TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

NEW SERIES
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"AMATEUR WIRELESS"
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March, 1934 : No. 73.

FIRST and EXCLUSIVE *DETALS of*

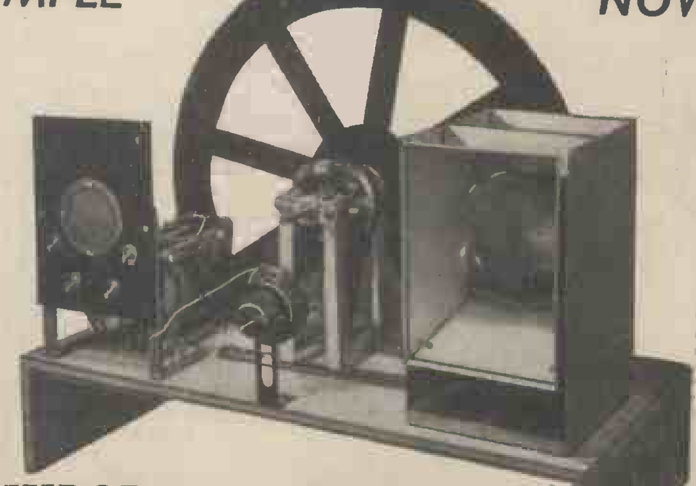
SCOPHONY STIXOGRAPH

Also

COSSOR'S NEW SYSTEM

BEGINNER'S TELEVISION RECEIVER

SIMPLE ***NOVEL***



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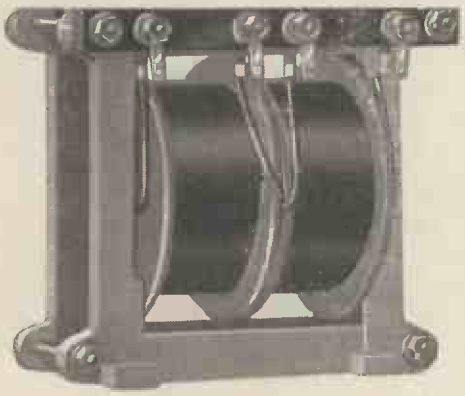

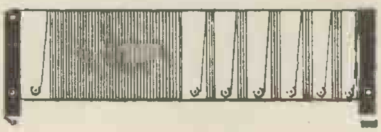

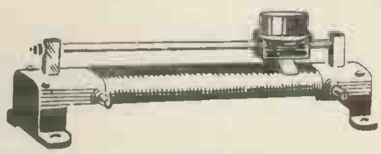

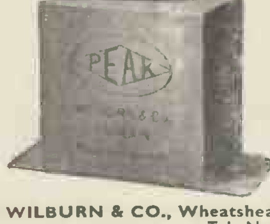
PEAK

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TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

In This Issue

TELEVISION

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COMMENT OF THE MONTH

Future Policy.

TELEVISION at the moment is in a vicious circle. There are plenty of potential buyers of receivers : there is the apparatus waiting to be made. Manufacturers, however, are not inclined to risk putting receivers on the market until there is some settled policy regarding the future transmissions which will cover a reasonable period. General impressions incline to the belief that the B.B.C. is loath to make any declaration of policy because of the possibility of developments which may take place in the immediate future. High-definition television is certainly accomplished ; it is the radio link that presents the problem. Assume, however, that this difficulty were surmounted ; would high-definition television be available to the general public? We should say not, as for some time to come the apparatus would be costly and complicated and there would also remain the difficulty of covering large areas on the ultra-short waves which would preclude a large portion of the populace from taking advantage of the transmissions. What then is the alternative? At the present time there are many thousands using simple receivers and taking a very keen interest in the television broadcasts. For the most part these enthusiasts are using home-built receivers, and it follows, therefore, that there would be many thousands more if receivers were available at reasonable prices. The old argument that those interested in television is a mere handful no longer holds good—the number is steadily increasing day by day. Definitely, for some time to come the 30-line transmissions with their constantly improving technique can provide entertainment and sustained interest for many thousands of people.

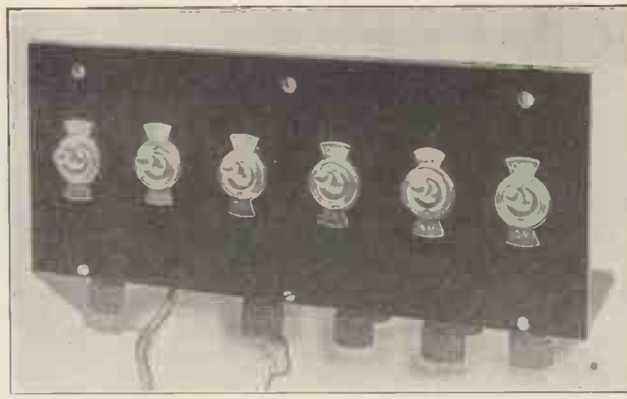
There is a concensus of opinion that the next logical step would be to increase the number of scanning lines to sixty and that it would be possible to transmit this scanning frequency on a wavelength between 150 and 175 metres and so still maintain a large service area. Sixty-line scanning would give more than double the detail of the present thirty lines and could be accommodated in a wavelength band only 30 kilocycles wide. The suggestion is made that the picture ratio should be six by seven, and preferably with horizontal scanning. Sixty-line scanning would enable existing apparatus to be modified to suit the new conditions with but little difficulty and those that have spent money already would have no cause for complaint on the ground that this would be wasted. Many advantages would result from a change of picture ratio and the one mentioned, in addition to assisting in the easy modification of apparatus, would be eminently suitable for film transmissions and bring our receivers into line with Continental apparatus so that advantage could be taken of foreign transmissions.

An Experimenter's Notes

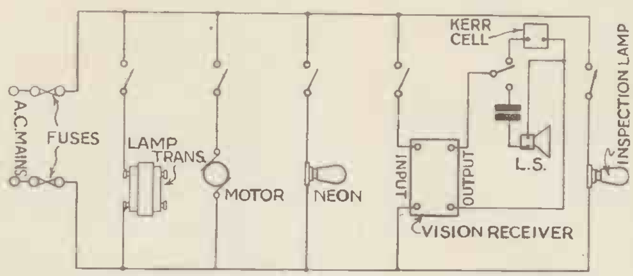
—A CONTROL PANEL: PROJECTOR LAMP POSITION

ANYONE who uses a television receiver of the mirror-drum type quickly realises how desirable it is to have every unit under immediate control. The duration of the programmes does not allow of connections being undone and remade unless most of the time available is to be wasted, so some proper method by means of which alterations can be made almost instantaneously will be found a great convenience.

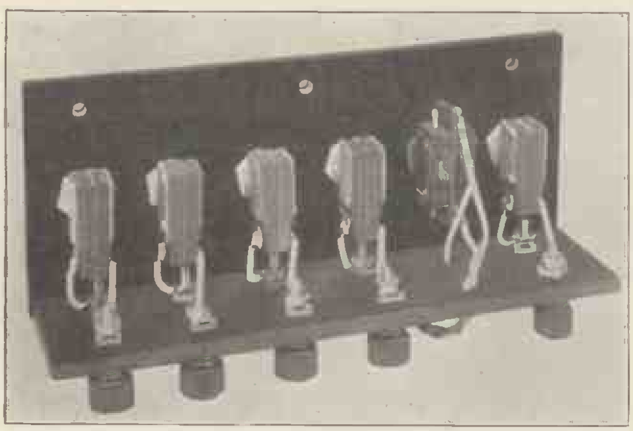
The actions which are desirable to have under immediate control are the ability to switch on the projection lamp independently of the other units, so that adjustment of the optical system can be carried out: switching arrangements so that the motor can be run, also independently of the other units, for warming up purposes; means of instantly switching on a neon lamp for testing the speed of the motor, and arrangements for switching the output from the amplifier on to a loudspeaker for preliminary tuning. A further refinement is an inspection lamp of the ordinary type for immediately providing a light in the darkened room.



The front of control panel; the uses of the various switches are indicated in the diagram below.



Circuit diagram showing how the various connections are made.



The switches are connected to terminals to facilitate coupling up the several circuits. These terminals may be omitted if desired.

The panel shown by the photographs was made up so that all these operations could be carried out by merely flicking switches over, and with the assurance that no mistake can possibly be made, with the risk of damage to any of the apparatus. For the whole series of operations detailed above six switches are used, five of these being simple single-pole toggle switches and the double-pole change-over switch. The actual switches used are Bulgin types S80T and S98 respectively. These are mounted on a small vertical panel and secured to this is another panel which has ten terminals fitted; that is, two terminals for each switch, with the exception of the S98 type to which flexible wires are taken directly. The object of these terminals is simply to provide an easy means of attaching the various leads to the switches, but, of course, they can be omitted if desired and the wires taken direct to the switches.

Reference to the diagram will show that the wiring is of the simplest character, two common wires from the mains being taken to each of the units and to one side of the switches. The other sides of the switches are connected to the remaining sides of the units. The only exceptions are the connections from the output of the vision receiver and amplifier which can be made alternatively to the loudspeaker or Kerr cell. It will be observed that a fixed condenser is connected in one of the speaker leads in order to prevent the direct current from the amplifier passing through the speaker windings, with the possibility of damaging these.

A unit of this description will be found a great convenience, for all possibility of error is automatically eliminated and once the positions of the various switches have become known the several operations can be carried out in the dark.

Projector Lamp Position

It is important to note that projector lamps should be burnt only in certain positions, otherwise there is every possibility of the life of the lamp being shortened. In some cases the burning position is indicated on the lamp and these instructions should be carried out. In cases where the correct position is not indicated regard should be had to the dissipation of the heat produced and the filament position. For example, a lamp of the bunched-filament type should not be operated upside down; it will not do any harm to burn it horizonatally, provided that in this case the filament is also kept in a horizontal position. Filaments that are long, as in some of the higher voltage lamps, should be maintained in a vertical position so that there will be little possibility of their sagging.

The Stixograph and Scophony

First and Exclusive Details

By the Inventor, G. W. Walton.

THERE are quite a number of people under the impression that the invention of the Stixograph is nothing more than a different way of accomplishing scanning as known in television. Such an idea shows that they must be so obsessed with the scanning idea that they are incapable of considering television and other picture problems in any other way. This attitude is an obstacle to progress, for very often has it been shown in the past that a different aspect of a problem shows a solution to an apparently insuperable difficulty.

The object of this article is to correct these mistaken ideas by a more complete discussion of those characteristics of pictures which have a direct bearing on some of the problems of television.

Picture Composition

The first requirement is the definition of what constitutes a picture. Commencing with a natural scene, we can state that it consists of a three-dimensional distribution of details. Each detail is distinguishable from adjacent details by differences of the colour and/or intensity of the light it emits or reflects. Each detail is limited in size in three dimensions. Should the scene be animated, then each detail must also have a time characteristic.

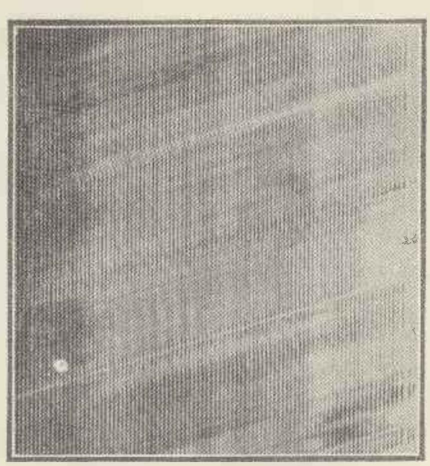
For the present, colour and time may be neglected, so that a natural scene at one instant of time consists of a number of details which are limited in size and position in three dimensions, and a detail exists as such, when it is distinguishable from its immediate surroundings because of a difference of light intensity. We are all more or less familiar with reproductions or representations of natural scenes, though perhaps few take the trouble to compare them. The very best reproduction is a full scale model, an example of which for animated scenes is a theatrical play. The next is perhaps small scale models, such as marionettes, and for stationary scenes wax-works and sculpture.

TELEVISION was the first to publish, in its January issue, some information about the activities of the Scophony laboratory. TELEVISION is even more privileged now by being in a position to publish a series of articles dealing with some of the basic Scophony inventions written by George William Walton, the inventor of the Scophony System.

George William Walton is not a newcomer to television. Some patents of his relating to improvements in disc systems were published as early as 1923, but already at that time he noticed the inherent limitations of the old known principles and had the courage to break away from old ideas and to attempt a solution along novel lines. He approached the whole problem from an entirely different angle, and after many years of patient and arduous work, he succeeded in evolving an entirely new method of pictorial presentation. This method is not limited to television only, it has equally important applications in cinematography, in picture-telegraphy, etc. A leading Continental expert said : " The Stixograph is the greatest revolution in pictorial representation, since the invention of the ' camera obscura.' "

The veil of secrecy, which has surrounded the Scophony System, is now lifted for the first time.

Unfortunately, these three-dimensional representations are difficult to produce, and something more simple is required. The only simplification possible is to distort or eliminate one dimension of the representation. The first example of these distorted representations is an optical image, which though still having three-dimensions has the depth or distance more or less reduced and not accurate, as it has a non - uniform characteristic. The human eye makes use of this kind of representation by a kind of searching action which is compounded from instinctive angular movements of the eye and head and an instinctive focusing of the eye. Actually, the retina of the eye can only appreciate a representation which has two effective dimensions.



A photograph of a piece of Stixograph film—a picture in one dimension.

Two-dimensional Pictures

Examples of representations having only two effective dimensions are photographs, paintings, drawings and optical images on screens, which are usually called pictures. The human eye sees these pictures as passable representations of an original scene and accepts them as accurate representations when the effect is natural and comparable with seeing the original scene. This natural effect does not lie entirely in the picture itself, but is greatly influenced by the distance, aspect, and lighting of the picture, and also to a large extent on the ability of the eye to continue its instinctive movements without the picture getting out of focus on the retina.

This last point can be proved by a very simple experiment. By looking with one eye through a lens of suitable focal length at a photograph, it will be noted that the picture is much more natural, it may even appear plastic, particularly for objects in the background and middle distance of the scene represented. The reason for this is that the eye, though changing its focus instinctively, does not put the picture out of focus, and the eye can adjust its focus to correspond to that distance the scene represented would be.

Ordinary pictures can be specified as two dimensional, in that they consist of details having limitations of size and position in two dimensions. Size and position in the third dimension is of no consequence, except perhaps in transparencies, where size in the third dimension may decide the shade value of details.

Until the Stixograph no attempt was made to further simplify pictures, for there was no readily apparent advantage to be gained by doing so. Further simplification could only lead to a picture being unintelligible to the unaided human eye constructed as it is, and even with special apparatus for the viewing of such pictures, no real advantage either in definition or brilliancy of the picture could be gained. It is not therefore surprising that the ordinary two dimensional picture had the field to itself for centuries, but with the invention of the cinema, the situation changed.

Modern Requirements

The modern ſarts dealing with picture cinematography, picture telegraphy and television, introduced new requirements, which can very largely be summed up in one word " motion." Motion has a time space characteristic, so that the innovation is really time.

A little consideration will show that the cinema is very greatly concerned with time, for it has shown a reasonably accurate representation of a scene which is changing in time. Picture telegraphy is concerned with distributing a picture in time, and reproducing a representation of that picture properly arranged in two dimensions of space from the time distributed representation. Television presents the special features of the cinema as well as those of picture telegraphy, so that it is very considerably more difficult than either.

Taking the problem of cinematography, we find that a three-dimensional scene and time has to be recorded. To do this, a four-dimensional record would be required, and I do not think anyone can properly conceive what it ought to be like to have each dimension continuous. Fortunately, one of the space dimensions can be dispensed with by the use of two-dimensional pictures, but time must be included, so that the record in such a case would be three-dimensional or solid. This also is very difficult, if not actually impossible.

In order to find a satisfactory type of record, it is well to look more closely into the actual requirements. The picture consists of details, the size and relative position of each detail must be given by the record. The light intensity of each detail for a monochrome picture must also be given, Lastly, variations of size, position and light intensity of details with time must also be given.

A photographic emulsion is the best known means of recording light intensity, and in its most convenient form is arranged substantially in two dimensions. As the emulsion will record the light intensity of a detail and changes of intensity, provided the part of the emulsion receiving the impression is also changed, we need only consider size and position of details and variations thereof with time when using photographic methods of recording.

The Importance of Time

There are only two dimensions of the record to accommodate size and positions in two dimensions and the third dimension of time. Time is very important and one dimension of the record must in some way correspond to time, either continuously or intermittently. In the ordinary cinema, the length of the film is the time dimension, though it is only intermittent time for size and position of details are also shown in that dimension.

The intermittency of the time record is only possible by drawing on that useful characteristic of the eye " persistence of vision." Suppose one dimension of the record to be entirely allocated to time, then the second dimension of the record would have to deal with size and position of details, i.e., picture details must be limited in size and position in only one dimension.

From this it appears that a one-dimensional picture instead of the usual two-dimensional type, might be useful. A readily apparent advantage would be that as time is continuous in the record, intermittent exposure is unnecessary and there is no need whatever to make use of the persistence of vision characteristic of the eye, for the recorded picture would be absolutely as continuous as the original scene. As there is no intermittent exposure, there is no idle period, so that other things being equal, there is something up to twice the light available. The record surface to record scenes having normal movement, need not move very fast. Furthermore, intermittency in time can still be used in a new way, for instance in recording colours.

Coming now to picture telegraphy and television, the process of transmitting a picture as commonly known, consists of breaking up the picture to obtain a regular succession of details, and obtaining therefrom a succession of electrical impulses, the amplitude of which at any one instant corresponds to the light intensity of one particular detail, and the time duration at that amplitude corresponding to the size of the detail in one dimension of the picture. The signals, therefore, of one complete picture are really an electrical representation of the picture distributed and limited in time. Time is one dimension, though not a special dimension.

Here again we have something like a one-dimensional representation cropping up ; true, it is not a picture, as it is a time distribution without spacial dimensions, and if converted into light, it could only be seen as a flickering of the light. A more detailed consideration of the production of such an electrical representation will show a number of interesting points.

The process can be separated into three distinct functions, first the actual break up or distortion of the picture so that the two other functions may be performed, second imposing a time characteristic on the picture, third the conversion of light intensities into electrical intensities, which can be ignored for the present.

Strip Division

The first of the above functions is actually a distortion in one dimension, say the vertical, of the picture, and consists in the first place, of making all details in that dimension of approximately uniform size. Should a detail of the original picture be larger in the vertical dimension than the uniform size chosen, then it is sub-divided to form a number of details of uniform size. If a detail of the original picture, or a part of a larger detail after subdivision in the vertical dimension happens to be smaller than the uniform size chosen, then its light intensity is distorted, as well as the size, to obtain a detail of the uniform size at some other light intensity. In the second place, the uniform details in the vertical dimension can only occupy certain positions which are integral multiples of the uniform detail size apart. In the other or horizontal dimension of the picture, no distortion is imposed.

All that the last paragraph means, is that the picture is divided into strips, but as dealt with the uniformity of detail size and the peculiar positioning of the details in the vertical dimension is emphasised. The reason for this distortion is that the limitations in the vertical dimension are neglected at the stage when the picture is converted into an electrical representation, i.e., the electrical representation could not be obtained without dropping the limitations in one dimension of the picture. Quite obviously, a one-dimensional type of picture can readily be converted into the electrical representation, and therefore it is probable

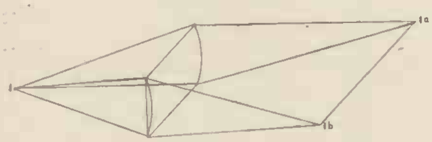


Fig. 1. The action of a cylindrical lens

that very definite advantages in picture telegraphy and television will be secured by its use.

It appears, therefore, that a one-dimensional type of picture might have advantages in cinematography, picture telegraphy and television. Before any further speculation on the possible advantages of such a picture, it is necessary to show that it can be obtained practically, and also that it can be converted into a normal two-dimensional picture, to be intelligible to the human eye.

The one-dimensional picture has been given the name of "Stixograph," a word derived from Greek to have the

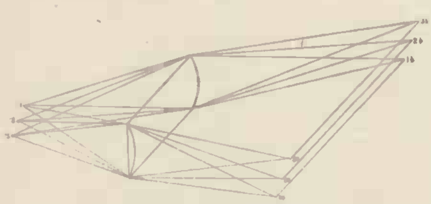


Fig. 3. The focus of points lying in a line not parallel to axis of curvature

approximate meaning of "a picture in lines," and this name has been accepted by the Patent Offices of the leading countries. Before the use of this name there was considerable misunderstanding, and I tried various terms, only to find that they were too literally interpreted. For instance, at the beginning I called it a "line picture" to convey the idea that it was something similar to the "line spectrum," in fact, the idea of the Stixograph did actually come from the line spectrum. Then I tried "one-dimensional picture," "one-dimensionally defined picture," and later "one-dimensionally limited picture." All these terms were taken to mean that the picture had length without breadth and therefore, could not exist at all! It is remarkable how difficult it is to explain an original idea in ordinary words.

Scanning Not Essential

In the following description of Stixograph optical systems, it must be clearly understood, that what is described has nothing whatever to do with scanning, any more than a camera lens is concerned with scanning. This warning is particularly for those who are so obsessed with the scanning idea, that any device for television becomes a scanner to them. To such people, I also definitely state that scanning is not essential to television and has introduced all the greatest difficulties.

One type of optical system will be described in order that the different optical functions can be thoroughly understood. Later, different systems will be given to show the comparative advantages.

The best forms of Stixograph optical systems use cylindrical lenses, and it is useful to discuss their behaviour when used to form images. A cylindrical lens can only focus a point as a line at the conjugate focus, as shown in Fig. 1. The image line is parallel to the axis of curvature of the lens.

Several points, which are in a line parallel to the axis of curvature, are focused into one line in the image plane, and considerable portion of that line is a true integration of all the points. This is shown in Fig. 2, where the portion *A* is the true integration, the remaining portions of the image line outside of the portion *A* are imperfect integrations and would not be used in many cases.

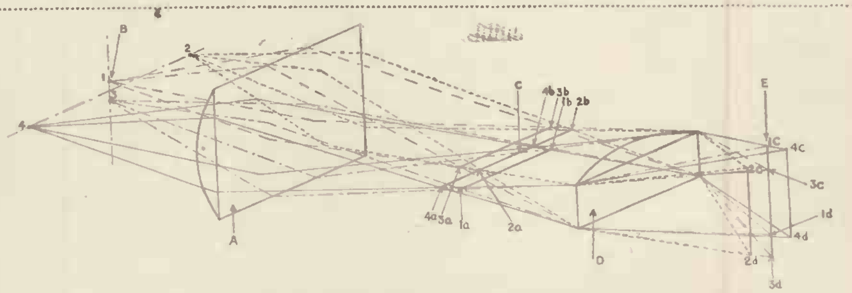


Fig. 4. Diagram showing the action of two cylindrical lenses

Several points lying in a line which is not parallel to the axis of curvature as in Fig. 3 would, in the image plane, be focused as an equal number of lines parallel to each other and to the axis of curvature.

A number of points arranged irregularly would be focused in the image as a number of lines parallel to each other and to the axis of curvature. Should two or more points lie in a line parallel to that axis, then they form only one integrated image line.

Two cylindrical lenses *A* and *D* in Fig. 4 with their axes of curvature at right angles, in all but one particular separation of the lenses, will have two

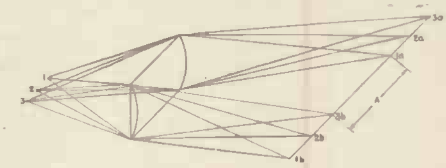


Fig. 2. Diagram showing true integration

image planes *C* and *E*, in each of which cylindrical images will be formed from objects in the plane *B*. The lines of the image in *C* will be parallel to the axis of curvature of lens *A* in Fig. 4, and the image lines in *E* will be at right angles to that axis. The image plane *C* of lens *A* may be before, at, in or after lens *D* by suitable separation of *A* and *D*.

All Stixograph optical systems use a stepped device, known as an eschelon, which has definite steps, displaced relative to each other. One form is shown in Fig. 5 and is a laminated cylindrical lens (shown as the dotted line structure), the axis of curvature being normal to the plane of the laminations. The laminations are linearly displaced transverse to the optic axis as shown. In the displaced arrangement, each lamination acts as an independent cylindrical lens.

The Complete Stixograph System

A complete Stixograph optical system, reduced to the most simple form and stripped of collimator lenses, stops and the like, is shown in Fig. 6, in side, plan and perspective views. It will be seen that it consists of a cylindrical object lens, having its axis parallel to the planes of the laminations of an echelon of the type shown in Fig. 5. Consequently, the axes of curvature of the laminations are at right angles to the axis of curvature of the object lens.

It will, therefore, be appreciated that each lamination together with the object lens forms an arrangement of crossed cylindricals as shown in Fig. 4 and each lamination will have an independent optic axis through the object lens to the object viewed by the system.

