TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

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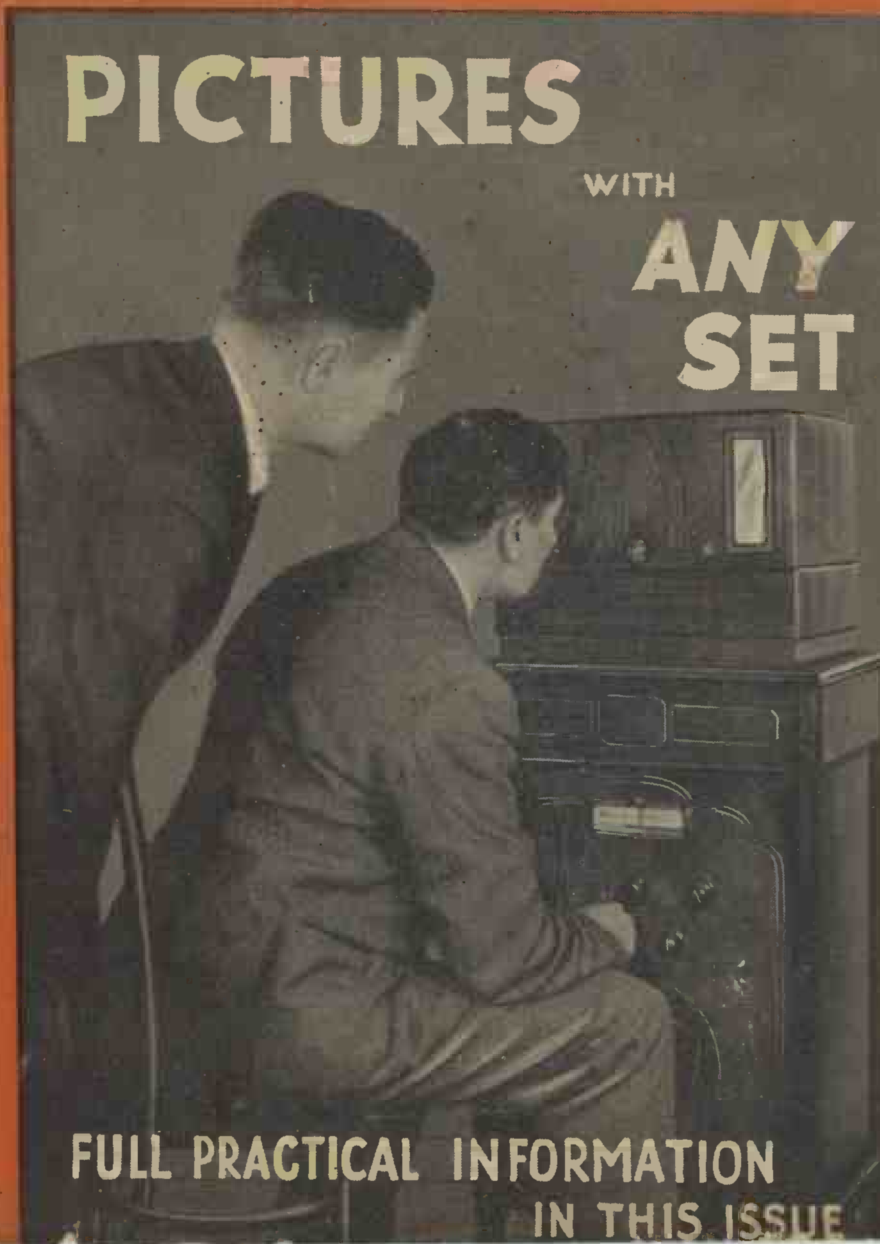

JANUARY 1/- 1935. No. 83

MONTHLY

Bernard Jones Publications Ltd., 58-61, Fetter Lane, E.C.4

THE POPULAR MERVYN TELEVISION SET

Easily Assembled — *Definite Results*

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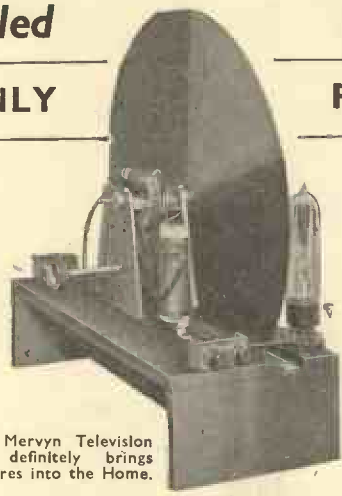
A Kit of parts specially designed by Mervyn for the Home Constructor. Readily assembled by the non-technical experimenter. This popular set offers remarkable value.

Thousands of Mervyn Television Kits have been sold to enthusiasts in all parts of the country. Full instructions for assembling sent with each set. Prompt delivery.



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LIST OF PARTS INCLUDED:

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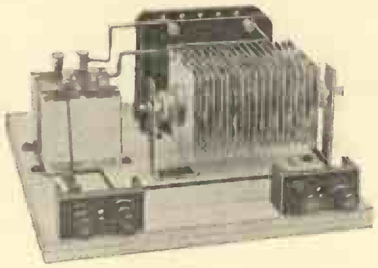

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£2/5/0

The Unisphere Mirror Drum.

Perfectly turned spherical main casting, 30 compensated curved carriers, mirrors, etc.

ONE SCREW fixing and adjusting — a really perfect system. Serves the dual purpose of transmitting or receiving scanner. Patented.

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Angle Mirror

Stand of entirely new design giving positive setting for directing the light beam in projection work or direct viewing: mirror size, 2½"x2½".

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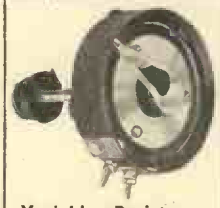
2" diameter. Interchangeable with standard synchronizing gear — will keep the motor steady on 50 cycles. For transmitters.

Price *7/6*



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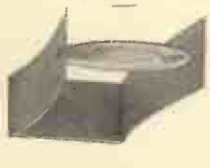

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A superfine flat-field highly polished 4" diameter Lens for increasing the size of images received.

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Clip-in lens-holder for above, 1/-.

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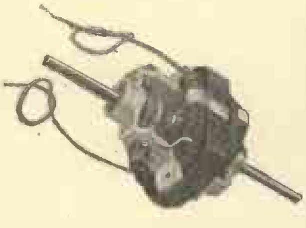
21/-



20/-

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The finest available from stock: BD3. 16" — 8 spokes, 7/6 BD4. 15½" — plain, 6/- AS1. 20" — 8 spokes, 12/6

The New Mervyn Duplex NU-GLO Lamp,

as announced last month. Striking voltage 180-200 volts: gives excellent pictures on only 17 milliamperes. Can be used up to 55 milliamperes. NU-GLO rich yellow-orange colour.

12/6

HERE'S ENTERTAINMENT — SCIENTIFIC INSTRUCTION AND A NEW AVENUE FOR YOUR FUTURE CAREER!

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The "Nu-Glo" Crater Lamp

for Mirror drums and lense discs provides an intense spot of light inside the lamp, and is easily modulated — no optical concentration necessary. Striking at 200-220 volts.

37/6

MERVYN *for* RELIABLE TELEVISION COMPONENTS *and* SOUND APPARATUS

No. 83 VOL. VIII JANUARY, 1935.

TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

Special Features in this Issue

TELEVISION

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COMMENT OF THE MONTH

The Neglected Film

PENDING the decision of the Postmaster-General's Committee it is unreasonable to expect that the B.B.C. will make any innovations in the thirty-line transmissions, but it has always seemed a pity to us that after this lapse of time the film has had no place in these. Technical articles in this journal have made it abundantly clear that the film is certain to play a very important part in television in the future and had it been used in the thirty-line transmissions a considerable amount of valuable data could, no doubt, have been obtained. There are, of course, many technical difficulties which would have to be met under present conditions, but they are by no means insuperable and though they would necessitate some modification of the existing transmitting arrangements this should not entail very much trouble. The two greatest snags are the accommodation of the standard film ratio to the present thirty-line ratio and the unsuitability of the average film for low-definition scanning. The vertical scanning system adds another complication, but we venture to say that all these problems could be overcome.

We do not suggest that at the present juncture a change is practicable, but in the event of a continuance of the thirty-line system, as is generally thought likely, the introduction of the film into the programmes would be desirable. As is well known, the film is employed for experimental purposes in all television laboratories, and it has the valuable feature of putting the transmission on a definite basis; in other words it cuts out much of the uncertainty which is still associated with studio practice. It is in this respect that we think it would be of real value to the " looker," for it would remove most of that element of doubt as to whether faults were present in the transmission, and therefore help in the elucidation of those that are in the receiver.

The Postmaster-General's Committee

AT the time of going to press with this issue there is little to report regarding the activities of the Postmaster-General's Committee. The representative sections which visited America and Germany have now returned and it was generally assumed that the next task of the Committee would be to draw up the report. However, we understand that arrangements have been made to witness repeat demonstrations in this country and that in some instances circumstances have arisen in connection with these which have caused delay. Although no time has been stated as to the probable duration of the deliberations, it is felt in manufacturing circles that the report is now somewhat overdue.

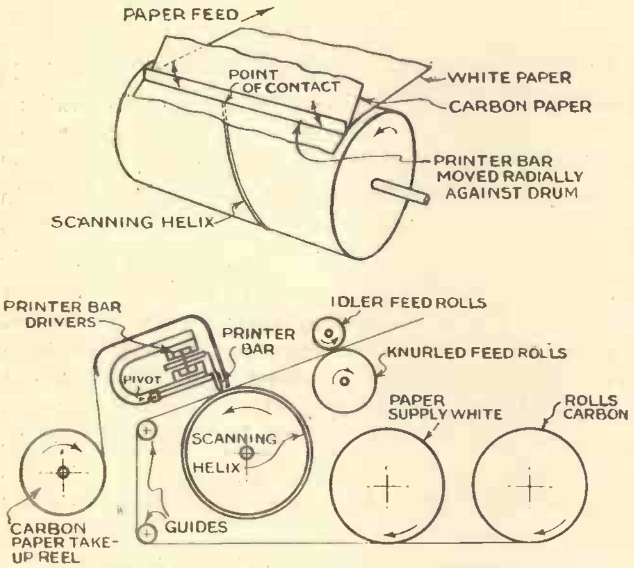
FACSIMILE TRANSMISSION

Considerable attention is being paid at the present time in the U.S.A. to simple systems of facsimile transmission. Below are particulars of a very efficient method which gives excellent results.

At the present time facsimile transmission is receiving a great deal of attention in America, and according to *Electronics* " the radio printing press in the home " may soon be a reality, paralleling the commercial use already made of the same facsimile methods by the great newspapers, for transmitting by radio or wire pictures and documents, complete in every detail, and almost indistinguishable from the original.

In this connection, this journal states, the Young " lawnmower " facsimile reproducer, using carbon paper as the means of inking, is now one of the most promising systems, since it eliminates all preparation of the paper, or the use of inks or jets.

Carbon paper was suggested in early facsimile experiments as a simple and direct printing agent, but the stylus which was used to produce the marks caused considerable difficulty. In the new system developed by C. J. Young for the R.C.A. Victor Company, the stylus has been supplanted by a roller-and-printing-bar arrangement. The roller contains a single spiral of piano wire embedded in and raised slightly above its surface. This wire presses through a layer of carbon paper and printing paper against a printing bar which lies parallel to the axis of the roller. As the roller is rotated, the point of contact between it and the printing bar travels in a straight line across the paper, and simultaneously the pressure exerted by the printing bar on the paper is varied by a magnetic drive controlled by the incoming facsimile signal. The line printed by the varying pressure constitutes one line of the image, and as the paper and carbon are moved slowly during the printing process, adjacent lines are printed parallel to one another and the image is built up. Variations in shade are produced by variations in pressure, and as a result half-tone images can be reproduced almost as easily as black-and-white.



The printing mechanism of the Young R.C.A. facsimile system.

In the transmitter the picture or message is placed on a roller and rotated underneath a photo-cell scanner which picks up the variation in light and shade in a series of closely spaced parallel lines. The amplifiers which take the output of the photo-cell impress the current variations on an audio-frequency carrier, of a frequency in the neighbourhood of 3,000 cycles per second. This tone output is then transmitted over radio or wire lines in the usual manner.

At the recorder, the printing helix (the piano-wire spiral) is rotated synchronously with the transmitting apparatus. The synchronisation is provided by power system connections, if both transmitter and receiver can be operated from the same system. Otherwise temperature-controlled tuning fork oscillators are used to control both receiver and transmitter independently, a regulation accurate to one part in 100,000 being possible by this means. The paper, of standard 8½ in. width, is fed over the printing helix at a rate of 1.2 inches per minute. The carbon paper is fed somewhat slower than this in order to economise its use. The printing helix rotates at a synchronous speed of 120 revolutions per minute, producing one line for each revolution. The picture has, therefore, one hundred lines per linear inch, a degree of detail quite sufficient for half-tone reproduction.

Transmission at this speed is possible when wire lines are used, or when strong signals are available in a clear radio channel. This speed corresponds to a message speed (assuming single-spaced typewritten material) of 100 words per minute, or a full letter size sheet in eight minutes.

The receiving circuit which feeds the signal to the magnetic drive of the printing bar consists of a detector-rectifier which rectifies the tone-modulations received from the transmitter, a filter which converts the rectified tone to D.C. pulses, and a D.C. push-pull output stage which amplifies these pulses and applies them to the magnetic control.

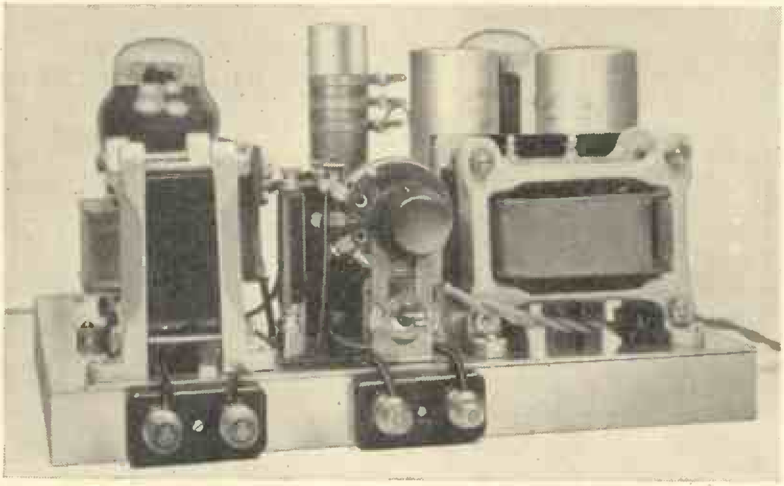
Fluctuations due to fading have been largely overcome by the use of properly designed automatic volume control circuits. This system has been used to transmit weathermaps to ships at sea, and during several months of operation it was found that reception was reliable on well over 95 per cent. of the transmissions. One map, sent from Rocky Point, was received on board ship lying in harbour at Havre, France. Electrical loading machinery used on the docks close by caused such interference that even slow code transmissions were very difficult to copy by ear. The facsimile receiver, however, produced an intelligible, if somewhat streaked, map under these conditions. This fact has indicated to Mr. Young that facsimile methods will permit the reception of transmitted intelligence through interference which is heavier by far than the signal itself.

TELEVISION WITH ANY SET

DETAILS OF A SPECIALLY-DESIGNED UNIVERSAL AMPLIFIER

This amplifier has been designed so that it can be used in conjunction with any receiver with the assurance that the output will be sufficient to receive the television programmes. It employs universal valves and can therefore be used on either A.C. or D.C. mains

UNLESS your receiver is a large one with a power pentode or power triode output valve, it is not certain that the undistorted output will be sufficient to modulate a neon lamp.



The amplifier is simple to construct as this photograph shows.

Providing Extra Power

There are many thousands of battery and mains operated sets, in fact most receivers that are over two years old, which have a small triode output valve giving about 300 milliwatts in the case of a battery set and up to 1,000 milliwatts with mains.

If you are still using such a receiver you cannot hope to obtain really satisfactory results even though you may attempt to increase the output by using paralleled valves. In the majority of commercial receivers, particularly of the mains type, you will be unable to get at the connections to add the necessary power valve.

In the few cases where the receiver connections are get-at-able, it is more than probable that the high-tension supply will be inadequate.

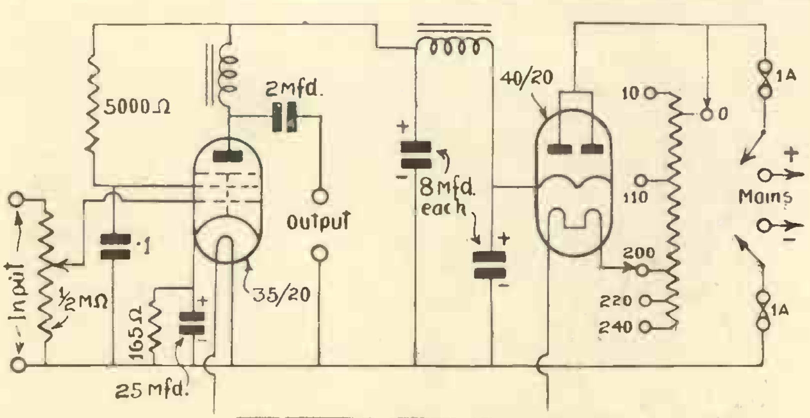
In normal circumstances the only solution to the trouble would be the construction of a really good amplifier, which in the case of A.C. mains would mean considerable expense. Thanks to the introduction of really good A.C./D.C. valves there is opened an entirely new channel for experiment. In fact we can go so far as to say that if you have mains available we would rather you constructed an A.C./D.C. amplifier than the conventional A.C. or D.C. arrangement.

