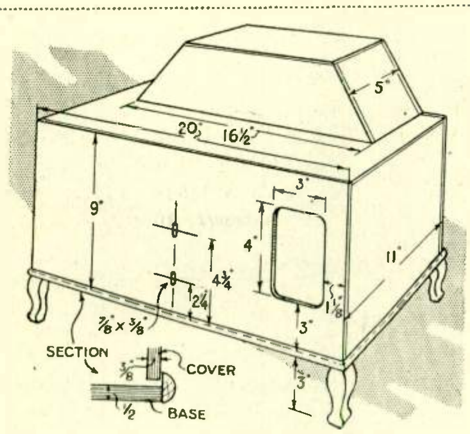
Three factors were kept in mind when this receiver was designed—efficiency, a good appearance and ease of construction—all of which have been amply fulfilled. Excellent reports have been received of the performance, mostly operated from ordinary standard three-valve broadcast receivers, which provide an adequate input under most conditions.

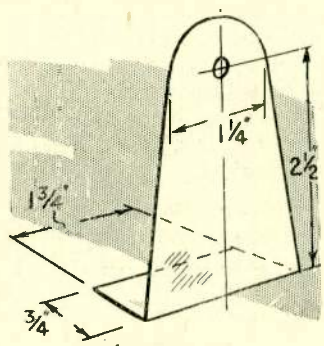
The appearance of the finished receiver can be judged from the photograph, and it will be seen that it is quite neat. Special attention was given to make its construction come within the abilities of the average amateur who only has the simplest tools available. The receiver does, in fact, represent the simplest and cheapest construction consistent with really good results. If it is not wished to make the woodwork, this can be obtained ready from Messrs. Peto-Scott, Ltd. All the other parts are available from the Mervyn Sound and Vision Co., Ltd.

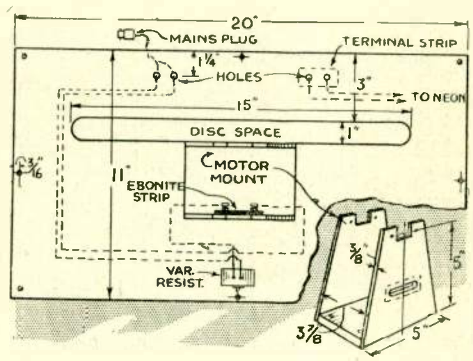
It will be seen that the main parts of the receiver are the scanning disc (which is of small size and was specially designed for this machine), the motor, the neon lamp (of the beehive pattern), two lenses and the motor-control rheostat. The small lens is a sixpenny reading glass.

The Components You Will Need

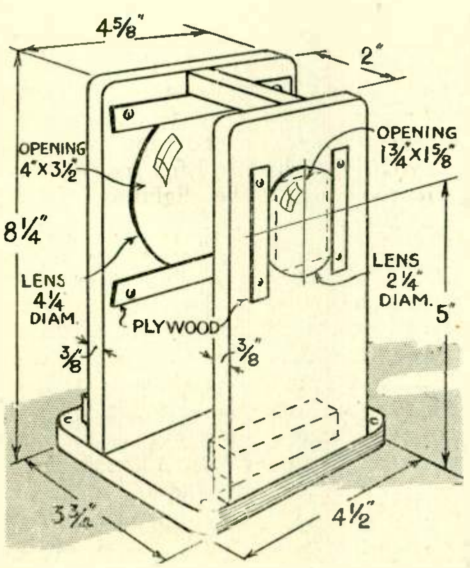
One scanning disc ready for use (Mervyn Sound and Vision Co., Ltd.).
One motor, type BR1 (Mervyn Sound and Vision Co., Ltd.).
One 4¼ in. diameter lens (H. Sanders and Co.). One small lens.
One beehive or spiral neon lamp (G.E.C., Philips).
One terminal mount, type "B" (Belling-Lee).
One 150-ohm variable resistance to carry .3 ampere (Mervyn).
One mains plug.
Baseboard and woodwork (Peto-Scott).







Here are details of the cabinet, baseboard and rheostat mount.



A large-scale blueprint of the complete set of parts is available, price 1/-.

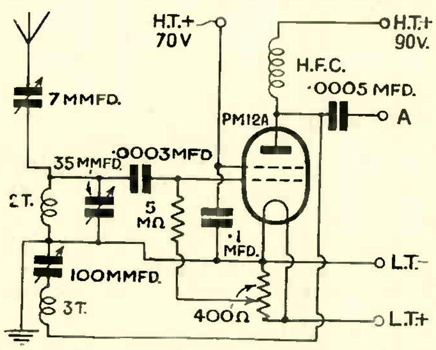
The photograph on the right shows the complete receiver; on the left is a dimensioned drawing of the lens mount.

How to Receive the Broadcasting House and Crystal Palace Short-wave Transmissions

Some General Hints on Ultra-short Wave Receptions

By Kenneth Jowers

THE first people to put the ultra-short waves to practical use were the Germans with their 7.5-metre station at Berlin. As this station was so successful, having a service area of up to 75 miles or so, these low waves began to occupy the attention of the whole world's radio engineers. From the very early days of television it has been quite clear that the broadcast wavelengths would be of very little use if a high degree of definition were to be obtained. After considerable data had been collected about the funny little ways of these quasi-optical waves, television was broadcast from Berlin every day. These transmissions were so successful that before long receivers were being installed at distances up to 75 miles from the transmitter. That the use of television receivers did not become universal was due mainly to the high initial cost, for remember that an hour or so's broadcast each day is not very much for an expenditure of between £30 to £40.



Hook up this unit and pick up television for yourselves. Note the low capacity of the tuning and aerial series condensers.

Round about this time Baird was experimenting at his Long Acre studio with various methods of transmission on a wavelength of 6.1 metres. That his experiments were successful are proved by his latest broadcasts from The Tower at the Crystal Palace.

In America some twenty commercial stations were soon on the air, using different transmitting systems. It was soon quite obvious that to present a nation-wide television broadcast a chain system of television is essential—that is, the linking up of a number of low-power transmitters which between them would cover a very considerable area.