The object lens *A* in Fig. 6 viewing the object *B* will form a cylindrical

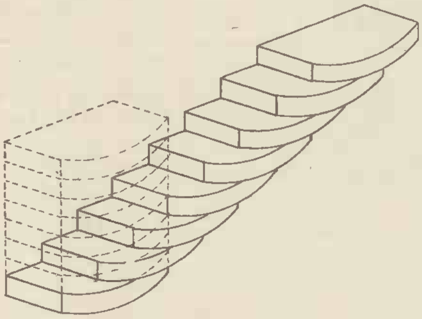


Fig. 5. Diagram showing the formation of the echelon

image in the plane *C*, as described in connection with Figs. 1, 2 and 3. The plane *C* is also approximately the plane containing all the entrant surfaces of the laminations of the echelon *D*. The image formed at *C* has vertical definition only, and is generally in the best forms of Stixograph optical apparatus, the point at which vertical definition is eliminated. The lamination *a* can only receive light from the strip 1 of the object *B*, because of the focusing action of *A*. Similarly the lamination *b* receives light only from the strip 2, which is adjacent to and above 1 in *B*, for as no two laminations overlap vertically in the plane *C*, each lamination can only receive light from an individual and independent strip of *B*.

The surfaces of the laminations which are in contact are polished, but are not

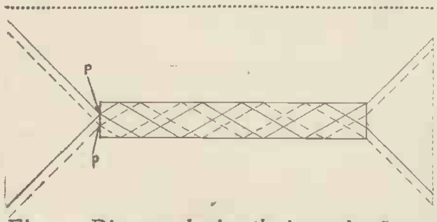


Fig. 7. Diagram showing the internal reflection.

in optical contact, consequently light entering a lamination from *B* cannot pass from that lamination to adjacent ones, but is internally reflected. Each lamination acts like two parallel mirrors and light is reflected repeatedly in the vertical dimension between the two horizontal surfaces of the lamination though not in the horizontal dimension.

This internal reflection is shown in Fig. 7, where the two points *P* and *p* represent focused image points. Light from the point *P* is shown by full lines and that from *p* by dotted lines. It will be noted that internal reflection integrates the light from these two points in a direction at right angles to the two reflecting surfaces.

Returning to Fig. 6, it will be seen that light emerging from an echelon lamination is, in the vertical dimension, an integration of all light entering the lamination from the object *B*. This means that even if the object lens *A* focuses several lines on one lamination, they all merge to form one hand in the vertical direction.

The Action

It is interesting to note at this point what has actually taken place. First, vertically the picture has been divided into horizontal strips, which if the laminations of the echelon are of equal thickness, are of equal width. Secondly, the vertical definition of the picture has been reduced, so that all the details are of uniform size. Thirdly, the uniform details can vertically only occupy certain positions, and the distance between two of those positions must be an integral multiple of the uniform size of detail. These are all but one of the necessary requirements for the elimination of all definition and limitations of size and position of details in the vertical dimension.

The last requirement is that the details of the picture shall be so arranged, that they cannot interfere with each other, no matter what size they assume in the vertical dimension. It should be understood that this assumed size bears no relation whatever to the size of details in the picture and is of no consequence, seeing that it may be infinitely great or small without affecting the picture at all.

This last requirement is obtained through the transverse (horizontal) displacement of the echelon laminations. In Fig. 6 each lamination being a cylindrical lens will form an independent image of the object *B* in the plane *E*. Each image consists of parallel vertical lines, i.e., is a cylindrical image as previously described. As each lamination, due to the object lens *A* can only receive light from an individual strip of *B* (e.g., *a* receives light only from the strip 1) then the image it forms in plane *E* can only be an image of details horizontally disposed in an individual strip of *B*. Similarly, the image formed by each lamination is of an individual strip of *B*.

Each lamination of *D* is displaced horizontally relative to adjacent laminations, in fact, relative to any lamination, consequently the image it forms is horizontally displaced from any of the images formed by other laminations. With a suitable amount of lateral displacement between adjacent lamina-

(*Continued on page* 134)

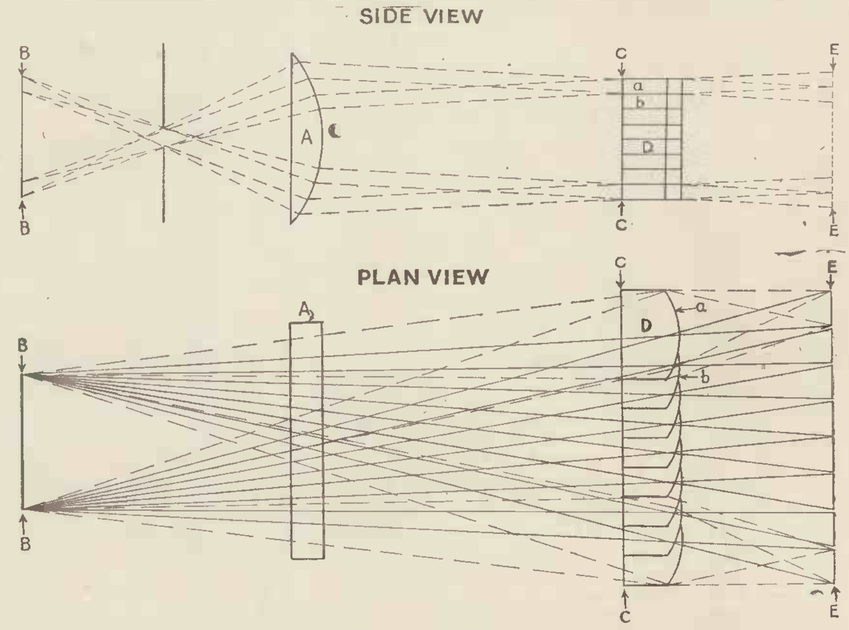


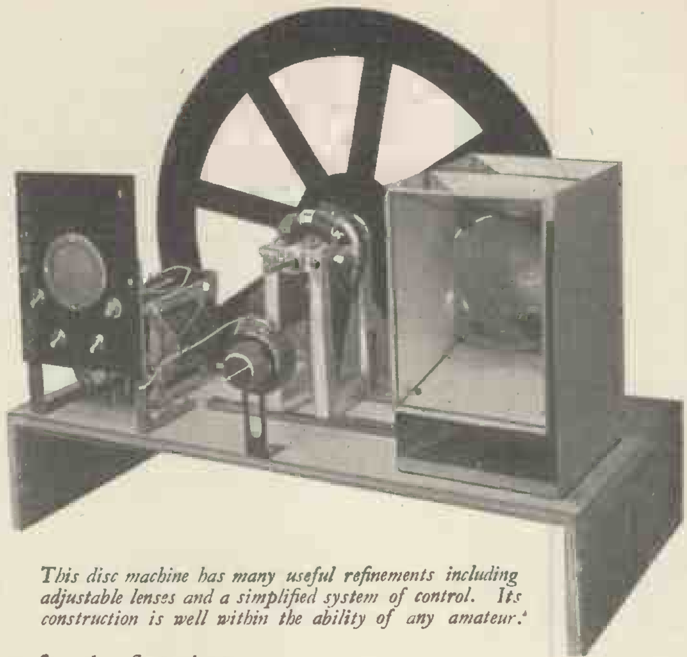
Fig. 6. The complete Stixograph optical system

IDEAL FOR THE BEGINNER

A Disc Receiver

INCORPORATING SEVERAL DISTINCTIVE FEATURES

By L. A. Chapman



This disc machine has many useful refinements including adjustable lenses and a simplified system of control. Its construction is well within the ability of any amateur.

ALTHOUGH amateurs are usually prepared to follow an approved and tested design to get results, there is the type of constructor who much prefers to know the whys and wherefores. I therefore propose to discuss briefly the need that led to this and that arrangement in this particular assembly of parts.

I will deal first with the chassis. This form of construction was decided upon for a number of reasons. It affords great stability and it permits the use of a shorter stand or support for the motor, thus keeping the centre of gravity low.

The overall height of the condenser-lens assembly is also maintained at a reasonable height. Finally, for those who possess a small commercial mains unit for supplying the striking energy for the modulator neon, there is ample space beneath the chassis and immediately under the switch panel to house this.

Rigidity in the mounting of the motor which drives the scanning disc is a very important feature. Quite a number of different cradle designs may suggest themselves to those who handle the Mervyn motor for the first time. I chose the skeleton arrangement of strip and angle brass which, I felt sure, would give me all the strength and rigidity required and the finished cradle is light, strong, and cheap. The total cost of the materials for this motor-stand was two shillings. I used brass rivets for holding together the different sections of the framework.

There are two points in the assembly of this cradle. Make each end-piece and foot first, and finally rivet the two together by means of the lower cross-members. Also, do not drill or mark the holes in the upright angle-brass members for the screws which screw into the aluminium frame of the motor, until the cradle has been completely assembled.

Here is the complete receiver in its cabinet. The appearance is particularly neat

Alignment of Parts

The height of the centre of the spindle from the top-surface of the chassis, must be the same as the centre of the scanning aperture at the rear of the lens assembly, and also the centre for the mounting of the two lenses. I suggest, therefore, that the wooden base for the lens assembly be next prepared. The runner bars may be mounted on it together with the metal side-pieces and metal back. A line should then be drawn down the exact centre of the metal back-piece and a further line should also be marked to indicate the centre of the front of the lens-assembly base.

LIST OF PARTS.

16-inch Disc.	Peto Scott.
Motor	Mervyn.
Motor Rheostat	Mervyn.
Condenser lenses	Peto Scott.
Lens hood assembly	Peto Scott.
Switch panel and window	Peto Scott.
2 Panel brackets	Peto Scott.
3 On-off switches, and 1 C.O. switch	Bulgin.
5-ampere plug and socket	Bulgin.
Flat-plate neon	G.E.C.
Indicator neon	G.E.C. (state voltage of A.C. supply).
Cabinet and chassis	Peto Scott.
3 Terminals marked "earth," "2 plus L.S." and "plus input"	Belling & Lee.
Ebonite terminal strip, 4 × 2	Peto Scott.
L.F. smoothing choke, 20-henry 50 m/a	Parmeko.
Brass for motor mounting	
2 Lamp holders	Local electrical stores.
Sundry wire, screws and 4BA nuts and bolts.	

The motor, it will be seen, is mounted half an inch to one side of the centre of the chassis. The distance between the centre of the motor spindle and the centre of the inner and outer holes in the scanning disc is exactly $7\frac{3}{16}$ in. This distance should be measured off and marked with a line from front to back of the chassis. Upon this line rests the centre of the lens assembly and also the centre for the flat-plate neon lamp holder.

These last two accessories should be screwed into position to simplify the next operation. This consists of mounting the scanning disc on the motor spindle and then marking out the confines of the scanning aperture on the back-plate of the lens assembly. This is accomplished with a needle which is first put through the outer hole in the scanning disc and the point allowed to run lightly over the surface of the metal back-plate. The same procedure is adopted in regard to the inner hole in the scanning disc. The correct curvature for the scanning aperurte is thus assured. All that now remains is to see that the centre of this aperture, from the baseboard upwards, coincides with the height of the motor-spindle centre. The distance between consecutive holes in the scanning disc should now be measured, then halved, and this final measurement marked off on each side of the horizontal centre line of the scanning aperture.

When this is done, the scanning-aperture hole may be cut out. I used a graving tool, cutting deep into the metal until I managed to tear out the section not required. A fine file may be used to finish off.

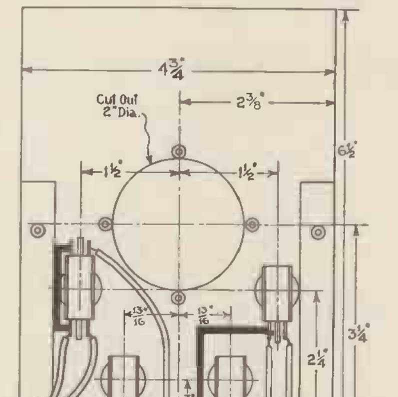
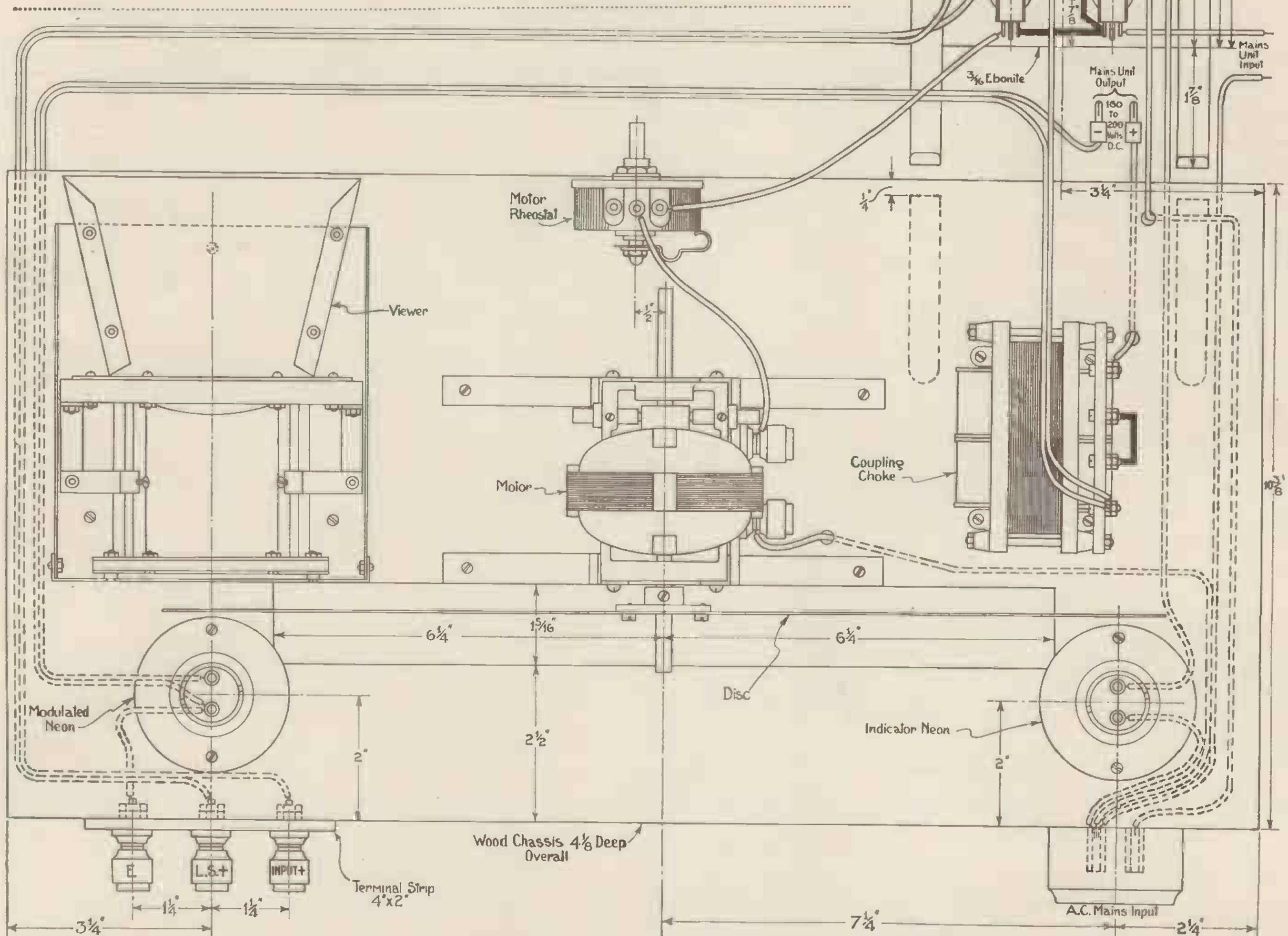
The remainder of the lens assembly is quite simple to construct. If the sliding feet are placed upon the runner bars and the cross-pieces and supporting brackets are temporarily mounted in position, the correct dimensions for the front lens-carrier may be determined. This wooden carrier may then be cut, the lens mounted in position, the cowl assembly made and fitted, and, finally, the whole arrangement permanently screwed together.

The Switch Panel

I decided to have the switches in an easily accessible position at the front, and to match up the scanning aperture in the cabinet with another aperture to take the switch panel. Further, I had already hit upon the idea of incorporating a "vision" indicator to allow correct adjustment of the speed of the motor.

The full benefit of this arrangement will be appreciated when the apparatus is completely enclosed in its cabinet and the instrument connected up to receive a transmission.

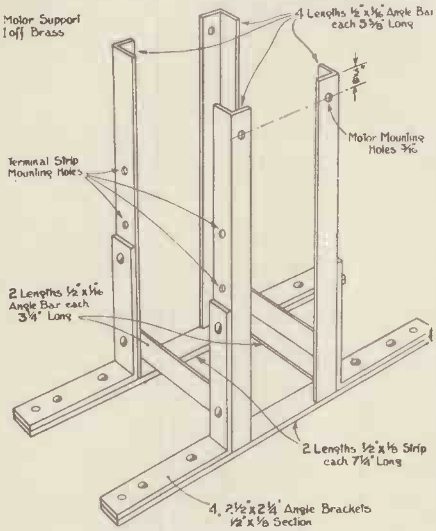
The switches mounted on the panel from left to right are, indicator neon

A plan view of the disc receiver showing the wiring. A large-scale blueprint is available, price 1/-

"on" and "off," motor "on" and "off," modulator neon-current "on" and "off," and modulator-loud speaker "change over."

The method of getting the speed of the motor accurate is quite simple. A neon indicator lamp when used on a



Details of the motor stand.

50-cycle supply, and in conjunction with a scanning-disc having eight spokes provides a stroboscopic effect which gives the appearance that the eight spokes of the disc are standing still when the motor is actually revolving at the correct speed.

is required for the initial working of the modulator neon. I use a Regentone mains unit capable of delivering 25 milliamperes at 160 volts. This, I find, supplies the neon with about 15 milliamperes of current at 180 to 200 volts—just sufficient to give me a clear and well-defined picture.

Connections to Receiver

A system of choke coupling has been adopted for connecting this visor to the wireless receiver. A choke for this purpose is permanently arranged in the vision instrument immediately behind the switch panel. Even so, it is still necessary for a standard choke-filter and condenser arrangement to be incorporated in the actual receiver. Instead of connecting the output from the filter-circuit condenser direct to the loud-speaker, it is first taken to the terminal at the rear of the visor marked "positive input." The connection to the loud-speaker is then taken from the terminal marked "positive L.S." on this same terminal strip, the other loud-speaker terminal being joined to negative H.T. in the receiver. If the terminal marked "earth" on the terminal strip is now connected to the earth terminal on the receiver, the whole of the connecting links between receiver and visor are complete.

It now only remains to connect up the power to the 5-ampere plug-and-

settle down to a constant speed. If you receive negative pictures, try changing the type of detection in your receiver. For instance, if you use leaky-grid change to anode-bend, or vice versa.

Practical Notes

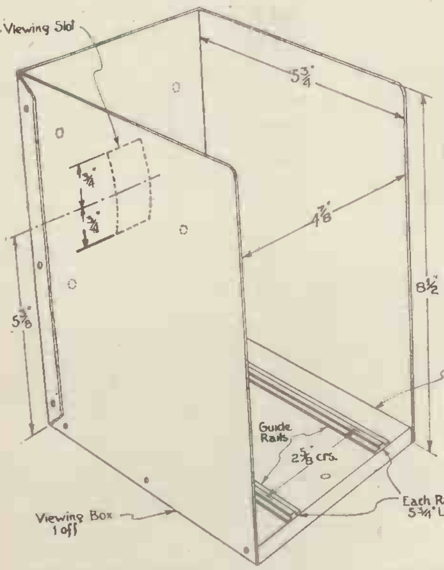
IT is common practice to connect a neon tube directly into the anode circuit of an output valve; this may be all very well with a triode valve, but with a pentode there is considerable danger of flashing over and condenser breakdown if the neon is not shunted with a resistance.

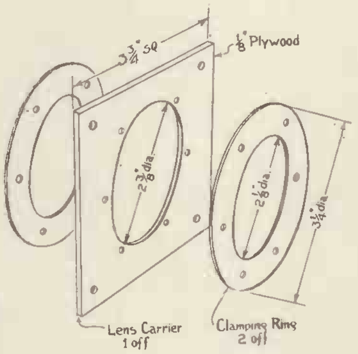
* * *

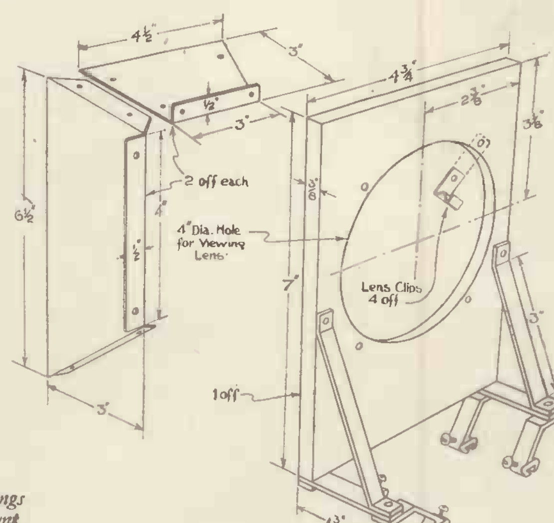
Television in colour with the cathode-ray tube may be an accomplished fact in the not far distant future; experiments are being conducted abroad, with the greatest secrecy, using a screen material that glows with a different colour when bombarded by electrons travelling at different velocity. At present the colour range is limited.

* * *

One of the greatest advantages of the mirror drum is that almost true white light is obtainable; many years ago there was a saying among cinematograph experts that a white projector light was halfway towards colour films.







Here are fully-dimensioned drawings of t' ight tunnel and lens mount.

Modulator-neon Striking Supply

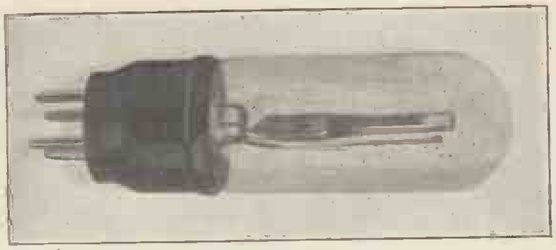
Mention has already been made of the fact that a separate source of energy

socket fitting to begin the first experiment in vision-picture reception.

Switch on the motor at least twenty minutes before the start of a programme so as to give it time to warm up and

When making a time base using a saturated diode as the constant-current device, remember that a bright emitter valve is superior to the modern low temperature valve.

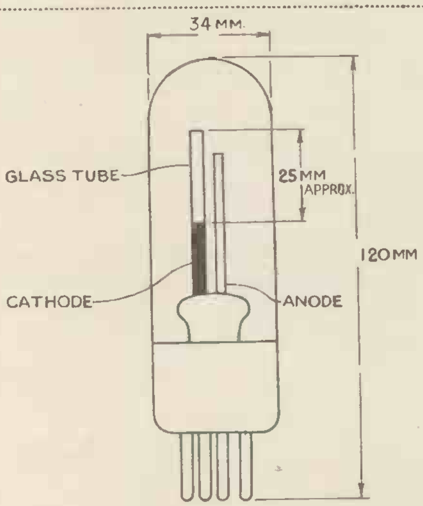
The information in this article, by J. SIEGER, is based upon experiments conducted in the Scophony Laboratory



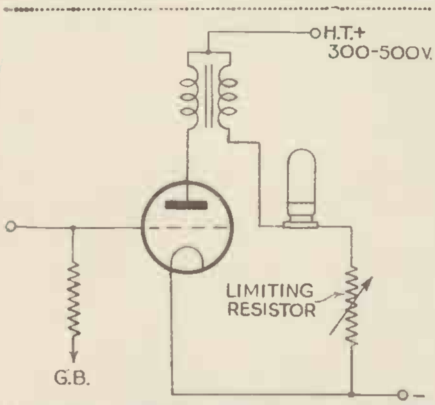
where mercury-vapour lamps are used for their low-definition system employing the rotating echelon.

The Characteristics of Mercury Lamps

FOR television receiver systems using moderate definition of not more than 40 lines, and where a line or spot source of illumination is required, the mercury vapour lamp has certain advantages over other gas-discharge tubes. In the Nipkow disc type of receiver the flat plate neon tube is used, but the brightness suffers somewhat owing to the large area over which the discharge takes place.



A diagram of the type D2 G.E.C. mercury recording tube.



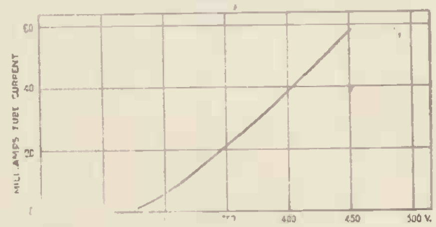
Transformer-coupled arrangement of mercury lamp where H.T. voltage is limited. The resistor is essential for current limitation.

How the Glow Discharge Tube Operates

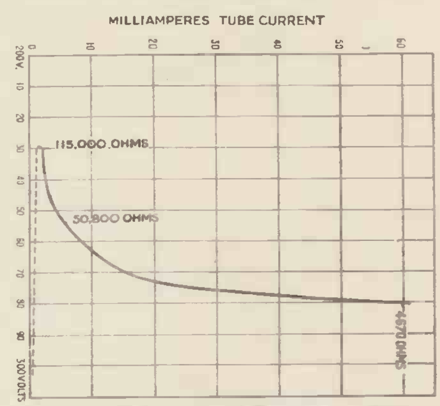
A brief explanation here, of the way in which a glow-discharge tube operates will not be out of place. If two electrodes are enclosed in a glass tube, and a potential is applied, a discharge will take place, and this will be in the form of a spark; in air something approaching 20,000 volts is required to discharge across a 1 in. gap. If now the glass tube is slowly evacuated, the spark will gradually increase its diameter, and will become silent. The discharge will then fill the entire tube. If a gas, such as neon or mercury vapour, is introduced into the tube, at a suitable pressure, a similar phenomenon takes place, but owing to the decreased resistance of the medium, ionisation takes place with considerably less potential. If now the current density of the discharge is made to change, so does the intrinsic brilliancy; that is, an increase of current will give increased light and vice versa.