Let us take a typical receiver, one that is still admittedly the most popular at the moment, the screen grid-detector-power valve arrangement. There are thousands of receivers of this kind being used at the moment and although they give good quality and ample volume when used with a loud-speaker, the 600 or 700 milliwatts output may be insufficient to modulate even the simplest type of television apparatus.

The use of another low-frequency stage culminating in an output valve giving up to 3,000 milliwatts gives a different complexion to the whole matter. You could fully modulate your neon lamp on a disc receiver and obtain some really worth-while pictures, without very much added expense. What is more important, non-technical readers who are afraid of having to make alterations to their existing family set will welcome an arrangement that can be added to their present receiver, without making any alteration whatsoever.

A Valuable Piece of Apparatus

We have designed what we consider is a valuable piece of apparatus which almost every television enthu-



The circuit of the amplifier. It employs a Mazda Pen 35/20 and a Mazda U40/20 for rectification.

siast will want to make up. This applies particularly to the beginners who may not want to go to the expense of constructing an entirely new television receiver. This piece of apparatus is a single stage low-frequency amplifier which is coupled

TELEVISION AMPLIFIER

CHASSIS.
1—Aluminium 10 in. by 8 in. with two angle strips 10 in. by 1 in. by 1 in.

CHOKES, LOW-FREQUENCY.
2—Sound Sales, 30-henry, 60-milliamperes, type 30v.

CONDENSERS, FIXED.
1—Dubilier .1-microfarad, type tubular.
1—T.C.C., 2-microfarad, type 50.
1—Ferranti 25-microfarad, electrolytic type CE91.
1—Dubilier 4-microfarad, type electrolytic.
1—Dubilier 8-microfarad, type electrolytic.

HOLDER, FUSE.
1—Bulgin, twin complete with fuses, type F14.

HOLDERS, VALVE.
1—Clix 5-pin, type chassis mounting.
1—Clix 7-pin, type chassis mounting.

RESISTANCES, FIXED.
1—Graham Farish 165-ohm, type 1½ watts.
1—Bulgin series filament, type MR34.
1—Graham Farish 5,000 ohm, type 1½ watts.

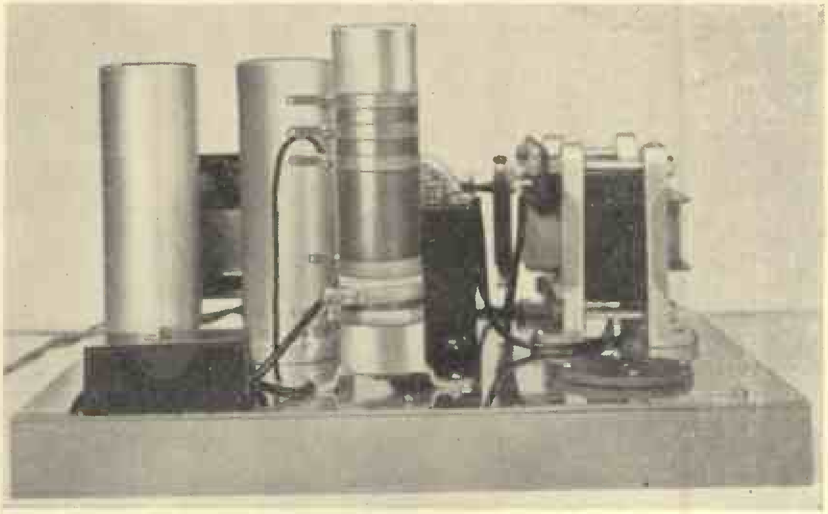
RESISTANCE, VARIABLE.
1—Ferranti .5 megohm.

SUNDRIES.
1—2½ in. metal mounting bracket.
2—Lissen terminal blocks.
Connecting wire and sleeving.

SWITCH.
1—Bulgin double-pole on-ox, type S104.

VALVES.
1—Mazda Pen. 35/20, 1—Mazda U40/20.

directly to the output stage of your existing receiver. The only point in doubt is whether or not your present set includes a choke filter output circuit. This is essential as it



A rear view of the amplifier.

completes the coupling between your present output valve and the new one.

Those readers who last month constructed the universal A.C./D.C. television receiver designed by Kenneth Jowers should take particular note that this amplifier will work in conjunction with that receiver without any alteration whatsoever to either the receiver or the amplifier. But we will tell you more about that later.

The output of your present receiver is fed into the grid of the new Mazda Pen. 35/20, a valve which when fully loaded will give up to 4,400 milliwatts. You will notice that to prevent distortion which can easily creep in when using a steep-slope pentode, a variable potentiometer which allows you to regulate the grid input is employed. By means of this the maximum amplification, without distortion, can be obtained.

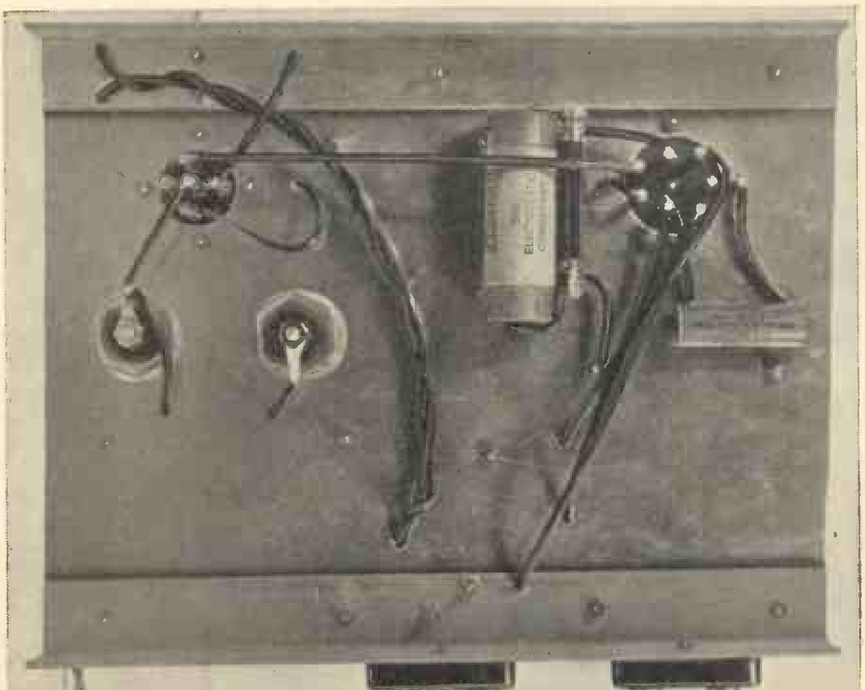
The output of this pentode is fed directly into a choke filter circuit so that the receiver can immediately be connected to the scanning apparatus. You may wonder why we have not mentioned cathode-ray apparatus. The reason for this is that only 30 volts are needed fully to modulate the cathode-ray tube which can be obtained from almost any small output valve so an amplifier is not necessary.

We have taken particular care in choosing the low-frequency chokes. Firstly to keep the reproduction up to a high standard, and secondly to reduce the hum content to an absolute minimum. During our tests we measured the actual amount of ripple present in this circuit and this was approximately .7 volt.

High Tension

You will see that high-tension is obtained by means of a half-wave valve rectifier in series with the mains supply. This valve gives a maximum of 240 volts and up to 120 milliamperes, but we are only taking approximately 55 milliamperes.

The slight rise in voltage is taken up by the drop across the two low-frequency chokes. Actually the amplifier is an entirely separate unit and can be added to any receiver, irres-



The underside wiring will be clear from this photograph.

pective of whether it is A.C. or D.C. mains driven. If you are using a battery receiver and have mains available then the same remarks apply. The battery set can be coupled directly to the amplifier, providing you have a choke filter output circuit incorporated.

The heaters of the two valves are joined in series with the mains, with a tapped resistance in the positive leg. The heater of the Pen. 35/20 requires 35 volts, whereas the U40/20 requires 40 volts. Therefore you will have to reduce the voltage from the mains from, say, 200 volts down to 125, that is to allow for the voltage required by the two valves.

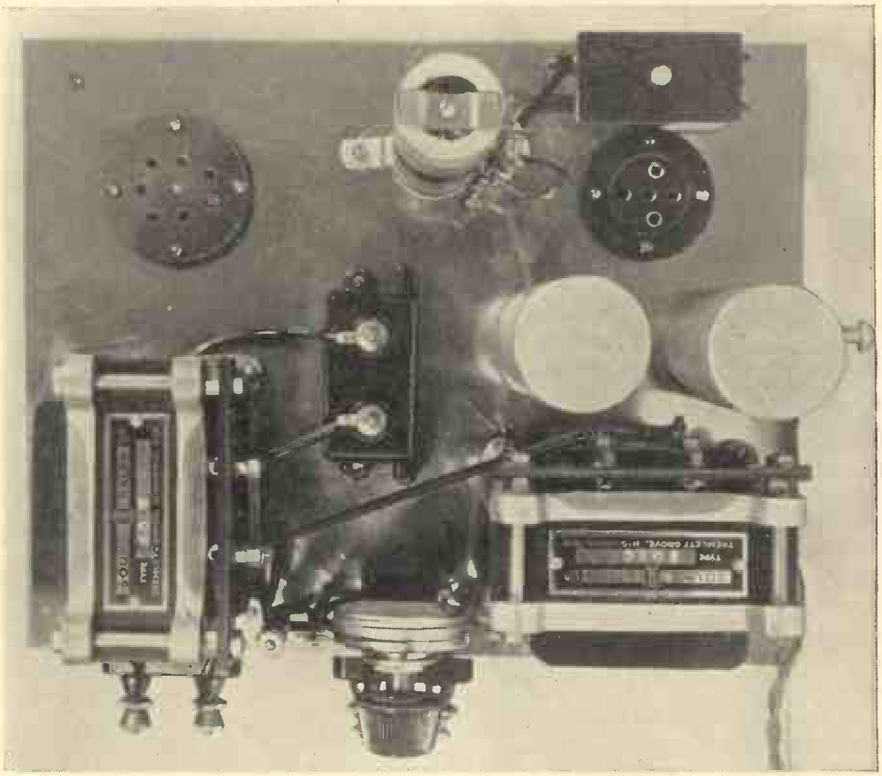
You can obtain the necessary resistance from Bulgin's, who make one that is tapped in several places, so that you can get the absolutely correct voltage.

You should not experience any difficulties at all in the construction of the amplifier. It is all perfectly straightforward. Where the variable components are placed can be seen from the illustrations, but let us just tell you one or two things about the making of a chassis.

Actually the chassis consists of a piece of alluminium and two pieces of aluminium channelling. The channelling is bolted to the front and back edges of the aluminium, so that we have approximately 1 in. to spare underneath the baseplate. This enables us to put the valve connections out of sight, to mount the electrolytic smoothing condensers in an upright manner, without the use of brackets and, for the small fixed condensers and the single resistance to be placed closed to the components to which they are adjoining.

The bulk of the wiring is beneath the baseplate, but do make quite sure that the holes you have to drill through the plate are fairly large and have been cleaned, otherwise you may cut through the systoflex and cause a short-circuit. The on-off switch breaks both sides of the mains and remember that the amplifier must not be earthed unless you have a condenser in series with the earth lead. When using an existing mains set there is no need for an earth connection, but with a battery set it will be advisable to earth the amplifier independently through a 2-microfarad condenser.

Remember that when you do not want to use the amplifier for television purposes it can be used to boost up the output from your present set, particularly if you are using a gramophone pick-up. Many readers who are on D.C. mains would be glad to know that the Pen. 35/20 will give up to about 3½ watts, undistorted output, which is considerably in excess of that given by any existing D.C. mains valve.



The layout of the components can be clearly seen in this picture.

Superhets for Television

A Note on the I.F. Stage

MANY television experimenters must have been disappointed with the results of receiving television with the usual superheterodyne type of receiver.

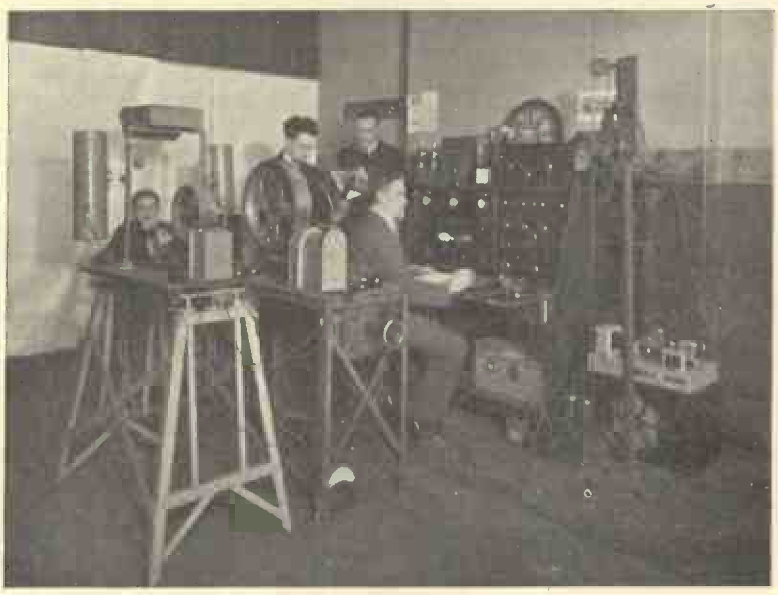
Such receivers nearly always have their I.F. stages tuned to 110 kc. (2,727.25 metres approximately). Now, one cannot, with much chance of success, modulate a carrier with more than 10 per cent. of the carrier frequency and then only with the aid of band-passing, while many authorities put 1 per cent. as the practical limit. Most superhets are built for "reaching out" and in consequence, owing to too many stations for the available wavelengths, receive an extremely narrow band, in most cases not even enough for the proper reception of sound and, of course, quite hopeless for television reception.

Turning to high-definition television (high, as we understand the term to-day, say, 180-line picture), it is interesting to consider what is the highest wavelength that will be necessary even when modulating with 10 per cent. of the carrier. For high-definition at least a 500 kc. side-band is required, while up to 1,000 kc. is desirable. Splitting the difference, we will take 750 kc. which means a carrier of 7,500 kc. (which equals 40 metres) the lowest I.F. of the superheterodyne of the future.

An order placed with your newsagent will ensure regular delivery of TELEVISION

10-METRE TRANSMISSIONS IN THE NORTH

MR. HAROLD BAILEY, the well-known Manchester experimenter, whose various contributions to radio are well known, is now transmitting three-dimensional objects and figures with 30-line scanning. His call sign is G2UF and his transmissions are on the 10-metre band. The results obtained are reported to be excellent.



The laboratory of G2UF, Denton, Manchester, as described in the text.

The equipment used for the 30-line scanning transmissions is quite straightforward, although the amplifiers are of special design to give a maximum of high- and low-frequency response with a minimum of distortion. The circuit and layout is devised to minimise stray capacity. Six photo-cells in specially designed holders to give wide angle and depth of image are employed. The power-valve conductance amplifiers are "floated" to eliminate inter-electrode vibrations.

In Mr. Bailey's latest apparatus a 60-line, 15 in. diameter mirror-drum transmitter and receiver are used and although no outside broadcasts have been made on this machine the land-line results have surpassed all expectations.

The drums are driven by induction motors and are separately synchronised by electrical impulses to prevent the image floating. These impulses are 1,000 per second. The picture-frequency is 16.6 images per second and flicker is practically eliminated. The light source is a 300-watt arc.

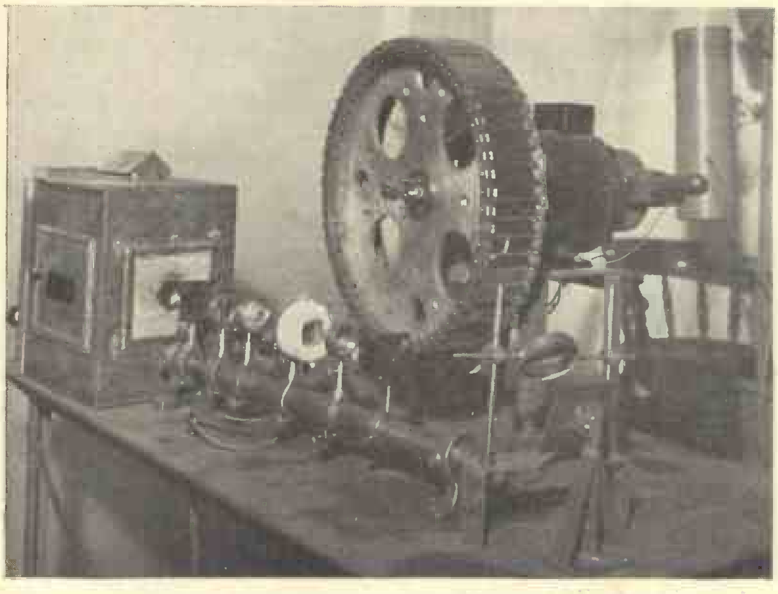
The receiver is the result of many hours of research and the problem of light modulation gave a considerable amount of trouble. As in the transmitter, a 300-watt arc is employed for light and four methods of light modulation are being tried, all in conjunction with double-image calcite blocks.