To-day plans are almost completed in America for the transmission of television on this chain system, the vision being transmitted on wavelengths between 7 and 8 metres, and sound on 4.5 to 5 metres.

In Germany the chain idea has already been put into action, where they have decided to erect twenty or so stations in or around the large towns and densely populated areas.

These stations will all radiate the same programmes and be synchronised, so that television will be on tap for almost all of the German people with the necessary receiving equipment. Naturally the cost is still a trifle high, but it is dropping very rapidly.

Short-wave Receivers

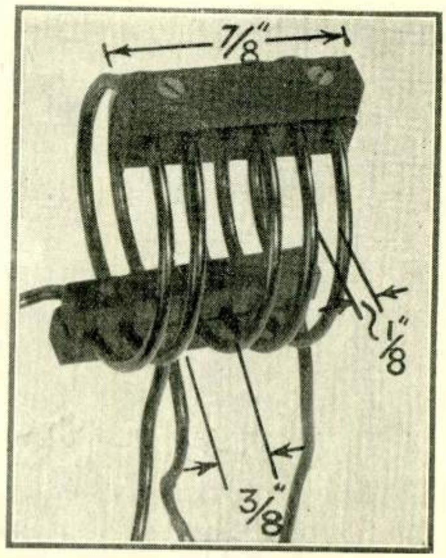
Do you realise that a 7-metre set is the easiest thing in the world to make, if you know how. If cost is a stumbling block, why not make a simple unit to work in conjunction with your present set? It does not matter if you cannot afford a vision receiver—see what you can do with a sound receiver. Experiment with these fascinating short waves and be the first to hear the 7-metre programmes in your district.

Before anyone knew very much about these quasi-optical waves, it was considered that the maximum useful range or service area was in the region of 10 to 15 miles. This idea has put off many amateurs from building their own sets, thinking that they were out of the range of the nearest station. Well, the reception record has gone up and up until now it stands at 200 miles, and this with a two-valve set.

Television and 7-metre sets are for the home constructor—for the man who likes making his own components—because they are so easy to make and cheap. Take the coils as an example. Merely two turns of a heavy gauge copper wire, wound on something like a broom handle. That is the grid coil. The reaction coil requires three turns.

Suitable Circuits

On the other hand, if you wish to buy these components, there are manufacturers who specialise in the coils and condensers that you want. The most difficult job is to decide on the best type of circuit to use without trying all of them, which would make it expensive.



Follow this photograph when making your 7-metre coils, and be very careful about the spacing between the turns as small variations will upset the tuning.

Luckily that trouble is soon overcome, for we have been experimenting with various types of circuit for a long time.

We have a laboratory 40 miles north of London—an ideal spot for television. Being a long way out of the official service area, our receivers had to be good, so you can be sure that when you make up your 7-metre set or unit you will be well repaid.

Except for those within a mile or so of a transmitter, the straight type of set must be ruled out. The popular reacting detector circuit is of little use, even if you can get the reaction smooth. At the moment the super-regenerative circuit does not give sufficiently good quality, although it is good enough for sound or for finding out if you are in the service area.

The only circuit that has stood the test of time is the superhet, but even this circuit must be modified for these ultra-short wavelengths. If you have a broadcast superhet, you will be full of trouble should you try to use a converter in front of it. Contrary to what you probably expected, selectivity is not wanted; the flatter the tuning the better.

Take a look at Fig. 1: quite simple, isn't it? A compromise between a theoretical and a practical diagram. At first glance you might think that it is a conventional screen-grid detector circuit; so it is, but with a few reservations. Starting at the beginning of all things, the aerial, the first component is a 7-micromicrofard variable condenser, not many of these in the junk box. Anyway, Strattons have plenty of them, as well as the 35-micromicrofarad tuning and 100-micromicrofarad reaction condensers. The only other special component you should buy is the high-frequency choke. Try Igranic or Strattons for this. The valve holder should be of low capacity, which you may have, otherwise Strattons again.

Coil-making is an easy job, but in case of accidents we have given a simple diagram. Obtain about 2 ft. of 14-gauge bare copper wire and stretch it to get out all the kinks. Then find a 1-in. former—our broom-handle was the exact size. Cut the wire in half and wind two coils on the 1-in. former. The first one, the grid coil, consists of two complete turns, and the second, the reaction coil, of three complete turns. The spacing between the turns should be about the same as the thickness of the wire. If fairly long ends are left, say about $1\frac{1}{2}$ in., the coils can be connected to the proper points without any holder. The grid coil is a good example of this, for it can be connected directly across the 35-micromicrofarad condenser.

Although hand capacity is not worth worrying about, it is advisable in case of accidents to use 6 in. extension handles. Ultra-slow-motion tuning dials, such as the Igranic microvernier, will be a great help in tuning.

Simple Construction

Constructing this simple unit will not present any difficulties. It is the receiver to which it will be added that must be looked at.

We have told you before that selectivity is not wanted, so it must be got rid of before anything else is done. Let us consider one of the most popular circuits of the day, the screen-grid detector pentode combination. If it is coupled to the aerial by means of a band-pass coil, this coil must be cut out. It is not necessary to upset the wiring. You just join the output terminal of the 7-metre unit directly to the G terminal of the screen-grid valve holder.