Discharge tubes of various types are used commercially now in large quantities for outdoor signs, recording, etc. The tubes which interest us particularly are those which have been specially manufactured for similar purposes to television; that is recording tubes for sound. Some of the best known of these are the recording mercury vapour lamps, made by the General Electric Co., Ltd.

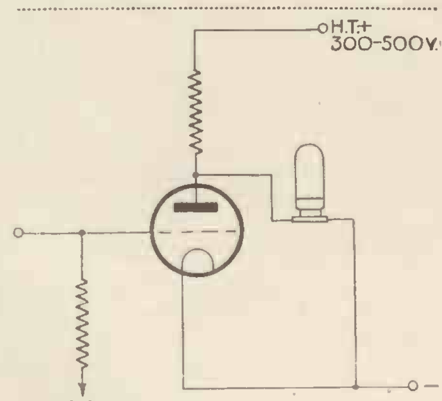
The photograph shows a typical tube made by this firm. The glow discharge is made to take place between the metal electrode parallel to a glass tube, which has an electrode at the bottom. The discharge takes place in the glass tube. Although it is primarily intended to be viewed end on for sound recording



The characteristic curve of the G.E.C. D2 recording tube.



Characteristic curve of mercury-vapour tube.

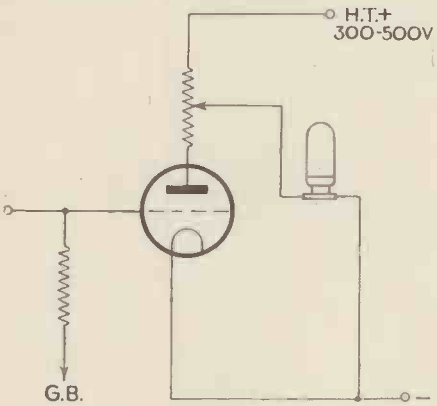


Resistance arrangement of mercury lamp.

purposes, ample light is given from the glass tube linearly, the line of light being about one inch long.

The advantages of using a mercury tube for television can be summed up as follows :

Firstly, the ease with which this



A useful circuit where voltage is limited; the value of the resistor should be equal to the optimum load of the valve, the amount of modulation being controlled by moving the slider.

tube can be used in conjunction with a small output stage; for operation a maximum of about 30 m.a. is sufficient to give good brightness. Secondly, the blue-white colour is pleasing to the eye, and with a television picture gives a better photographic effect than the neon tube.

30,000 cycles. This is the first disadvantage, for it means that the mercury tube can only be used for low-definition pictures.

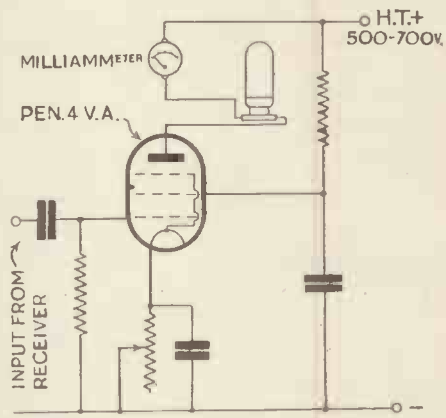
A suitable type is the D.2 recording tube made by the General Electric Co., Ltd. Its operating potential is from 300—450 v., and the most suitable steady running current is about 25 m.a. The electrode inside the inner tube is the cathode, the other one of course being the anode. The cathode is connected to the grid pin on the valve base, the anode being joined to the anode pin.

Methods of Using the Tube

The most suitable way to use this tube is directly in the anode circuit of an ordinary power valve, which should have a mean current of 25 m.a., because as the tube is made without a resistor in the lamp base the tube current must always be limited by a series resistance of a few thousand ohms; when used directly in the anode circuit of a valve this, however, is unnecessary.

The striking potential is some 100 or more volts above the running potential, and the usual method employed to start the discharge is to set the tube volts at about 450 and use the discharge from an ordinary spark coil momentarily. Another method is to use a small transformer with an A.C. output of between 800—1000 volts, in series

available, as, assuming the output valve nominally requires 200 volts and the mercury tube requires a minimum of 300 volts, at least 500 volts must be available for the last stage. This might be a disadvantage in some cases and an alternative circuit is shown in which

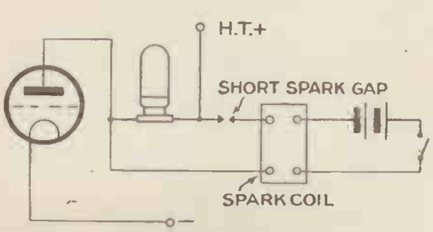


Recommended circuit for use with a mercury-vapour lamp, the current is controlled by means of the bias resistor.

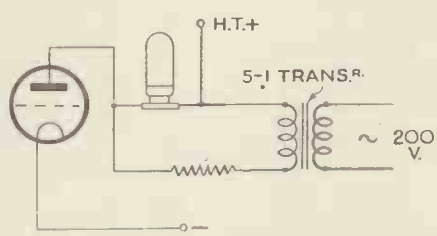
the tube is not used directly in the anode circuit, but across the H.T. total supply, modulation being applied by a transformer.

This method is not to be recommended unless a very good transformer is used. As most television enthusiasts know, a transformer centainly tends to spoil a good picture.

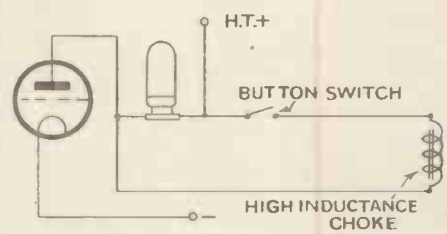
Methods of starting mercury-vapour discharge.



Using a spark coil.



A transformer fed from A.C. mains.



Using a high-inductance choke.

Frequency Response

The frequency response of a mercury lamp has been tested up to one million cycles, but the maximum which is required for a 30-line television picture is not more than 12,000 cycles, which is, therefore, well within the scope of the tube.

On certain experiments, it was found that the maximum modulation frequency which could be applied was

with the limiting resistor again momentarily applied across the tube. This transformer can be an ordinary 5-1 L.F. type, used with 200 volts A.C. mains.

Still another method which is very satisfactory and very easy, is to connect an ordinary smoothing choke momentarily across the tube; the inductive kick given by this choke is usually sufficient to start the discharge.

It is essential when using the mercury tube directly in the anode circuit of a valve, to have sufficient extra volts

An alternative circuit to this is also shown, in which a resistor is connected in the anode circuit, the tube being connected in shunt with the valve.

A typical characteristic curve of G.E.C. mercury tubes is given, and also one of a special type of tube. In this curve it will be seen that the impedance of the tube varies with the current density, and at 60 m.a. the impedance is just under 5,000 ohms. It will be clear then, that a tube of this

(*Continued at foot of next page.*)

News *from* Abroad

By OUR SPECIAL CORRESPONDENTS

Italy

Ultra-short Wave Transmissions

Ente Italiano par le Audizione Radiofoniche started experimental television transmissions from the experimental broadcasting Stations at Rome and Turin. The transmissions take place on ultra-short wave bands, and the wave band employed is from 5 to 8 metres. 180 lines are used. Although the transmissions consist chiefly of films, living objects and short plays are also televised.

America

A Sound and Vision Comparison

Mr. J. G. Maloff of the R.C.A. Victor Company Incorporated, of Camden, New Jersey, discussing problems of cathode-ray television, makes the following interesting comparison:

He says that the fastest speed of speech transmission is about 200 words per minute, it covers a frequency band up to 5,000 cycles at least, and for its transmission requires an air channel 10 kilocycles wide. For television transmissions at about 24 frames or pictures per second the channel required is about 2 megacycles, or 200 times wider than the channel required for speech transmissions. This television channel then would accommodate 40,000 words per minute. In other words, one picture or frame is transmitted for the cost of 28 words of air space.

Television Recommendations Made to the Radio Commission

A special radio commission made recommendations to the Federal Radio Commission following approval by the R.M.A. Television Committee, of which Mr. D. F. Replogle is chairman (as reported in last month's TELEVISION) and also of a special R.M.A. committee headed by Mr. Walter E. Holland. The organization has formally requested the Radio Commission to reserve for television service, a continuous band of frequencies from 40 megacycles to at least in the neighbourhood of 110 megacycles. The R.M.A. resolution also declared that from present indications, the television requirements of the future will be such that assignments in the television band should be at least 4 megacycles wide, to provide continuous entertainment and television service.

Farnsworth Patents

Mr. Philo T. Farnsworth, assigned Television Laboratories Ltd., of San Francisco, and Philadelphia, nearly 100 patents which cover every detail in the successful reproduction of motion pictures by radio, including the transmission of living objects. The transmissions are to take place on a wavelength of approximately 5 metres. The received images are reproduced in brilliant black and white. A motion picture contains 90,000 elements, repeated at a rate of 24 pictures per second (300-line scanning is employed). The sound part is also transmitted on ultra-short waves.

Germany

The Question of Programmes

In television circles the question of programmes is being discussed at great length. It is considered in Germany that a satisfactory solution of television programmes has not been found either in Germany or abroad. It is stressed that one has to take the programme side of television service most seriously, as it may become easily a crucial problem, as soon as the technical difficulties of transmission on ultra-short waves are solved.

It is considered that films will be definitely the subject to be transmitted, but it is emphasised that standard talkie films should not be transmitted, as this would incline the public to make comparison between the television image and the film.

C. Lorenz Take Up Television

The well-known German firm, Messrs. C. Lorenz A.G., who supplied the Heilsberg, Leipzig, Munich and Frankfurt high-power stations and are a subsidiary of Standard Telephones and Cables, Ltd., London, have recently taken up work on television. The well-known experimental worker and inventor, Baron Manfred von Ardenne is one of the main collaborators. It will be remembered that Baron von Ardenne was previously associated with the Lowe radio people who have since opened a television laboratory of their own.

Direct Scanning for 180 lines

The opening by the German Post Office of a new experimental 180-line television service with two ultra-short wave transmitters is expected in April. The programmes will not only consist of film transmissions as The "Fernseh A.G." are at present developing scanning apparatus for the television of actual scenes. It is a well-known fact that direct scanning with as many as 180 lines per picture presents a very difficult task.

"The Characteristics of Mercury Lamps"
(*Continued from preceding page*)

sort can be used in the anode circuit of a pentode valve.

In my experiments with mercury tubes, I have found that a pentode is the most suitable valve to use; there are many valves of the small output class which are suitable, namely, the MPT4. Marconi or Osram Catkin, the Pen4VA Mullard and others.

It is advisable always to use a milliammeter in the anode circuit with a control either on the grid bias of the valve or in the anode curcuit so that the current density can be varied. It will be found that with too high current the picture becomes hard, and with too low a current, besides the light being very poor, the tube tends to oscillate and a number of little beads will be seen on the picture. Various tubes have various operating characteristics, and these can be easily found out by experiment.

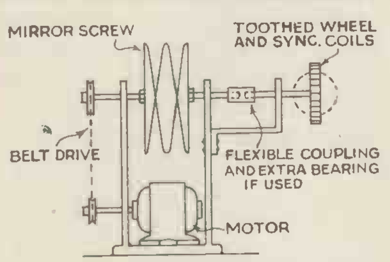
Operating The Mirror Screw

This article, by E. L. Gardiner, B.Sc., deals at length with the operation of a mirror-screw receiver of the type of which constructional details were given in the January issue of "Television."

The mirror-screw receiver is very simple to construct. Details of the one shown above were given in the January issue of "Television."

ON account of its simplicity and high efficiency, the mirror screw is quickly gaining popularity as it is a very good scanning device for use in home reception of the present 30-line transmissions. The purpose of the present article therefore is to offer advice to those experimenters who having obtained or constructed a satisfactory screw are considering how best to incorporate it into a complete receiver.

I intend to offer suggestions in the choice of the other apparatus to use with any good screw, which will apply to practically all cases, and to larger numbers of lines than 30. It must be borne in mind that the mirror screw is better suited than most older systems for a large number of scanning lines,



A suggested layout for driving a mirror screw by step-down belt gearing.

and in general its relative superiority increases as the number of lines is increased and also when horizontal scanning is used.

Driving the Screw

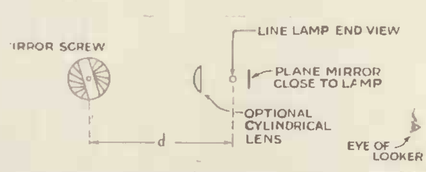
There are two chief problems to be considered in setting up a screw receiver of the simple kind, and which are in every sense fundamental. One is the method adopted to rotate the screw, with which is included synchronising arrangements; and the second is the choice and arrangement of the light source.

The first of these may appear too simple to deserve much consideration, but in actual practice the wise choice of a motor makes all the difference in the result obtained.

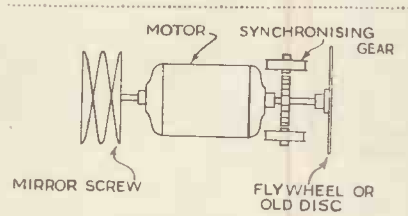
Most experimenters have at some time in their work had experience with the simple disc receiver and I cannot too strongly advise every television experimenter to get experience with this type of receiver because the experience gained in its operation is invaluable ground work for success with mirror-drum and other rather more difficult systems. Everyone who has used an ordinary disc will have noticed the comparatively good synchronisation which can be obtained with it in comparison with a small diameter mirror-drum; many operators can hold a disc image practically stationary by hand rheostat or friction control alone for long periods, provided that the motor is a good one and the disc well balanced.

Fly-wheel Effect

The key to this comparative ease of handling lies of course in the fly wheel effect of a scanning disc which tends to hold the speed of the disc steady against small variations in motor speed. A second factor of almost equal importance is that the type of motor generally used with a disc is of about the right power to drive the disc at scanning speed, but has not the reserve of power to drive it very much faster, owing to the rapid increase of air resistance which occurs as the speed of rotation of a disc of large diameter is increased. Those who have tried a disc on the spindle of a high-powered motor of, say $\frac{1}{8}$ horse power will have noticed how very much harder it becomes to get the correct scanning speed and to hold it by hand control.



Suggested circuit for stabilising a mains driven motor that is too powerful.



A simple way of stabilising motor speed

The Best Motive Power

Easy handling comes with the motor of just enough power, but not too much. Luckily this consideration also fits in with that of low cost and low current consumption.

Of course, the use of a motor designed and wound to run at a speed as nearly as possible to 750 r.p.m. is also a great help; unfortunately this speed is very low for motors of small power, size and cost, and the optimum speed of such motors usually approximates to 3,000 r.p.m. This is especially the case with second-hand fan motors, and the like.

When changing over from a disc to a mirror drum of much smaller diameter, used with the same motor, it is generally found that even if the drum is considerably heavier, the motor tends to run at far too high a speed. Moreover, when additional series resistance is used to reduce its speed, the motor tends to " run away " from true scanning speed very easily, due to the fact that with high series resistance and small load the motor is working on a very unstable part of its operating curve, and that there is less inertia effect and air resistance to stabilise it. Another defect is a tendency for the image to rock when synchronised, making the use of a flexible coupling between the drum and driving motor desirable.

Actually, the solution of this speed instability would be simply a lower powered motor, as the average motor suited to a disc is too powerful for ideal use with a small mirror drum. But few of us want to change the motor unless really necessary, and so a compromise is generally effected.

Speed Control

This discussion is intended to lead up to the case of the mirror screw in a logical manner, since here we have a case of a scanning device which is much lighter than a mirror drum of the usual type. A typical screw of outside diameter between two and five inches may have a similar ratio of weight to inertia as an average disc, but the power needed to rotate it would be perhaps a tenth only, so that a disc motor is very far from the right thing to use.

Very high series resistance is needed, and so the motor becomes very unstable and runs away on the slightest provocation. Control by hand becomes almost an impossibility.

This does not mean that a normal size of motor as used for disc or drum working cannot be used, and in the case of the more expensive and larger motors which are designed to a large extent for low speed, quite good results may be expected with care ; but the less expensive types of motors in which the speed regulation characteristics are not quite so good may be expected to give trouble in speed adjustment. A saving factor is that the light mirror screw needs less power for electrical synchronisation, and with an efficient synchroniser this may go a long way in compensating for the unsuitability of the motor to which it is attached, as long as the synchroniser has control of the speed.

Fortunately, however, there are several simple schemes by which ease of handling can be retained. If it is desired to retain the too powerful motor previously used for a disc or drum, the characteristics of this can be enormously improved by placing on the other end of its spindle, or wherever there is room, a suitable flywheel, which might be an old disc, or a small disc without holes made up for the purpose. This expedient is bulky, and perhaps more useful when making tests, than for incorporation in a receiver design ; but nevertheless it is often most helpful. A heavy fly-wheel of smaller diameter can, of course, be used with nearly equal success, and the writer has seen the fly-wheel from a small gas engine giving good service in this position.

In the case of low-voltage motors working from batteries the case is easier, since far better stability is to be expected if the voltage of the battery is reduced by removing cells from the circuit, instead of increasing the series resistance. An equivalent if smaller effect in the case of mains motors results from feeding the motor from a tapping on a relatively low resistance potential divider connected across the mains, a small adjustable resistance being used as well for fine setting. The circuit and suitable values are shown together with diagrams illustrating the other points just mentioned. Of course, all these remarks on electrical stability refer mainly to the series-wound motors in general use, and to a lesser extent to shunt or compound-wound motors.

Reduction Gearing

A second and in many ways a better method of attack is that used in the mirror-screw receiver recently described in this journal, in which a standard motor is used but coupled to the spindle which carries the screw by a step-down belt drive. This scheme operates because the motor is run at a much higher speed than that of the screw ; thus if a pulley-ratio of 4 : 1 be chosen, the motor can run at 3,000 r.p.m. which is about the most suitable speed of most small mains motors, and one at which they tend to stay fairly constant. The use of a reduction gear also increases the effect of the inertia of the screw in stabilising the motor by four times.

The motor at high speed will be running under better conditions in other respects ; it should keep cooler, and take less current from the mains. With this arrangement any electrical synchronising arrangement used must be mounted on the spindle which carries the screw.

An elastic belt will give to some extent the effect of a spring coupling. A definite spring coupling device if used should lie between the screw and the remainder of the screw-spindle which carries the driving pulley and synchronising gear.

Having now suggested a few points to watch in selecting a suitable motor, the remaining component essential for satisfactory reception is a suitable light source. The correct lamp for use with the mirror-screw of course, is one giving a long narrow line of light, the length of which should be rather greater than the width of the screw measured along its spindle, and the best width between about one and three millimetres according to the dimensions of the screw used. This width is easily found experimentally after the apparatus has been set up, by the simple expedient of masking off the line of light by means of opaque black paint upon the glass envelope until the stationary scanning spot appears a true square.

With most neon lamps it will be found that when the plates are viewed edge on, a line of light can be seen, of suitable dimensions for mirror-screw use. This can be used as it is, or better by conversion into a parallel pencil of rays by means of a cylindrical lens of fairly long focal length.

In our next issue various arrangements of the optical system will be described and methods of providing current for the lamp.

Ultra Short-wave Transmissions in Berlin

Early in April it is hoped to open an experimental television service on ultra short-waves in Berlin. The present ultra short-wave transmitter which has been working for the past year will be used for sound transmissions, and the new transmitter which was recently ordered by the Post Office will undertake 180-line television transmissions. This means that Berlin will have a sight-and-sound experimental television service within a few months.

A recent demonstration in the German Post Office laboratories showed further improvement on the pictures shown at the Radio Exhibition.

Lydia Sokolova, Ballerina of the Diaghileff in the programme of February 14

STUDIO & SCREEN

Laurie Devine wearing a period dress in whic she appeared on February 13

AS I write, the removal is in progress. Programmes are suspended and engineers are shifting their apparatus from Broadcasting House to Number 16, Portland Place, where a sound-proof partition with a plate-glass window five feet square now divides the drawing-room on the first floor. On one side is the studio, on the other the projection room, and, as at Broadcasting House, a shaft of light from the scanner will be directed through the window to the scene in the studio. Both rooms have a parquet floor in which a duct has been cut to carry the wiring. In the projection room, a few feet from the scanner are two desks with panels, one controlling sound and the other vision. Between the panels is a seat for the Programme Director, who will thus be able to supervise both sound and vision without having to leave his place. To the left of these controls and within easy reach is a table for the small caption machine and against the wall in front are two visors and a loud-speaker for checking the programme.

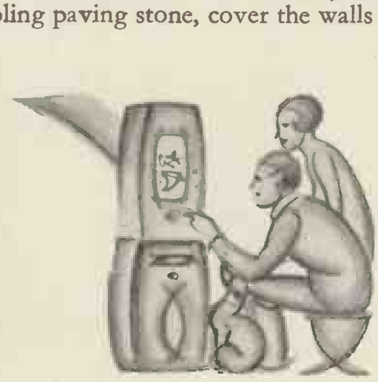
During transmission one screen will show a picture received *via* ether from Brookmans Park through an aerial on the roof, while the picture in the other visor will be reproduced by line from the studio. So it will be possible to compare a line with a radio image in every programme and there will be no risk of transmitting a negative picture as happened once at Broadcasting House.

* * *

The new quarters are a great improvement on Studio BB in the basement at Broadcasting House. The engineers have at least six times more space for their gear in the projector room and the studio itself is larger. Both rooms are lofty and have large windows which will carry away the heat of the arcs when pictures are not being broadcast. The three windows of the studio overlooking Portland Place have been covered with white boards which open in casement fashion and when closed fit flush to the wall which forms the backscreen. There is an advantage here, for the projector will have a lateral swing of about thirty feet, giving the dancers in particular much greater scope. I shall be interested to see what use the producer makes of this extra space. When needed, it should be possible to fit up two separate screens side by side and to swing the projector from one set to the other.

Two large dressing-rooms have been equipped at the rear of the house on the same floor, and offices for the staff and another dressing-room have been furnished on the floor above.

Acoustic board cut in slabs, resembling paving stone, cover the walls and ceiling of studio and control room, giving a suitably "dead" effect to all sound. For ordinary purposes the studio is lit by pendant lamps which are all controlled by a slow-fading switch in the projector room. So no flash will be seen in the picture as the lights are raised or lowered and the studio can be lit to any intensity desired.



* * *

For a personal appearance without make-up, engineers used to fit a blue arc in the projector, then they tried a red filter, but when the Duke of Marlborough took his place before the scanner, I noticed that no change was made in the machine. Experience has shown that only a very slight improvement results from altering the light and, as the process slows up production, the practice has now been discarded. The producer feels that he cannot ask an illustrious guest to submit his face to the paint-box, and what the programme lacks in definition it gains in distinction. Though the reflection from his stiff white shirt did not improve the picture, the Duke was a good subject for television, and the resemblance to his kinsman Winston Churchill was remarked by everyone present in the checking room at Broadcasting House that evening.

The Duke found his appearance in the picture less of an ordeal than many others who have graced the studio. Once again the powers of the system were tested by the exhibition of a queer assortment of objects and the producer was able to demonstrate, to my satisfaction at least, that these displays are well worth giving.

A new use was found for the miniature transmitter on the same evening, when works of art were televised which could not have been shown by other means. A coloured miniature of Queen Anne, several old pencil drawings, three engraved playing cards and the pages of an ancient book were focused in turn by the little machine. The cards had a political interest, for Charles the Third of Spain represented the King of Clubs, a contemporary lady the Queen of Hearts, and a Prince was the Knave of Clubs. It would have been a pity to miss these little exhibits and Eustace Robb should have the credit for this ingenious presentation.

* * *

After seeing Anny Fligg in the studio dressed in diaphanous material without the usual black and white contrast, I was surprised to find that she made such an effective picture in the visor. Hurrying back to the studio to discover the secret, I found that the explanation lay in the deep shadows which were thrown on her gown by cells placed in odd positions on the floor. The object was to secure the effect of flickering firelight, and the producer, by turning the controls of the cells up and down in time to the music, gained a peculiar rhythmic effect. As the output from one cell was raised, the strength of another was reduced. The novelty may have puzzled some lookers.

* * *

We have grown accustomed to transmissions on four nights each week but as we were warned by the B.B.C. in December last, the time allotted to "30-line" pictures will be reduced from the end of March. Engineers at Broadcasting House are continuing their experiments with ultra-short wave systems which give higher definition and meanwhile our entertainment will be concentrated in two programmes per week.

* * *

In Sir Thomas Beecham a cynically humorous outlook conceals a kind heart, and it was typical of the great conductor's consideration for his artists that he fixed rehearsals of the Philharmonic Orchestra which allowed Cyril Smith to get to Broadcasting House for rehearsals on the day when we saw Thea Philips, Alicia Markova and Gavin Gordon. A sinister effect was achieved by low lighting for Gordon's Mephistopheles. Thea Philips is a favourite concert artist and the appearance of Markova adds yet another well-known name to the list of famous dancers who have faced the projector. A celeste was heard for the first time in television during this programme.