The four methods of light modulation that have so far been employed consist of (1) high-voltage Kerr cell, (2) Faraday effect, i.e. the rotatory power of borosilicate of lead glass, (3) the same effect on quartz plates, and (4) pot. tartrate. These systems are being closely examined by Mr. Bailey and his television engineer, Mr. E. Reader. Results obtained at the moment include a 4 ft. square image on a ground glass screen with high definition. The brilliancy of the image is such that it can be viewed in a room which is not completely dark.

The first of the accompanying pictures shows the vision and sound transmitter, G2UF, Denton, Manchester, and gives an impression of how a broadcast is made. On the extreme right of the picture can be seen the 10-metre oscillator with modulator at the base. Mr. Harold Bailey is seated at the transmitter. The two panels shown are (left) the short-wave receiver and (right) the medium-wave. A check receiver is available so that it can be seen how the picture is going out.

The first two stages of the amplifier

(Continued at foot of next page).



Close-up of the 60-line scanner showing the optica assembly.

AN ENTERTAINING EXPERIMENT

THE TALKING LIGHT BEAM

Here are details of an interesting experiment with which you will be able to entertain your friends using apparatus which is probably in your possession.

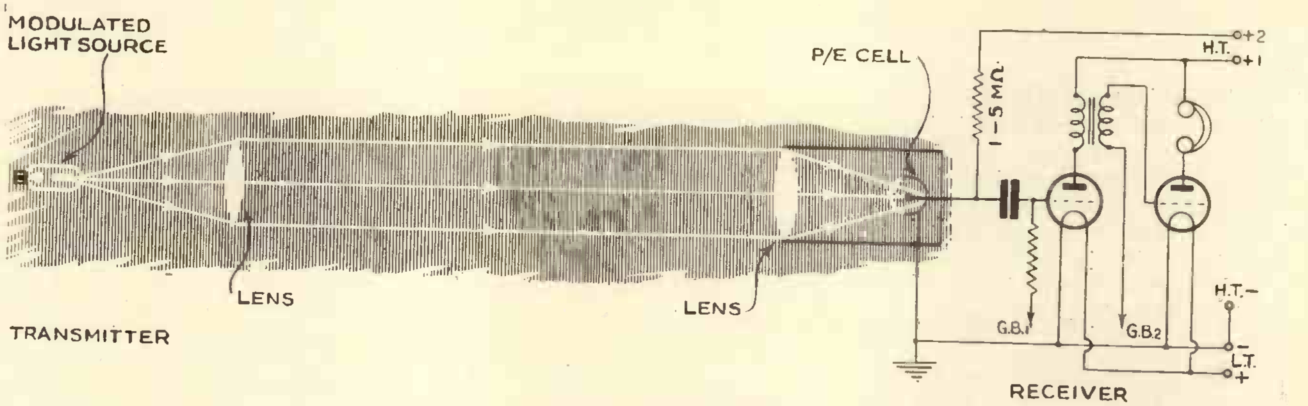
TELEVISION enthusiasts who are experimentally inclined might well occupy some of their time during the holidays with this modulated light-beam experiment. If your visor is of the projector type embodying a " point " light-source, all that you need in addition will be two cheap lenses and a photo-cell and amplifier. Lenses of about 4 inches in diameter with a focal length of about 12 inches will serve admirably.

For the transmitter, it is only necessary to place the light source—which may be a crater neon, Kerr cell or recording tube—at the focal point of one of the lenses, to produce a parallel beam of modulated light. If you are using your visor for this experiment it is not even necessary to remove the light source from the chassis as a small piece of mirror placed at 45 degrees to the beam will enable the latter to be brought out at the side.

The receiver is simply a second lens with a photo-cell at its focal point. This should be placed at a distance of a few yards from the transmitter with the optical axis of the lens along the modulated light-beam. Using headphones a 2-stage amplifier should be sufficient to give good signal strength over a short distance. If your television receiver is tuned in to a fairly strong station it should be clearly heard in the headphones.

The choice of photo-cell will depend on the type of light source used at the transmitter. For a Kerr cell or any of the neon crater lamps a gas-filled caesium photo-cell will be satisfactory. If a blueish lamp, such as the recording tube, is used a gas-filled potassium photo-cell will be found best. Enclose the cell in an earthed metal box of some kind and use as high a cell voltage as permitted by the makers. Gasfilled photo-cells will glow when the potential across them exceeds a certain voltage and they are most sensitive when operated a few volts below this condition. Cells should never be allowed to glow for a long period or they will be damaged.

These light-beam experiments open a very attractive field of research and if more elaborate apparatus is used communication over quite long distances can be effected. The Marconi Co. has covered distances up to 2 miles using a sodium lamp and parabolic mirror as transmitter. Secret communication may be effected by this method if non-visible light is used. A few years ago, engineers of the Baird Co. carried out experiments in this direction using as light-source a modulated arc. All visible light was eliminated by a thin sheet of ebonite which passed only infra-red rays. Although great distances were not attempted in these experiments it is more than probable that secret communication over long distances could be attained in this manner.



The layout and circuit arrangements for talking along a beam of light.

"10-metre Transmissions in the North"

(*Continued from preceding page.*)

are at the base of the photo-cell stand and the third stage is in the bottom of the cabinet. The covers have been removed from the mirror-drum transmitter to show the drums. The large drum is the 60-line instrument and the 30-liner is on the left of the picture. It will be seen that it is an easy matter to transfer the programme from 60 to 30 lines by moving the portable photo-cell stand.

The second picture is a close-up of the 60-line receiver and shows the modulation system. From the lamp house that contains the 300-watt arc the units are mask, collimating lens, double-image prism, borosilicate of lead glass wound with coil, converging lens and mask. The light then passes on to a mirror and is reflected through a lens and on to the drum.

The apparatus has been constructed entirely at the works of H. Bailey & Co., Ltd., Denton, Manchester. Mr. Bailey will be pleased to hear from television enthusiasts who are interested in these transmissions.

Our Policy
"The Development of Television."

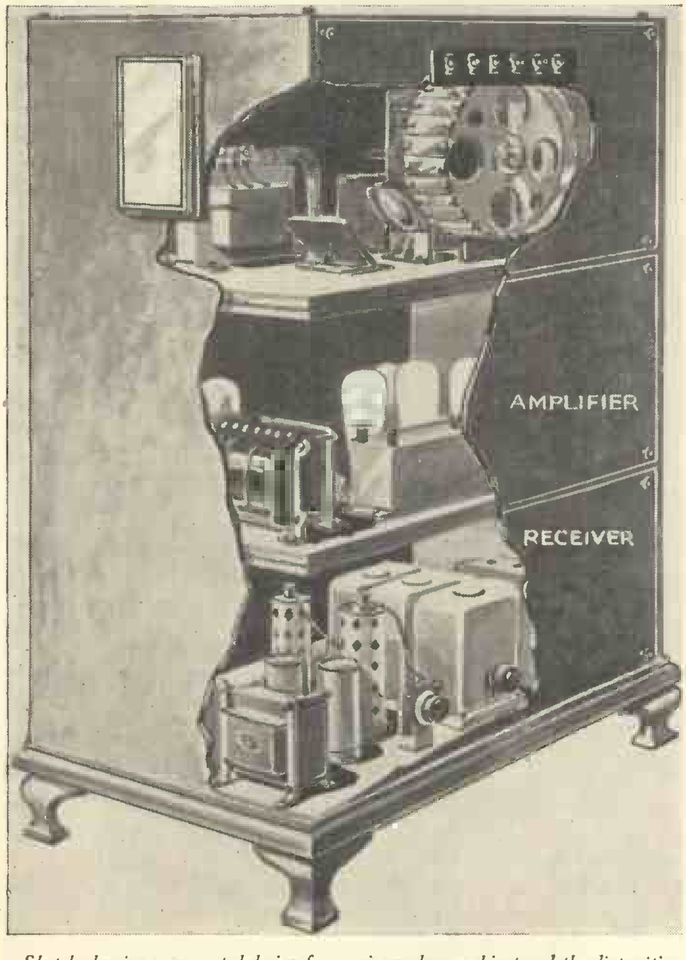
HOUSING THE RECEIVER

This article contains suggestions for housing the receiver in such a way that maintenance and adjustment are facilitated.

AS a rule the first tests of a receiver are made with it in hook-up form and this is to be recommended for there are usually a number of adjustments to be made which may entail some difficulty when the entire apparatus is assembled in a cabinet. It soon becomes apparent, however, that protection from dust must be afforded and so the question arises as to the most suitable form that the cabinet should take. The writer's experience is that this is not a very simple matter to decide and actually only after the third attempt was a satisfactory arrangement devised. It is, of course, mirror-drum apparatus which is under consideration, for the disc machine presents very little difficulty.

The first scheme attempted was to build the whole apparatus into a rack or framework, so designed that the entire assembly could be slipped into a cabinet from the back. It appeared with this that when the rack was withdrawn from the cabinet it would leave the whole of the "works" exposed and adjustments could be easily made. However, in practice the scheme was a failure, for even a minor adjustment entailed taking the whole thing out of the cabinet, and incidentally the removal of the control knobs. More often than not it was minus the cabinet because of the trouble of replacing it.

Experience with this showed that there were several matters which should be given attention. One of the most important was the desirability of having all the controls at one side so as to obviate passing in front of the screen during the operation of the receiver. Secondly it was decided that it was necessary to have the screen at the level of the eyes when seated in a chair. Accessibility, as previously mentioned, is very essential and on this account it was decided that receiver, amplifier, and visor should all be mounted on separate baseboards so that they could be withdrawn individually. In order that this could be accomplished easily all connections were of such a nature that they could be removed in a few moments and replaced without risk of confusion; in many cases plugs and sockets were employed.



Sketch showing a suggested design for a mirror-drum cabinet and the disposition of the various units.

Earlier experience had shown that unless due precautions were taken there was a strong possibility of getting interference from the motor, so in order to obviate this the receiver was placed at the bottom, then above this the amplifier and on the top the mirror drum, lamp transformer and resistances. Each shelf was lined with aluminium foil in order to prevent interaction.

The basis of the cabinet is a wooden frame to which panels are secured by screws. The front panel is in one piece but the right-hand side (looking from the front) and back are made up of three panels each, any of which can be removed quickly. Terminal heads with screws soldered to them are used to hold the panels and these can therefore quickly be removed without recourse to a screwdriver.

Switching Arrangements

Six switches were mounted on the top side panel; the first one controls the current supply to the motor, the second the neon indicator lamp, the third the receiver, the fourth the amplifier, the fifth is a change-over switch from loudspeaker to Kerr cell, or vice versa, and the sixth is the projector lamp switch. Wires are taken from these switches to sockets mounted on a strip of ebonite so that disconnection of any unit is a matter of a few seconds. It will be noted that the order of these switches is roughly that in which they are used; The second one has notches filed in the sides of the knob and the fourth on the top and bottom so that it is an easy matter to select the one required in the dark merely by touch alone.

A very useful refinement is an on-off switch connected to a length of flex which will allow the motor cir-

(*Continued on page* 13.)

Simple Television Optics

Television Made Easy

THE purpose of the mirrors and lenses used in a television receiver is simply to direct the light where we want it. Mirrors produce the result by reflection, lenses by the process of refraction or bending.

In general, whenever a ray passes from one ordinary medium into another—e.g., from air into glass—this refraction takes place. Thus, if in Fig. 1 AB represents the surface of separation between air and glass, a ray PQ will be bent somewhat as shown by QR, towards the normal or line perpendicular to the surface at Q on entering the glass, and is bent away from the normal at R on emerging

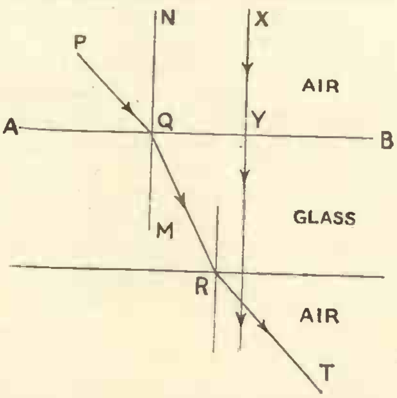


Fig. 1.—Diagram showing how a light beam is bent on passing from one medium to another of different density.

from the glass. If, however, a ray such as XY strikes the surface normally, or at right angles, no bending takes place; the ray passes straight through.

Let us apply this to a lens. (Fig. 2.) A ray AB from an object at A striking the lens at B is bent towards the normal, travels in a straight line inside the glass to C and is bent away from the normal at C on emerging again into the air. Another ray AE would follow a path somewhat like AEFD, and so on. The amount of bending depends upon the angle between the ray from A, and the normal at the point where the ray strikes the lens. Hence rays from A striking at the points H, K, etc., are changed in direction or deviated by the lens by different amounts, and if the distances AO and OD have suitable values the rays will combine again at D to form an image of the object.

In this discussion we have confined ourselves to rays which strike near the middle of the lens only. Had we traced accurately the paths of rays striking the outer portions of our lens (and rays from an object spread out in all directions), we should have found that they do not all pass through one point. This always happens with simple lenses and gives rise to a form of image distortion known as spherical aberration. A simple case of this defect can be observed by looking through a converging lens at a piece of squared paper, the squares will be distorted into shapes such as those in Fig. 3. On covering the outer portion of the lens with a paper washer or "stop" and again looking through at the squared paper, the distortion will be found to be much less, but on the other hand the amount of light reaching the eye through the lens will be less, and more light will have to be directed towards the squared paper to bring the image back to its original brightness. Hence one effect of such a stop used in a television projection lens is to dim the resulting spot of light.

Ordinary white light such as sunlight, or the light from a projection lamp, is made up of many different colours, all of which are refracted by different amounts when the compound light passes into glass. If the piece of glass has parallel sides, the effect on emerging just compensates for the effect on entering, so that the

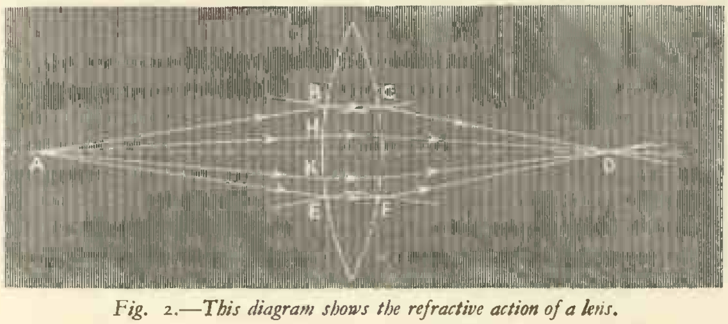


Fig. 2.—This diagram shows the refractive action of a lens.

TELEVISION OPTICS FOR THE BEGINNER

compound light is made up again; but consider a triangular prism of glass as shown in Fig. 4. When a ray of white light AB passes through this prism each of its constituent colours is refracted by a different amount both on entering and leaving the glass, red being refracted the least and violet the most, with the result that the light is split up or dispersed by the prism into its simple colours.

Now consider again the ray AB of white light striking our lens (Fig. 5). The lens behaves exactly as the prism: it disperses the light. Only lines representing the extreme refracted rays, the red and violet, are shown, the others occupying intermediate positions, but it will be seen

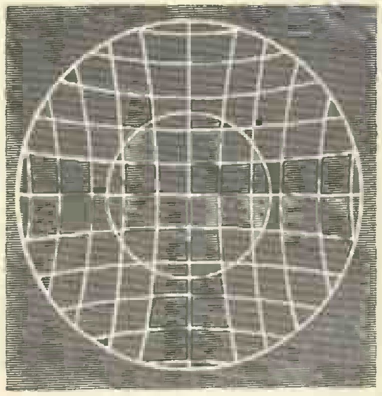


Fig. 3.—Diagram showing the distortion produced by a simple lens.

that not one image is produced, but several, the number of images being equal to the number of simple colours in the original light.

This colour effect or chromatic aberration, as it is called, can easily be seen by viewing through a simple lens a black line drawn on a sheet of white paper, the edges of the line will be seen to be coloured as shown in Fig. 6. The most important result for our present purpose of this defect is that the outline of the image is blurred; instead of a sharp change when passing along the paper from white to black, we have the colour changing gradually. If a more complicated object is viewed or projected, the coloured outline cannot generally be seen, but the blurring effect is still there.

We cannot, therefore, with a simple lens project a sharp clear spot of white light on to the screen of a televisor. At the present state of our science we have more than enough causes of indistinctness in our pictures, but much of the haziness so fre-

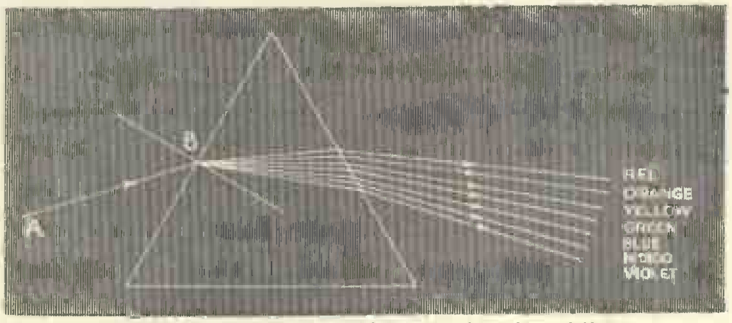


Fig. 4.—Each of the constituent colours of light is refracted to a different degree and the light split up into its component colours.

quently attributed to the amplifier, etc., is often due to a faulty optical projection system.

It does not appear to be generally realised that the purpose of the lens used for projecting the moving spot of light in a mirror-drum television receiver is fundamentally different from that of the lens used in a camera or cinematograph. With these latter we have to project the whole picture at once, but with the former we do not actually project a picture at all: the televised picture, in fact, like beauty, exists only in the eye of the beholder.