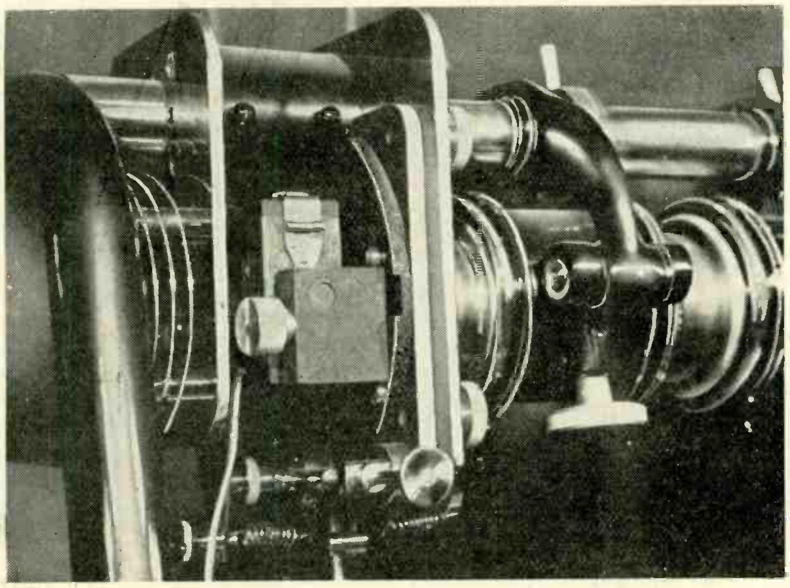
Should there be an adjustable condenser coupling the screen-grid stage to the detector stage, screw this down as far as it will go. That's about all you can do, except to make quite sure that the receiver is quite free from distortion. Connect up the unit in the usual way—high tension plus to about 90-volts, the A terminal on the unit to the A terminal on the family set, unless there is a band-pass coil, and then to the grid of the valve holder. You might notice that when a common high-tension battery is used there is not a second high-tension negative tapping. Should there be the slightest trace of distortion in the output stage, replace the output valve with one having a larger grid swing. Quality rather than quantity is the order of the day; remember a cathode-ray tube only requires 30 volts to modulate.

The Best Aerial

All your precautions will be in vain if the aerial system is incorrect. When within the normal service area, 10 or 12 feet of wire, one end on the aerial terminal of the set and the other end as high as possible, will be as good as anything.

But when the receiver is 20 or 30 miles away from a station more care must be taken. An effective aerial is the simple T-type, the length being approximately the same as that of the wavelength of the station you are going to pick up. The length need not be very accurate. An example will show you just what we mean.

At the present moment the Baird Company are broadcasting from the Crystal Palace on a wavelength of 6.055 metres. This is about 20 feet. Erect an aerial of this length, and in the exact centre tap off the lead-in wire. That gives you half wavelengths either side of the lead-in. Make the lead-in wire the same length as the aerial. Then you will be able to erect it about 15 to 18 feet high. Any increase in height or length will probably cause damping of the grid circuit, and the converter will stop oscillating.



The light cell of a German daylight transmitting system.

Photo-electric Cells for Colour Television

THE art of making talking pictures has called into being several new types of photo-electric cells. Television in natural colours with which experiments are being made has caused a demand for yet other types of these cells. The success which has attended the physicists' efforts to evolve these new cells is remarkable, and tends to show how surely all the many intricate problems connected with television will be overcome in due time.

Natural-colour television, depending as it must for the time being on the principles of three-primary colour vision, it is, of course, a *sine qua non* that a transmission must involve the use of three wave-bands, the blue-violet, the green, and the red components of the image being each transmitted on its own wavelength. The alternative method—to send blue-violet, green, and red signals after each other in cycles—has failed completely in colour cinematography (on account of colour "fringes"), and is hardly likely to succeed in television.

Splitting Up the Image

The need for splitting up the image to be transmitted into its blue-violet, green and red components sounds a difficult matter at first, but it has now been accomplished in an amazingly simple manner by the invention of new types of photo-electric cells, which are sensitive to different colours themselves.

Just as photographic films have had to be made sensitive to different colours for the purpose of natural colour photography, so colour-sensitive cells have been produced.

One well-known type of photo-electric cell consists of a vacuum bulb, one side of which is coated with potassium, in the centre of the bulb there being a ring anode which collects the electrons thrown off by the potassium on its being illuminated. The potassium is converted by hydrogen into potassium hydride for greater sensitivity, and where instantaneous response to light is not the first consideration, the resistance of the bulb is reduced by the introduction of a trace of inert gas.

A cell has been developed in which sodium is substituted for potassium, and its active surface is vastly increased in sensitiveness to light by a process involving the use of sulphur vapour and oxygen, instead of the glow discharge of hydrogen.

Photo-electric cells made in this way respond to the entire spectrum range of colour—violet, blue, green, yellow, orange and red.

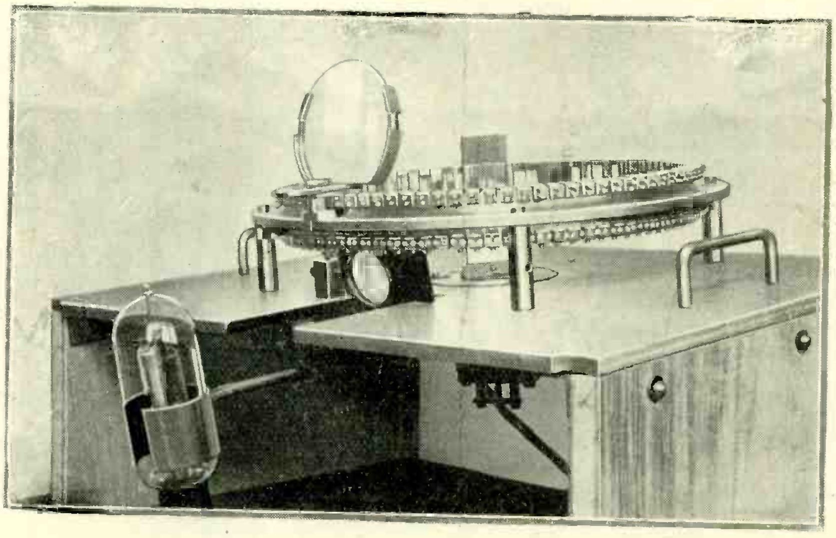
The Bell System

The Bell system of television, to which these cells have been applied, employs a scanning disc which throws an intense spot of light on the face of the sitter or scene being "televised." The spot of light traces a path over the entire area of the subject every one-eighteenth part of a second, and the light from the subject is reflected back upon the photo-electric cells.