The performance of the Vardel Four emphasised the need for a vertical movement in the projection apparatus, for several times the boys in this amazing acrobatic troup were sent hurtling towards the ceiling out of range of the light. I was particularly impressed by the scene when the man lay on the floor with a boy spinning on his upturned feet.

* * *

In case you were in doubt, the "Loch Ness Monster" displayed by John Tilley was a monstrous little creature in grey rubber about eighteen inches from snout to tail. He was transmitted from the big cells.

* * *

The producer is determined not to embarrass his staff with complicated programmes for the first few days in the new studio. They will have plenty to do settling in and no ambitious production is to be expected before the middle of March. To simplify things and limit rehearsal, the programme of February 26 will be repeated on February 28, so Anona Wynn, Kenneth Blain, Leslie Douglas and the Eight Step Sisters will then be seen and heard again. Other engagements include Harold Stern, Leoni Zifado, Birgitta and Anton Dolin on February 27; Doris Hare, Psyche, and Osborne and Hadden on March 2.

Ediswan portable cathode-ray tube equipment shown partly withdrawn from its case. Underneath the tube can be seen the thyratron for the time-base. On the front panel are the controls for the time-base and for the focusing tube

A Mirror-Screw Hint.

The versatile mirror screw is readily adaptable to many ingenious ideas, among which the following is very good.

The present 30-line picture ratio is, according to some, rather too narrow when viewed. The image, however, can easily be "squared up" a little by adding four more mirrors so that the picture width is increased, but if they are added in a certain way the number of lines remains constant at 30.

Try it this way. When setting the first line and an image is picked up in the slits add another strip and without moving the mirror screw adjust this to exactly the same point. In operation these two mirrors will give the same reflection but the line will be twice the width. No. 2 line and Nos. 29 and 30 are added to in the same way. Very little difference will be noticed in the picture, but the general impression created will be worth the trouble. Of course the same thing can be carried out with No. 3 and No. 28 lines, but it will spoil the image if taken any further.

Velocity Modulation

Full Details of the Cossor System

The photograph above shows the designers of the new velocity-modulation system, L. H. Bedford (right) and O. S. Puckle, making adjustments to the transmitter at the Cossor laboratories.

A NEW television system has been developed by L. H. Bedford and O. S. Puckle, of A. C. Cossor, Limited. Details were first made public when a paper was read by the designers of the system before the I.E.E. on February 7.

The advantages claimed for this unique and revolutionary system are: complete absence of the synchronisation problem in the line scanning direction; a very simple solution to the difficulties of synchronisation in the traversing direction, including automatic framing; greatly relaxed modulation requirements on the receiving oscillograph; greatly increased picture brightness for a given receiving oscillograph, as compared with the intensity modulation system; improved concentration of detail in the light portions of the picture and nearly constant percentage modulation of the radio transmitter.

The basic principle of this system is the production of light and shade by varying the time taken by the spot to pass any given point and not the brilliance of the spot; in other words the spot will travel over the whole picture in a regular manner but not at a uniform rate.

When a picture is being transmitted the spot speeds up for the dark portions and slows down for the light portions; consequently, when a bright portion has to be created the spot slows down and when a dark portion is being reproduced the speed at which the spot travels is proportionately increased. Any degree of light and shade existing between these two extremes is, of course, obtainable by proportionate speeds.

The re-creation of true light and shade is dependent on the phenomenon of persistence of vision. If a light spot of constant size and brilliance describes a repeating design in which the actual speed of movement at any particular point varies from that of other points, the eye will only appreciate this state of affairs as such if the movement is very slow.

If the movement is so rapid that the oscillogram is completed in the period within the persistence of vision, the eye renders a totally different impression namely, that of a stationary design, split up into various grades and intensities of light and shade. The principle of modulation by velocity therefore permits introduction of light and shade into a received picture without either altering the intensity, size or brilliance of the spot, and it is claimed, therefore, that it is ideal for television reception by means of a Cossor cathode-ray oscillograph tube. The cathode-ray has sufficient freedom from inertia to reproduce successfully the extremely abrupt changes of velocity which are called for.

The Transmitting End

It will be apparent that it is quite impossible to realise velocity-modulated pictures at the receiving end from the uniformly scanned object at the transmitting end. The scanning at the transmitting end must also be velocity modulated. For scanning the object to be transmitted by velocity modulation it follows that the scanning element at the transmitter end must also be a cathode-ray, which means that the cathode-ray oscillograph must serve as the source of light. At the present time, this means that the picture subject matter is, on the grounds of scanning light restrictions, limited to filmed material, at least when the ordinary low-voltage oscillograph is contemplated. It is of interest, however, to note that direct subject transmission is not considered to be outside the bounds of possibility by the designers. Further in the opinion of the designers, the restriction to filmed material does not constitute a drawback, as the same restrictions are forced upon any television service by quite other considerations, particularly the desirability of broadcasting to a large audience in the evening an event which has taken place at a time in the day when the audience would be very limited.

In practice, at the transmitting end, the light spot of the oscillograph is focused on to a cinema film through a suitable lens and the light or such portion of the light that may penetrate the film falls on a photo-cell. Current variations through the photo-cell produce the voltage, which duly amplified is fed back into the scanning oscillograph in such a manner as to control the instantaneous scanning speed.

The spot must also possess a path so arranged that it will cover every point of the picture as is customary in television transmission. The function of this arrangement will be better understood when it is realised that a copy of the picture must appear on the screen of the transmitting tube itself, bearing in mind that the voltage dependent upon the film intensity from point to point is fed back into the tube.

When transmitting from a positive picture increased light on the photo-cell must bring about a decrease of the scanning velocity, giving the appearance of light, and when the real image of the spot falls on an opaque portion of the film the spot is speeded up, giving the appearance of darkness on the transmitter.

It has already been mentioned that the appearance of the picture on the transmitter is an integral part of the system. No special significance might be attached to this happening until it is remembered that this picture has come about solely by means of the voltages applied to the deflector plates of the oscillograph and that the same picture, therefore, will obviously result on any similar oscillograph to which these voltages are faithfully transmitted.

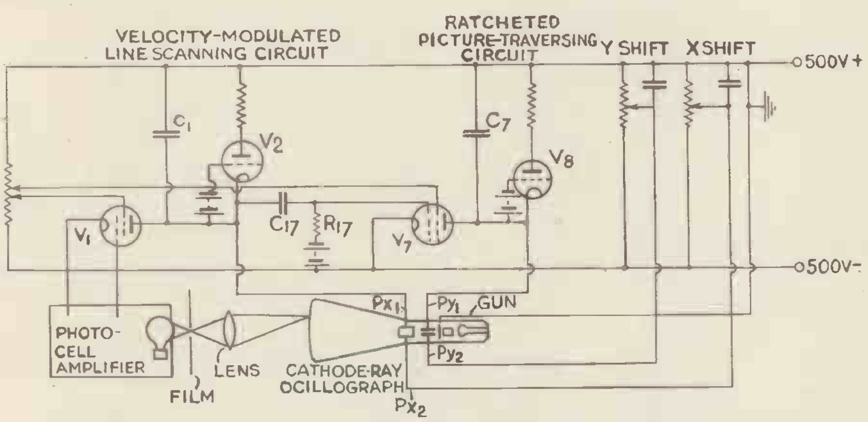


Fig. 1. The schematic circuit of the transmitter for producing velocity-modulated scanning.

If two channels are available the transmission problem is reduced in fact to that of connecting one pair of plates on the transmitter to a pair on the receiver and the other pair on the transmitter to the other pair on the receiver, and if this happy state of affairs were possible the question of synchronisation at the receiving end would not arise. This feature is, according to the designers, unquestionably one of the most important advantages offered by the principle of velocity modulation.

The tying together of the two pairs of plates of the receiver and transmitter would, unfortunately, require two communication channels, which is, normally speaking, impracticable. The solution adapted by the designers which makes it possible to convey the intelligence actually in a single channel is to sacrifice the feature of implicit synchronism in the picture traversing direction, whilst retaining it in the line scanning direction. Synchronisation is made absolutely solid by means of a signal impressed on the line scanning, so that, in effect, the system still operates as though the synchronisation were wholly implicit and not implicit in one direction only.

Increased picture brightness and concentration of detail in the light portions of the picture result from the fact that the scanning is relatively slow in the lighter portion of the picture; both the light and scanning time not required in the dark places are made use of in the lighter portions.

Concentration of detail in the light portions of the picture, is an advantage only if the contrast ratio of the picture is kept low, but as soon as high contrast ratio is attempted the sacrifice of detail in the dark places in favour of the light becomes objectionable, as the detail in the dark is inadequate. Further, it becomes impossible to obtain a satisfactory change from one intensity to another, more particularly from dark to light, without the use of an unduly widened frequency band, which would, of course, become more and more undesirable as transmission of television became more and more general.

The present system, therefore, transmits a velocity-modulated picture at low contrast level and superimposes intensity modulation upon it at the receiving end. This system proves to be a remarkably advantageous combination of the two principles, since both kinds of modulation work at their best only when called upon to operate over a relatively restricted range.

It might be supposed that the lowering of the velocity modulation contrast ratio would seriously reduce the advantage of increased picture brilliancy, but in practice this is not so, as the increased picture brightness is retained almost intact. This will be more clear when it is remembered that the spot is at its full brightness in the light portions of the picture and is dimmed only in dark places. Consequently the intensification process involves only the extraction of light from the places where its presence is detrimental, thus increasing the contrast level while retaining the intrinsic brilliancy of the system.

Having explained the general outline of the system it will be convenient to divide the subject into two parts in order that both may be discussed without confusion. The first section is the television transmitter as far as reducing the picture intelligence to terms of electrical impulses is concerned; the second section concerns the receiver.

The Transmitter

The system of velocity modulation is sufficiently flexible to permit of various alternative detailed arrangements regarding the number of lines, whether line scanning is in the vertical or horizontal direction, and so on. The following remarks, however, are based on the system and detailed arrangements used by A. C. Cossor Ltd., for demonstration purposes.

The transmitter at present working has a picture speed of 25 complete pictures per second. The scanning is 120 lines in the horizontal direction and the equivalent of 160 lines in the vertical direction.

The Basic Transmitter Circuit

Fig. 1 shows a schematic version of the transmitting circuit for a stationary picture, by which velocity-modulated scanning and the appearance of the picture on the transmitter is brought about. The screen-grid valve V1, condenser C1 and gas-discharge triode V2 constitute a time-base circuit, the valve V1 forming the "constant-current" charging element, in view of its being operated with the plate voltage well above that of the screen, that is to say, in the saturated part of its anode current/anode voltage characteristic.

The instantaneous charging current is determined from instant to instant by the voltage on the grid of V1, which voltage is actually the output of the photo-cell amplifier. The bias on the grid of the gas-discharge triode V2 determines, at least nominally, the voltage amplitude of the time-base sweep.

The cathode of V2 is connected to one of the X deflector plates (PX1) of the oscillograph, the opposite plate (PX2) being taken to a biasing potentiometer for the purpose of shifting the picture. The arrangement thus constitutes a time base providing a scanning sweep whose speed is modulated by the instantaneous light falling on the photo cell, and a rapid fly-back on the occasion of each discharge of the gas-discharge triode. This fly-back is so rapid as to be invisible, so that it is not necessary to quench the spot on the fly-back in order to obtain a correct picture unmarred by the tracing of the line fly-back.

Constant-voltage Scanning

The term constant-voltage scanning is used to indicate the method of scanning outlined above, in which the scanning lines are allowed to take their own time, which will vary from line to line, according to the amount of light or dark encountered by the scanning spot, the lines being all the same voltage length.

Referring to the traversing circuit (Fig. 1), the screen-grid valve V7 and condenser C7 and gas discharge triode V8 constitute the traversing time base. It will be appreciated that since the scanning lines take unequal time it is not satisfactory for the traversing time-base sweep to be uniform, and the arrangement adopted is that of allowing the scanning lines to be moved on in a step-wise manner between consecutive lines, the magnitude of the step being fixed and independent of the time taken by the lines.

The Practical Transmitter Circuit

It is not proposed to go deeply into the question of a practical transmitter and it will suffice, therefore, to say that a number of other considerations must be taken into account and to show how they can be achieved in practice.

An actual transmitter for practical purposes will have to deal with moving films and will require in addition to the basic requirements outlined above, first of all some means of synchronising picture frequency and provision of facilities for transmission of a moving picture from a uniformly running film, which may be referred to as the chasing circuit. It should be clearly understood that the film is continually and evenly moving and that the separate pictures do not jump on one at a time as in a cinema projector. This ingenious feature makes for a considerable saving of time.

In addition there will be certain detailed improvements, such as picture synchronisation signal to give a momentary cessation of scanning at the end of the last line, and the substitution of the gas-discharge triode by a pair of hard valves, made necessary by the fact that the scanning lines are allowed to take their own time which can, of course, vary over a relatively wide range. At the frequencies concerned, it was not possible to design a gas-discharge tube which in these circumstances would fire at a constant voltage amplitude irrespective of the wide frequency changes.

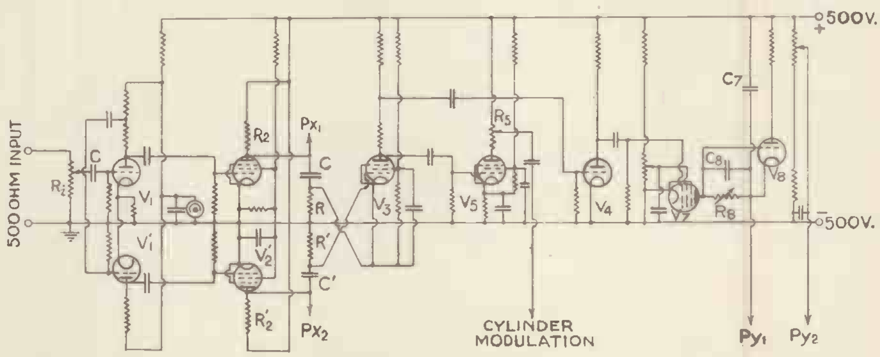
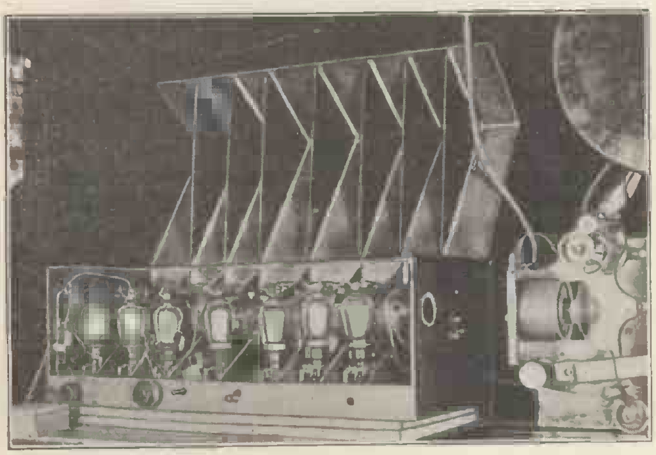


Fig. 2. The circuit of the receiver which comprises a line-scanning amplifier, picture-traversing time-base and an intensifying system.



This picture shows the amplifying bank for the transmitter: note the screening arrangements on the underside of the lid.

As a matter of interest it may be added that at the higher frequencies corresponding to a succession of dark scanning lines the behaviour of the gas discharge triode could only be described as wildly erratic. The manner in which hard valves are used to take the place of a gas-filled valve is extremely interesting.

Referring again to Fig. 1, during the charging of the condenser C1, the valve V2 takes no anode current owing to its being biased beyond cut-off by the drop in the resistance R3 in the plate circuit of V3. As the charging continues, the voltage across V2 rises until a point is reached where anode current commences to flow; this causes a voltage drop over the resistance R2, which is fed through condenser C23 on to the grid of the valve V3. This reduces the current in R3, hence the grid voltage of V2 rises, the anode current increases and the action is cumulative. At the end of the discharge the current in R2 drops, the cumulative action is reversed, and the circuit re-sets itself for the next charging stroke.

It is not proposed to go into details of the photo-cell amplifier, but it is interesting to note that the requirements of such an amplifier are both diverse and difficult of attainment and include a voltage gain of the order of 5,000 times, and effectively level frequency characteristics from 25 to 240,000 cycles per second.

(Continued on page 132.)

THE TELEVSION ENGINEER

Modern Forms of Kerr Cell

THE DOUBLE-IMAGE POLARISCOPE

By H. Anthony Hankey

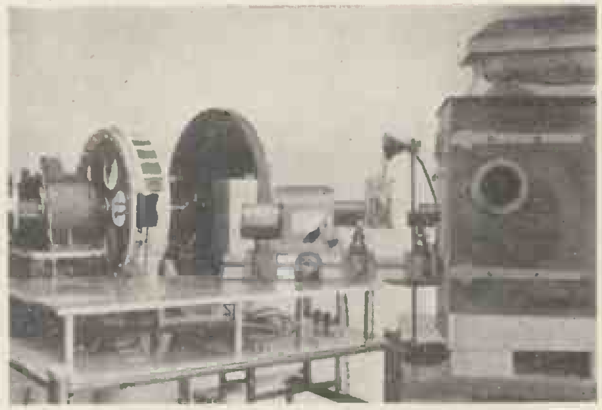


Fig. 3. A photograph of the double-image polariscope employed in conjunction with the Wilson scanning system.

ALL forms of Kerr cell employed in connection with the single-image polariscope can now be classed as old-fashioned. By single-image polariscope I mean that in which the Nicol prism, the Thompson prism and the like prisms are used as polariser and analyser respectively. It has been worked out that the efficiency of these prisms is about 13 per cent. when used in connection with the Kerr cell. Despite this fact, quite a number of people continue to employ this device in television and it is to be concluded, therefore, that many are not aware of the more modern designs of Kerr cell which have been the outcome of Mr. L. M. Myers' research during the last three years.

The Double-Image Polariscope

In February, 1932, Mr. Myers showed me his new form of polariscope and I believe I was the first to be so privileged. Later, this device was shown to a number of interested persons. Mr. Myers has informed me that the double-image polariscope is by no means new to science and that it was probably known even to Huygens himself. Curiously enough, Kerr employed the double-image polariscope in connection with his investigation with respect to the artificial double refraction in glass. Publications on this subject have apparently been very scarce so that I shall attempt to describe the device in detail.

In Fig. 1 we see at the left-hand side of the diagram two calcite blocks arranged with their principal sections parallel. It will be noticed that the ordinary ray in the first continues as the ordinary ray in the second. *O* represents the condition of light in the first prism and the subscript indicates the condition in the second prism. Therefore *Oo* represents the ordinary ray of the first and the ordinary ray of the second. The extraordinary ray of the first also becomes the extraordinary ray of the second.

In the lower right-hand diagram *PP* represents the vibration direction of the two calcite blocks and the short lines in the circles represent the vibration direction of the two rays leaving

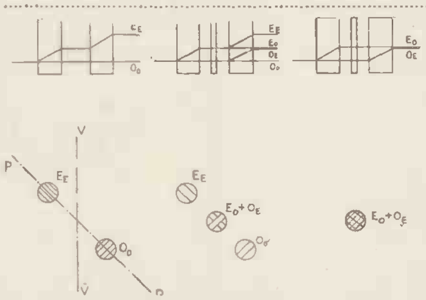


Fig. 1. A diagram explaining the action of the double-image polariscope.

the second block; for the ray *Ee* the vibration direction is parallel to the optic axis, as the crystal is negative.

In the centre diagram we have introduced a quarter-wave plate between the two parallel calcite blocks.

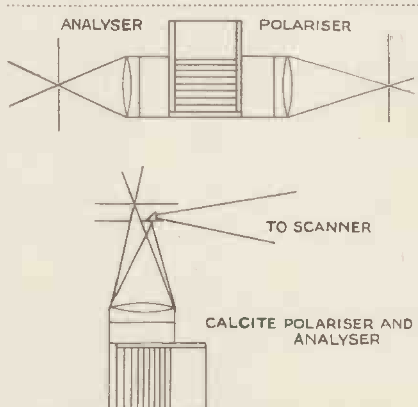


Fig. 2. Two forms of light modulator.

This means that the ordinary ray must now be resolved in two directions, one component travels through as the ordinary in the second block and is thus represented by *Oo* and the second component, vibrating at right angles to this, pursues the course of the extraordinary ray in the second block and it is thus represented by the symbol *Oe*. The extraordinary ray of the first block is also resolved into two components and these two components are *Ee* and *Eo*. In the lower centre diagram the state of affairs is shown by the three circles which represent the image of one spot seen through the whole combination of parallel calcite blocks and quarter-wave plate. It is to be noted that *VV* is the vibration direction of the quarter-wave plate.

We now pass on to the right-hand diagram in which a half-wave plate is introduced into the polariscope. The effect of a half-wave plate is to orient the vibration directions of the rays *O* and *E* through one right angle so the extraordinary ray of the first block now, by virtue of its oriented vibration direction, becomes the ordinary ray of the second block.

For the same reason the ordinary ray of the first block becomes the extraordinary ray of the second block. Hence, for a half-wave retardation the two outer spots vanish entirely, and all the light goes to form a centre spot. In the lower diagrams, the number of short lines in the circles represent the intensity of that particular beam. It can be readily seen, therefore, that as the retardation increases from zero to half wave, the intensity of the centre spot increases from zero to a maximum, and in particular that the intensity of the centre spot at half-wave retardation is equal to the sum of the intensities of the two outer spots at zero retardation.

It will be appreciated that the multi-plate Karolus cell can be substituted for the retardation plate, and this has been done in the upper diagram of Fig. 2 which is a practical form of Kerr cell employed with the double-image polariscope. In his initial experiments Mr. Myers used Rochon double-image prisms but he prefers simple calcite blocks which give parallel displacement of the two beams, as against angular displacement sustained with Rochon prisms. For it is obvious that with a multi-plate cell parallel light should pass between the electrodes.

In the upper diagram, therefore, light is focused on an aperture shown on the left-hand side and then is collimated by an achromatic lens. The light now enters the analyser, traverses the cell and passes through the polariser into the second collimating lens. With

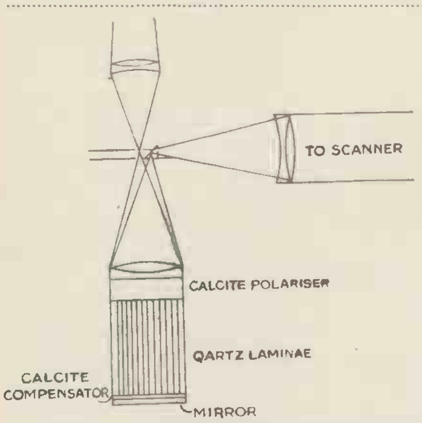


Fig. 4. Quartz aperiodic modulator.

unstressed liquid two spots are formed on the right-hand side screen and between these two spots a third one is formed as in Fig. 1 when the liquid is stressed. Of course, it is opposite this third spot that the aperture in the right-hand side screen is disposed.

In this form of cell the light should not be perfectly parallel in the liquid, because if perfectly parallel light reaches the second collimating lens only one spot will be formed at its focus. By shifting the cell so that it is given an axial displacement two spots are readily formed on the right-hand screen.

Combined Polariser and Analyser

In the lower diagram of Fig. 2 it will be seen that only one calcite block is used. This block serves as both polariser and analyser. This is because the light is reflected by a mirror when it has reached the end of the cell. This ingenious device gives twice the path length for the same capacity of the multi-plate cell and thus reduces the operating voltage by $\sqrt{2}$. Furthermore the cost of the cell is greatly reduced as only one block of spar is used.

It will be seen in the diagram that the planes of the two apertures do not exactly coincide. This is in order to ensure that the light is just not parallel in the cell. This is necessary for the reason given above. In Fig. 3 we see an actual photograph of the double-image polariscope employed in conjunction with the Wilson scanning system for the production of 30-line pictures. Just to the left of the arc lamp a brass tube is seen which contains both collimating lens and polariser, to the left of the cell the second collimating lens and analyser is contained in the brass tube. The double-image polariser is shown in the centre of the picture. With this apparatus it was possible to obtain pictures ten times as bright than have hitherto been produced on 30 lines. The pictures were so bright that they could be seen in full daylight. The picture size was 6 ft. by 4 ft.

Aperiodic Quartz Modulator

So far we have been considering only the use of nitrobenzene in the Kerr cell, but we now come to an interesting device in which thin quartz laminae are substituted for the less desirable liquid. The disposition of this device is as follows:

The light enters the collimating lens and a very nearly parallel beam traverses the polariser and the quartz laminae. The light now passes through a calcite plate and is reflected from a mirror so that it retraverses the calcite plate before passing through the quartz laminae a second time.

The light then leaves the quartz laminae and emerges from the collimating lens as shown in Fig. 4. The retardation is effected by applying the stress voltage to electrodes conveniently disposed between the quartz laminae. The electrodes can take the form of silvering on the polished surface of the quartz.