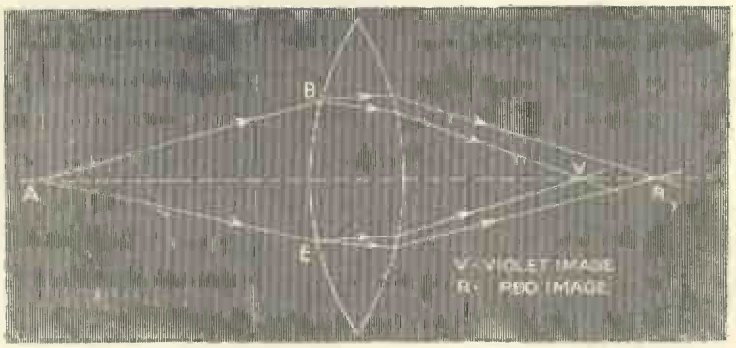


Fig. 5.—Diagram showing how chromatic aberration is produced.

In order that an ordinary projected picture may have the required sharpness in outline, and freedom from distortion, the usual defects of a simple lens, spherical and chromatic aberration must be corrected. This necessitates the use of relatively complex and therefore expensive lenses, but the purpose of the lens through which the light passes after going through the Nicols and Kerr cell is purely to produce a thin parallel pencil, or perhaps a pencil converging to as near a point as possible, of pure white light, and so long as the spot of light on the screen is sufficiently small its shape does not matter very much. Distortions due to spherical aberration do not therefore produce any effect whatever upon the image which is built up by persistence of vision upon the retina.

It is an easy metter to construct a lens corrected for colours only. It can be shown by fairly simple mathematics that if we take two simple lenses, made of the same kind of glass, and separated by a distance equal to half the sum of their focal lengths, as in Fig. 7, then the lenses will act as an achromatic combination.

Suppose we require an achromatic projection lens of three inches focus or focal length, we find that two simple lenses each of three inches focus fixed three inches apart will give us what we require, for a four-inch focus projector, two four-inch simple lenses four inches apart, and so on.

Such simple lenses can be purchased quite cheaply. Quite satisfactory

SCREENS AND ILLUMINATION INTENSITY

projectors can be made with lenses purchased from a sixpenny store. Spherical aberration is present, of course, and the lenses would not be satisfactory in photography, for instance, but the spot of light obtained with them is quite clear of colour effects.

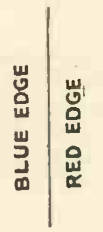


Fig. 6.—Because of chromatic aberration the edges of a line are blurred when viewed through a simple lens.

To make the projector up properly obtain a stout canister with lid, and of diameter slightly greater than that of the lenses and of length equal to the focus of the required projector. Cut holes in the lid and bottom of the canister of such a size that a rim about ⅛ in. wide is left all round as shown in Fig. 7. Two pieces of stout wire of about 16 s.w.g., each rather less in length than the inner circumferences of the canister are next required; these should be of fairly springy material. Bend the wires to a circular shape, but leave a gap in the circle as in Fig. 7. If the canister is a really stout one, it may be used as a former round which the bending may conveniently be done. The suitability of the material of the wire may next be tested; it should be possible to close the gap by pressure with the fingers, but the gap must reopen again on relaxing the pressure. Now place one of the lenses in the bottom of the can, close the gap in the ring and slip this into the can, pushing it down to the bottom with a pencil so that it holds the lens firmly in position. Fix the other lens in the lid of the canister in the same way, place the lid on the canister, and put two spots of solder at opposite points on the circumference of lid and can, to keep the latter in position. Take care over the soldering; if too much heat is used, the lens in the lid of the can may be cracked.

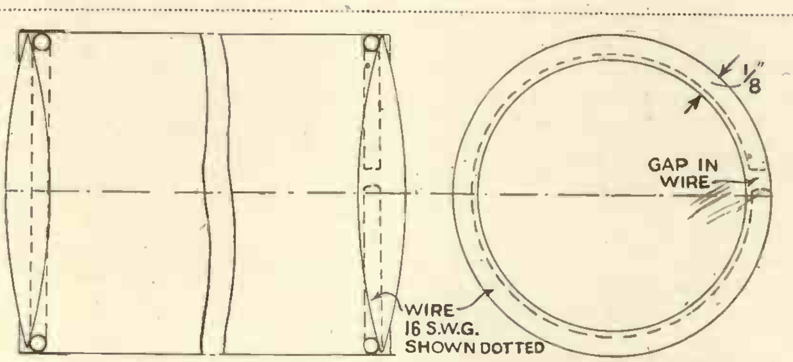


Fig. 7.—Details of the construction of a simple projector combination.

Such a lens, made at a cost of about one shilling, will be found to give results for television purposes equal to one costing a hundred times as much.

Intensity of Illumination

The size of a screen which can be used for television projection and adequately illuminated depends upon the law of inverse squares. If an object A is exactly halfway between the source of light L and the screen S, then its shadow will cover on the screen an area exactly four times that of the object. It will be clear, therefore, that at twice the distance the light which reaches A has to cover four times the area, and at three times the distance nine times the area. The intensity of the light falling on a screen, therefore, is "inversely as the square of the distance" from the source of light.

Diagram explaining the principle of intensity of illumination.

"Housing the Receiver"

(*Continued from page* 10)

cuit to be broken momentarily at a distance from the receiver; this, of course, must be of the double-break quick action type. It is found with this arrangement that if the motor control is set so that the motor normally tends to run a trifle fast, correction can be instantaneously applied by the simple flick of the switch and, of course, the operation can be done from a distance. A switch which will allow the synchronising coils to be shorted will answer equally well.

The speaker is placed in the same compartment as the mirror drum; no provision is made to allow the sound to be projected as it is only used for tuning purposes, the sound receiver being entirely separate. As there are occasions when it is necessary to get at the back of the cabinet, which normally stands against a wall, it was found that large-size castors greatly facilitated moving the entire instrument without undue vibration which might disturb some adjustment.—R.D.

Major Gladstone Murray, the B.B.C. director of public relations, speaking recently to a representative of the *Daily Mail* upon the future of television, said: "Television may possibly join forces with broadcasting under one charter, but there is no definite indication of such a move yet."

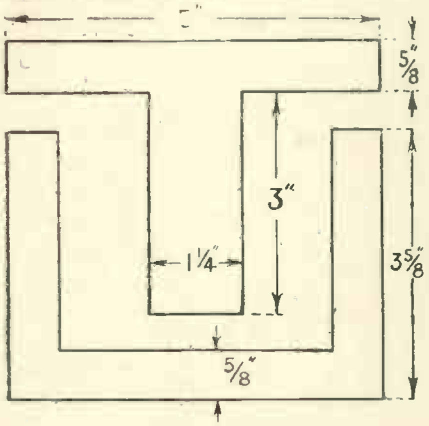
HOW TO BUILD A PROJECTION-LAMP TRANSFORMER

By R. F. Scarisbrick

IN projection-type television receivers using a Kerr cell as a light modulator it is essential to use as the light source a lamp having a small bunched filament. These are usually of the small projector type, rated at 12 volts, 100 watts, and the current supply must be obtained from a mains transformer.

It is proposed to describe in this article the construction of a transformer suitable for this purpose, designed to work on 50-cycle mains of 200-240 volts. A list of the necessary materials is given and these can be obtained from most wireless or electrical dealers. In the case of the spool for the windings, no dividing flanges are required as the primary winding is wound over the secondary.

Winding the primary of the transformer.



Details of the transformer laminations.

The Secondary Winding

The secondary winding is put on first and this consists of 72 turns of 16 s.w.g. d.c.c. wire. This is rather heavy wire to handle and a fair amount of patience is required to get the turns to lie evenly. First cover the centre of the spool with two thicknesses of insulating material such as empire cloth. Drill a hole in the end flange close to the core of the spool and pass about eight inches of wire through from the inside for the purpose of connection, using a nine-inch length of insulated sleeving.

The turns may now be put on, guiding each one into place with the thumb and keeping them as close and even as possible. The accompanying photograph will show the method of winding. It will be found that a layer will accommodate about 34 turns if the work is done carefully. When a layer is complete cover with a piece of empire cloth and then continue the winding until the full 72 turns have been put on. The end of the winding is brought out in the same manner as the commencement, but through the opposite end flange. Cover the winding with a few layers of insulation followed by a length of thin sheet fibre or leatheroid, which will provide a firm foundation for the primary winding.

Winding the Primary

The winding of the primary, consisting of 1,440 turns of 26 s.w.g. enamelled wire, is carried out in a similar manner to the secondary, leaving a short length, covered by sleeving, for the connections. It is not essential that the turns be placed side by side as with the secondary, provided that the winding is carried out as evenly as possible, working from end to end of the spool. A covering of insulation should be put on after each layer of wire.

To provide for use on mains of different voltages tappings should be taken at 1,200 and 1,320 turns. These are brought out through the nearest end flange, as with the ends of the windings, labels being attached and marked 200 volts and 220 volts respectively. Care should be taken to see that the tappings and also the ends of the windings are brought out in such a position that they will not foul the core or aluminium clamps when the latter are placed in position.

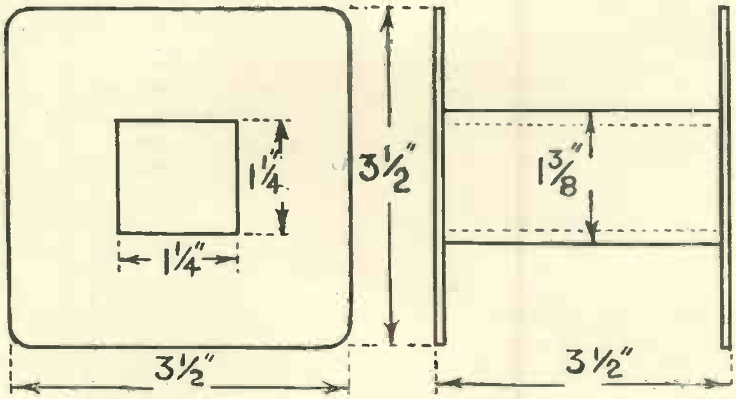
Materials Required

½ Gross 28 Stalloy stampings.
1 pair aluminium clamps.
1 fibre spool.
1 lb. 16 s.w.g. d.c.c. wire.
1 lb. 26 s.w.g. enamelled wire.
Terminal block and 6 terminals.
Empire cloth and leatherette.
1 yd. insulated sleeving.

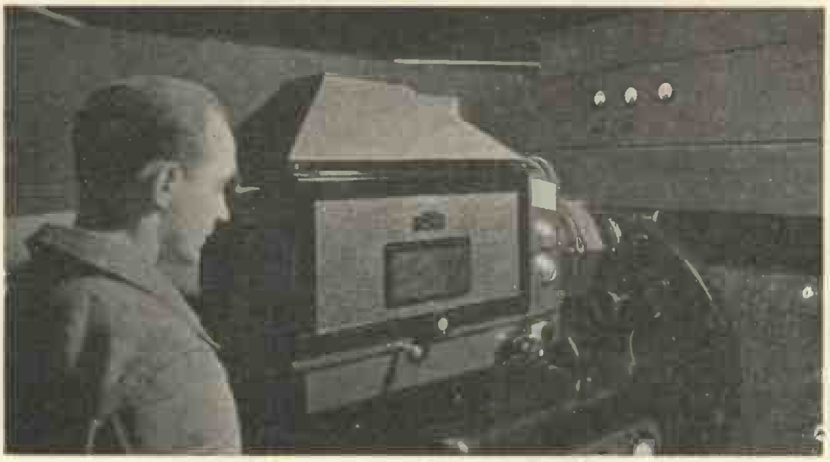
The winding of the primary may be carried out much more quickly by attaching the spool to the chuck of

(Continued on page 17.)

Dimensioned drawing showing the construction of the coil former.



MODERN HIGH-DEFINITION TRANSMISSION



The Fernseh A.G. 180-line spot-light transmitter.

TELEVISING ACTUAL SCENES

By G. Baldwin Banks, B.Sc.
(Late of the Baird Laboratories)

The writer of this article has been actively engaged in transmitter design for a number of years and the information given represents the latest practice.

LAST month I described methods and apparatus used for the transmission of moving-picture films. In this article I shall deal with the televising of actual scenes as they are taking place in the studio or on the set. The same standard of definition—180 lines—will be taken.

Three methods are in use, these being the "Spotlight" system, the "Iconoscope," and the Intermediate-film process. Before going on to deal with the last process in detail, a brief description of the spotlight and iconoscope systems will be given.

The Spotlight System

The principles underlying this system will be familiar to most readers of TELEVISION. The scene to be televised is scanned by a spot of light and the reflected light falling on to a bank of photo-cells causes minute current variations which are amplified and transmitted to the receiver. This system—which was probably the first successful television process and has been used in the B.B.C. studios for some years—presents no difficulties when the standard of definition required is only of the order of 30 lines. When we come to high-definition, however, it becomes a very different proposition. The light-spot is so small in comparison with the area scanned—less than $\frac{1}{40,000}$—that very little light is available.

Taking a particular case in which a 3-ft. disc revolving in a partially evacuated casing was used in conjunction with a high-intensity arc lamp consuming 125 amperes, the maximum size of scene which could be televised was only 3 ft. by 4 ft. From the foregoing remarks it will be seen that the spotlight system is limited to close-up shots—a screen of the size mentioned would only accommodate two half-length figures.

The Iconoscope

In contradistinction to the system just described the iconoscope may be termed a "floodlight" system. Its development is due to V. R. Zworykin, of the R.C.A. Victor Company, who has been responsible for invaluable work in connection with photo-electrics, cathode-ray tubes and allied television apparatus. In this case the scene to be televised is directly illuminated, as in moving-picture practice, and the image focused on to a mosaic of tiny photo-cells arranged on

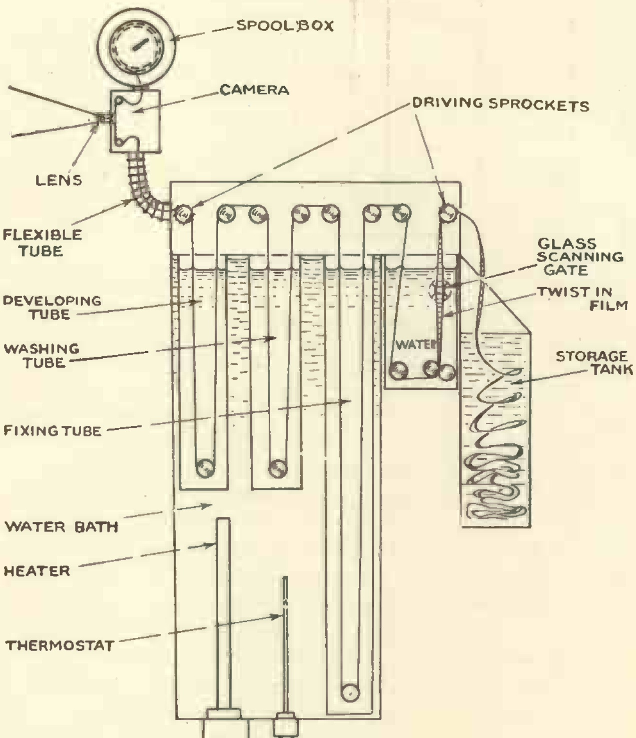


Fig. 1.—The mechanical arrangements of the intermediate-film gear as used for experimental purposes by Baird Television, Ltd.

THE INTERMEDIATE-FILM SYSTEM

the end of a cathode-ray oscillograph. This mosaic, which takes the place of the fluorescent screen of the normal cathode-ray tube is composed of a great number of metallic particles on which photo-electric material is deposited. Each individual cell emits electrons and becomes positively charged in proportion to the amount of light which falls on it. The cathode-ray beam which is caused to scan the mosaic discharges the cells and the beam current fluctuates according to the amount of light falling on the individual elements.

Two untouched enlargements from 9.5 mm. film after use in the intermediate film scanner.

Although little is generally known in this country about the practical performance of the iconoscope it is definitely the system of the future. The main advantages are that it is non-mechanical, silent in operation, and portable and is equally useful in the televising of films or actual scenes. Another advantage is that it may be used for either intensity- or velocity-modulated systems.

The Intermediate-film Process

At the present stage of television technique the intermediate-film is undoubtedly the most practical of the three systems. We saw in last month's article that the televising of films presented no insurmountable difficulties and the idea of using a photographic film as an intermediary at once suggests itself. The principle is very simple: a cinematograph film of the scene to be televised is made and after rapid chemical processing passed through the film scanner. This entails a certain amount of delay as the processing takes some time to accomplish. For this reason it is necessary that some provision should be made to delay the sound in order that it will synchronise with the picture.