Now, in photography it has never been possible to make a film quite *evenly* sensitive to all colours; the film may be, for instance, twice as sensitive to red as it is to green, and ten times as sensitive to blue. The same trouble has been found with these new photo-electric cells. As a result it is necessary that the light reflected from the sitter's face (or other subject) be cast upon an arrangement consisting of *two* cells provided with blue-violet screens or "filters," *eight* cells with green filters, and *fourteen* cells with red filters. In this way, colour equilibrium is obtained, the blue, green, and red cells being respectively coupled up in parallel, and the current from each set after amplification being simultaneously transmitted on its own wavelength.

Three sets of television signals are thus received at the viewing station, representing the three primary colour components of the coloured subject being televised. Each series of signals is made to actuate one of three light sources, which must in turn produce flashes of blue-violet, green, and red light respectively. The scanning disc through which the observer's eye is directed is, of course, in synchronism with the transmitting disc and recombines the three primary colour images into a single image in natural colours.

But here again difficulty was encountered in the fact that the ordinary neon lamp does not emit blue and green rays of light. As all who have seen the neon lamp can appreciate, there is no difficulty about the red. The neon glow is very rich in red rays, and by placing in front of it a suitable red glass screen or filter, pure red and orange rays only will be obtained. To produce light sufficiently rich in green and blue rays, argon lamps are employed.



The Mihaly stationary mirror drum Receiver. In the Mihaly apparatus the mirror drum is stationary, the modulated light passing underneath this on the lower part of the revolving mirror in the centre of the mirrors.

principal media which can be used in a Kerr cell (though it must be remarked that most liquids show the Kerr effect to some degree.

For the experimenter, the most convenient medium to use is nitro-benzene, provided he obtains it of excellent quality, and is careful not to let it come into contact with air until it is to be used. No difficulty should be experienced in obtaining a plate-to-plate resistance of over a megohm through the liquid, and if the resistance falls below this it should be changed. More, however, will be said of this and other practical considerations in the final article of this series, which will deal with the construction of a cell for television purposes.

For best results, the plane of polarisation of light entering the cell must be at 45° to the plane of the plates, as illustrated in Fig. 1*a*. If the plane is vertical or parallel to the plates, *no result at all will be obtained.*

Following a suggestion of Dr. W. D. Wright (*Proc. Phys. Soc.*, Vol. 44, pp. 325, 1932), the plates may be sloped to conform to the rays of light coming from a condensing lens, in the manner shown in Fig. 2. This gives slightly increased sensitivity to the cell, and also tends to minimise the obscuring effect of the plates in the beam.

Limitations of the Kerr Effect

We come now to a most important property of the Kerr effect, and one which in practice limits its utility somewhat; this is the fact that after a certain voltage (corresponding with the condition shown in Fig. 1*e*) is reached, the cell begins to pass less and less light through the analyser until zero is again reached. Thereafter, maxima and minima of light passed alternate, as the voltage is increased, indefinitely. The voltage of the first maximum sets a limit to the length of characteristic over which the cell can be operated, and *most important of all: this maximum is not the same for light of different colours:* thus, blue and violet are the first colours to reach their maximum transmission, and orange and red last. This gives rise to distinct colouring, when white light is used, as the voltage approaches the higher values, and finally when the first maximum has just been passed, a characteristic reddish-brown colour is observed in the emergent light. Theoretical curves for a typical cell are given in Fig. 3.

From this it will be seen that, although from some points of view (notably in order to increase the sensitivity of the cell) the slope of one of the high-voltage "humps" would seem best for operation, yet in practice this would mean very poor efficiency owing to the fact that the blue part of the light would be increasing while the red was being extinguished (or *vice versa*). To use monochromatic light (that is, light of only one colour) would be very inefficient, and a source of very great brightness would be required. Also, there is a danger of the medium breaking down if too high voltage is employed.

Chromatic Dispersion

The separating out of the component colours of white light owing to the unequal effect of the cell upon them is termed "chromatic dispersion."

Next month we shall give some examples of characteristics of actual cells, which differ in some respects from the theoretical one given in Fig. 3. For those who wish to calculate the magnitude of the voltage, or the distance apart of the plates, to obtain a given effect, the value of the "Kerr constant" for several media is given in the table and can be inserted in formulæ given in the appendix.

APPENDIX I.

For a birefringent liquid, $KP^2 = 1/\lambda x - 1/\lambda y$

where K is the Kerr constant for the liquid, P is the electric field strength,

λx and λy are the wavelengths of the two rays in the liquid.

Hence $\Delta = 2\pi KlP^2$ is the angular phase difference of the two emergent rays, where l is the length of path in the liquid.

If I is the incident plane polarised light-vector :—

$I = a \sin wt$ say, whence :

$x = a \cos i \sin wt$

$y = a \sin i \sin wt$

where i is the angle I makes with the field-direction.

When the electric field is applied to the cell, these become :

$x = a \cos i \sin (wt + \Delta_1)$

$y = a \sin i \sin (wt + \Delta_2)$

where $\Delta_1 - \Delta_2 = \Delta$ above.

Hence $\dfrac{x^2}{\cos^2 i} - \dfrac{2xy \cos \Delta}{\cos i \sin i} + \dfrac{y^2}{\sin^2 i} = a^2 \sin^2 \Delta$

which is, in general, an ellipse as stated in the text.

APPENDIX II.

We can derive an equation for the light emergent from the analyser :

where I′ is the intensity of this light we have :—

$I' = a^2(\cos^2 \overline{i - \phi} - \sin 2i \sin 2\phi \sin^2 \Delta/2)$

where ϕ is the analyser angle.

For $\phi = 45°$ and $I = -45°$ (the case dealt with in the text) we have :

$I' = a^2 \sin^2 \Delta/2$

and since $\Delta = 2\pi KlP^2$ from Appendix I we get :—

$I' = a^2 \sin^2(\pi KlP^2)$.

Converting this to a form involving the voltage v on the cell, and putting $a^2 = 1$, we have :

$$L = \sin^2 \left\{ \frac{\pi}{2} \left(\frac{v}{E} \right)^2 \right\}$$

where E is the potential across the cell giving the first light-maximum.