Now the retardation in unstressed quartz, which is a positive uniaxial crystal with birefringence $\beta=0.009$ will be given by the simple expression

$$R = l\beta\sin^2\phi$$

in which l is the path length of the light and ϕ is the angle between the direction of light travel and the optic axis of the crystal. In the laminae employed for this particular cell $\phi=$ 90 degrees; that is, the light is travelling normal to the optic axis of the crystal. The compensating retardation in the calcite plate, which is a negative uniaxial crystal with birefringence $\beta'=0.172$, will be

$$R' = l'\beta'\sin^2\phi'$$

For compensation the positive retardation in the quartz must be equal to the negative retardation in the calcite so that

$$\frac{l'}{l} = \frac{.009}{.172\ \sin^2\phi'}$$

and this expression gives the thickness l' of the calcite plate, that of the quartz laminae l having been predetermined.

Complete compensating having been effected by this simple method, the extra retardation needed to illuminate the field of the polariscope will be supplied by the stressed quartz laminae. This effect is generally known as the Pockels effect, because it was Pockels who originally observed retardation in a compensated lamina of quartz.

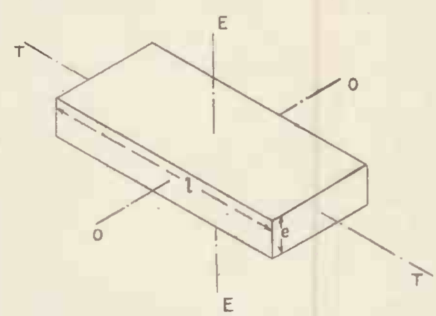


Fig. 5. Piezo-electric quartz showing how the application of an electric field brings about a strain.

The voltage required to operate this cell has been calculated by Mr. Myers to be in the order of 3,000 volts. In this case the laminae are 1 mm. thick and 5 cm. long, measured in the direction of light travel. The effective length of the light path is, therefore, 10 cm.

In connection with the Pockels effect it may be remarked in passing that a repetition of his work on isometric crystals has been carried out recently in Germany by von Okolicsanyi with a fair degree of success. Up to the present, however, the efficiency of the nitrobenzene cell has not been surpassed.

It is of interest to compare the intensity expressions for the two effects. In the first place for the Kerr effect in nitrobenzene the intensity is given by the formula

$$I \times I'\sin^2\delta/2$$

in which I1 is the intensity of the light entering the polariser. It will be

(Continued on page 134)

THE TELEVISION ENGINEER

Gas-filled Relays

By C. R. Dunham, B.A.

This is the second of the short series of articles on the theory and operation of the Gas-filled Relay.

FROM the remarks made towards the end of the preceding article of this series, it will be clear that the most obvious application of the gas-filled relay is when used as a rectifier of alternating current, in which case the grid may be made to control the amount of current that is rectified per cycle. Suppose, for instance, that a gas-filled relay be connected in series with a suitable resistance load and fed from an alternating supply, as shown in Fig. 5. Current will flow through the valve and the resistance during the alternate half cycles of the supply voltage in which the voltage is so as to make the anode of the gas-filled relay more positive than the cathode.

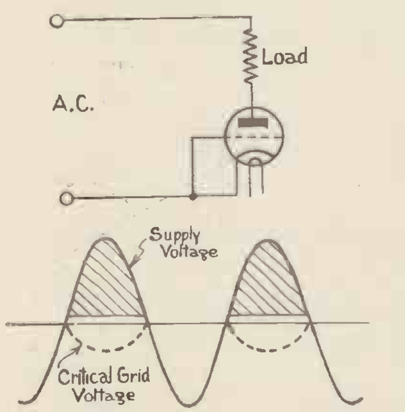


Fig. 5 Diagram showing the formation of unidirectional pulses when A.C. is applied to a resistance loaded gas-filled relay.

If the grid is connected to the cathode current will start to flow as soon as the applied voltage reaches the value (about 15 to 20 volts) required to start and maintain a discharge in the valve. The current continues to flow until the end of the half-cycle, when it ceases because the applied voltage falls below that which is necessary to maintain the discharge. The current which flows in the load resistance, therefore, consists of a succession of unidirectional pulses. If desired, these may be smoothed into a uniform direct current by suitable filters.

If instead of connecting the grid of the gas-filled relay to the cathode directly, it is biased to a negative potential, the anode current will not start to flow at the beginning of the half-cycle, but its initiation will be retarded until the voltage applied to the anode reaches a higher value equal to m times the grid-bias voltage; m is the "grid-control ratio" of the gas-filled relay, described in the previous article in connection with Fig. 3. The current once started, continues to flow until the end of the half-cycle. The conditions are now as shown in Fig. 6. It is clear that as the value of the grid bias is increased in the negative direction the length of time during which anode current flows is foreshortened, and consequently the average value of the direct current output is progressively reduced.

Finally, the condition indicated in Fig. 7 is reached, where the bias is just sufficient to withhold the discharge until the peak of the applied voltage wave, and the mean output current is one half of that in Fig. 5. If the bias is made still more negative the gas-filled relay is prevented from striking at all, and the output current is zero.

Control

Sometimes it is desirable to have a rectifier in which it is possible to control the output uniformly from its full value right down to zero. This can be achieved by applying to the grid an alternating voltage of the same frequency as that applied to the anode circuit, but of variable relative phase or magnitude. This permits the instant at which the gas-filled relay will strike to be controllable to any point in the positive half-cycle of the supply voltage wave.

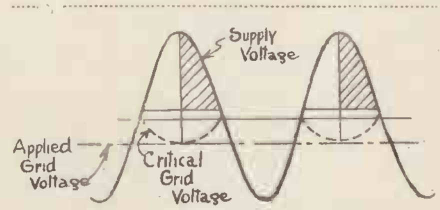


Fig. 7 Condition when critical bias is applied.

Referring to Fig. 4a in the previous issue, where "phase-control" is illustrated, it is seen that when the phase difference between the voltages applied to the grid and anode is 180 degrees, the striking of the valve is totally withheld (provided, of course, that the applied grid voltage is of sufficient magnitude to exceed the "critical grid voltage" $= \frac{1}{m}$ times the anode voltage).

Figs. 4b, c, d, e, f, and g show the effect of advancing the phase of the grid voltage by progressive amounts. The average output current steadily increases as the phase is advanced until when the phases are the same (Fig. 4), the output current is at its maximum value. Fig. 4h shows what happens when the grid voltage is retarded by a small angle from the case of Fig. 4a, and it will be noticed that the output current has attained its full value. Thus, when the grid voltage is in directly opposite phase to the anode voltage the mean current is zero; by advancing the grid phase progressively through 180 degrees the mean current steadily increases; by retarding the grid phase by even a small angle the mean current jumps to the maximum value. Thus according to the method chosen, phase-control can provide either a gradual adjustment of output current, or else a sudden change between zero and full.

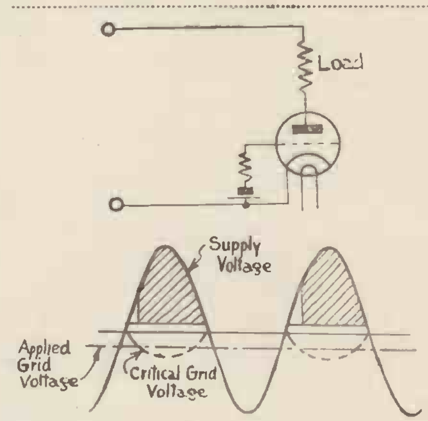


Fig. 6 Showing the effect of biasing the grid of the gas-filled relay.

Practical Applications

The question is now asked as to what practical use can the gas-filled relay be put when employed in this manner, and for this reason it is worth while to consider what amount of power may be expected from a gas-filled relay, and also what power is necessary in order to effect grid control.

Take for example the Osram GT.1 gas-filled relay, which in size and construction is not unlike a wireless receiving valve of the Osram ML4 type. It is rated to carry a peak current of .6 amp, and to withstand a peak voltage of 1,000 volts. This means that on a 1,000 volt D.C. circuit the GT1 gas-filled relay may be used to control 600 watts.

On an A.C. supply the permissible R.M.S. voltage is

$$\frac{1{,}000}{\sqrt{2}} \text{ or } 700 \text{ volts, and}$$

the permissible mean current $\frac{.6}{\pi}$ or .2 amp. The power that is required by the grid circuit in order to control this large available anode power is of the order of a few milliwatts. This very large ratio between input and output is made possible because during the periods when the grid is functioning, preventing the discharge from striking the grid behaves in the same manner as the grid of a high-vacuum triode, and the grid current is minute. When the discharge has been struck, and the gaseous filling is ionised, the grid impedance can fall to a low value. An external impedance is, therefore, usually advisable in the grid circuit in order to limit the grid current after the valve is struck; this may be of the order of 10,000 to 2,000,000 ohms.

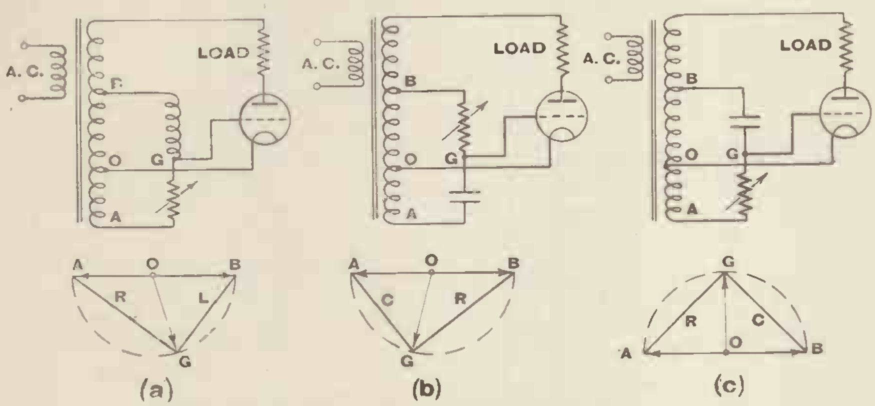


Fig. 8 Three typical grid-circuit arrangements.

Fig. 8 shows three typical grid circuit arrangements for obtaining control of output current of a gas-filled relay by variation of the grid voltage phase. In Figs. 8a and b, there is a gradual control of mean output current from zero to full, whereas Fig. 8c gives a sudden change between zero and full.

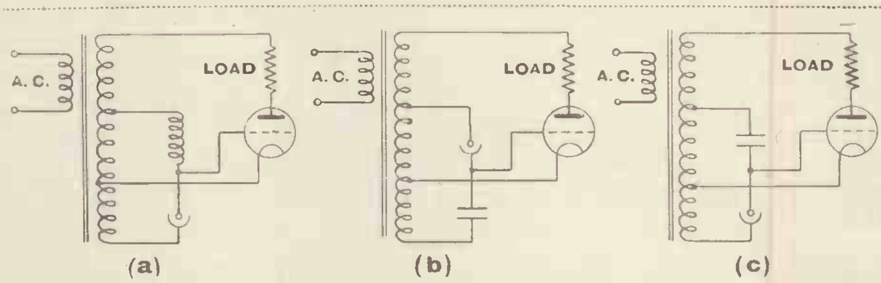


Fig. 9. Three arrangements showing how the gas-filled relay is adapted to be worked from a photo-cell.

Because of the very small power required in the grid circuit the gas-filled relay is well adapted to be worked directly by a photo-electric cell. In Fig. 9a, the output current increases gradually as the amount of light falling on the photocell decreases and vice versa; in Fig. 9b the current increases as the light is increased, and in Fig. 9c the gas-filled relay passes current or not according as the light falling on the cell is less or greater than a certain value.

In alternating current circuits, such as these, gas-filled relays have been used for controlling the speed of motors, the output of generators, the temperature of ovens for crystal-controlled oscillators, and also for operating contactors in heavier powered circuits. Many other applications are readily apparent.

D.C. Supply

When a gas-filled relay is used with a D.C. anode supply, once the discharge has been struck it will continue to flow indefinitely until the anode circuit is broken, or voltage removed. Thus it will provide a permanent indication of single transient effect of any kind which can be converted into a grid-voltage variation. The anode current may be made to perform various appropriate functions. For instance, a gas-filled relay may be used in conjunction with an electromagnetic relay to open a circuit in the event of an overload occurring in that circuit. When operated in this manner the gas-filled relay is reset by breaking the anode circuit for an interval of sufficient duration to enable the grid to regain control of the discharge.

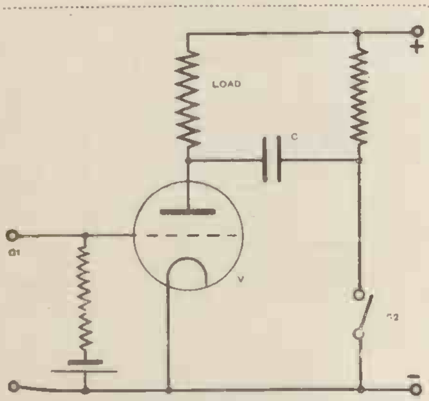


Fig. 10 A method of resetting the relay.

Another method of resetting is shown in Fig. 10; when anode current is flowing, the condenser *C* becomes charged, through the high resistance R,

(*Continued at foot of next page.*)

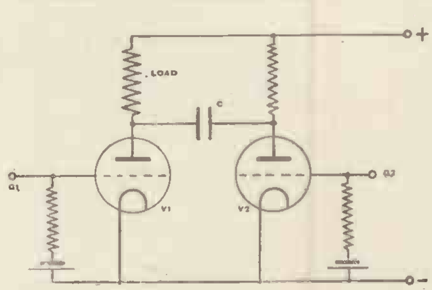


Fig. 11. How the function of the switch can be performed by a second relay.

Television Terms Suggested by the Research Committee of the Television Society.

Transmission.—The scanning device and optical gear.

Conveyance.—The radio frequency link.

Reception.—The reconstituting apparatus.

Scanning.—At the transmitter is analysis. At the receiver is synthesis.

Multi-component Scanning Device.—Devices like mirror polyhedra which are used in co-operation with circles of lenses, etc.

Zone Scanning Device.—Apparatus for scanning in zones.

Continuous Scanning.—Lissajou figure scanning—e.g., spiral traverse.

Strip Scanning.—Rectilinear or arcuate lines which are substantially parallel.

Rotary Strip Scanning.—Rectilinear strips progressively orientated about a centre (radii).

Mosaic System.—Either lamps or cells in large mosaic.

Commutated Mosaic System.—The same, but only one element in circuit at a time.

Synchronising.—Causing analysis and synthesis to concur in period and phase.

Isochronising.—Causing analysis and synthesis to concur in period only.

Kipp Oscillator.—To describe all forms of oscillators or circuits producing wave-forms, known loosely as "saw-tooth," "time base," "relaxation oscillator," etc.

Gun.—Anode of C/R tube.

Screen.—Fluorescent screen of C/R tube.

Deflection.—Traversal action in C/R tube.

Beam.—Electron pencil in C/R tube.

Focusing.—Image formation of cathode upon screen in C/R tube.

Fascinculation.—Parallel beam formation in C/R tube.

Picture Ratio (r).—The mean strip length of a picture (or scan) divided by the mean lateral breadth.

Underlap (%).—Synchronising (or other) deduction from scan length in direction of strip.

Notation for Describing Scanning of Picture

H 2.5.—Denotes horizontal scanning in the picture ratio of 2.5 to 1, starting at the bottom left-hand corner and ending top right.

Phasing.—Bringing isochronous systems into phase.

Framing.—Adjusting relative portions of synthesised picture and picture surround.

Strip.—Picture strip or picture line.

Picture Element.—Picture elements quadratically defined.

Field.—Area traversed at transmitter or receiver.

C/R.—Cathode ray.

em.—Picture element.

em/sec.—Elemental scanning rate.

c.p.s. or c/s.—Cycles per second (pure sine wave).

p.p.s. or p/s.—Periods per second (heterogeneous wave).

Picture Frequency (fp).—Number of scans per second.

Strip Frequency (f3).—Number of traversal strips per second.

Phase Delay.—Measured in radians (w db/dw).

Envelope Delay.—Measured in microseconds (db/dw).

Attenuation.—Given as voltage (or current) ratio and preferably stated as the Naperian logarithm of the ratio (giving the Neper as the unit) to distinguish from the decibel.

"THYRATRON."

It has been brought to our notice that the word "Thyratron" is the trade mark owned by the British Thomson-Houston Co., Ltd., and as such is strictly applicable only to the mercury-vapour grid-controlled tubes manufactured by that company.

We regret that the term should have been inadvertently applied to the Ediswan mercury-vapour-relay reviewed in our columns in the preceding issue. The B.T.H. Co. are the manufacturers of the original Thyratron, which is marketed under the name "B.T.1."

When the new long-wave high-power station at Droitwich comes into operation Midland Regional, the station from which the television sound signals are put out at present, is to take the wavelength of London National and the power will be some 70 kilowatts.

"Gas-filled Relays"

(*Continued from preceding page.*)

to a voltage equal to that of the supply less 15 volts valve-drop. Upon closing switch S_2, the condenser is connected directly across the valve and reduces the potential of the anode to a negative value for the period of its discharge. If the condenser is large enough to permit the deionisation of the valve during the discharge time, and if the grid is at a negative potential, the anode current will be broken.

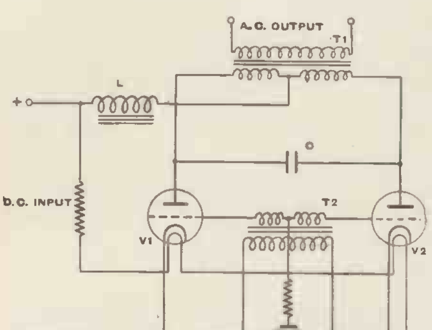


Fig. 12. *An inverter circuit.*

In the circuit, Fig. 11, the function of switch S_2 is performed by a second gas-filled relay. When V_2 is struck by variation of its grid voltage, the condenser C is discharged through it, extinguishing V_1. Similarly, when V_1 is struck again, V_2 is extinguished.

By suitable modification of this circuit an efficient method of changing D.C. energy into alternating is obtained. Such a converter is called an inverter (or inverted rectifier), and consists in principle of a transformer with two primary windings through which the direct current alternately flows controlled by two gas-filled relays. An alternating flux is produced in the core of the transformer inducing an alternating voltage in a secondary winding. The frequency of operation is controlled by applying a small A.C. voltage to the grids of the gas-filled relays, or alternatively the grids may be fed from the A.C. output, in which case the inverter is said to be self exciting and has its frequency controlled by the constants of the circuit.

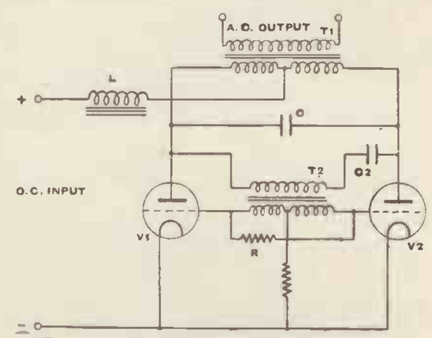


Fig. 13. *A self-exciting inverter circuit.*

RECENT DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS

Specially Compiled for this Journal

"Film" Television
(Patent No. 402620.)

One method of producing television pictures of topical interest is to take a motion-picture film, and to scan the film by means of a photo-electric cell on the spot. For this purpose it is usual to develop and dry the film rapidly before it is fed to the television scanner, as otherwise clinging drops of moisture are liable to obscure the clearness of the picture. According to the invention, the film is not dried, but is presented to the scanning apparatus whilst still immersed in a narrow transparent trough containing water. This prevents the sensitised surface from carrying casual "blobs," and ensures that all parts are surrounded by a liquid film of uniform transparency. To prevent any undue absorption of light the trough is made as narrow as possible, whilst to prevent damage to the film by the intense scanning-ray, the liquid in the trough may be slightly coloured by a dye which absorbs any harmful rays.—(*Fernseh Akt.*)

"Saw-toothed" Oscillator
(Patent No. 402629.)

Scanning-voltages are applied to the deflecting plates of a cathode-ray tube by a pair of back-coupled valve-oscillators, respectively generating the horizontal and vertical control voltages. One oscillator valve feeds a "peaky" voltage to an amplifier, which is so adjusted as to transform it into a saw-toothed current for application to the horizontal deflecting electrode. The second oscillator operates similarly to develop the vertical scanning voltage. The amplitude is alike in both cases, but the steepness of the horizontal current-wave is greater than that of the vertical. —(*Marconi's Wireless Telegraph Co Ltd.*)

Cathode-ray tubes
(Patent No. 402781.)

In order to control the density or concentration of the bundle of rays forming the main discharge stream, one or more flat rings 1, 2 are mounted on the inner walls of the tube between the cathode *C* and the deflecting electrodes *D*, *D*1. If the rings are biased positively they tend to spread the discharge stream as shown in Fig. 1a, whilst if charged negatively they serve to converge it as indicated in Fig. 1b.

In other words a negatively-charged ring acts like a convex lens in optics, whilst a positively-charged ring is the equivalent of a concave lens. This enables a reduced or enlarged image of the spot to be produced on the fluorescent screen as desired. A combination of ring and disc may be used to produce a sharper focal effect.—(*Siemens-Shuckertwerke Akt.*)

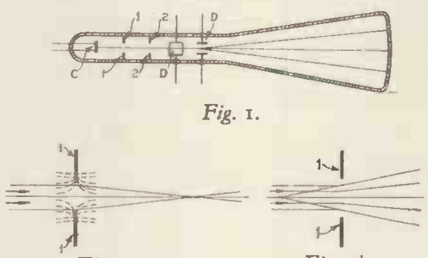
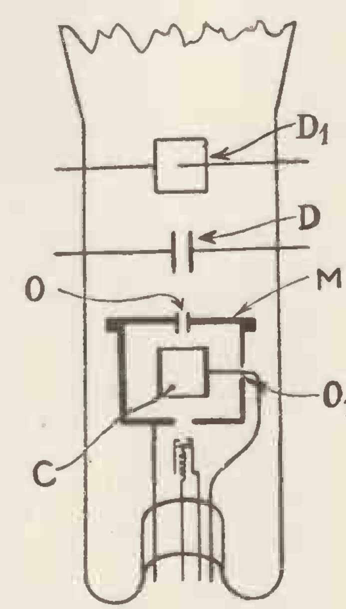


Fig. 1.

Fig. 1a. Fig. 1b.

A scheme for controlling the density of the cathode-ray beam.



A method of obtaining sharply defined scanning at high speeds.

High-speed Scanning
(Patent No. 403018.)

If a cathode-ray is vibrated at scanning speeds exceeding 100,000 cycles per second, the spot on the fluorescent screen, instead of being sharply focused, takes on a woolly appearance. In order to counteract this the usual anode or Wehnelt cylinder *C* near the cathode is enclosed by a metal cage *M*, which is kept at the same potential as the anode. A central aperture *O* allows the stream to pass through towards the deflecting plates D, D1 and the fluorescent screen, whilst a side-aperture *O*1 is provided for the H.T. lead to the inner cylinder. —(*International General Electric Co. Inc.*)

Television on Long Waves
(Patent No. 403395.)

The object of the invention is to radiate television signals on a wave length of the order of 1,000 metres in such a way as not to interfere with the reception of existing broadcast programmes. Instead of using a carrier wave and side-bands, the elementary picture signals, having a frequency of the order of 300,000 cycles a second, are fed directly to the transmitting aerial. Changes of light intensity which correspond to an increasing illumination are arranged to produce impulses of opposite phase to those which represent a diminishing light-intensity. Since in a normal picture it can be anticipated that there will be as many of the one as of the other, the resulting radiation is built up half of positive and half of negative waves.

An ordinary wireless set will not be affected by such radiation. The effect of one received impulse is nullified by the next received impulse, since there is no time for the signals to build up. A special circuit can, however, be designed to receive television signals sent in this way.

The picture to be televised is first transformed optically into a mosaic of small elements, each of which is of uniform brightness over its own area. For this purpose the light is passed through a grating *P*, Fig. 1, built up from a series of thin flat glass plates cemented together. Owing to the large number of internal reflections, each plate produces a line image which varies in intensity along the length of the plate but is uniform in the direction of the thickness.

The resulting image is next scanned by an echelon *E* of refracting members, each unit of which corresponds to one scanning line. Owing to the echelon, or stepped arrangement, each emerging line of elementary picture signals is projected to one side of the preceding line, with the result that the entire picture is now represented by a single long line of varying light values. To an image which has split up in this way the inventor gives the name "Stixograph."

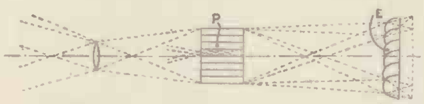


Fig. 1.

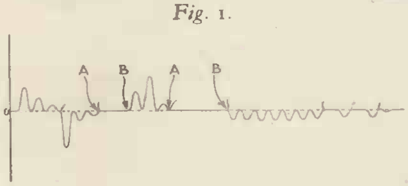


Fig. 2.

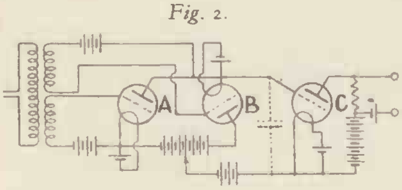


Fig. 3.

Details of the Stixograph principle upon which the Scophony system is based.