The considerations set down herewith, together with details of the apparatus entailed, are the result of the actual experience of the writer in superintending the design and construction of an intermediate-film transmitter for the Baird laboratories. It was decided that the process of scraping off the emulsion after scanning, re-emulsioning the film and passing it back to the camera as a sort of endless band would be too complicated. The apparatus needed to accomplish this would render the gear too bulky for practical purposes so it was decided to use a continuous supply of new film. In order to keep down the running costs it was essential to choose the smallest size of film consistent with photographic quality, and after a considerable amount of work on the part of photographic experts, a special 9.5 mm. film with a rapid processing emulsion was produced. This film had centre sprocket perforations between each frame and the grain was sufficiently fine that the amount of detail was judged to be enough to do justice to 180-line scanning. The illustrations re-

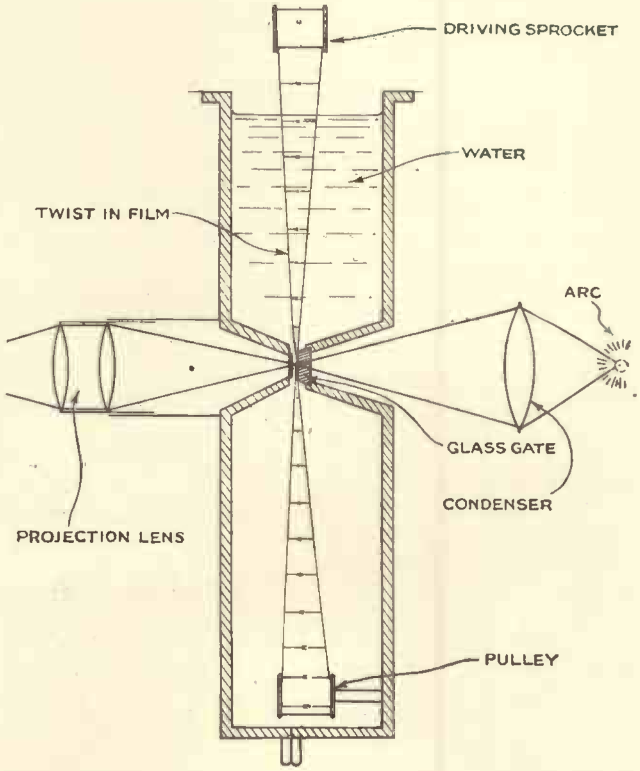


Fig. 2.—The scanning gate and optical system of the intermediate-film transmitter.

SOUND DELAY IN INTERMEDIATE-FILM SYSTEMS

produced here are untouched enlargements taken from some of this 9.5 mm. film after it had emerged from the intermediate-film scanner. Portions of the centre sprocket perforations can be seen at the top and bottom of each picture.

Some idea of the speed at which this special film can be processed may be obtained by reference to the following time delay chart:—

Time required for

		secs.
(a)	film to pass from camera to processing tank	½
(b)	developing	2½
(c)	washing	1½
(d)	fixing	5
(e)	film to pass from fixing tube to scanning gate	1½
	Total delay	11

In order to keep the time delay down to a minimum it was decided to scan the film in a wet condition. For the same reason a negative picture was used, as the process of making a positive would entail further delay apart from being entirely unnecessary. As is well-known, picture signals alternate from positive to negative with every stage of low-frequency amplification and it was only necessary to use a photo-cell amplifier with one stage more or less than what would normally be used with positive film.

The mechanical arrangements of the intermediate-film gear are shown by Fig. 1. The unexposed film passes from the spool box into the camera where 25 exposures are made every second. From the camera it moves over a driving sprocket into the processing tank containing developing, washing, and fixing tubes which are enclosed in a water bath maintained at 75° F. by means of an immersion heater and thermostatic control. From the processing tank the film passes into the gate where it is scanned under water before moving over a second driving sprocket and out into a storage tank. It will be seen that the film is twisted through an angle of 90 degrees when passing over the glass "gate." This was necessary in order to accommodate the optical system which is at right angles to the plane of the paper in Fig. 1.

Fig. 2 shows the scanning gate and optical system in detail. Although the film is under water it will be seen that the beam of light has to pass through only a small thickness of water and in practice it was found that no optical distortion was introduced by under-water scanning. Elaborate mechanical filters ensured a steady motion of the film through the scanning gate. The rest of the apparatus is identical with the tele-cine transmitter which was described in the first of this series of articles. The combined camera-processing plant and tele-cine projector was mounted on a truck, which also carried the photo-cell amplifier; the complete assembly was fully mobile and could be manœuvred into position for a "take" in any part of the studios.

Sound Delay

In order to delay the sound 11 seconds it was magnetically recorded on an endless steel tape moving over a series of pulleys at the speed of approximately 100 yards per minute. A magnetic pick-up was placed at a point on the tape which represented a delay of 11 seconds. The type of apparatus used was similar in principle to the Blatnerphone used by the B.B.C. for recording programmes for re-broadcasting.

Recent Modifications

Although this intermediate-film apparatus gave excellent results it was decided to make certain modifications for two reasons. In the first place the photo-electric impulses resulting from the centre sprocket perforations tended to overload the amplifiers. Secondly, because, not having a permanent sound record, it was not possible to re-run the film with sound. To eliminate these defects a somewhat wider film was selected having sprocket perforations at one edge. The extra width enabled a 2 mm. sound track to be embodied giving the required sound delay without resource to the steel tape apparatus. In the dry state this film can be re-run many times.

The intermediate-film process provides a very satisfactory solution to the problem of televising scenes, the only disadvantages being the delay and cost. As these are not serious matters, the system is likely to be generally adopted for practical use in television transmission; at any rate until the iconoscope is perfected.

"How to Build a Projection-lamp Transformer" (*Continued from page* 14.)

a hand drill, which is then gripped in a vice. The number of turns required may be ascertained by counting the teeth on the gears of the drill, which will give the gear ratio.

When the primary winding is completed the end is brought out through the nearest flange, as with the commencement and a label attached, which is marked 240 volts. Cover the winding with three or four thicknesses of empire cloth or other insulation, and if desired an outer covering of leatherette or American cloth will give the work a neat finish. The core is now placed in position and is assembled in the usual manner, a T section stamping being inserted from each end of the spool alternately, the corresponding U section stamping being placed in position at the same time.

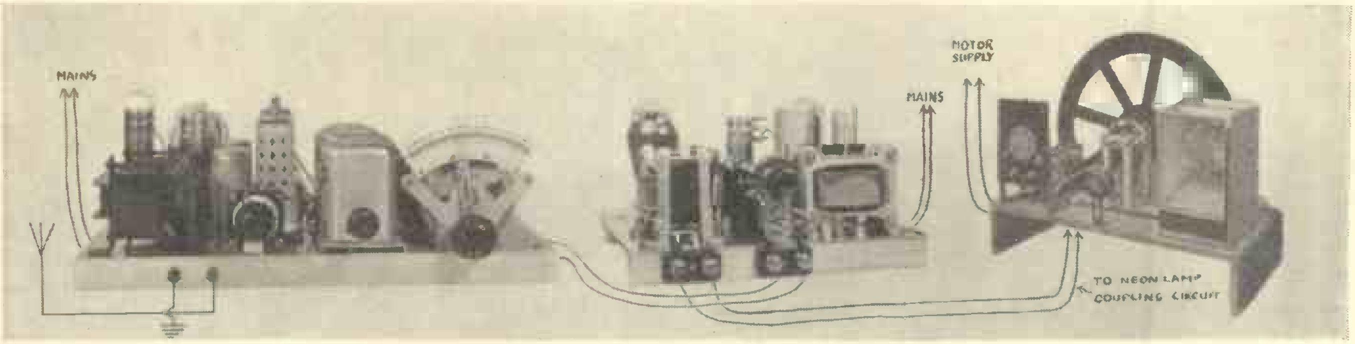
Assembling the Stampings

It will be noticed that the stampings are grey on one side and black on the other and they should be placed in position with all the grey surfaces facing in one direction. The spool should be packed as tightly as possible, the last few stampings being lightly tapped into position.

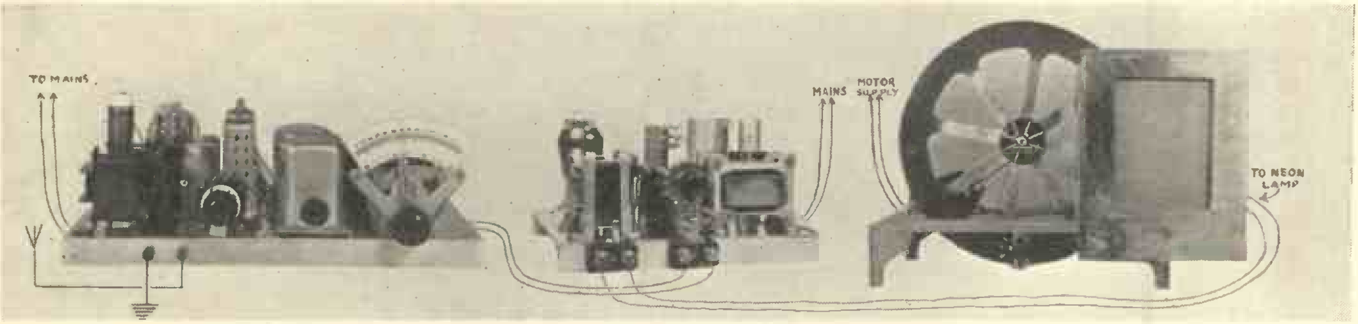
The windings should now be tested for insulation and if satisfactory may be tested on the mains with the projector lamp in circuit. It should be noted that the transformer must not be connected to the mains before the core is inserted. After testing, the aluminium clamps are bolted in position and a terminal block mounted in any position most convenient to the constructor. The six leads from the windings are now cut to the correct length and soldered to the appropriate terminals and the transformer is ready for use.

RECEIVING SYSTEMS IN PICTURE

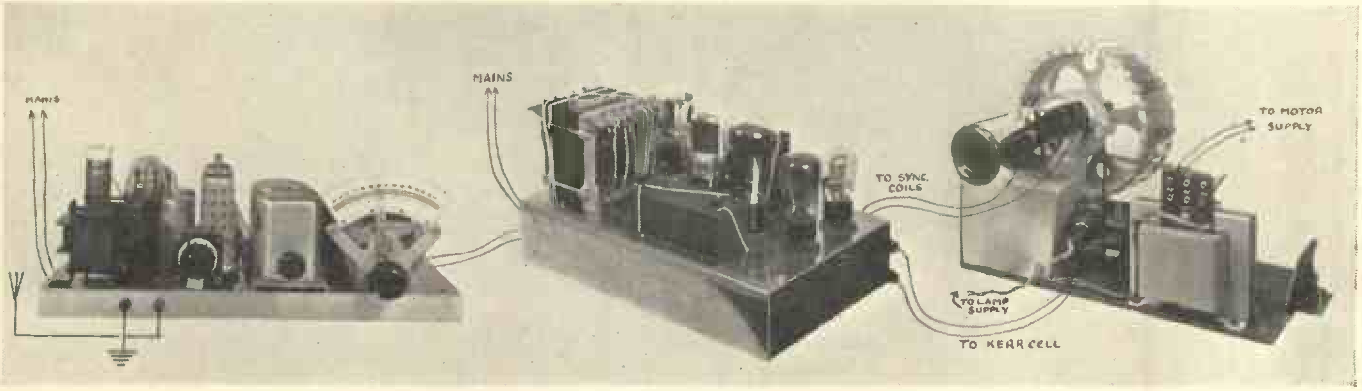
Receiving apparatus which has been described in this journal has been designed, so far as is possible compatible with assured results, so that it is adaptable to various purposes. These pictures give an outline of the methods of employing the Universal receiver for any class of reception. Alternatively the amplifiers shown are suitable for use with most existing wireless receivers, whether home or commercially built. In addition the Universal receiver forms the basis of the Simplest Cathode-ray Receiver which is the subject of articles in the November, December (1934), and current issues.



Although the average three-valve receiver is suitable for receiving pictures with disc apparatus, an amplifier such as is described on other pages in this issue is desirable. The scheme shown above employs the Universal receiver and the single-stage amplifier, though the place of the Universal receiver can be taken by any good-class three-valver.



This picture shows the same combination as that above but in use with the disc-screen projection apparatus which was fully described in the October, 1934, issue.



A mirror-drum scanner demands greater output for its operation than the disc and this scheme shows a complete outfit of this type employing the Universal receiver and a powerful three-valve amplifier with an additional stage for synchronising. Complete constructional details of the amplifier, which is based upon Baird design, were given in the June, 1934, issue.

ADDITIONS TO THE UNIVERSAL RECEIVER

By Kenneth Jowers

This article is in response to a number of requests for additions to the Universal Receiver which was described in the November, 1934, issue. Included are delayed automatic volume control, simple A.V.C. and L.F. volume control.

WHEN I started on the design of a universal receiver for television I was under the impression that with television in its present uncertain state, the average constructor would require simple apparatus, so as to avoid expense.

The volume of correspondence has proved that I was completely wrong and, that providing the results obtained were of a high order constructors were prepared to go to the additional expense and put in the refinements which could have been there in the first place.

I did endeavour to reply to readers individually and give circuits as to how they could embody these various little points raised, but I soon realised that most of the readers wanted either simple or delayed automatic volume control, a low-frequency volume control and some means of increasing the output to modulate a neon tube or mirror drum receiver.

So instead of writing dozens and dozens of letters here are the details which all of you appear to want.

Delayed A.V.C.

Firstly, delayed automatic volume control. The connections are shown in Fig. 1, where you will see the existing circuit is very little altered.

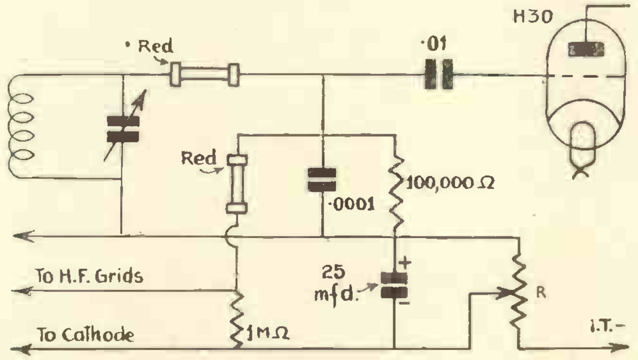


Fig. 1.—A straightforward method of obtaining delayed automatic volume control. This addition will not affect the sensitivity of the receiver in any way.

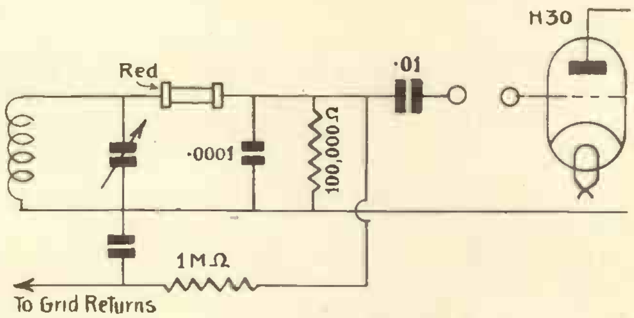


Fig. 2.—Simple automatic volume control can be obtained in this way. No additional rectifier is wanted.

In this circuit a fixed voltage has been introduced to prevent the automatic-volume-control operating until the signal is of a pre-determined value. Then the automatic volume control becomes fully operative. In practice this means that the receiver works normally at full sensitivity on all these signals, but is even more effective in keeping signals steady after they reach a certain value.

The particular value at which the automatic volume control becomes operative is determined by means of the potentiometer R, which carries a return anode current from all the valves in the receiver. The value of the resistance should be chosen to give a maximum of about 10 volts drop when carrying the full anode current. In this circuit 2,000 ohms should be suitable.

The additional Westector providing the automatic volume control voltage is of the WX6 type and make quite sure that the positive side of this goes to the negative side of the Westector used as a rectifier.

The circuit is more or less explanatory. You will see that one feed

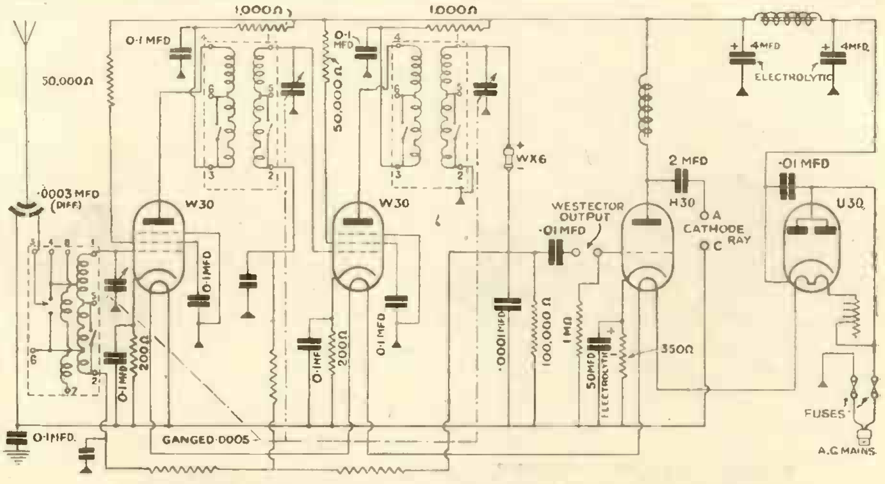


Fig. 3.—You will see from this how the automatic volume control voltage is fed back to the earth ends of the coils in the grid circuit of the W30's.

THE UNIVERSAL RECEIVER—L.F. VOLUME CONTROL :: REVERSAL

wire goes to the grid, that is the earth side of the coil in the high-frequency stages, while the other goes to the cathode returns.

If you do not wish to go to so much trouble you can obtain automatic volume control in a more simple way. In Fig. 2 you will see that I have simply tapped off behind the speech detector and the high-frequency current is fed back into the grids of the two high-frequency valves. It is carefully decoupled by a simple condenser and resistance network.

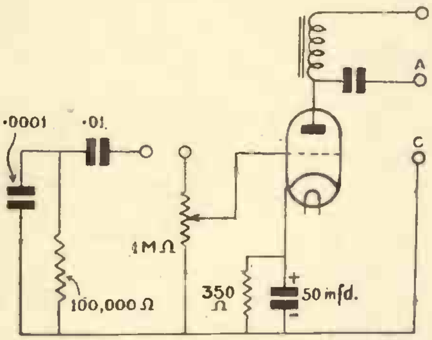


Fig. 4.—It is quite an easy matter to include a low-frequency volume control. In this circuit a potentiometer takes the place of the grid leak.