THE CONSTRUCTORS' CIRCLE

Application for Membership

To be filled in and sent with a *stamped envelope for reply* to the Editor, "Television," 58-61, Fleet Street, London, E.C.4.

(1) I already subscribe to your journal at the address below.

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The Television Society

President : Sir Ambrose Fleming, M.A., D.Sc.. F.R.S.
Hon. Secretaries : J. J. Denton, A.M.I.E.E., 25, Lisburne Road, Hampstead, London, N.W.5. W. G. W. Mitchell, B.Sc., "Lynton," Newbury, Berks.

A MEETING of the Society was held at University College, London, on December 13, at 7 p.m. Dr. Clarence Tierney, F.R.M.S., chairman, referred to the importance of members studying the fundamentals of their subject, and welcomed the lecturer of the evening, Mr. Leonard M. Myers, B.Sc.(Fellow), who had prepared for them an interesting paper, with experiments, which would be published fully in the Journal of the Society.

Abstract of lecture entitled :—

ELECTRO-OPTICS AND TELEVISION.

The study of electrostatically induced stress in both solids and liquids is of the utmost importance for television work. Up to the present liquids have enjoyed the greatest popularity, and it has been found that nitro-benzene, owing to its high Kerr constant, is the most suitable liquid to be employed. The question remains, however, as to the manner in which the crystalline liquids acts in order to produce the essential retardation.

As far as we can see, when the beam of polarised light enters the nitrobenzene, it is split up into two components vibrating in mutually perpendicular directions. When the stress is applied, the one component, vibrating parallel to the direction of the lines of force, is accelerated and the other component is retarded. For this reason the liquid under stress is regarded as having the characteristics of a negative uniaxial crystal, of which Iceland spar is an example.

But this assumption is not strictly true, for in a negative uniaxial crystal there is always one direction perpendicular to the optic axis in which the ordinary ray appears. By the ordinary ray is meant that ray which has the same velocity as light passing through the unstressed medium. In the stressed nitro-benzene this ordinary ray does not appear for any direction normal to the field. Now in a negative biaxial crystal there is one direction for which the ray vibrating parallel to the optic axis is accelerated, and that vibrating perpendicular to this axis is retarded. This direction is normal to the axial plane of the crystal—that is, the plane which contains both the optic axes.

But again for the direction parallel to the axial plane the ordinary ray appears. Therefore it is not possible even to compare the stressed nitrobenzene with a negative biaxial crystal. The character of this stressed liquid must be, then, of a particular nature, and we can regard its ray surface as being a prolate spheroid encased in an oblate spheroid in such a manner that their axes of revolution are equal in length and that they coincide. This common axis, then, forms the optic axis of the stressed liquid, and it is parallel to the lines of force.

In any direction in which the light in the cell travels the oblate spheroid forming the ray surface of the fast ray will be in advance of the surface of the prolate spheroid, the surface of the slower ray. As the fast ray is vibrating parallel to the optic axis, the crystal must be negative by definition.

Uniaxial Crystals

Experiments were performed to indicate the change in character of uniaxial crystals and isotropic media when subjected to stress. In the case of isotropic media, glass was taken as an example, as the conversion of this substance into a negative uniaxial crystal was shown when the glass was compressed. When the glass was subjected to tensile stress it became positive uniaxial in character. The glass was bent in the polariscope, in which was placed a quartz wedge. It could be observed that the upper part of the glass strip was in tension and that the retardation bands advanced; therefore this part of the stressed glass was behaving as a positive crystal. Quartz itself is a positive crystal so that an advance of retardation as that occasioned by the wedge would indiacte a positive crystal. But for the lower portion of the glass the retardation bands receded, thus showing that the glass under compression acted as a negative uniaxial crystal.

The character of stressed uniaxial crystals was then discussed, and it was shown that when these crystals were subjected to stress normal to the optic axis they became biaxial, having, however, the same sign as formerly. In order to illustrate this point by a practical demonstration, the uniaxial crystal was observed in highly convergent light. This method gave a picture on the screen of the isochromatic lines of the crystal. By stressing the crystal in the polariscope, it was seen that the isochromatic rings became ellipses, thus demonstrating that the crystal had become biaxial in character.

Electrostriction

A short discussion of electrostriction followed, in which it was shown that it is possible to bring about retardation in the polariscope by this means. But the stress set up in media by electrostriction alone are insufficient to illuminate the field brilliantly with comparatively low voltages. It is interesting to note, however, that the electrostriction formula is identical with the Kerr effect formula except in the value of the constant. The constants for the two expressions have widely different magnitudes.

From the Kerr effect in liquids attention was drawn to this effect in solids, which had received by no means the same popularity with the designers of electro-optical devices. Particular stress was laid on the employment of piezo-electric quartz as a method of obtaining the desired retardation. An experiment was then made with a disc of piezo-electric quartz cut in such a manner that it would vibrate in the direction of its thickness. Both the optic axis and the third axis of the quartz was in the plane of the small disc, but the electric axis was in the direction of its thickness.

This piece of crystal was held between two solid brass electrodes pressed against it, so as to prevent it slipping out when in vibration, and so as to damp the crystal. The crystal was so dimensioned that it would vibrate at the frequency of about 3 megacycles, corresponding to a wavelength of 100 metres.