The picture has, in effect, been divided up into an elongated series of elemental areas, each of uniform intensity though the average light-value of the whole is equal to that of the original picture. This line-of-light is next swept over an aperture in front of a photo-cell by means of an oscillating mirror. The transparency of a lens covering the cell aperture is such that when the intensity of one elementary area of the picture differs from the preceding one, the corresponding photo-electric current always has the same shape but varies in slope according to whether the light is increasing or diminishing in intensity.

The resulting currents are passed through a transformer and appear as a series of impulses of constant frequency but of different amplitudes according to the light-value of each elementary area. In addition they differ in phase according to whether the light-value is increasing or decreasing. This current, when amplified and radiated, is of the form shown in Fig. 2, which as previously stated will not affect the ordinary type of wireless receiving circuit. Straight-line portions such as that from *A* to *B* correspond to parts of the picture having the same light-value, e.g., portions which are uniformly white or dark.

The signals are received on the special type of "push-pull" circuit shown in Fig. 3. The plate of the valve *A* is connected to the filament of the valve *B*, and vice versa. The plate of valve *A* is connected to the grid of valve *C*, whilst the plate of valve *B* is connected to the filament of valve *C* through a tapping on the H.T. battery. Received positive signals are passed by valve *A* to valve *C*, whilst negative signals are similarly transferred to the latter by valve *B*. The result is that both positive and negative cycles, instead of cancelling out, are built up in the output of valve *C* to reproduce the original picture.—(*G. W. Walton.*)

Other Television Patents

(Patent No. 402397.)

Cathode-ray tube generating X-rays which serve to reproduce a picture. —(*A. Kerr.*)

(Patent No. 402418.)

Improvements in the composition of fluorescent screen used in cathode-ray television receivers.—(*M. von Ardenne.*)

(Patent No. 402443.)

Wireless direction-finding system in which bearings are indicated by television signals.—(*Marconi's Wireless Telegraph Co. Ltd.*; *H. M. Dowsett, L. E. Q. Walker* and R. *Cadzow.*)

(Patent No. 402460.)

Cathode-ray tube with improved electrode-arrangement.—(*Electrical & Musical Industries Ltd.*, and *J. D. McGee.*)

(Patent No. 402418.)

Improvements relating to the fluorescent screen used in a cathode-ray tube. —(*M. von Ardenne.*)

(Patent No. 402607.)

Improved scanning arrangements for cathode-ray tubes.—(*Marconi's Wireless Telegraph Co. Ltd.*)

(Patent No. 402631.)

Method of scanning photographic films for television projection.—*Fernseh Aktiengesellschaft.*)

(Patent No. 402636.)

Producing synchronizing oscillations for television reception.—(*Radio Akt., D. S. Loewe.*)

(Patent No. 402636.)

Producing saw-toothed or "tilting" oscillations, particularly for television control.—(*Radio Akt., D. S. Loewe.*)

(Patent No. 403155.)

Construction of Kerr cells of the interleaved electrode type.—(*W. W. Jacomb* and *Baird Television Ltd.*)

(Patent No. 403283.)

Saw-toothed synchronizing control for cathode-ray receivers used in television transmission or reception.—(*Marconi's Wireless Telegraph Co. Ltd.*)

U.S.A. Short-wave Broadcasts

EXTENSION and improvement of existing television facilities to the point where images may be received in any part of California was demonstrated in a series of experiments in Alameda on January 5th and 6th, when television images from the Don Lee television station, W6XS, at Los Angeles were shown to a number of San Francisco Bay university professors and radio authorities. Not only were close-ups received, but outdoor scenes and boxing bouts from Paramount motion picture shorts and features were shown and identified.

Commenting upon the reception, Dr. Lester E. Reukema, professor of electrical engineering at the University of California, Berkeley, said, regarding a close-up of a motion picture star: "One could readily see the movement of her head, causing a slight waving of the pendant ear-rings she wore, and could see her lips move as she spoke. Following this was a picture entitled 'Over the Jumps,' a water scene in which the bodies of the swimmers and their wake in the water could be really seen, also at times the splash of the bodies entering the water. In the picture 'Madison Square Garden,' the bodies of the boxers in trunks could be clearly seen at times, also the footwork, striking of blows, the boxing gloves, dodging of blows, etc. Considering the distance covered, approximately 350 miles air-line, I was surprised that the fading was not more severe."

The Don Lee stations, W6XS, 2,800 kilocycles (107 metres), and W6XAO, 44,500 kilocycles ($6\frac{3}{4}$ metres), broadcast full-length Paramount feature pictures.

Problems in Cathode-ray Television

By G. Parr

III—PRODUCING THE SCANNING

If a sufficiently high voltage be applied to the simple resistance condenser combination described last month, a linear time base of sufficient range is produced, but in the case of battery operated apparatus this is not always practicable or economical.

For H.T. voltages of 200-250 the circuit will have to be modified to produce a linear charging curve over the full working range of condenser voltage. This can only be accomplished by replacing the resistance with a constant-current device which will ensure that the charging current flowing into the condenser is independent of the voltage dropped across the series resistance. Accordingly a saturated diode is connected in place of the resistance, the circuit now being as Fig. 1. In order to obtain the best shape of saturation characteristic and to allow of varying the impedance of the diode it is usual to fall back on the

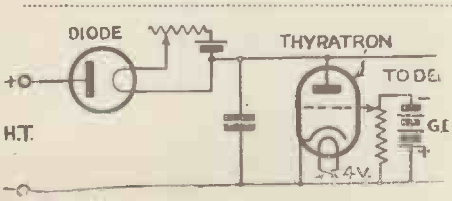


Fig. 1. The circuit with a saturated diode in place of the resistance

" bright-emitter " tungsten filament, of which the emission is definitely limited and proportional to the filament temperature.

An old " R " type valve with the grid and anode joined will probably be suitable for the purpose, but special types of bright emitter have been designed for the purpose with low filament consumption, notably the Ediswan CR2. The saturation characteristic of this valve is given in the curve of Fig. 2, and it will be seen that the current is substantially constant over an anode voltage range of 50-200. To avoid running on the bend of the curve the circuit conditions must be such that the condenser voltage at the instant of discharge must not be less than 700 volts below the battery voltage. This implies that the capacity of the charging condenser must be chosen with respect to the speed at which the time base will operate. With 30-line scanning the CR2 diode works well with 0.01 mfd. for the vertical time base and 0.05 mfd. for the horizontal time base.

Referring again to Fig. 1 it will be noted that the deflector plates are connected to the anode of the gas-discharge tube and to the slider of a potentiometer connected across the H.T. supply.

When the time base is operating there is inevitably a D.C. component of the deflecting voltage which permanently biases one of the deflector plates. The spot is thus forced off the screen, and can only be restored to centrality by the application of an equal and opposite bias to the other plate. It will be seen that a potentiometer serves to provide this bias, since when the slider is at one end, the deflector plate is at anode potential, and at the other end it is at the full H.T. potential above anode.

Closed-circuit Plate Connection

The anode of the tube is, of course, the point of reference of any potential applied to the deflector plates, and it is essential in most experimental work

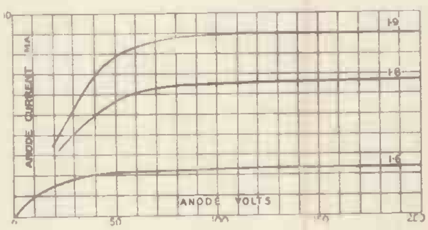


Fig. 2. Characteristic curve of the CR2

with a cathode-ray tube that the plates be connected to closed circuits. An open-circuited plate will acquire a charge from stray electrons in the tube

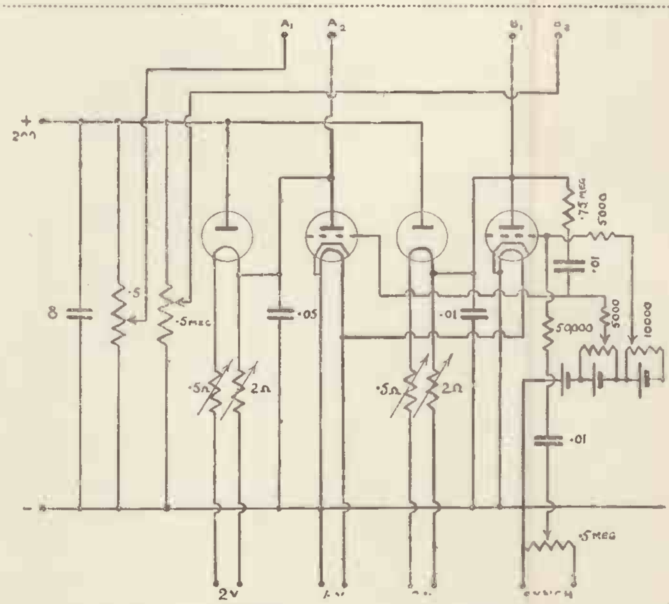


Fig. 3. The circuit of the complete double time base employing saturated diodes

which will result in deflecting the beam to one side of the screen and rendering it unmanageable.

The complete double time base employing saturated diodes is shown in Fig. 3, and as this forms the basis of most low-voltage saw-tooth time bases it is worth examining in detail.

The single time base of Fig. 1 is duplicated to provide the horizontal and vertical traverse of the beam, and the time bases are further interlocked by a resistance and condenser connected

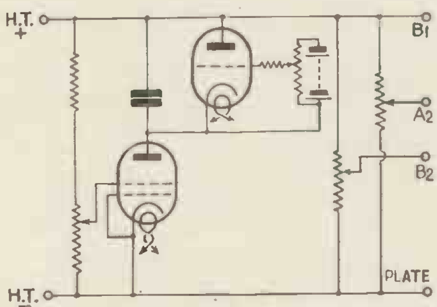


Fig. 4. Simple time base adapted for use with mains valves. The letters refer to the plates of the oscillograph

between the anode of one mercury-vapour relay and the grid of the other. The horizontal time base thus receives one impulse in 30 (with 30-line scanning) from the vertical one which serves to keep the picture in frame. Without this interconnection there is a tendency for the picture to drift in either the horizontal or vertical plane, since there is no equivalent of the mechanical interlock found in the mirror-drum.

High-speed Scanning

With higher speeds of scanning, such as would be found in 120-line transmission, the diode time base has a disadvantage.

It is well known that the emission from a hot filament is not unvarying, but is liable to slight instantaneous fluctuations. These fluctuations become appreciable when their time of occurrence is compared with the speed of charge of the condenser, and hence with high scanning speeds there is an increased difficulty in keeping the picture stationary. For example with a 120-line picture scanned 24 times per second the vertical traverse occupies 1/2880 second and a fluctuation in condenser charging speed of this order will obviously throw the picture out. This implies the abandoning of the diode time base in favour of other types such as the high-voltage resistance-condenser combination, or special oscillators.

Before leaving the constant-current devices it is well to note that the diode can be satisfactorily replaced by any form of valve having constant current characteristics such as the screen-grid pentode, or H.F. pentode. For single linear time bases for research work such valves have the advantage that they lend themselves to A.C. mains operation, and a typical A.C. mains single time base is shown in Fig. 4. The impedance of the valve can be controlled by grid bias or by variation of the screen voltage, the latter being perhaps the simpler. Note that the charging condenser is connected in the anode lead of the screen-grid and that therefore the cathode of the mercury vapour relay is "live."

This necessitates the use of a separate bias battery for the grid of the discharge tube unless elaborate means are used to provide the bias from the H.T. supply unit. Separate L.T. supplies for the heaters of the discharge tube and the valve are required in order to avoid the possibility of direct interference.

The effect of vapour pressure variations in the mercury-vapour relay will inevitably affect the operation of any

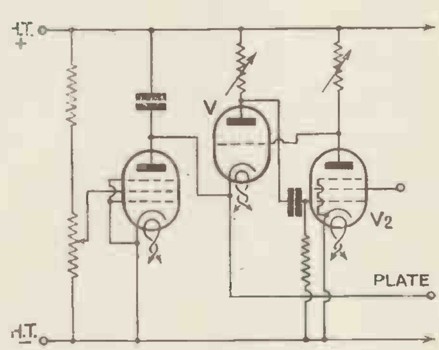


Fig. 5. Time base employing hard valves used by the Cossor Co.

time base in which it is employed, and for this reason it is desirable to allow time for the tube to warm up before final adjustments are made to the circuit. If the time base is used in very cold atmospheric conditions this time relay may prove annoying and the tube may require wrapping in some heat insulating material to improve starting. This fault is unfortunately inherent in gas-filled relay tubes and it is with the object of overcoming it that the Cossor Company have produced a modified form of saw-tooth time base employing hard valves throughout. This circuit which is patented, is shown in outline in Fig. 5. The condenser is charged through the pentode valve as in the circuit of Fig. 4, but across it is connected a triode, the grid of which is connected to the anode of a second pentode across the H.T. supply. The anode of the triode V is connected to the grid of the second pentode through a condenser and leak.

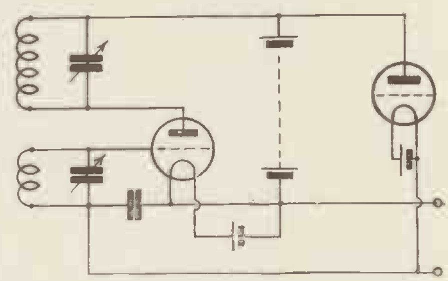


Fig. 6. "Ticking-grid" time-base circuit, developed by Appleton, Watson-Watt and Herd, using a valve oscillator

Operation

The operation of the circuit is as follows: The grid of the triode V is normally biased beyond the cut-off point by the voltage drop in the anode resistance of the second pentode V_2. As the condenser charges, the voltage across the valve V increases until the anode current commences to flow.

Immediately a pulse of voltage is applied to the grid of the valve V_2 by way of the condenser coupling. This reduces the anode current of this valve which in turn decreases the bias applied to the grid V. The anode current of this valve is, therefore, increased and the action goes on until the condenser is discharged and the voltage falls below the point at which anode current in V starts to flow.

A variable resistance in the anode circuit of the valve V controls the rate at which the condenser discharges, while a similar resistance in V_2 determines the amplitude of voltage change and hence the swing of the beam on the screen.

The advantage of this circuit is its stability (since hard valves only are employed and the increased frequency range obtained for research work). The limit of speed of a gas-filled relay is determined by the time taken for the

(Continued on page 121)

Correspondence

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

The 30-line Transmissions :: High or Low Definition ?

The Double-Image Polariscope :: Patents and Criticisms

THE 30-LINE TRANSMISSIONS.

SIR,

We take the opportunity of congratulating you on the make up and information in the first issue of TELEVISION by Bernard Jones Publications Ltd. We think that the striking cover is well in keeping with the subject.

We believe that both low and high-definition broadcasts are necessary for some time and a strong case should be made out for the retention of a low number of scanning lines broadcast for longer daily periods and at more convenient times. Many people who have "looked-in" do want a longer period than the present short half hour.

We are sure that the large number of new adherents of television, during even the last two months, who are successfully receiving the present broadcast programmes will serve to dispel the recent pessimistic press suggestion of "phantom audiences." No charge of "expensive apparatus" can be made as reliable equipment at low prices can be obtained.

THE MERVYN SOUND & VISION CO. LTD. (London, W.C.).

* * *

HIGH OR LOW DEFINITION ?

SIR,

Referring to the letter of Mr. O. S. Puckle, published in the February issue of TELEVISION, I would like to make a few remarks.

I agree with Mr. Puckle that a picture of the 30 or even 60-line standard, will not give the *ideal* picture for home entertainment, and we have to make every effort to obtain a much better picture. I also agree that perhaps a picture approaching the present-day home cinema picture will be good enough for the above-mentioned purpose. But I do not agree with his assumption that for this picture, a picture, size 8 in. by 8 in., will be sufficient. As we all know, a good home cinema picture is somewhere about 3 ft. wide. If we assume a picture 8 in. by 8 in., we are limiting the number of observers to a small circle of three or four persons. One can experience in a cinema theatre that the best viewing distance for a picture is where the ratio between the width of the picture and the distance is somewhere between 1 : 3 and 1 : 5. Mr. Puckle can make this experiment himself very easily, by taking a suitable picture and observing what is the best viewing distance for the picture as a whole. With a picture 8 in. wide, the viewing distance by this ratio would be about 24 in., and assuming that two persons are sitting close to each other the distance between the eyes is somewhere about 14 in. Under these circumstances, the outside observer has an angular view of the screen somewhere about 30 degrees, which is equal to the worst side seats in a cinema theatre. Even on a cathode-ray tube we could not tolerate a bigger angle without considerable distortion of the picture

From this we can see that to obtain an ideal picture for more than three or four observers, the size of the picture ought to be enlarged. Surely this is not an *easy* matter with cathode-ray tubes.

We, who are engaged in television research work, know that compromises are necessary. Such a compromise can either be made in the size of the picture obtained, or in the number of picture elements. Furthermore, Mr. Puckle mentions that to avoid the flicker on the receiving screen, 25 cycles per second are necessary (he means, obviously, 25 pictures per second) or even a higher picture frequency. We know the necessity of avoiding the flicker, but I do not think that the method suggested by Mr. Puckle using a higher number of pictures per second, is very desirable, and the *only* solution. We know that in the cinema, 24 pictures are normally projected, and not one cinema engineer would think of trying to avoid flicker by means of projecting an increased number of pictures per second, which, apart from being costly, is unnecessary. In non-technical language, the utilised frequency band width in television may be compared with the length of film material in the cinema technique. A wider frequency band would increase the difficulties both at the transmitter and at the receiver. Surely, I would have thought, cathode-ray tubes permit of *more refined* methods for the purpose of avoiding undesirable flicker.

In the ultimate, the buying public will determine which type of picture is best; in the absence of anything better than a 30-line picture to-day, the public can only express an opinion on the merits of 30-line sets.

However, I am glad that Mr. Puckle agrees with Mr. Sagall's views that the 30-line transmissions should be dropped as soon as the *broadcast* transmission of high-definition pictures *commences, but not before, and not as long as high-definition pictures are in an experimental stage.*

Mr. Puckle says he spent *four entire* days at the Berlin Radio Exhibition in August, 1933. I myself was not able to spend more than one-and-a-half days at the Exhibition, because of my engagements in connection with urgent work in the Scophony laboratory on high-definition pictures, but even in this much shorter time, I noticed several features at this Exhibition which must have escaped his notice. He says that good synchronisation was not demonstrated at the Exhibition. I did not see a picture obtained either by mechanical scanners, or by cathode-ray tubes, which went out of synchronism. Most of these receivers worked without a great deal of interruption from 10 a.m.—7 p.m. every day during the show. As far as public demonstrations go in this country, the demonstrated 30-line television pictures with cathode-ray tubes needed readjustment of the synchronisation every few minutes.

Mr. Puckle further says that Mr. Sagall's statement "is definitely misleading," in that the 90-line mirror-screw receiver had better definition than the cathode-ray tube. Mr. Puckle says that on the mirror-screw receivers, only head and shoulders of a person were shown. Apparently, in the *four* days he was at the Exhibition, he did not notice the TeKaDe stand, where complete news films were shown. These were at times *exactly the same as were shown on the cathode-ray receivers*; for instance, Hitler delivering a speech to a large crowd, a car racing on the Avus racing track, an aeroplane landing, dancing girls on a stage, etc. This point is also stated in the report on the

Berlin Radio Show by Georg Kette in "Fernsehen & Ton Film," No. 5, 1933, where he mentions that TeKaDe were showing unabbreviated news films. In these films, the small printed titles, which were difficult to read on the cathode-ray receivers, working on 180 lines, were quite clear on the mirror screw, using *only* 90 *lines*. But even Mr. Puckle himself agrees with Mr. Sagall, that the definition on the mechanical scanner *was better*, and when one considers that the frequency band width required for 90 lines was roughly one-quarter of that used by the cathode-ray tube receiver, it is difficult to understand why Mr. Puckle favours the cathode-ray tube.

Furthermore, Mr. Puckle mentions that the mirror screw "had the advantage of a spurious three-dimensional effect, due to the fact that the image was seen directly in a mirror"; I do not understand how a mirror could produce from a film transmitter, where the picture is obviously two-dimensional, a three-dimensional effect. Mr. Puckle refers, perhaps, to the different planes of sharp definition in the vertical and horizontal directions, which is a peculiarity of the mirror screw; but this peculiarity does not improve the definition and does not produce a three-dimensional effect. On the contrary it slightly deteriorates the definition.

From the aforesaid in my opinion it is the statements of Mr. Puckle which are *misleading*.

Dipl.-Ing. G. WIKKENHAUSER.
(Scophony Laboratories, London, W.)

* * *

THE DOUBLE-IMAGE POLARISCOPE.

SIR,

In a letter to TELEVISION of last month, Mr. E. L. Gardiner gives the impression that I was the inventor of the double-image polariscope which I have developed in connection with television. While thanking Mr. Gardiner for his remarks, I feel that I should point out that before I experimented with the double-image polariscope in connection with television, the idea of using both the extraordinary ray as well as the ordinary ray in light modulators had already occurred to others. I therefore would like to give the names of two investigators, whose researches are definitely before my time.

In the first case Kerr, who discovered the effect which bears his name, actually employed the double-image polariscope as far back as 1888. I append a rough sketch of his device (Fig. 1). It will be seen in the sketch that a rhomb of calcite is used to give lateral separation to the two beams. This parallel displacement of the beams was, according to Kerr, no less than 14 millimetres so that we may conclude that he had very large rhombs indeed. A half-wave plate was introduced in the polariscope so that the parallel disposed analyser, also in the form of a large calcite rhomb served to bring the two beams together again.

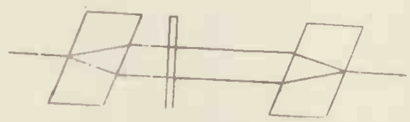


Fig. 1. Kerr's double-image polariscope.

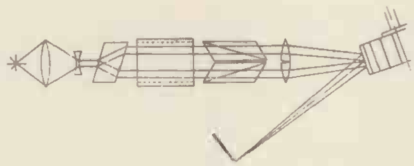


Fig. 2. Wilson's double-beam modulator.

This device will be recognised as identical with the form I am at present employing in my work. In my case the Karolus multiplate cell is substituted for Kerr's half-wave plate.

We now come to a more recent suggestion for harnessing both beams. It is due to Mr. J. C. Wilson, who, incidentally, has just written a group of interesting articles for this publication. Mr. Wilson has kindly given me permission to reproduce his drawings in the Patent Specification 31879-30.

In Fig. 2, Mr. Wilson's device for double-beam modulation is self-explanatory. Light, after being collimated by the negative lens, enters the calcite polarising rhomb, with the result that lateral displacement of the two beams take place. After they have passed through the Kerr cell, the two beams are separately analysed by the Nicols. The beams are then recombined to form the image of the light spot on the screen with the aid of two split lenses.

I have been unable to find further documentary evidence with regard to the employment of the double-image polariscope in this connection, and have rejected any nebulous claim to the use of the two rays without such evidence to show how they are used. I refer, of course, to such evidence appearing before my first public demonstration at University College in October, 1932.

Mr. Wilson concurs with me in the belief that this device in itself is not patentable as it is so well known to science.

Kerr's device is described in Phil. Mag., October, 1888.

L. M. MYERS (Hampstead).

* * *

THE 30-LINE TRANSMISSIONS.

SIR,

I have been amazed to note the apparent indifference with which television experimenters in this country are receiving the B.B.C.'s announcement of the curtailment of the 30-line transmissions which TELEVISION worked so hard to obtain for us.

Undoubtedly the 120-line transmissions are a big step forward, but I am safe in saying that these will be quite useless for nine out of every ten experimenters, since the range of the ultra short-wave transmitter is necessarily exceedingly small. A glance through back numbers of TELEVISION will show that experimenters in the North, Midlands, and South (judging by their keenness in describing their results, at any rate) greatly out-number their more favoured brethren in London yet they are to be allowed only a single hour per week.

The B.B.C. has shown the world that 30-line pictures are capable of giving definite entertainment; are they going to nullify all their good work just when a market has been created, and public interest thoroughly aroused? Speaking personally, I was just on the point of building a mirror-drum and Kerr-cell receiver to replace my present disc instrument, when the original statement by the B.B.C. in September made me realise that in March I should possibly be landed with expensive apparatus that was absolutely useless down here. There must have been many more who held off for the same reason.

May I urge all experimenters to write personally at once to the B.B.C. asking for the continuance of the present transmissions at least, although the times are not by any means ideal.

May I take this opportunity of congratulating you upon TELEVISION. You have effected a very great improvement indeed, and if you are able to maintain this standard its sales should soon be rivalling those of your two other excellent journals.

E. H. WARE (Exeter).

RECEPTION IN SPAIN.

SIR,

I read in last month's TELEVISION a report about a 300-miles away television reception. I have the impression the writer was surprised to obtain well-detailed images—marred, of course, from time to time by fading at such a long distance.

For one year and a half I have been carrying out here in Spain, television reception experiments from London National station with remarkably good results latterly. A great part of this time was spent in trying to reduce the harmful fadings effect, common enemy of us far-distanced lookers.

I am working now with a standard all-wave 12-valve superhet for vision attached to a Baird flat plate neon lamp televisor.

Several methods of A.V.C. were tried to regulate the strength of signal, including Westector circuits. I found that usual R.F. grid biasing A.V.C. systems give perfectly regular volume on sound reception but they spoil the signal carrier in television on deep faded periods, resulting in ghost images. All A.V.C. which vary the biasing on R.F. grids, of which the screen and plate voltages remain unvaried are subject to a slight rectifying action resulting in characteristic distortion of the picture.