If you use this circuit, Fig. 2, the only alteration you will have to make to your Universal set is to remove the earth side of the two grid coils, that is terminal No. 2 on the first two coils must be removed from earth and connected as shown.

Take a look at Fig. 3 and you will see just what I mean. The leak immediately after the detector should have a value of 1-megohm while the leaks actually in the grids should be approximately 10,000-ohms and by-passed with .01 condensers. This circuit, of course, does not give any delay action and some of the weaker stations may be lost, but as this receiver is for television reception and the weak stations may not be of any use anyhow, there is no need to worry about that.

Now as regards adding a low-frequency volume control. Personally, I don't think it is entirely necessary, for the output from the Westector is not very high and you should not even when close to a local station, be able to overload a H30. However, the simplest way of adding a volume control is to take out the 1-megohm grid leak in the grid circuit of the H30 and connect between the second socket and the chassis a 1-megohm variable potentiometer. The slider of this potentiometer is then taken to the grid of the H30.

When it comes to increasing the undistorted output from a universal receiver there are a few more complications. First of all I have not yet come across an output triode, with a .3-ampere heater that will give much over 1-watt. The Mazda people have a series of D.C. valves with .1 heaters, so the obvious solution is to make a simple two-stage amplifier as a separate unit with resistance capacity coupling having a very low stage gain.

You will get the idea if you take a look at Fig. 5. In this the terminal marked A and C are connected directly to the terminals marked A and C on the receiver. The input to the grid of the first valve a D.C. 3HL is controlled by means of a $\frac{1}{2}$-megohm variable potentiometer. In the anode circuit of this valve is a resistance of 10,000-ohms, while the whole anode circuit is decoupled by means of a 5,000-ohms resistance and 4 mfd. condenser.

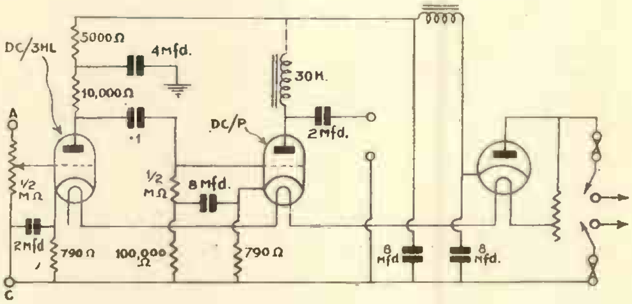


Fig. 5.—This suggested amplifier can be used with all types of receivers, whether A.C. or D.C. mains operated.

The coupling condenser between the DC/3HL and the DC/P is rather a variable quantity, but a good average value is .1-microfarad. Notice how the grid of the output triode is decoupled. The grid circuit consists of a $\frac{1}{2}$-megohm leak in series with a 100,000-ohms resistance, the centre of which is coupled to the cathode by means of an 8-microfarad low voltage electrolytic condenser.

The self-bias resistance for the DC/P should have a value of 790 ohms. This is the theoretical value and is rather odd, so in practice use either 750 ohms or 800 ohms.

The amplifier is perfectly straightforward but when used on D.C. mains where the available voltage is likely to be low, you must make quite sure that the smoothing and the output chokes are of low resistance. The Sound Sales people make suitable chokes having a resistance of 215 ohms each.

I mention this point particularly because there are so many chokes on the market at the moment, having a resistance of about 1,000 ohms which, if used in an amplifier of this kind, would reduce the voltage to about 130 or 150. There is little possibility of modulation hum being noticed, but in the case of accidents it will save you writing in, all you have to do is to connect a .01-microfarad condenser between the anode of the rectifying valve and earth.

There were several letters asking how to obtain image reversal, with the Universal receiver. A WX6 type Westector was carefully mounted in a holder for this very purpose, so remember that if your pictures show black when they should be white and vice versa, simply reverse the rectifier, so that the negative side connects to the coil and the positive to the .01-microfarad coupling condenser.

Readers who wish to increase the amplification can do so by reducing the value of the bias resistance in series with the cathodes of the two W30's. At the moment there is a standing resistance of 200 ohms. This can be reduced to 100 ohms with advantage providing the receiver is not used too close to a local station, otherwise distortion may be set up.

The Edison Bell Co. have developed a method of recording television on film and it is understood that it is proposed to put the apparatus on the market at an early date. Four tracks are used on the film, which is caused to travel backwards and forwards. A photo-cell is, of course, an essential part of the apparatus. It is hoped to give full details at an early date.

REVIEWS OF THE PROGRAMMES AND RECEPTION REPORTS

"DISSOLVING" the picture presents a problem of transmission that has still to be solved. Lookers are familiar with the "fade" from the miniature caption transmitter to a scene in the studio and of the "slide" from one caption to another. They have seen, too, a cunning use of a drawing in the caption machine as a foreground to action in the studio, and maybe they have been puzzled sometimes when the two scanners have been used together. The dissolving picture is a favourite device of the cinema and it is not surprising that the producer has attempted the same effect. The clumsy method used explains why it has not been seen more often.

In a "dissolving" picture the scene must slowly fade away until only a void remains and film producers demonstrate that the most effective finale to this manœuvre is a momentary flash on a blank white screen. We see it in many films. It is easy to "fade" a television picture and the difficulty lies in the final flash of white which distinguishes the shot from a slow "black out." Illumination is needed for this and in every "dissolving" picture up to date the ultimate effect has been achieved by holding a large square of white cardboard a few feet in front of the main scanner.

Renita Kramer who appeared on December 1 in her wonderful "double" dance. The clearly defined contrasts in this subject made it particularly suitable for television purposes and excellent reports of the clarity of reception have been received from all parts of the country.

The time has come to discard such clumsy tricks and a small permanent white screen is being fitted for use in emotional moments—whenever the producer decides to dissolve on a lovers' kissing or on a deathbed scene.

* * *

A scene in the studio was most effectively combined with a drawing in the caption machine in Hermione Gingold's number, "Nobody believes that I am a mermaid; but I am! I am! I am!" She rose clad in scales (in the studio) from the sea (in the caption machine) and the illusion was complete. But this was not all. The sea got rougher as one drawing followed another in the caption transmitter and a second figure appeared above the waves in the picture. It was Barnacle Bill, rather slow for a sailor. Did you ever know a seaman mistake a mermaid for a kipper? She pushed him under and the next shot was obviously at the bottom of the sea. Harold Scott was the sailor, for I recognised his voice and his song was not unsuitably "The Bride's Lament." Did you spot the fishes swimming past and the waves breaking (in the caption machine) as Barnacle Bill sank in close-up in the studio? Altogether an ingenious and artistic comedy effect which was produced by scanning panoramic drawings in the caption machine and action in the studio simultaneously. Half and half, as they say.

* * *

It is the end of the year, so let us attempt to survey progress during 1934. The most important events have been the transfer from Broadcasting House to a studio and control room specially equipped in 16 Portland Place, and the extension of programmes by half an hour each week, which coincided with a change in days, enabling lookers to use their visors on Saturday afternoons. It had long been obvious that the studio at Broadcasting House, designed for a dance band, was unsuitable for use by television. There the scanners were fitted in a small listening cabinet where movement was restricted and the heat from the arcs was oppressive.

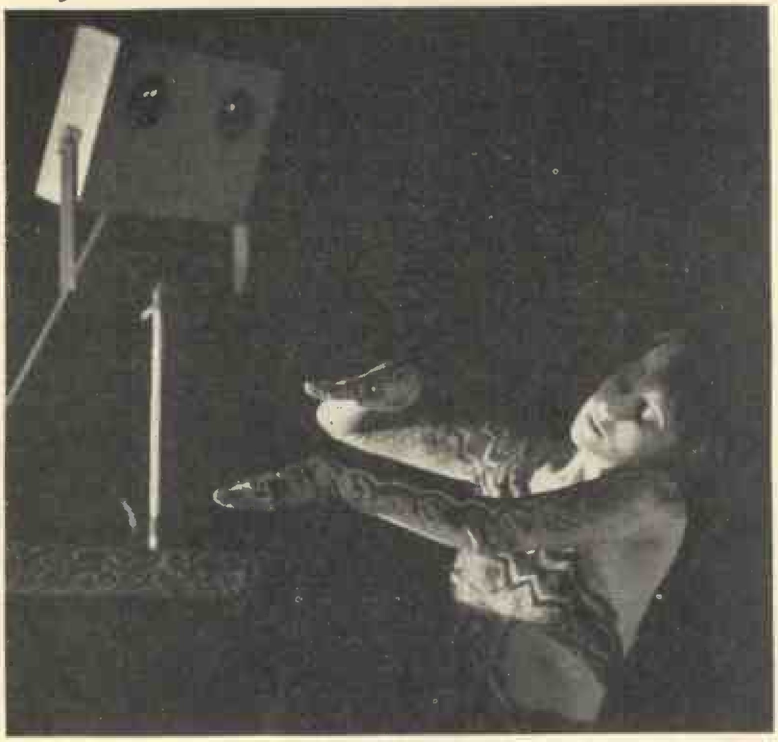
On removal to the studio and projection room specially designed for the job in Portland Place, programmes soon showed that the producer was taking advantage of the new facilities which included a much wider screen and longer travel for the scanner. At this point, too, the musical accompaniment showed signs of improvement. There was room for a small orchestra behind the black silk curtains of the new studio and we began to hear less and less of the solo piano.

With the new accommodation, larger dressing rooms became available and more ambitious productions followed as soon as proper care could be taken of costumes. Operatic scenes became possible and ballets with an impressive décor were transmitted. The new conditions brought such famous singers as Heddle Nash and Sarah Fischer to perform in costume for a *Carmen* programme, and Sokolova appeared in an elaborate ballet.

Oliver Messel designed a dress especially for Laurie Devine to dance in the studio, and John Hendrik sang Schubert songs in a costume reminiscent of the West-End production of *Blossom Time*.

The producer was quick to seize the opportunity offered by longer programmes. Scenic effects were developed. Novelties such as the flying trapeze were introduced; stairs and window scenes became a common feature of the programmes. Shaw Desmond gave a talk on Ju-Jitsu with practical demonstrations of the art—thus illustrating for posterity the informative and educational value of the new medium. Dancing has been a strong feature of most programmes. Agnes de Mille gave an exhibition of her exceptional art.

In the control room at 16 Portland Place the studio and the caption machine were controlled from the same desk and much greater use has been made of the small transmitter. Most nights we have seen titles and artists' names during the overture, and a polish has been given to production by frequent switches to designs specially drawn for the caption apparatus while the scene has been changed in the main studio. No more blank intervals now; there is always something to see.



Another photograph of Renita Kramer as she appeared in the television studio in the Snake Dance.

* * *

It was a pity about the goldfish. Who was to know that the brilliant light of the arc would have a disastrous consequence? Eustace Robb had seen a bowl of the pretty fish in an office and he carried it triumphantly to the studio for a trial. The bowl was placed on a table in a close-up, the light was focused upon it and a good picture appeared on the screen as the fish swam round and round the bowl. Exposure to light is a useful treatment for many complaints; but apparently it is not so for fish. One succumbed and we were deprived of what might have been an informative and novel programme.

* * *

Children were looking in their fathers' visors on a recent Saturday when the producer showed toys from Selfridge's bazaar. The display of tops, masks, dolls, railways, motor-coaches and animals must have whetted the youthful appetite for Christmas—and the toys all worked. Harry Hemsley was again Father Christmas and his "Winnie" wanted, as usual, the toys which were not included. Just in case the boys felt that too many dolls were on view, Santa Claus produced a football, and we had the pleasure of seeing this venerable figure kick-off.

But of all the delightful toys that were seen during the month, the one which caused the biggest sensation around my screen was Tiddly-Winks, the ambiguous dog carried by Anona Wynn for her song on another evening. He came from the same shop. His colouring, black and white, was perfect for the medium, and did you notice the whites of his eyes? His pupils of amber, turned skywards, gave a pathetic air to an expressive face, which caused a stir in the home circle of at least one humble looker.

* * *

Eustace Robb continues to bring artists of the highest standing before the projector, drawing for talent upon the theatre, the opera, the ballet, music-hall, radio and cabaret. Leila Megane is one of the most distinguished recruits of the month. Of Welsh origin and a pupil of the famous Jean de Reszke, this artist was prima donna at the Opera Comique in Paris, where she and the producer first met. Discovering that she was in town the other day, Eustace Robb persuaded the singer to come along for a transmission. She has a lovely mezzo-soprano voice of great range and her performance confirmed what I have always believed—that a thorough stage training is a great asset to an artist in the television studio.

* * *

Renita Kramer, the girl who gives a startling performance, dressed half as a man and half as a girl, is a star from another sphere, who made a first appearance during the month. In my visor the illusion of a couple embracing was complete. Both the dance and the original costume were her own invention.

THE TELEVISION ENGINEER

A DESCRIPTION OF AN  ICONOSCOPE EXPERIMENTAL TELEVISION SYSTEM

By R. D. Kell, A. V. Bedford and M. A. Trainer
(RCA Victor Company Inc., Camden, N.J.)

This article is a description of an experimental transmitting system using the Iconoscope as the signal generating device. Tests of the apparatus included motion-picture film and studio and outdoor scenes. It is published by permission of the Institute of Radio Engineers, New York.

THE previous experiments indicated that the iconoscope offered the most satisfactory solution of the problem of increased detail. Due to its mode of operation, as has already been explained*, the sensitivity of the iconoscope was sufficient to allow a further increase in the number of scanning lines. With considerable increase in detail, there was still sufficient sensitivity to make possible the use of the camera with light conditions suitable for a regular motion picture camera.

Early preliminary tests with the iconoscope had indicated that the resolution of the system was no longer limited by the television elements. Strictly speaking, these elements are only the kinescope and iconoscope; the resolution of each is considerably greater than could be transmitted through the remainder of the system. In using film transmission of 180 lines, all component parts had been designed to pass the top theoretical frequency of 500 kilocycles. Without major changes, it was found possible to extend thiis range to 600 kilocycles.

Picture Frequency

The conventional method of calculating the maximum picture frequency required for a given number of lines is as follows:

$$f=\tfrac{1}{2}\, a^2Rn \text{ or } a = \sqrt{2f/nR}$$

where f is the maximum frequency in cycles, a is the number of scanning lines, n is the frame repetition frequency, and R is the aspect ratio of the picture. This equation gives the fundamental frequency which would be generated by scanning a pattern composed of alternate black and white vertical bars in which each bar has a width equal to the line pitch. The line pitch is the distance between centres of adjacent scanning lines.

A system capable of transmitting the maximum frequency given by this equation and having a scanning spot of diameter no greater than the line pitch, would resolve the bars in so far as peaks of black and white are concerned. This would hold for any horizontal displacement of the test pattern. With the same test pattern in a horizontal position so that the bars lie along the scanning lines and with the bars and lines coinciding, proper resolution is again obtained. If the pattern is now moved vertically a distance equal to half the line pitch—due to each line covering half of a white bar and half of a black bar—no signal will be generated and the resolution will be zero regardless of the frequency band the system is capable of transmitting. For intermediate positions of the pattern, the resolution will vary gradually from 100 per cent. to zero.

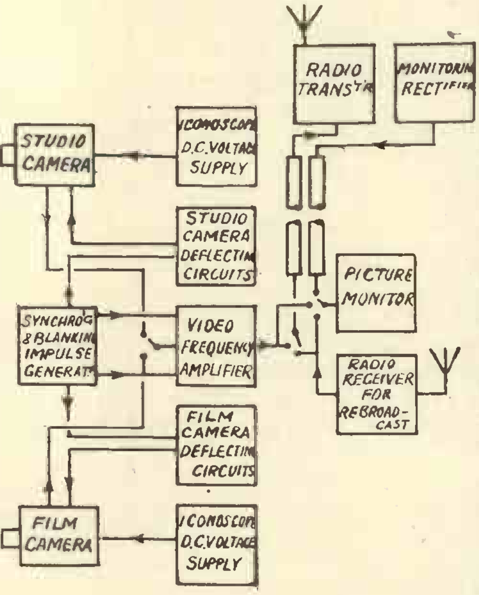


Fig. 1.—Diagram showing the relationship of the principal units in the installation.

It is axiomatic that for best resolution of random picture subject matter, equal resolution should be obtained along all axes. The equation given above fails to fill this demand for at least two axes at right angles to one another, using even the basic test pattern upon which the equation is founded. Analyses for other axes are difficult but observations indicate that they would generally support the same conclusion. Therefore, the above equation makes the number of scanning lines too low to secure the maximum amount of detail in a given picture frequency band width.

In television we are not interested in viewing uniform bars in various positions, any more than we wish to listen to sine waves of sound, but such bars and waves are considered best for analytical purposes. Tests made with a calibrated resolution pattern projected upon the plate of the iconoscope and with a variable number of scanning lines showed the resolution to be substantially equal along horizontal and vertical axes when the number of scanning lines, a, was approximately 1.25 times that calculated by the equation given above. This justifies the introduction of an additional constant, k, making the formula

$$f=\tfrac{1}{2}a^2Rnk \text{ or } a=\sqrt{2f/nRk}$$

where k equals $1/(1.25)^2$ or 0.64. From the above corrected equation the 600-kilocycle channel is found to give equal vertical and horizontal detail when 240 lines are used at a

* V. K. Zworykin, "The iconoscope—A modern version of the electric eye," *Proc. I.R.E.*, vol. 22, no. 1, pp. 16-22; January, 1934.

repetition rate of 24 pictures per second. With this number of scanning lines a complete television installation was made having facilities for transmitting studio, film, and outdoor scenes. Impulses having an amplitude greater than the picture signal were transmitted at the end of each scanning line and at the end of each frame for synchronising.