Now, as the optic axis was in the plane of the crystal it was necessary to compensate for the retardation set up by it in the polariscope, and this was accomplished by introducing a second crystal of exactly the same thickness. The light in the polariscope then travelled through both crystals parallel to the direction of their thickness and, therefore, in the crystal which was

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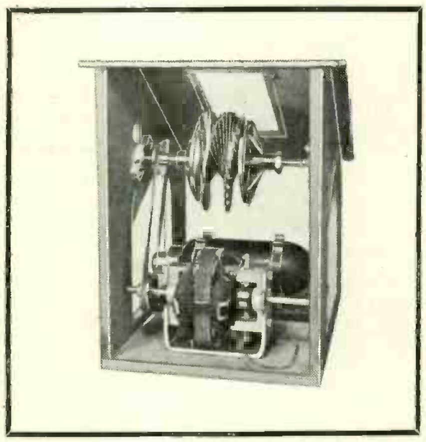

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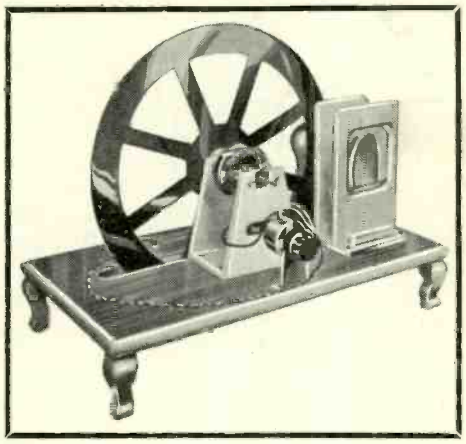

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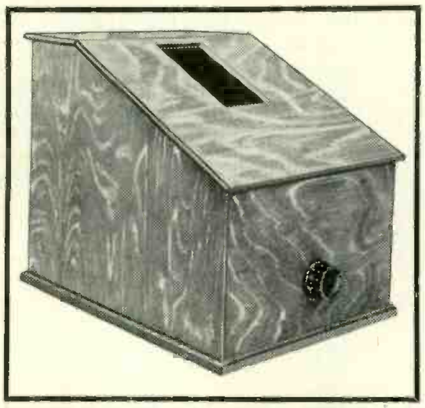

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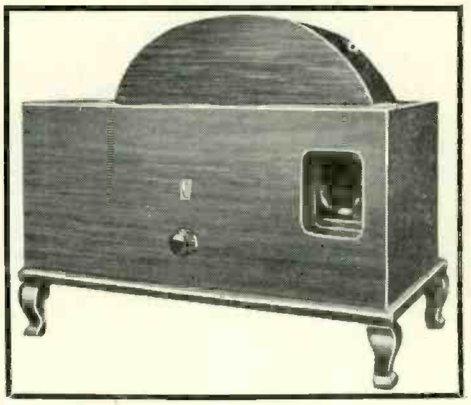

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excited, through the electrodes. A hole of about ⅛ in. in diameter was bored in both electrodes to allow of the passage of the light through them.

Effect of Oscillation

When the crystal was at rest the field of the polariscope was extinguished, but as soon as the crystal was put into oscillation, by means of a single valve oscillator, by virtue of the stresses set up within the crystal, the quartz became biaxial in character in accordance with what had been previously discussed. This being the case, the field at once became illuminated. The illumination of the field by such a method is, of course, not constant, but can be likened to a lamp giving out light at the frequency of three million cycles per second. It appears to the eye, therefore, as though the illumination was constant as the frequency is so high.

The important question which now arises is how shall the vibrations of the crystal be modulated so that it can be used for television. As the crystal stands alone and undamped, it is impossible to modulate much higher than 2 or 3 kilocycles. This is because the frequency characteristic of the crystal is so peaked. If such a crystal is employed in a receiving circuit, as in the case of a Stenode Radiostat crystal receiver, the crystal is undamped so that the side bands above 2 kilocycles are so highly attenuated that high audio-frequency correction must be introduced. But the crystal can be damped in the first place by pure mechanical pressure, and by this means the modulation frequency can be increased.

Of course, the crystal does not vibrate at one frequency only, and the frequency discussed above is the fundamental frequency. Crystals can be cut so as to vibrate at a large number of frequencies not always along the direction of the thickness of the crystal. Therefore it appears that the ideal crystal for modulation in television is one cut so that there are a large number of resonant frequencies within very short tuning distance of one another.

Advantages of Crystal Modulation

The advantage of crystal modulation for television over the nitrobenzene cell is very great indeed. In the first place, there is practically no absorption of light, which is the case when the light has to pass through a thick oily yellow liquid. Secondly, there can be no gradual disintegration of the quartz as there is of the nitro-benzene. The latter being a complex organic compound which soon becomes disintegrated, carbon being deposited on the electrodes and at once reducing the resistance of the cell. No amount of plating or silvering can prevent this disintegration. By suitable electrodes (which may even take the form of transparent colloidal films or, alternatively, a transparent metal film, such as the film produced by steel), all light can pass through the crystals, and the section of the light beam can be as large as desired.

As to the question of cost: at present, as there is but little demand for such crystals the cost comes out to about £4 per pair, but this could be reduced by half, no doubt, if the demand was adequate. It must be remembered that the crystals have to be first very carefully selected and then ground and polished to within a wavelength accuracy. (A wavelength is roughly one-thousandth of a millimetre.)

In passing, mention was made of some research into the possibility of utilising the piezo-electric vibrations of Rochelle salt as a light modulator for television. But it was found, despite the rather encouraging fact that Rochelle salt had about 16 times the piezo-electric constant of quartz, that the stress optical coefficient was so low that retardation of any considerable magnitude could not be brought about even when the crystal was mechanically stressed to its breaking point.

Finally, a novel form of polariscope for television was suggested. In this polariscope use was definitely made of both the ordinary and the extraordinary rays of the polariser. In the present-day methods only the extraordinary ray of the (Nicol prism) polariser is used, so that at the outset half the available light is wasted. In the polariser demonstrated as representing the general method to be employed, two Rochon double image prisms were used. With the first prism alone it was possible to discern two separate spots of light, but when both were used these two spots of light further resolved themselves into four spots.

A hearty vote of thanks to Mr. Myers concluded the lecture and discussion.

Television Amplifiers

It is not always necessary to build a large and expensive amplifier to obtain a high output for a mirror-drum televisor. An arrangement that is not very often used is a variable-mu screen-grid valve as a low-frequency amplifier, R.C. coupled to a valve such as the PP5400. With the correct resistance network a very high stage gain can be obtained while the characteristics of the variable-mu screen-grid valve are very useful, as a silent and smooth volume control can be obtained. With an amplifier of this kind a minimum of 5 watts can be obtained without any difficulty, while if it is compared with the conventional 5-watt amplifier the cost is very much less.