I think I have arranged an efficient device to avoid this and keep the A.V.C. action effectively. This consists of feeding two power detector valves and the first R.F. super-control valve through only one plate resistance, so that the first R.F. stage will become more sensitive when the detector current decreases.

JAVIER ZABALZA (Jaca, Spain).

PATENTS AND CRITICISM.

SIR,

It has been pointed out to me that certain of the remarks contained in the third paragraph of my letter published last month might be taken as meaning other than that which I intended at the time, and I would like to take this opportunity of correcting any false impression. It was not, of course, my intention to suggest that I have knowledge of unpublished Patent Applications, except in those cases in which the inventor himself has given this to me. Nor was it my intention to belittle or criticise any particular patent or inventor, but rather to assist any workers in the field under discussion from possible waste of time in going over ground which might have been covered already by other workers.

Might I also take this opportunity of adding my views to the low versus high-definition television transmission controversy? I have probably seen more television demonstrations than most, in various countries, and have been struck by two facts. One of these is that the demonstrations employing the greatest number of scanning lines are not necessarily the most satisfying or convincing to the eye; and the second, that very few workers seem as yet able to get the very best possible even out of systems employing comparatively few lines. I regard a low-definition transmission as absolutely essential for the next few years, partly because no other method of covering large areas of country with an adequate service has been put forward as practicble and also because I believe that we have not yet got anything like the best results possible out of low-definition television systems; this line of work is as important as the development of high-definition systems.

It is much too early in the history of television to state that systems which will reduce the frequency band required for transmission of adequate detail are impossible, and I know of work in progress at present which might lead to the transmission in a band of about ten kilocycles of a degree of detail now generally regarded as within the "high-definition" class, but, of course, by unorthodox systems. There is too much tendency to-day to regard television as a fully understood art in which unexpected or unorthodox improvements are already ruled out. The entire discontinuation of transmissions on a limited frequency band, as I prefer to describe "low-definition" transmissions, would discourage such research, as well as constituting a serious setback to a fast developing new British industry.

E. GARDINER, B.Sc. (London, W.1.)

"Probl ms of Cathode-ray Television"

(*Continued from page* 118.)

tube to de-ionise, and rapid as this is, circuits employing it are seldom satisfactory at speeds exceeding 8,000 cycles per second. With the valve time base just described the speed of traverse can be made considerably greater than this value, the charging capacity being that of the residual capacities in the circuit.

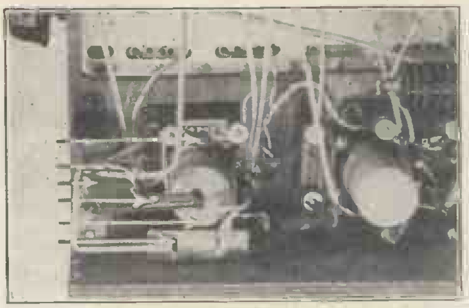
The disadvantages would appear to be the somewhat elaborate circuit arrangements, particularly when synchronising controls are added, and the cost of the valves required. The current consumption of the various

potentiometers and valves is also appreciable, but if the circuit is operated from A.C. mains this will not be of great importance.

Another ingenious circuit based on a different principle is that developed by Appleton, Watson-Watt, and Herd (British Patent 235254). This is shown diagrammatically in Fig. 6 and makes use of the alteration of potential in an oscillating valve circuit. The oscillator consists of two coils tuned to approximately one megacycle/sec. A condenser and resistance (which is preferably a diode or other constant-current device) are inserted in the grid circuit of the valve. If, while the circuit is oscillating, the value of the resistance is made sufficiently high to partially insulate the grid, the condenser accumulates a charge which makes the grid negative and shuts down the oscillations. The condenser then discharges through the diode resistance, the grid potential and the anode current rise and the circuit again oscillates, to repeat the cycle. The deflection of the beam thus takes place while the condenser is charging, but this is rapid in action and corresponds to the "fly-back" of the simple discharge-tube circuit. The true traverse of the beam is due to the slow discharge of the condenser and this rate is controlled by the constants of the condenser diode circuit.

A detailed description of the circuit will be found in the Proceedings of the Royal Society, 1926—111-165.

Messrs. F. G. Heayberd & Co., who are well known as manufacturers of mains radio equipment are now specialising in television components in addition. A recent catalogue gives details of an amplifier, synchronising equipment and a cathode-ray exciter unit. Copies of the catalogue will be sent free on request upon mention of TELEVISION. The address is 10, Finsbury St., London, E.C.2.



This photograph shows the only part of the set which requires modification. The arrows indicate additional components.

The Modified Standard Television Receiver

By S. Rutherford Wilkins

THE Standard Television Receiver described last month was a simple three-stage affair consisting of a single high-frequency stage followed by a double-diode triode, resistance coupled to the modulating stage consisting of two Mazda AC2Pens in parallel. Using this simple arrangement on a good outside aerial it is possible to fill up the output stage from the London National programme. This gives about 3½ watts output and is sufficient to modulate the Kerr cell of the mirror-drum apparatus.

With the limited amount af amplification provided by a set with a single high-frequency stage and no reaction, however, a fairly high aerial input is required to give the required modulation output. This is all the more necessary on the "Standard" receiver because of the voltage lost in the double band-pass system of tuning that is employed.

For this reason those readers who are situated a considerable distance from the National transmitter may be disappointed with their picture reception, owing to the fact that they have not sufficient aerial input to load the output stage. This would result in poor picture definition and insufficient synchronisation. To combat this difficulty, I am showing this month a slight modification of the original receiver employing an extra high-frequency stage.

By means of an extra high-frequency stage sufficient high-frequency amplification is obtained to enable even distant listeners to receive well-defined pictures on their mirror-drum apparatus when used in conjunction with the "Standard" receiver.

A glance at the circuit diagram will show that very few modifications have been introduced and except for the cost of the extra valves the additional expenditure is negligible. The original band-pass input coils have been utilised as an aerial and tuned-grid coil for the first high-frequency stage, the small band-pass coupling coils being connected in series with the main tuning coils.

The screening grid and variable bias voltages for this extra valve are obtained from the same sources as those which supplied the original high-frequency stage, the only modifications being a decoupling circuit of 1,000 ohms resistance and a .1 condenser on the screen, and a similar arrangement consisting of a 250 ohms resistance and a .1 microfarad condenser in the cathode circuit. To prevent instability and distortion due to overloading of the second high-frequency stage, the fixed bias resistance in the cathode circuit has been increased from 250 to 500 ohms. Only one extra resistance, namely, 500 ohms need be purchased, however, as the 250 ohms resistance removed from the second high-frequency cathode circuit can be utilised in that of the first high-frequency stage.

Tuned grid coupling is used in the additional high-frequency stage, the high-frequency currents being by-passed into the tuned circuit by means of a screened high-frequency choke and a .0001 microfarad fixed condenser. The high-tension supply to the anode of this valve is obtained from the same point as that of the second high-frequency valve *via* 1,000 ohm resistance, by-passed by a .1 microfarad decoupling condenser. The layout of the few additional components is quite simple and may be followed easily from the under-baseboard photograph showing this end of the receiver.

The additional amplification afforded by this arrangement will enable a much larger rectified voltage to be obtained from the output of the double-diode triode, and provided that the listener is situated within about 40 miles of the London National transmitter, this output should amount to some fifteen or twenty volts, which is more than sufficient to load the present output stage. An input of 15 volts is all that is required to load a Mazda A.C. Pen, and consequently will be sufficient to load an output stage consisting of two A.C. Pens in parallel. This arrangement provides nearly a watt more

(*Continued at foot of page* 124)

COMPONENTS FOR THE STANDARD VISION RECEIVER

CHASSIS.
1—Peto-Scott Metaplex 16 in. by 12 in. by 3½ in.

CHOKES, HIGH-FREQUENCY.
2—Wearite screened, type HFP.
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1—Lissen astatic, type LN 987

CHOKES, LOW-FREQUENCY
1—Sound Sales, type 1250 SRC

COILS
1—Set Colvern types G1S, G2, G11S, G12 with on-off and pick-up switches, mounted on one base

CONDENSERS, FIXED
3—T.C.C. .0001-microfarad, type 34
1—T.C.C. .001-microfarad, type 34
5—T.C.C. .1-microfarad, type 65
3—T.C.C. .1-microfarad, type 87
1—T.C.C. 1-microfarad, type 65
1—T.C.C. 1-microfarad, type 87
3—T.C.C. 2-microfarad, type 87
1—T.C.C. 2-microfarad electrolytic, type 561
1—T.C.C. 4-microfarad, type 95
1—T.C.C. 4-microfarad, type 105
1—T.C.C. 25-microfarad electrolytic, type 511
1—T.C.C. .2-microfarad centre tapped type 125A

CONDENSERS, VARIABLE
1—Polar four-gang .0005-microfarad, type Star Minor, with slow motion drive, type horizontal

HOLDERS, FUSE
1—Belling Lee, twin complete with 1-ampere fuses

HOLDERS, VALVE
1—Clix four-pin, type chassis mounting
3—Clix five-pin, type chassis mounting
3—Clix seven-pin, type chassis mounting

RESISTANCES, FIXED
1—BAT 175-ohm
3—BAT 100-ohm
1—BAT 250-ohm
1—BAT 500-ohm
1—BAT 600-ohm
2—BAT 1,000-ohm
1—BAT 5,000-ohm
2—BAT 15,000-ohm
1—BAT 20,000-ohm
1—BAT 40,000-ohm (2 watt)
2—BAT 40,000-ohm
1—BAT 50,000-ohm
1—BAT 100,000-ohm
1—BAT 200,000-ohm
2—BAT ½-megohm
1—Zenith 4,000-ohm

RESISTANCES, VARIABLE
1—Claude Lyons 5,000-ohm type M5
1—Claude Lyons 100,000-ohm type ST 100

SUNDRIES
1—British Radiogram 2 in. metal mounting bracket
Connecting wire and sleeving (British Radiogram)
3 ft. screened sleeving (British Radiogram)
1—British Radiogram valve screen
4 yd. thin flex (British Radiogram)

TERMINALS
1—Clix chassis mounting strip, marked: A1, A2, E
1—Clix chassis mounting strip, marked: L.S.+, L.S.—, Pick-up

TRANSFORMER, LOW-FREQUENCY
1—Mervyn, type 375 cycle peak

TRANSFORMER, MAINS
1—Varley type EP 24

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2—Marconi VMS4
1—Marconi MH4D
2—Mazda AC Pen
1—Marconi PX25
1—Marconi MU.14

TELEVISION

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PT16 16 watt Pen.	25/-
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MARCONI VALVES

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.

At the February meeting of the Television Society held at University College, London, a paper was read by G. Winifred, Esq., A.M.I.E.E., reviewing the theory and application of "Photo-electric Effects."

Following the description of photo conductive properties of selenium, and recently devised selenium bridges, the lecturer continued in historical sequence the work of pioneers in the development of the photo-cell. By aid of lantern slides quantitative expressions were considered and apparatus illustrated.

Supplementing the lecture, experiments on photo-electricity were conducted by Mr. J. J. Denton, Hon. Sec. (Members).

These included use of the actual spark gaps employed by Sir Ambrose Fleming, F.R.S. (President), in his historic demonstrations of the discovery by Hertz of photo-electric phenomena. A series of spectrum tests on various photo-cells and a demonstration of automatic daylight photo-electric control apparatus kindly lent by the General Electric Company, were included in the experiments.

The chairman, Dr. Tierney, F.R.M.S., referred to Nature's laboratory and her photo-electric methods in plant economy.

Mr. Mitchell, Hon. Sec. (Lectures), called attention to the proposed changes in the times of television transmissions and invited discussion regarding problems involved in television transmission and reception.

The next meeting of the Society will be held at University College on March 14th, Following the Annual General Meeting, the Presidential Address will be given by Sir Ambrose Fleming, F.R.S., at 7 p.m. Cards of admission can be obtained by readers of TELEVISION, also particulars of the Society and membership proposal forms on application to Mr. J. J. Denton, 25, Lisburne Road, Hampstead, N.W.3.

Reception in North London

The following is an outline of reception conditions in North London.

The receiver is situated in Edgware. The radio part consists of an outdoor aerial, crystal detector, followed by three R.C. coupled L.F. stages.

The visor is a very carefully designed Nipkow disc, and Baird flat-plate neon. This receiver has been in use without any alteration either to the radio or television side, since the inauguration of regular transmissions by the B.B.C., and therefore by comparing results of reception since that time it is interesting to note what progress has been made on the transmitting side.

Although the results at the inauguration of the television service were decidedly good, steady progress has been observed, due, no doubt, to more efficient handling of the transmission side, and the experience gathered in the programme technique, make-up, distance from the scanner, etc. It must be noted that in North London, fading is non-existent, and very clear and bright pictures can be obtained.

Results have greatly improved since the additional photo-electric cells were fitted in the studio: this particularly applies to long shots, dancers, etc.

For apparently unexplainable reasons the results have been still better, since the wavelength changes of January 15th. The programmes on the 16th and 17th of January were excellent.

As the receiver has been the same throughout, any improvements in reception cannot be attributed to the receiving side. This has been confirmed by a number of spectators who have seen television programmes on different occasions; now some of the close-ups are so good that one is agreeably surprised as to what really good pictures can be obtained with 30 lines.

It would be a great pity if the present 30-line transmissions should be curtailed.

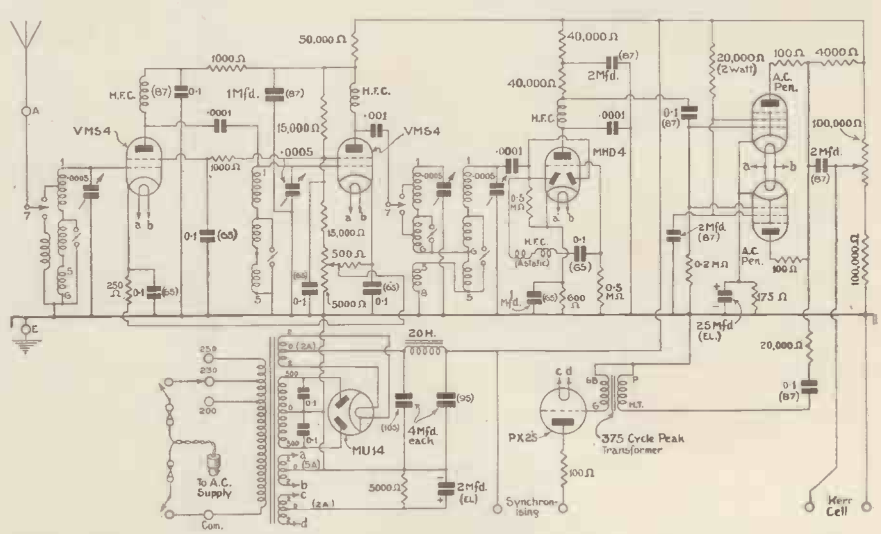
"The Modified Standard Television Receiver"

(Continued from page 122)

output than the two A.C.2 Pens, and has accordingly been introduced into the modification of this receiver.

This will result in deeper picture modulation and a better control of synchronisation, since a greater voltage will be fed to the synchronising valve.

The only alterations entailed by this arrangement to the present receiver is the fitting of a different bias resistance. This will have to be altered from 70 ohms to 175 ohms. Since both the A.C.2 Pens and the A.C. Pens are fitted with seven-pin bases and have identical base connections, it is only necessary to plug the new valve in the original holders.



Comparison of this circuit with that given last month will show the alterations necessary to increase the range and power

Synchronism With Cathode Rays

This article, by J. H. Reyner, is a comprehensive survey of the methods used to obtain synchronism in cathode-ray receivers.

PERHAPS the most remarkable feature about a cathode-ray television outfit is the fact that it can be synchronised with the transmitter. In a mechanical arrangement the scanning motor has to run at the same speed as that at the transmitter. It is not difficult to conceive numerous methods whereby exact synchronism may be maintained.

With a cathode-ray outfit there are no mechanical moving parts, the necessary scanning being produced by the discharge of condensers triggered at the correct instant by special gas-discharge tubes or other arrangements of valves, and it has always seemed to me a point of interest that without any tangible link it is nevertheless possible to obtain the degree of synchronism required.

It is interesting to consider for a moment how close the synchronism has to be. Let us consider a 30-line picture and we will suppose that it slips out of frame by exactly one picture in five seconds; in other words the picture can float slowly across the screen from right to left or vice versa and will re-frame itself five seconds later. In five seconds we have 12½ by 30 by 5 = 1,775 lines, and if we slip one picture we lose or gain 30 lines in that time. Hence the error is 30 in 1,775 or 1.69 per cent.

Such a degree of synchronism would not be tolerable in practice. It would involve continual readjustment and even if some form of synchronising circuit were employed to pull the picture into step the error would be too great for satisfactory operation. The synchronising arrangement might hold the picture for 20 or 30 seconds but the whole of this time the error would be building up, until finally the synchronising arrangement could not hold the picture in step and the picture would disappear through the frame in the aggravating manner so well known to television workers.

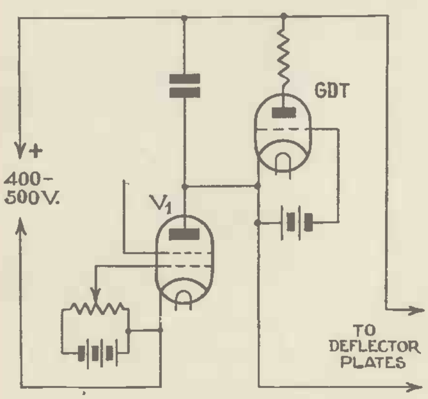


Fig. 1. A simple gas-discharge time base.

In practice, and particularly with cathode-ray tubes, it is necessary to get the speed correct to less than half per cent. if satisfactory running is required, and all adjustments should be made in the first place without any synchronism in an endeavour to hold the picture steady by a mere correct adjustment of the speed. Then the application of a small synchronising voltage to the system will have a fair chance of holding the picture quite steady over a prolonged period.

The Methods Employed

Let us now turn to the methods actually employed for synchronising on the time base unit employed with cathode-ray tube reception. Fig. 1 shows a simple time base circuit using a gas-discharge tube. The valve *V*1 acts as a resistance of which the value is controllable by altering the grid bias. In series with this valve is a condenser and the whole is connected to a source of D.C. of 400 to 500 volts. On switching on the voltage the condenser commences to charge up. It takes a certain fraction of time to do this because of the relatively high resistance introduced into the circuit by the valve, but ultimately it builds up to a voltage somewhere approaching the full value.

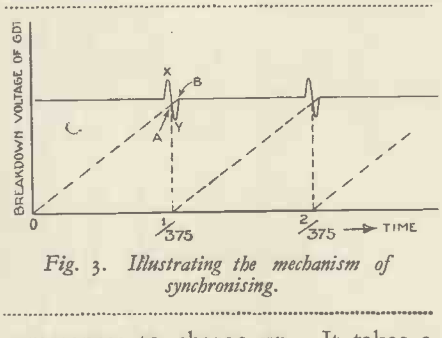


Fig. 3. Illustrating the mechanism of synchronising.

At this point the gas-discharge tube which is connected across the condenser becomes conducting. These tubes are, in effect, ordinary valves with a small filling of neon or mercury vapour. The grid is biased back to a suitable point so that no anode current will flow until the voltage on the anode exceeds a certain value. In this respect the tube behaves just like an ordinary valve biased as an anode-bend detector but adjusted well beyond the cut-off point. At a certain critical value of anode voltage, however, current does begin to flow through the valve and as soon as this happens the gas inside becomes ionised, a very rapid increase in current takes place and, in fact, the valve will pass a very large current as long as there is any voltage whatsoever on the anode.

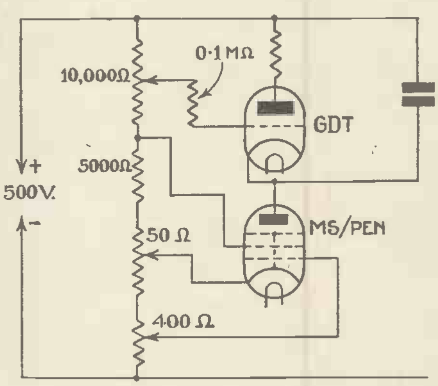


Fig. 2. Fine adjustment on the 375 base is essential.

The effect of this is to discharge the condenser completely. When the current through the valve ceases the ionisation disappears and the valve automatically resumes its former condition of conducting no current until the anode voltage is at a certain critical value. Hence the charge on the condenser once more proceeds to build up until the critical value is reached and the process goes on indefinitely at a steady rate determined by the capacity of the condenser, the effective resistance in the charging valve *V*1 and the setting of the triggering valve which determines the point at which the condenser will discharge.

The voltage across the condenser is applied to the deflector plates of the cathode-ray tube so that the spot of light is caused to move over the screen at a relatively slow rate while the condenser is charging and then flies back very rapidly when the condenser discharges. In order that this rate may be as uniform as possible it is customary to use some form of constant-current charging valve such as a saturated diode or, as in the case shown in Fig. 1, an ordinary screened pentode.

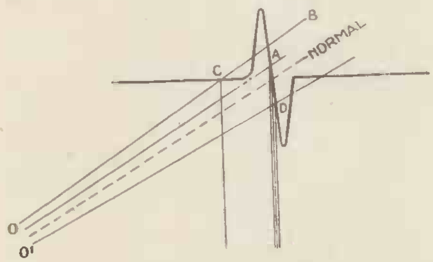


Fig. 4. Synchronism is only effective if the speed is slow.

Let us suppose that we adjust a valve such as this to give 375 lines per second, which is the requirement for a 30-line picture repeated 12½ times a second. By careful attention to detail such as using high-grade components, allowing the apparatus to run for a short time to settle down and so on, we can arrange that the time base gives 375 cycles per second consistently and reasonably regularly. Some form of fine adjustment over the control is essential and the circuit shown in Fig. 2 is one which I have used myself with some success. There are two potentiometers controlling the grid bias on the discharging valve, one acting as a fine adjustment on the other, and with the values shown the arrangement will be found very suitable.

Having got the frequency as near as possible to the required value we must now find some means of holding it exactly steady, and the simplest solution is to send out a 375 cycle timing pulse from the transmitter. If this pulse is actually produced by the transmitter scanning disc and the receiver is operated thereby, the two systems must hold in synchronism if suitable conditions obtain at the receiver.

Suppose that the rate of charging of the condenser in the time base is slightly too slow, so that at the end of 1/375 second the voltage on the condenser does not quite reach the critical value at which the gas-discharge tube breaks down. Suppose, however, that we inject into the grid circuit of the gas-discharge tube a small voltage which is generated by the synchronising pulse. This pulse will momentarily reduce the value of the grid bias and cause the tube to trigger at a little lower than its normal voltage. In fact the actual point at which the condenser discharges *will be controlled by the synchronising impulse* and not by the setting of the time base, and as long as the error is not too large this process will continue indefinitely.

It is useful to examine the process a little more closely because certain important points come to light. Fig.

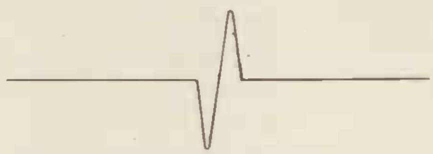


Fig. 5. The direction of the synchronising pulse is not important.

3 illustrates the process diagrammatically. The full horizontal line represents the critical voltage at which the gas-discharge tube breaks down and once every 1/375 second this voltage is modified by the application of a synchronising pulse on the grid. This synchronising pulse actually consists of a short oscillation of the type shown in the figure and for convenience it has been converted into its relative effect on the anode circuit, although it is actually applied to the grid. Making the grid more negative increases the breakdown voltage of the tube and vice versa.

The dotted line represents the voltage on the condenser which gradually builds up from O until it reaches the point A, at which the tube breaks down. It then discharges and re-commences the process. It will be clear that without the synchronising impulse the tube would not discharge until it reached the point B, which would take rather longer than the allotted time, but the presence of the synchronising signal triggers it at the right moment. It should be noted that provided the error is not too large the process is not cumulative. In other words the condenser makes a fresh start each time, always at the same relative point in the cycle and the triggering operation continues perfectly satisfactorily

Strictly speaking the synchronising pulse should be very short and sharp, so that the portion XY is nearly vertical, but this condition does not always obtain in the B.B.C. transmissions.

It should also be noted that the synchronising is not obtained if the condenser is charging *too fast*, unless the error is very small. Fig. 4 represents the state of affairs with too rapid a charge. The position A represents a very slight increase over the correct speed and it will be seen that here the effect of the synchronising pulse is to delay the actual discharge very slightly, thereby tending to hold the system in synchronism. The line OB, however, represents the state of affairs with a slightly more rapid charging, and it will be seen that here the condenser voltage has reached the critical value at which the tube discharges (at C) *before the synchronising impulse has been generated.* In fact, the synchronism is quite ineffective. Yet an exactly similar amount of lateness, as represented by OD, is satisfactorily triggered by the synchronising.