The relationship of the major components of the installation is shown in Fig. 1. The film and studio cameras are practically identical. In the film camera a motion picture projector was used to project the image upon the iconoscope plate, while in the studio camera a photographic lens formed the image of the scene to be transmitted on the iconoscope plate.

Fig. 2 shows the general arrangement of parts in the camera. The partition *a* through the centre is an electrostatic shield separating the picture frequency amplifier from all other voltages applied to the iconoscope. This shielding is quite essential due to the magnetic and electrostatic fields around the deflecting coils and plates. The deflecting coils for causing the scanning beam to move vertically are seen at *b*. The deflecting plates for causing the beam to move horizontally are not visible in the photograph. They are mounted directly on the electron gun structure. The leads from the plates are brought out through the base with the other voltage leads.

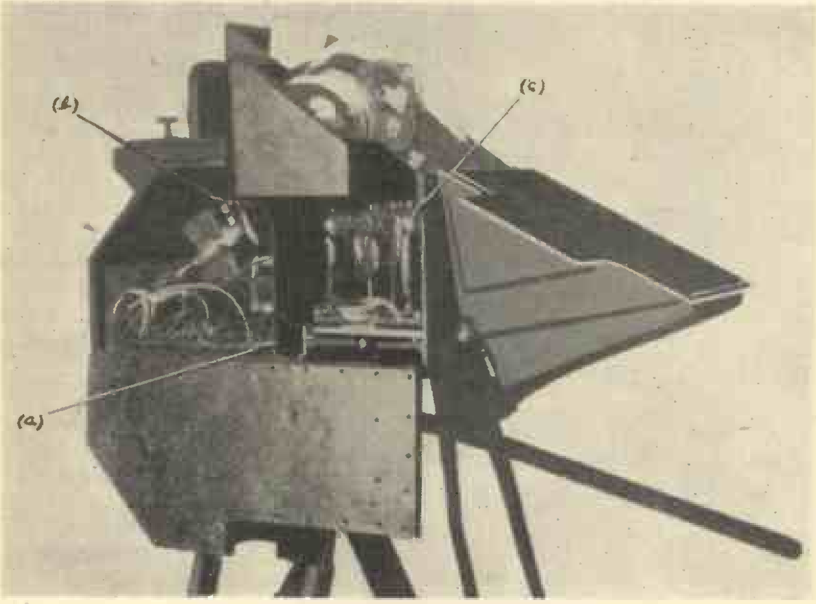


Fig. 2.—Photograph of the studio camera used.

The amplifier *c* consists of three stages. The third stage has an output impedance sufficiently low to allow the picture frequencies to be transmitted to the control room through a considerable length of special cable.

The circuits for causing the electron beam of the iconoscope to scan the photo-electric mosaic plate are similar to those used for deflecting the beam of the receiving kinescope, the greatest difference being due to the fact that the mosaic plate is not at right angles to the electron gun.

Since the scanning beam and the optical image strike the same side of the iconoscope mosaic, it is impractical for the axis of both the electron gun and the lens to be at right angles to the mosaic plate. The use of standard lenses requires that the plate be perpendicular to the optical axis of the lens. This requires that the scanning beam strike the plate at an angle. An outline of an iconoscope is shown in Fig. 3a.

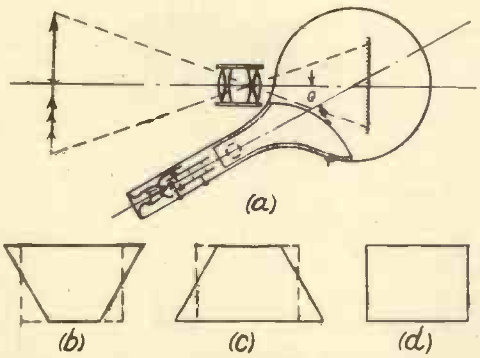


Fig. 3.—Schematic diagram showing the arrangement of the Iconoscope and diagrams explaining the necessity of deflecting the angle of the beam.

"Keystone" Effect

If the iconoscope is subjected to the regular scanning a "keystone" shape pattern will be formed due to the longer beam path to the top of the mosaic plate as shown in Fig. 3b. The deflecting means serve only to vary the direction of travel of the electron scanning beam. Hence, the amplitude of the deflection at the plate depends upon the distance from the deflecting means to the plate. In order to scan a rectangular area, Fig. 3d, on the iconoscope plate and avoid distortion of the transmitted picture, it is necessary to deflect the beam by the scanning action in such a way that if it fell upon a plate at right angles to the average axis of the beam, it would scan a pattern such as Fig. 3c.

The required horizontal scanning voltage wave is obtained by modulating the horizontal saw-tooth in

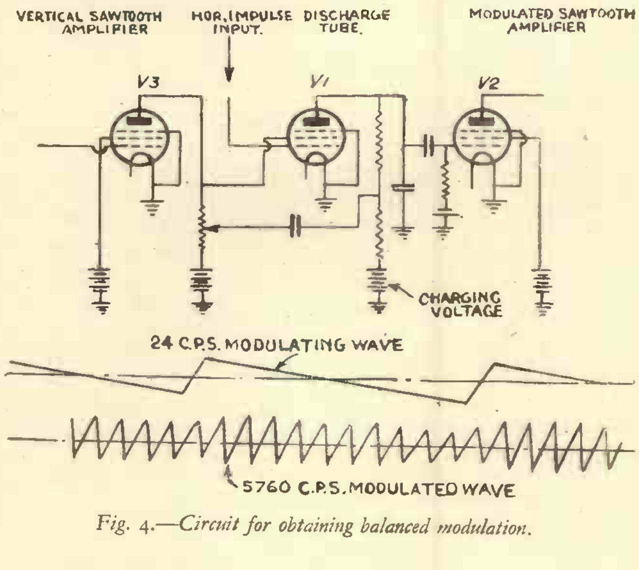


Fig. 4.—Circuit for obtaining balanced modulation.

amplitude by the vertical saw-tooth wave. The modulation requirements are unusual in that, to produce a symmetrical scanning pattern, the modulated horizontal saw-tooth wave must contain no component of the vertical saw-tooth wave. Furthermore, the modulated wave must retain a good saw-tooth (or triangular) wave shape throughout its cycle of modulation.

means of the vertical saw-tooth of voltage. The combined action of these two vertical saw-tooth voltages on the horizontal saw-tooth generating circuit is to produce the desired amplitude modulation of the horizontal deflection of the scanning beam.

As previously mentioned, the effect of moving the camera forward or away from the subject is obtained without physicaly moving the camera. By adjusting the position of the scanning pattern to various sections of the mosaic, the effect of turning the camera may also be obtained.

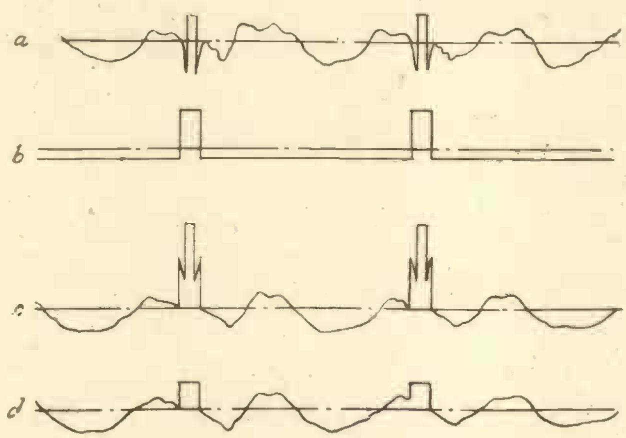


Fig. 5.—Graphs of the generated signals.

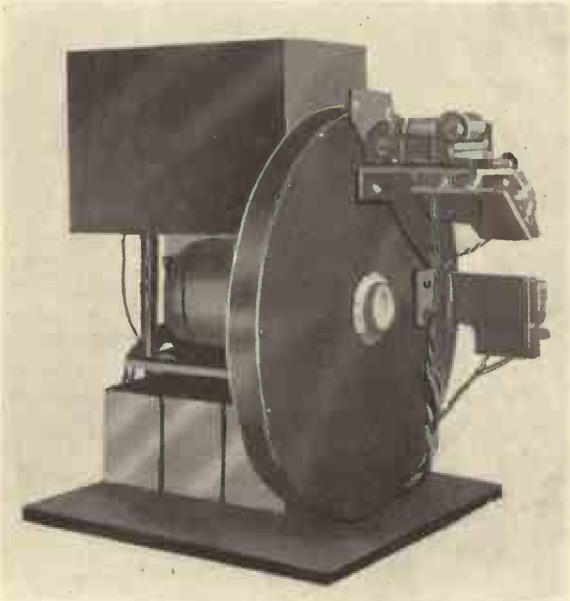


Fig. 6.—Photograph of the electrical signal impulse generator.

Due to the very extended range of harmonics and the precise phase relations required to form a good saw-tooth wave, wave filters have been found to be of little aid in the problem of separating the modulating and modulated waves after they are once mixed. It has been found much easier to guard against any mixing of the waves in the modulating process, by using a special type of balanced modulation.

A circuit arrangement for accomplishing this is shown in Fig. 4. The horizontal deflecting circuit makes use of a condenser charged through a high-resistance and intermittently discharged by a four-electrode vacuum tube V_1. This arrangement produces a saw-tooth wave of voltage across the condenser which is amplified and applied to the deflecting plates. During the vertical scanning cycle, the amplitude of the condenser charges on the condenser C in the horizontal deflecting circuit is decreased at a constant rate by decreasing the supply voltage to the charging resistor by means of a vertical saw-tooth of voltage.

To maintain the discharge always equal to the charge, the control-grid or the screen-grid voltage of V_1 is also varied in exact proportion by

resolution of the iconoscope is considerably better than the rest of the system is capable of transmitting. As a result of this, it is possible to scan an area considerably smaller than the full size of the iconoscope plate before the resolution of the iconoscope becomes the limiting factor. This makes possible an unusual flexibility in the use of the camera. By changing the horizontal and vertical scanning amplitudes simultaneously, the

This shifting of the scanned area with respect to the entire area of the mosaic is accomplished by introducing direct-current components into the saw-tooth deflecting circuits. The combined result of these two controls makes possible various effects; for example, first showing a close-up of a person, moving slowly away to take in the full scene, and again moving forward to a close-up of another per-

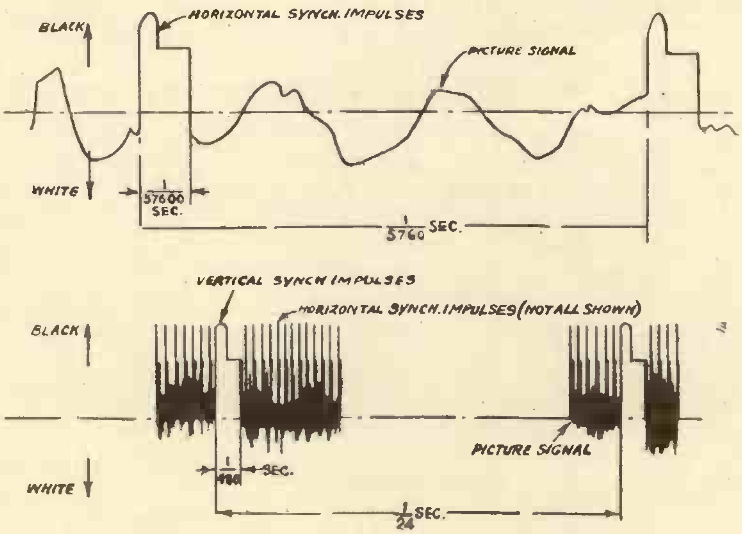


Fig. 7.—Appearance of a complete signal as viewed on an oscilloscope.

son; all this apparent movement of the camera being accomplished by purely electrical means.

The picture signal generated by the iconoscope is produced by the electron beam discharging the elemental condensers forming the surface of the mosaic. The current released as a signal at any picture element is a function of the illumination of the point under scanning and also upon the time the scanning beam covers the elemental picture area. In other words the signal generated is

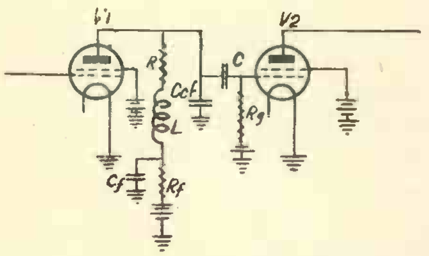


Fig. 8.—Typical amplifier stage.

not only a function of illumination but also a function of the velocity of the scanning beam. This means that to produce a picture signal which is truly representative of the light values of the picture, the velocity of the scanning beam must be constant. By careful design of the circuits for deflecting the scanning beam, this has been practically accomplished during the actual picture scanning time. But during the reversal and return of the scanning beam the velocity cannot be constant and undesirable signals are generated. The total signal generated has the general appearance of that shown in Fig. 5a.

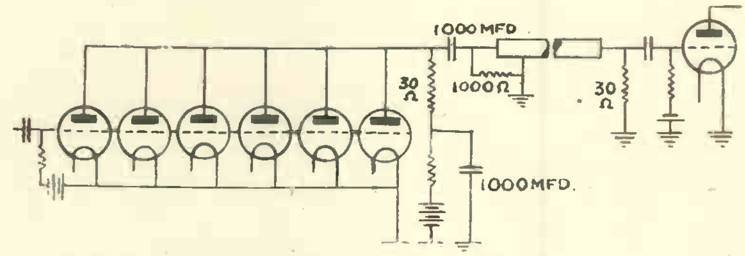
The undesired signal generated during the reversal and return of the scanning beam may have an amplitude of several times the useful picture signal and, of course, it must be removed from the final transmitted television signal. To do this a square wave-shaped signal generated by the disc that produces the synchronising impulses is introduced into the amplifier. The wave shape of this signal is shown in Fig. 5b.

The amplitude of the signal is such that the white parts of the undesired signal are shifted with respect to the axis to a point that corresponds to black, as shown in Fig. 5c. The picture frequency amplifier is so arranged that this combined signal is of such a polarity and amplitude that the undesired signal swings the grid of an amplifier tube beyond cut-off. The result is a signal in which the amplitude of the blanked-out section is, for practical purposes, a constant with respect to the axis, as shown in Fig. 5d.

Fig. 6 is a photograph of an electrical impulse signal generator. A disc containing two circular rows of apertures is driven by a motor at 1,440 revolutions per minute or 24 revolutions per second. An illuminated optical slit is imaged on each of the two rows of apertures. Behind each row is a photo-cell with its associated amplifier. One set of apertures is of sufficient width to generate the wave which blanks out the amplifier signal during the return line time of the iconoscope horizontal scanning beam.

These are the impulses used to remove all extraneous signals, as previously described. They occupy a time equal to 10 per cent. of the horizontal scanning cycle. The vertical impulse is sufficiently long to produce a black signal for a time interval slightly longer than the vertical return line time on the kinescope. This serves to extinguish the kinescope scanning beam during its vertical return across the screen.

Fig. 9.—Circuit arrangements of coupling.



Synchronising

The synchronising impulses are generated by the light passing through the second set of apertures in the disc. These signals are introduced into the amplifier after the signal level for black has been set by the cut-off action of the amplifier. They are so phased that they occur at the beginning of the blank or black sections. Since all signals generated in the iconoscope pass through the limiting tubes that remove the undesired signals, it is impossible for any picture signal to become of such an amplitude as to interfere with the proper synchronisation of the receivers. Furthermore, since the synchronising impulses are superimposed upon the blank sections or "pedestals," the height of the synchronising impulses will remain constant, thus facilitating the use of amplitude separation of synchronising signals from the picture signals at the receiver. The appearance of a complete signal as viewed on an oscilloscope is shown in Fig. 7.

The peak signal obtained directly from the iconoscope is approximately 0.001 volt across 10,000 ohms. With this input, an amplifier having a voltage gain of 2,000 is sufficient to supply signal at a two-volt level. A typical amplifier stage is shown in Fig. 8. The response of the amplifier at the high frequencies is equalised by placing a small inductance L in series with each plate resistor R. The value of the inductance for a given circuit may be determined by a very simple rule which gives a flat amplifier characteristic and negligible phase distortion. The plate resistor in an amplifier stage should be equal in ohms to the effective reactance of the tube and distributed capacity C_{ef} at the highest frequency which it is desired to pass. The reactance of the inductance in the plate circuit at this frequency should be equal to one-half the value of the plate resistor. In order to obtain a flat frequency response at the low frequency end, plate filters are used.

Each plate supply is filtered through a resistor R_f by-passed by a condenser C. The circuit constants are so selected that, as the reactance of the coupling condenser between stages rises as the signal frequency is lowered, tending to cause a loss in voltage applied to the grid of the following stage, the reactance of the by-pass condenser on the plate filter rises, increasing the effective plate circuit impedance. This balance of

(*Continued on page* 43.)

THE TELEVISION ENGINEER

MODERN PHYSICS AND TELEVISION RESEARCH—II

By J. C. Wilson,
of the Baird Laboratories

As was pointed out last month in the first of this series of articles, although the television engineer is not directly concerned with pure physics, a wide knowledge is usually a great advantage, particularly in any new line of research.