ANSWERS to QUERIES

Cathode Rays: Scanning Lines

I have read the articles on the cathode-ray tube with interest as it seems to be the solution of the problem of receiving a large number of lines. How far can one go in the number of lines produced?

Theoretically, of course, there is no limit to the number of lines produced by the time-base since its speed of traverse can be increased to 5,000 per second easily. In practice the limit is set by the size of the scanning spot and the dimensions of the picture. In the present tubes the limit would appear to be about 180 lines, but 120 lines can be produced with ease.

The Sound of the Transmissions

I have often tuned in the television transmissions and listened to the sounds produced. My intention now is to make a simple disc receiver, and I should like to know whether, when receiving a picture, the noise of the broadcast is heard.—T. G. (Newcastle-on-Tyne).

No, the noise is not heard, as the signals are fed to the neon lamp instead of the loudspeaker, and this lamp converts the varying signal impulses into the light and shade of the television picture. A separate receiver is, of course, used for receiving the sound signals which accompany the pictures. The sound is broadcast from Midland Regional and the vision from London National.

Range of Television Reception

My home is in Edinburgh, and though I am anxious to take up television it seems to me that the distance from the transmitter is too great to get any results. Will you please advise?—F. E. R. Edinburgh).

There are many amateurs in Scotland who are receiving television successfully, both with disc and mirror-drum equipment. Naturally conditions are a little more exacting, but if you can receive the London National station at fair loudspeaker strength, you will be able to receive the pictures. Reports of excellent reception have been received from Madeira, and several amateurs in the South of England receive the French and German transmissions quite successfully.

Cathode Rays and Weak Reception

I am troubled with fading of the London National and the signal is not very strong. From what I have read, the cathode-ray tube requires very little voltage to operate it. Would it be better than the mirror-drum for my purpose?

Yes. Provided that your output stage will give good headphone strength it should be sufficient to modulate the C.R. tube. The fading of which you complain will have to be counteracted by some form of A.V.C. or you will find it difficult to keep the picture in synchronism.

Enlarging the Image

I am using a lens to enlarge the image produced by my disc receiver, but I find that the picture is distorted when the lens is placed in the position to give the largest picture. Do you consider that I am using an unsuitable type of lens, and can you suggest a method of obtaining high magnification without distortion?—R. D. (Leicester).

The lens which you are using is evidently of short focus, and though this will give high magnification it is also bound to produce distortion. High magnification without an undue amount of distortion can only be obtained by using a combination of two lenses. Focal lengths of 9 and 18 inches are suitable values, and the distance between them should be from 1½ to 2 inches. The focal length may be determined by producing a spot of light from the sun and measuring the distance between the spot and the lens. Lenses specially made for the purpose are obtainable from advertisers.

The Output to the Neon

Is it quite essential that a 1—1 transformer be used on the output from the receiver to couple the neon?—P. A. (Ely).

Transformer coupling for the output is only one method employed. Details of several other schemes are shown pictorially on another page.

Operating a Kerr Cell

I have made up a Kerr cell, but I can only get a small amount of light to pass through it when the voltage (which is approximately 370) is applied to the plates. Can you give me some indication what is likely to be at fault?—B. D. (Hendon).

If the electrical connections to the plates of the cell electrode assembly are all right, the fault is probably either that the light rays do not pass, due to the electrodes not being in line, or that the nicol prisms are not correctly set. Test the line-up by removing the second Nicol (analyser) and adjusting the plates, etc., until the light rays emerge. Then replace the Nicol and rotate it so that all emergent light is blacked out. The voltage applied to the plates should then produce an effect. For maximum effect the Nicols have to be set correctly. With the oblique-ended prisms, the ends are diamond section and the polariser is fixed with the diamond section at an angle of 45 degrees to the plane of the electrodes of the cell.

ANSWERS TO QUERIES

An expert service is available to assist readers who experience difficulties in the construction, operation and maintenance of television apparatus or associated wireless receivers and amplifiers.

The following rules should be observed:

Please write clearly giving all essential particulars.

A stamped, addressed envelope and also the coupon on the last page must accompany all queries. Not more than two questions should be sent at any time.

Reply will be made by post, usually within twenty-four hours.

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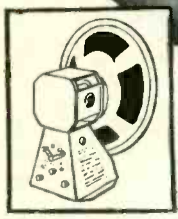

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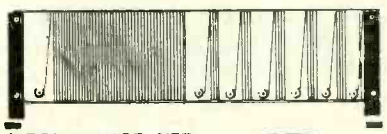

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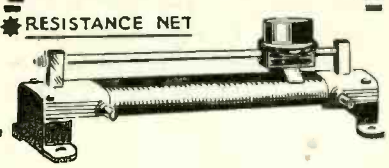

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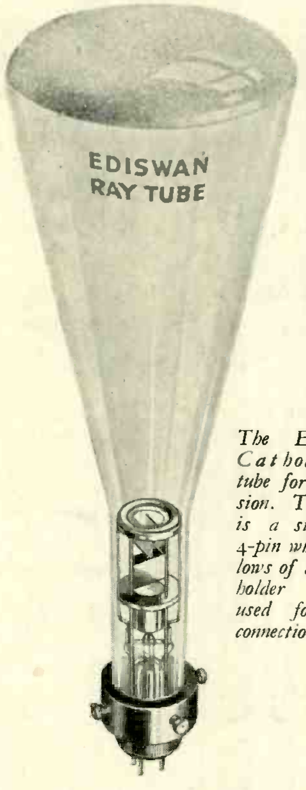
THE EDISWAN C.R. TUBE :: LOW-PRICED POLARISERS AND ANALYSERS :: THE PHILIPS' PROJECTION LAMP

The Ediswan Cathode-ray Tube

WE have received from the Ediswan Co. one of their new type "T" cathode-ray tubes, which is primarily intended for use in television viewing, but which can also be used in radio research. The illustration shows the main details of the tube, the operation of which is no doubt familiar to our readers.