It therefore stands out that for satisfactory operation the time base should be adjusted to run slightly slow and under these conditions the synchronism will hold for prolonged periods. I find, myself, that with relatively crude apparatus I can hold the synchronism steady over the whole of one item without much difficulty. Synchronism is often lost when a performer walks towards the camera or does any very rapid movement from side to side involving tracking round at the transmitter, yet if the conditions which I have just mentioned are complied with the synchronism will often hold quite well. (*Continued on page* 128)

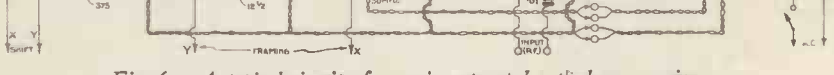


Fig. 6. A typical circuit of a mains operated cathode-ray receiver.

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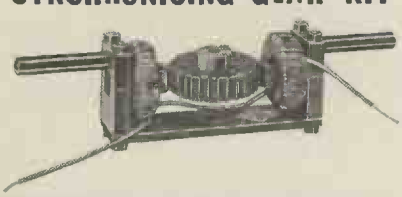

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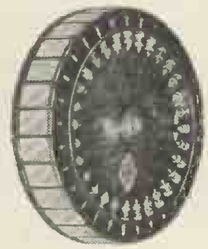

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Synchronism with Cathode Rays

(Continued from page 126)

The amount of lag should be very little. As I have already said the speed should be practically correct without any synchronism at all, but the conditions should be such that with no synchronism applied there is a slight tendency for the picture to drift from right to left. The application of a small amount of synchronising voltage will then lock the picture in a most satisfactory manner.

It should also be observed that the direction of the synchronising voltage has no effect. Since we are dealing with a short sharp pulse at relatively long intervals the operation is practically the same irrespective of the direction of this pulse. In other words it does not matter whether the pulse is as shown in Figs. 3 and 4, or whether it is reversed as shown in Fig. 5, provided we are operating on a slow time base. An arrangement as shown in Fig. 5 would not correct a rapid time base at all, and in this respect the direction of the synchronising is important, but we have already seen that the amount of correction for a too-rapid time base is negligible, so that in practice direction can be disregarded.

Fig. 6 shows a complete receiving circuit in which this principle is applied. There is one important point in the application of this synchronism which is that the grid of the gas-discharge tube must not be tied direct to the bias control. Otherwise it is impossible for the synchronising voltage to cause the necessary variation. A series resistance of about 100,000 ohms should be introduced in the grid lead in order to allow the grid complete freedom of action to follow the variation required.

It will be noted that a similar synchronising arrangement is used to lock the 375 and 12½ cycle time bases, a small portion of the 375 cycle voltage being fed on to the grid of the 12½ cycle tube. I hope to say more about this in a further article.

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will ensure "Television" being delivered to you regularly each month.

Oxford Photo-cells

The Oxford Instrument Co., Ltd., of Keble Road, Oxford, have placed on the market a photo-cell intended for television and other purposes where only a limited amount of illumination is available. Features are a large window and high sensitivity, and they can be supplied in either the vacuum or gas-filled types. A photo relay is also made by this firm which is designed to operate directly from A.C. or D.C. mains. We hope to give full details of this device in our next issue, but in the meantime readers who are interested can obtain full particulars upon request and mention of TELEVISION.

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.

Queries should be addressed to the Query Department, TELEVISION, 58-61, Fetter Lane, London, E.C.4.

Indexes and Binding Cases for "Television"

Indexes and binding cases for the 1933 volume of this journal are now ready, and may be obtained on application to these offices. The price of the index is 3d., or 4½d. post free. The binding cases are of cloth with stiff boards suitably titled, and the price is 2s. 6d., or 2s. 9d. post free; these last prices include the index.

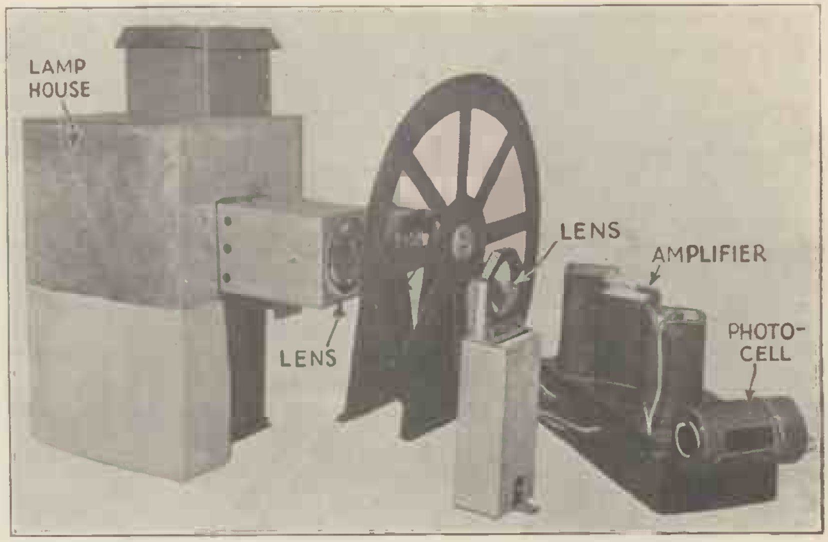
H. E. Sanders & Co. wish readers to note that the price of £2 10s. od. in the fourth item of their advertisement in the February issue is for the kit of parts for the mirror-screw only.

In the advertisement of the Radio Reconstruction Co., Ltd., in the February issue there were two misprints. "Plake" neon lamp should, of course, have read plate neon lamp. Mondays *and* Fridays 4 to 7 p.m. are the hours during which callers can be seen—or by appointment.

There is news in the "Television" advertisements

An Amateur Transmitter

Here are details of a "hook-up" television transmitter for room-to-room use.



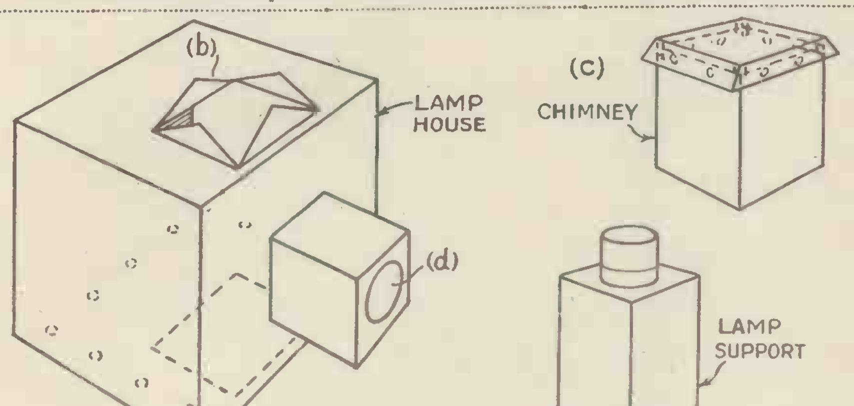
Here are the units of the simple transmitter arranged in "hook-up" form.

THE possession of a transmitter will enable amateurs to experiment independently of the B.B.C. transmissions and at more convenient times. The apparatus about to be described is more or less in hook-up form and is intended to indicate what is required for simple transmission and it can be left to the ingenuity of the experimenter to assemble it in more compact form should this be desired. Excellent results have been obtained with this apparatus, the images being easily recognisable.

The transmitter comprises three sections: (1) a light source, (2) a scanning device, (3) a photo-electric cell and associated amplifier.

Television enthusiasts who already possess a disc receiver should use this as a scanning device, both for the transmitter and receiver, until such time as the results they obtain warrant the use of a separate scanning system. Used this way the object is scanned by one side of the disc and viewed on the other side as the received neon-lamp picture. A split picture will be viewed at the receiver end, in the case of this one disc receiver transmitter and this is unavoidable, but a considerable amount of preliminary experience will be obtained.

If a photograph or print is being transmitted, however, it can be cut vertically in half, and the two halves mounted to form a split image to begin with. This will be automatically rectified and a true picture will be viewed at the receiving end.



Details of lamp house, chimney and lamp support.

The source of light chosen for this outfit is a 1,000-watt projection lamp of the voltage to suit the user's mains. This lamp requires an adequately ventilated housing. The housing can conveniently be made out of a biscuit tin. As shown above a number of ventilating holes are cut in the bottom of the tin; a large square hole is cut at (*b*). The hole at (*b*) is formed by piercing a hole in the centre of the marked out square, then making a cut from the centre to each corner of the square, leaving four triangular-shaped pieces. These pieces are turned upwards, at 90 degrees to the top of the bore, forming a support for the chimney (*c*) which may be made out of a sheet of tin or from a tin box.

The lampholder is mounted on a block of wood of such height that the centre of the filament of the lamp, when screwed in position, lines in the same horizontal plane as the motor shaft of the disc receiver. A hole is then cut in the base of the box large enough to allow the box to be slipped over the lamp and lamp base and to rest on the block of wood supporting the lamp.

Another hole about 2½ in. diameter is now cut in the front of the box, with the centre of the hole opposite the centre of the filament of the lamp. The condenser lens specified is mounted in a box shown at (*d*), Fig. 1. The distance from the centre of the lens to the filament should be approximately 7½ in.

The focusing lens should be mounted in a substantial holder which is screwed to a flat plate of metal. This flat plate is mounted in a slide on to a block of wood. The height of the centre of the lens from the baseboard should be the same as the height of the motor shaft from the baseboard.

Full details of the amplifier and optical arrangements will be given in next month's issue.

Mention of "Television" will ensure prompt attention

"Velocity Modulation"
(*Continued from page* 109.)

The Receiver

It is only proposed to deal with the television part of the receiver and not with the radio portion. This is designed to work from a low level of signal voltage, although, of course, in the interests of selectivity or for other reasons radio frequency amplification may be necessary. Naturally, any tuned circuits must be so designed that they will not encroach upon the channel necessary for the accurate conveyance of the picture intelligence.

The television part of the receiver (see Fig. 2) comprises essentially a line-scanning amplifier, picture traversing time base and intensification circuit.

The line-scanning amplifier consists of two paraphase stages, the plates of the valve in the second stage are connected to the horizontal deflector plates of the receiving oscillograph. The traversing time base operates in a ratchet fashion and in exactly the same way as the corresponding element at the transmitter, that is to say, the scanning line is moved on one step on the occasion of each line fly-back; the picture fly-back occurs on the momentary cessation of the scanning at the end of each picture.

The intensification voltage is obtained essentially by "differentiating" the line-scanning voltage. This is done by means of a condenser resistance circuit CRC 'R.' The intensification voltage across the resistances RR is amplified by the valves V3 and V5 and applied to the focusing shield of the receiving oscillograph.

It will be noted that the loading of the anode resistance R2 $R2^1$ with the condensers CC^1 gives the line-scanning amplifier a falling frequency characteristic. This is a great advantage from the point of view of the receiver design; the frequency characteristic droop is compensated at the transmitter end.

The paraphase arrangement of the line scanning amplifier provides various advantages, including the avoiding of low-frequency distortion, which latter has necessarily to be kept down to a low level in order to avoid mis-shaping the picture.

Controls

The controls of the receiver are extremely simple. The input potentiometer R1 is adjusted to give the required picture breadth and the screen voltage of valve V7 is then set to give the required picture depth, which it does by varying the pitch of the scanning grill or raster. It should be noted that there is no synchronising adjustment, because the values of R8 and C8 are fixed. The remaining controls are the intensification volume control, namely the potentiometer R5 and oscillograph focusing, viz., the cylinder biasing potentiometer.

These adjustments can, of course, only be made while the signal is actually being transmitted. It might be supposed that if the transmission were cut off, the spot on the receiving oscillograph would come to rest and possibly damage the screen. This, in practice, is not the case, because as soon as the transmission is cut off, the ratchet driver valve V4 ceases to pulse, and the grid of V7 thereupon slides to zero voltage and causes a traversing movement to start off on its own account, thus moving the spot in a regular manner and preventing the screen from damage.

There is just one other aspect which should not be entirely overlooked, and that is picture size. A. C. Cossor, Ltd., have already produced experimental tubes of sufficient size to give a nine-inch picture. The difficulties of projecting the image on a still larger screen, it is considered, would not be insurmountable.

How it Feels to be Televised

Yvette Darnac talks to "Television"

TELEVISION make-up hardly improves one's personal appearance. Yvette Darnac was evidently blissfully unconscious of her looks during a recent rehearsal of a television show, or else completely indifferent. Deep blue lips, thickened eye-brows, purple-blue eyelids, and a good smudge of blue either side of her nose, not forgetting a high light of white on the bridge of it, is a trying make-up at the best.

Miss Darnac answered our direct question as to whether she liked being televised quite frankly. She gave us to understand she could not see how anyone could enjoy it because of the circumstances under which it had to be done. The make-up did not worry her in the least, merely because she did not see it except in a mirror in the dressing room.

She was ready to face the light even to looking straight into it. "That I must do fairly often because it has the effect of my looking at you who are watching the transmission, but I have not found it affects my eyes at all."

Concentration

The point that seemed to trouble Miss Darnac more than any other was one of concentration. Like all artists, she likes to "live" her part. In ordinary broadcasting this is easily possible. A microphone can easily be forgotten. If one is reading from a script, as is generally done in broadcast plays, any actress who has broadcast a few times is able to enter into a part and forget her surroundings.

The more a broadcaster gets used to broadcasting the more easily does complete concentration come. This, Miss Darnac considers, is not easy of achievement in television.

She pointed out that facial expression is the first consideration. In ordinary broadcasting she may sing a song dressed in an overcoat and hat, for nobody is the wiser. In television, she has to dress for the part and, what is more, look the part.

Theatre-work naturally teaches any actress all that. Television is more likely to take the unwary very much by surprise and cause facial expressions totally at variance with the subject in hand.

Sitting before the "gun," especially when it is not possible to see what one really looks like is not an experience calculated to help. *It is so difficult to forget the fact that one is being televised.*

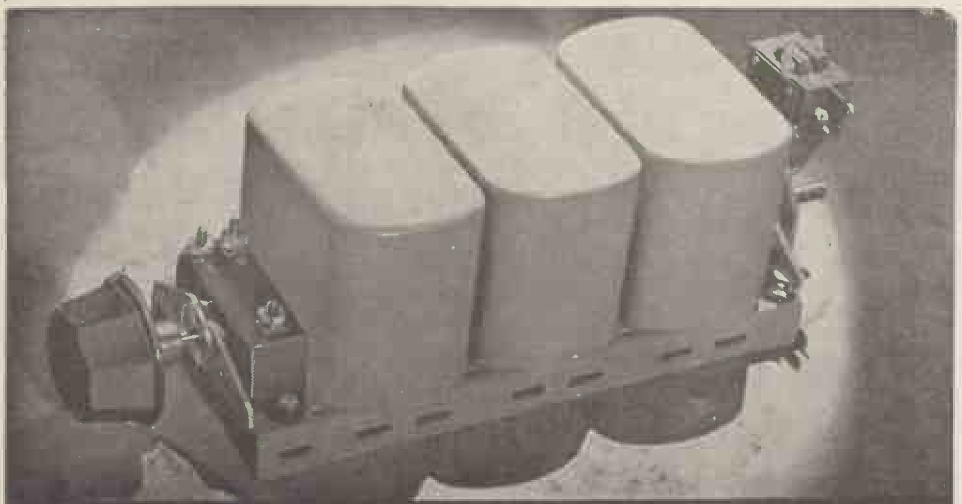
Another point, of course, is that one has to be so careful with one's hands. They must be kept close to the body at all costs. Otherwise they appear enlarged, just as they do in ordinary photography. This is not the platitude it may seem.

After all, the hands help so much in the matter of expression. If one is tied to a few effective movements (and must at all costs avoid those which are ineffective) there seems very little one can do safely.

Concentration is always difficult to attain in any circumstances. We all suffer from lack of it. Surely it is reasonable to conclude that anyone who can forget actual surroundings and look on their art in this "new light" must benefit in the long run? Perhaps television is a cure for a wandering mind?

Colvern 'Ferrocart' Coils

- *the better coils . . . specified for*
- *Standard Television Receiver*



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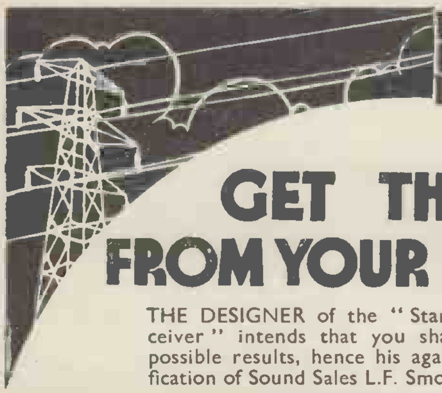
Quality reception in television depends entirely on the quality of the components—that is why the designers used and specify Colvern Ferrocart Coils for the Standard Television Receiver! Ferrocart Coils are the finest coils yet constructed—a triumph of engineering precision. This outstanding advancement in coil construction has been made possible only by years of ceaseless research and experiment.

For the Standard Television Receiver, the types specified are: Ferrocart types G.1.S. G.2., G.11.S., and G.12

Price 60/- complete.

COLVERN, Ltd., Romford, Essex. London Depot: 150 King's Cross Road, W.C.1

Made under licence from the patentee Hans Vogt.



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AUTOMATIC VOLUME CONTROL

Usually the introduction of Automatic Volume Control necessitates complicated alterations. But even delayed A.V.C. may be obtained in a simple manner with the Westector.

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Used as a battery economiser, the Westector enables a large output to be obtained from a battery set without using special equipment, and is applicable to any type of receiver.

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When used as the second detector in a Superheterodyne the Westector gives straight line rectification with distortionless detection, and it is almost impossible to overload it.

A development of the permanent Westinghouse Metal Rectifier, the Westector retains all the qualities of long life, reliability, etc.

You will want to know more about this useful component. A 3d. stamp to Dept. T. will bring you a copy of our booklet "The All Metal Way, 1934."

THE WESTINGHOUSE BRAKE & SAXBY SIGNAL CO., LTD.
82, York Road, King's Cross, London, N.1.

When replying to advertisements, please mention "Television"

"The Stixograph and Scophony"
(*Continued from page* 96.)

tions and a suitable horizontal size of *B* no two laminations image in the plane *E* can overlap horizontally. The total image formed in the plane *E* (i.e., all for every detail in the picture, in exactly the same way as a camera lens forms a two-dimensional image. Even if the optical system, or a part of it, such as the echelon, is moving at any speed in any direction, which maintains

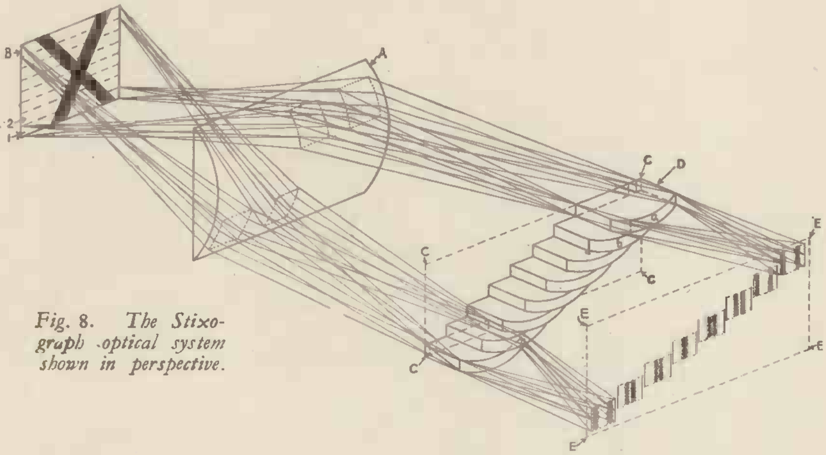

Fig. 8. The Stixograph optical system shown in perspective.

the lamination images) is a Stixograph of the object *B*, for all vertical definition and limitations have been removed and all that remains is horizontal definition. Each detail of the picture has an individual and independent position horizontally and its size corresponds to the size horizontally of the detail it represents in the object *B*. The vertical size or position of a detail in the Stixograph in the plane *E* is totally unimportant. The appearance of a Stixograph such as would be formed by the optical system of Fig. 6 is shown in the focal plane *E*.

It must be pointed out that the various functions of the system of Fig. 6 are performed simultaneously correct focal distances, a Stixograph will be simultaneously formed for all the picture except obscured portions, should this happen intentionally or accidentally.

A Stixograph or one-dimensionally limited picture can actually be produced with great ease, and may have any degree of definition with a suitable design of apparatus, and choosing an echelon having a sufficient number of laminations.

MORE ABOUT THE STIXOGRAPH IN OUR NEXT ISSUE

"Modern Form of Kerr Cell"
(*Continued from page* 111.)

noticed that in the case of the double-image polariscope, it is not necessary to reduce this by 50 per cent. due to total reflection of the ordinary ray as in the case of the single image polariscope. In the above expression δ is the angular retardation, or phase difference. Now we can put

$$\frac{\delta}{2\pi}=\frac{R}{\lambda}$$

because δ bears the same relation to 2π as the linear retardation to the wave length. On substitution for δ in the above expression we have

$$I=I'\sin^2\left(\frac{\pi R}{\lambda}\right)$$

We now write down Kerr's law introducing his constant :

$$R=\frac{clV^2}{d^2}$$

Here we have c, the Kerr constant (which is in the order of 20.10^{-6}) V is the potential difference in volts between the electrodes and d is the distance, in cm. between them. l is the length of the light path, in cm., through the cell.

On substitution for R we find :

$I=I'\sin^2kV^2$ intensity expression for Kerr effect, where k stands for the product

$$\frac{\pi cl}{\lambda d^2}$$

An order placed with your Newsagent will ensure regular delivery of "Television."

We now have to derive the intensity expression for the quartz laminae. Referring to Fig. 5, we see that the application of an electric field along the direction of the electric axis of the piezo-electric quartz brings about a strain in the quartz along the electric axis of magnitude S where

$$S=\frac{KV_e}{e}$$

K is the piezo-electric constant and Ve is the voltage which, as the subscript indicates, is measured in electrostatic units. This strain is equivalent to that brought about by direct stress T. If, then, E is the elasticity of the quartz for this particular axis we have

$$T=ES=\frac{EKV_e}{e}$$

Now the retardation brought about by such mechanical stress is given by the well-known photo-elastic expression.

$$R=CTl$$

Here C is the stress-optical coefficient and l is the length of the light path through the stressed medium. On substitution for T from the previous expression we find

$$R=\frac{CEKV_el}{e}$$

In this expression the value of T must be given in megadynes cm.^{2} so that we have to divide by 10^6. Furthermore, in order to reduce to volts we have to divide by 3.10^2, so that the expression reduces to

$$R=\frac{CEKVl}{e.3.10^8}$$

If we put $k^1=\frac{\pi CEKl}{\lambda e.3.10^8}$ and if we then substitute for R in the intensity expression we have $I=I^1\sin^2k^1V$. Intensity expression for effect in quartz.

Now whereas in the Kerr intensity expression each successive loop of the curve of illumination against voltage becomes steeper, the slope of the succeeding loops in the quartz effect is always the same. This is because in the former case we are dealing with V^2 but in the latter case with V.

For particular calculations the value of the stress-optical coefficient for quartz is about 5. The Young's modulus for the e axis is in the order of 10^{12}, and the piezo-electric constant can be taken as $6.4.10^{-8}$.

The Bennett Television Co. inform us that, owing to increased business, it has been necessary to take larger premises, and that they have now moved to 50a, Station Road, Redhill, to which all communications should be addressed.

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THE CONSTRUCTORS' CIRCLE

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(2) I have placed a regular order for TELEVISION with my booksellers, Messrs..........
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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.

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ORIGINAL Pressler Cathode Ray Tubes, Cells, Crater Lamps, as reviewed in "Television," are available from the sole British representative, EUGEN J. FORBAT, 28-29, Southampton Street, Strand, W.C.2. Temple Bar 8608.

PATENTS—Trade Marks, "Advice Handbook" free.—B. T. King, Regd. Patent Agent, 146a, Queen Victoria Street, London.

SPECIFIED DISC KIT, 50/-. All Television Components, Discs, Neons, Motors, Lens, etc.—Lists free, Bennett Television. Note New Address.

ALUMINIUM, 20 inches square, 32 gauge, polished, 3/-; 20 inch punched discs, ready for use, 10/-.—Vose, 15, King Edward Road, St. Helens, Lancs.

A. MATHISEN, B.Sc., F.T.S., Patent Agent and Consulting Engineer, British, Foreign and Colonial Patents, Trade marks and Designs.—First Avenue House, High Holborn, London, W.C.1. Holborn 8950.

KINGSTONE COMPANY OFFER—"Kindrag" Synchroniser outfit, 14/6; Slide resistance, 7/-; Synchroniser coils, 4/- pair; Toothed wheel, 4/9; Television H.F. choke, 2/6.—Stamp for details, 372, Essex Road, London, N.1.

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Telephone: Central 4611.

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Address ____________________

March, 1934.

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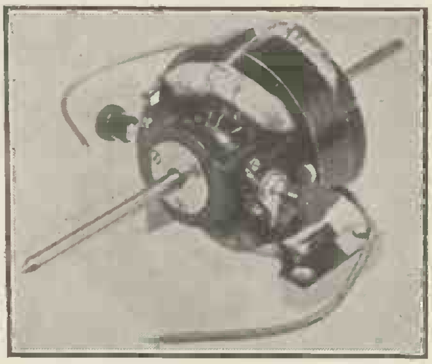

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