The electrode structure is assembled on the usual glass "pinch," the anode



The Ediswan Cathode-ray tube for television. The base is a standard 4-pin which allows of a valve holder being used for the connections.

lead being shielded by a glass tube projecting from the pinch to avoid the possibility of leakage at high voltages. Passing through the flat anode and insulated from it by mica washers are the supports for the deflecting plates. Above the plates themselves is a metal ring which serves as a collector for stray electrons returning from the screen, and prevents excessive deflector plate current.

The overall dimensions of the tube are 46 cms. long by 14 cms. diameter at the screen end. The basing arrangements are simple and make for ease in connecting the tube in circuit. The electrode structure is connected to the 4 pins of a standard 4-pin base, and above this base surrounding it is an ebonite collar on which 4 terminals are mounted making connection to the 4 deflector plates. These are labelled A^1, A^2, B^1, B^2 respectively.

The rating of the tube is as follows :

Filament current—1 amp. approx. at .45 volt.

Anode voltage—300-1,500.

Each tube when sent out is labelled with the correct operating current, and the manufacturers state that this should not be exceeded except in certain cases, when a tolerance of 5 per cent. is allowed.

On connecting the tube to the exciter circuit recommended in the leaflet supplied, a vivid green spot appeared on the screen which reduced to .75 mm. diameter under the correct focusing conditions. It should be noted that it is usually necessary to re-focus when the spot is expanded to a line, and a line can easily be obtained smaller in thickness than the spot itself.

For wave-form observations, it was found possible to operate the tube satisfactorily with an anode voltage of only 450 without taking special precautions to screen the end of the tube from direct light. For television, however, it would appear advisable to increase the anode voltage to a minimum of 900.

The sensitivity of the tube (*i.e.*, deflection in mms. per volt applied to the deflector plates) varies inversely as the anode voltage of the tube, and therefore no definite figure can be given for this. From tests made at 450 volts, the sensitivity is approximately .7 mm. per volt.

The Ediswan Co. have been experimenting for some time with simple circuits for the application of this tube to the reception of television images, and they state that they will be pleased to send information to any interested enquirer. We have witnessed a demonstration of the tube in the reception of Baird television, and the results are extraordinarily good considering the small size of screen (approximately 14 cms. by 6 cms.).

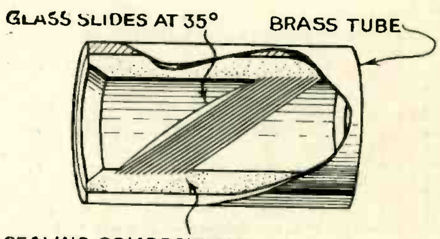
The colour of the screen is in marked contrast to the reddish glow of a neon, and, if anything, is more soothing to the eye. A slight trace of persistence of the glow of the fluorescent material assists in toning down the harshness of the picture and increases the steadiness.

An interesting point is the negligible energy required to produce the picture. The modulating voltage is applied to the shield of the tube, and a total fluctuation of some 10-20 volts is all that is required to produce full modulation in intensity of the beam. This is an advantage for users of battery sets who cannot provide heavy power outputs.

The list price of the tube is £6 6s., and, considering the multitudinous uses to which it can be put, it represents a good investment. The standard screen supplied is green, but a blue-white screen adapted for photographic work can be obtained. The manufacturers are The Edison Swan Electric Co., Ltd., Radio Division, 155, Charing Cross Road, London, W.C.2.

Low-Priced Polarisers and Analysers

Messrs. Wilburn & Co., of Carmelite Street, London, E.C.4, have submitted for test a pair of Nicol substitutes. The Nicol substitute is, of course, well known. It consists of a



number of thin glass plates placed at an angle of about 35 degrees within a

Miscellaneous Advertisements

Readers who wish to sell, exchange or purchase apparatus will find this column a very successful means of disposing of their surplus gear, or obtaining new apparatus at bargain prices.

The charge for advertisements in these columns is 12 words or less 2/-, and 2d. for every additional word. All advertisements must be accompanied by remittance. Cheques and Postal-orders should be made payable to Bernard Jones Publications Ltd., and crossed, and should reach this office not later than the 15th of the month previous to date of issue.

mount, but this, we believe, is the first time that this article has been made commercially for television purposes. The construction will be clear form the illustration.

Specially selected glass plates are used in the Wilburn composite prisms, and these are cemented securely into the brass mounts. Tests showed that an entire blacking out could not be obtained when the prism substitutes were placed in the correct position, but that the efficiency compared with actual Nicols was approximately 80 per cent. This slight advantage was compensated for to a considerable extent by the fact that the surface is larger than with a normal Nicol, and that damage is not likely to result from heat; they may thus permit a greater light intensity to be used. They are eminently suitable for use with an arc lamp. The price of the pair is 17s. 6d., which is less than half the price of an equivalent pair of Nicols.

The Philips Projection Lamp

We have received from Philips Lamps, Ltd., of 145, Charing Cross Road, London, W.C.2, a projection lamp suitable for use in conjunction with mirror-drum apparatus. The lamp is rated at 100 watts and the candle power is approximately 200. It is intended for 12-volt operation. The filament is of the bunched variety, so that the total length of the incandescent portion is about $\frac{3}{16}$ in., thus providing a highly concentrated and intense source of light. The lamp has the usual standard screwed base which will fit any standard holder, but Messrs. Philips supply a special base made of bakelite which is detachable by means of a quick-screw arrangement, and also is provided with an automatic locking device to enable quick adjustment of the position of the lamp to be made.

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Since the first days of radio, the word "gadget" has always played a prominent part. No matter how good your present set may be, there is always a simple way of improving reception by the addition of some gadget or another. This interesting article in the January *Wireless Magazine* describes many useful accessories and their advantages are fully explained.

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This January issue contains a host of useful and entertaining features that no set owner should miss.

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