EINSTEIN AND PHYSICS

IN the preceding article we met the hypothesis that all bodies, when moving, contract to $\sqrt{1-v^2/c^2}$ of their length when at rest with respect to an observer, where v is the velocity of a moving body and c is the velocity of light. This hypothesis was set up to account for the apparent impossibility of determining what is the velocity of, for example, the earth through the ether (through which light-waves were, of course, presumed to travel with fixed velocity c).

We have now to discuss how this remarkable result follows directly from a four-dimensional conception of the universe, allied with a velocity of propagation of light which is constant in a very special and novel sense. This is Einstein's view; and it has the merit not only of being simple itself, but of simplifying and unifying many things on which it bears.

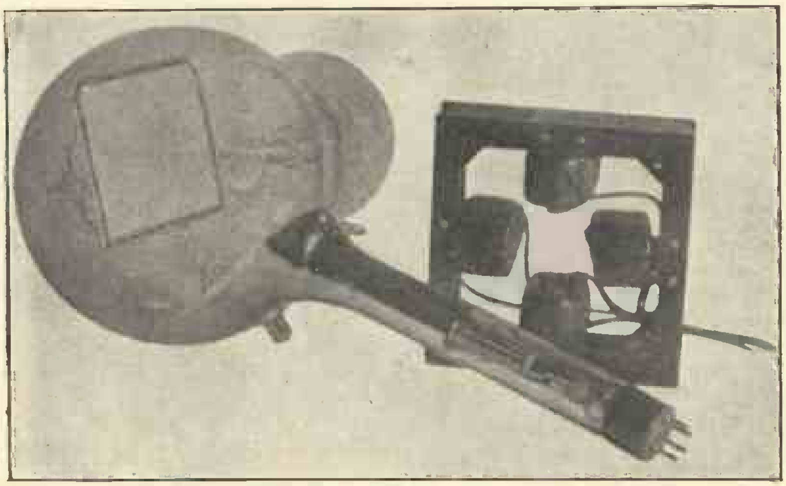
To understand this view, we must get rid of certain preconceived ideas about light-waves, and this can best be done by an analogy with sound-waves. Suppose a train is travelling along with the velocity of sound (eleven hundred feet per second, or about 750 miles per hour) and the guard puts his head out of the window and calls out to the driver. The driver would never hear the guard, owing to the fact that the sound waves would travel through the air at the same rate as the train, and so would never get any nearer to the engine. On the other hand, if the driver called out to the guard, the sound would reach him in half the time it would take if the train were stationary.

But if the experiment were carried out with light, from a train travelling nearly at the velocity of light (about 186,000 miles per second) a vastly different result would be obtained, according to Einstein's view. Suppose the guard flashed a pocket-torch: the driver would see it just as soon as if the train were still, whereas if the driver flashed it to the guard, he would see it no sooner.

In other words, if a beam of light is shining past you, and you measure its velocity, you obtain the figure 3×10^{10} cm./sec. If you then begin to move along the light beam in the direction it is going, and gradually increase your speed up to substantially that of the light itself, *you will still obtain the figure 3×10^{10} cm./sec. for the rate at which the light is moving past you!*

This may seem fantastic to those accustomed to so-called "intuitive" ideas about time and space: nevertheless it leads, amongst other things, when worked out, to a system of geometry which is more consistent with the facts of physics than is Euclidian geometry. The proof of the pudding, in other words, is that it tastes nice.

So vitally important is this new point of view, and so necessary is it to know *what* modification of Euclidian geometry is the result, that (at the risk of seeming too severely mathematical) I will try to indicate some steps in the algebra in which the modifications are defined.



The Iconoscope tube and deflecting coils.

Now the distance between two points in space, one of which is the "origin," or the point where the x-axis, y-axis and z-axis cross, is

$$D_1 = \sqrt{x^2 + y^2 + z^2}.$$

Also, if c is the velocity of light, then in time t a ray of light will have travelled a distance:

$$D_2 = ct$$

But if the light is sent from the origin and reaches the point x, y, z in time t (i.e., if $D_1 = D_2$), we have, on squaring both sides;

$$x^2 + y^2 + z^2 = c^2t^2.$$

By performing an experiment involving measurement of x, y and z (indirectly, of course) and also t, an observer could calculate c from this equation. Now according to the older, classical Newtonian ideas, if another observer in a railway train moving along the x-axis (for simplicity) with velocity v took as his "framework of co-ordinates" a new set x', y', z' and t', moving with him but pointing in the same directions as the stationary set, he would write down a different equation, namely:

$$x'^2 + y'^2 + z'^2 = c'^2 t'^2$$

and if he wanted to exchange ideas with the stationary observer, they would agree that:

$$\left.\begin{aligned} x' &= x - vt \\ y' &= y \\ z' &= z \\ \text{and } t' &= t \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \text{(A)}$$

so that c' could be calculated, and would (they thought) turn out to be slightly different from c owing to the fact that the second observer was moving through the ether at a different rate.

This is just what Einstein, with a brilliant flash of genius, knocked on the head; he substituted:

$$x'^2 + y'^2 + z'^2 = c^2t'^2$$

that is, with the same value c for the velocity of light as in the stationary case. This immediately means that the set of equations marked A (called a *transforming set*, or simply a *transformation*) cannot possibly be true, classical though they are. In order to find out a new transformation that fits his theory, we must introduce a little algebraic trickery and write:—

$$\begin{aligned} x' &= m(- vt) \\ y' &= y \\ z' &= z \\ t' &= nx + \beta t \end{aligned}$$

where m, n and β have to be determined.

Now $x^2 + y^2 + z^2 = c^2t^2$ must be equivalent to $x'^2 + y'^2 + z'^2 = c^2t'^2$ so that we may write:

$$x^2+y^2+z^2- c^2t^2=m^2(x-vt)^2+y^2+z^2- c^2(nx+\beta t)^2.$$

Comparing coefficients we get:—

$$\begin{aligned} m^2 - n^2c^2 &= 1 \\ m^2v + c^2n\beta &= 0 \\ m^2v^2 - c^2\beta^2 &= -c^2 \end{aligned}$$

and solving these equations we find that m and β are both equal to $1/\sqrt{1 - v^2/c^2}$ and that n is equal to $(v/c)\,(1/\sqrt{c^2 - v^2})$.

On putting these values in the transformation we get:

$$\left.\begin{aligned} x' &= (x - vt)/\sqrt{1 - v^2/c^2} \\ y' &= y \\ z' &= z \\ t' &= (vx/c^2+t)/\sqrt{1-v^2/c^2} \end{aligned}\right\} \quad \ldots\ldots\ldots \text{(B)}$$

This transformation (B) is known as the Einstein or Lorentz transformation, as opposed to the Newtonian transformation (A). It will now be seen that according to it *there is a contraction in the length of moving bodies of exactly the same amount as we found in the last article was required to account for the result of the Michelson-Morley experiment*. That this contraction does not enter into everyday measurements is due to two things:

(a) If we measure the length of a body at rest and then in motion, we can only do so by the expedient of putting a ruler alongside it and checking it against marks thereon; but the ruler contracts just the same amount as the body when moving with it!

(b) If we could, by magic, examine the length of a body in motion without a moving ruler or its equivalent, we would not notice the change in length at any velocity likely to be obtained: for example; the change in length of the new Cunarder No. 534 (now *Queen Mary*) when proceeding to New York at 30 knots would only be about 0.00000016 of an inch due to Lorentz contraction.

In fact, one of the very few ways in which we can test the truth of Einstein's theory by direct experiment is by inference from another consequence of it: it can be shown that not only should the shape of bodies alter when moving, but their mass should increase with their velocity relative to an observer. For example, the apparent mass of an electron travelling with 90 per cent. of the velocity of light should be just over twice its "rest-mass."

This means that if we can make an electron travel very rapidly (for example, in an electron discharge tube) it will be more difficult to deflect it from its path with a magnet than it would be if its mass did not increase; and it was in this way that Neumann*, owing to the extreme importance of the question, tested the theory by direct experiment. He used electrons travelling at from 0.4 to 0.8 times the velocity of light, and in order to obtain these very great velocities he used the β-rays (which had at that time only recently been shown to consist of fast electrons) given out by radioactive elements. In twenty-six experiments he obtained very consistent results, all definitely in favour of the Einstein increase in mass.

Four-Dimensional Space

We have now to notice some peculiar properties of the Einstein view of the universe, and examine the meaning of the often-talked-about fourth dimension, which is sometimes associated with it.

Look at the equation:

$$x^2 + y^2 + z^2 = c^2t^2$$

once more, for a moment, and permit me, if you will, to rewrite it as:—

$$x^2 + y^2 + z^2 - c^2t^2 = 0.$$

Now we have already agreed that this equation could be equally validly written by anyone, however rapidly moving, to describe a certain physical experiment (viz.: measuring the velocity of light) and that all observers, however moving, would get the same answer, c. Permit me, therefore, to call it an *invariant* equation, and, since the quantity ct is indistinguishable from a distance, let me call it w. We then have:

$$x^2 + y^2 + z^2 - w^2 = 0.$$

This does not satisfy me æsthetically, because of the odd-looking minus sign, so I will put for $-c^2t^2$ the new symbol u^2, and then have:

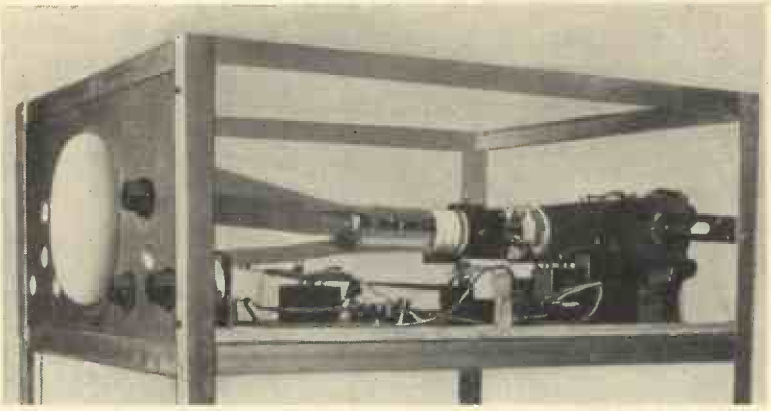
$$x^2 + y^2 + z^2 + u^2 = 0$$

which is simply a statement involving four quantities x, y, z and u, which (unless we insist on dragging in "time" by the heels) might perfectly well stand for four distances. The mere fact that only three of them can be measured physically along mutually rectangular directions (up-and-down, north-and-south, and east-and-west) seems so trifling to mathematicians who

(*Continued on page* 48.)

* See C. Schaefer, "Phys. Zeits.," 14 (1913), p. 1177.

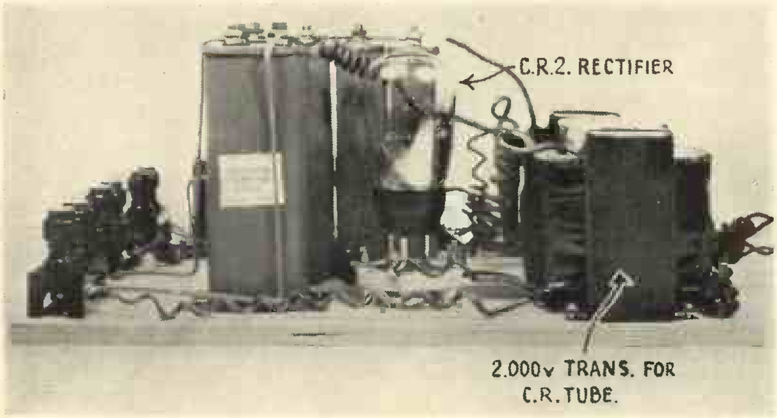
THE SIMPLEST CATHODE-RAY RECEIVER



The chassis and double time-base, descriptions of which were given in the two preceding issues.

BUILDING THE EXCITER UNIT

AT the commencement of these constructional articles it was pointed out that the voltage used was higher than that of the average set, and that care would be required in the construction and wiring of the units. At the risk of becoming wearisome this warning is repeated—the voltage applied to the tube circuits is 2,000 and that of the time-base 1,000, and the greatest care is required in wiring the rectifying circuits to avoid risk from shock and damage to components.



A side view of the exciter unit.

Ensuring Safety

To make the job as safe as possible the actual H.T. rectifying unit is totally enclosed in a steel box with a safety switch in the lid, and this can be deposited on the ground away from the receiver.

The constructor may object that this detracts from the appearance of the completed instrument, but it is a minor point, and the advantages are twofold: the unit is out of the way and there is less liability of accidental contact with the H.T., and the interference from the magnetic field of the transformer is minimised.

The screening box is supplied by Messrs. Ferranti, and is known as their type 1. The dimensions are 13 ins. by 10 ins. by 7¾ ins. high, and the baseboard is therefore cut to fit inside these dimensions, ⅜ in. plywood being suitable.

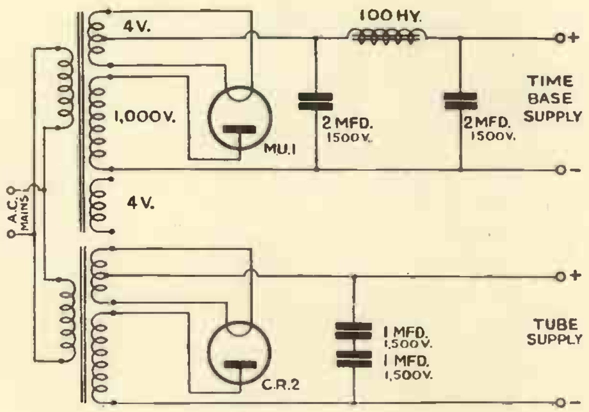
Components

The H.T. transformers are fixed at the end of the baseboard, with the mains connections towards the end of the board. The type used had no terminals, and this is of no importance as the leads are long enough to reach to the various components without a join.

The valve holder for the tube rectifier is of steatite ("Eddystone shortwave type") since there is 2,000 volts between the anode socket and the filament sockets. For the time-base H.T. supply a similar socket may be used, but the ordinary Bulgin holder will stand 1,000 volts and has been used in the unit illustrated.

The condensers used are the new Dubilier ones, specially designed for high-voltage working. Hitherto it has been difficult to obtain high-voltage condensers of a reasonable size, but the introduction of the oil-filled paper dielectric condenser has

The theoretical circuit of the H.T. Unit. Owing to the low current drain the smoothing condensers can be of lower value than usual.



solved the problem and made a neat inexpensive job. At the time the unit was constructed in the TELEVISION laboratory the only type of condenser available was that with a working voltage of 1,500, and accordingly two were wired in series on 2,000 volts (shown on the right of one of the photographs), but the Dubilier Co. have since produced a 2,000-volt working type. The unit can therefore be modified slightly and the two condensers replaced by one. This correction has been made in the list of components.

The smoothing choke in the 1,000-volt rectifier circuit for the time-base is a special one wound by British Television Supplies for 100 henrys. The current consumption of the time-base is low—about 5 ma.—and the inductance of the choke will not be appreciably lowered on full load.

LIST OF COMPONENTS.

TRANSFORMER
200-240 v. primary.
1,000 v. secondary.
4 v. centre-tapped secondary.
4 v. centre-tapped secondary (Savage, "Massicore" type TU1).

TRANSFORMER
200-240 v. primary.
2,000 v. secondary.
2 v. centre-tapped secondary (Savage, "Massicore" type TU2).

CHOKE
100 henry, 5 ma. (British Television Supplies).

CONDENSERS
4—1 mfd. Dubilier type 951 oil-filled 1,500 v. working.
1—1 mfd. Dubilier type 951 oil-filled 2,000 v. working (Dubilier).

VALVE HOLDERS
1—"Eddystone" 4-pin short wave holder (Stratton & Co.).
1—Bulgin 4-pin.

TERMINALS
Belling-Lee type B, marked h.t. (2); h.t.— (2); l.t. a.c. (2).

TERMINAL MOUNTS
3 (Belling-Lee).

SCREWS AND SYSTOFLEX.

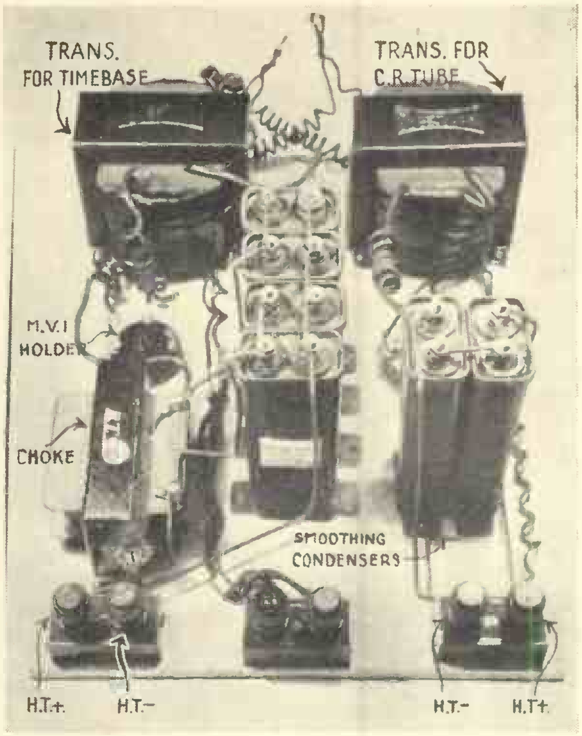
SMALL CLIP FOR HOLDING LEADS TO BOARD.

VALVES
Ediswan M.U.1 mercury-vapour rectifier.
Ediswan C.R.2 high-voltage rectifier.

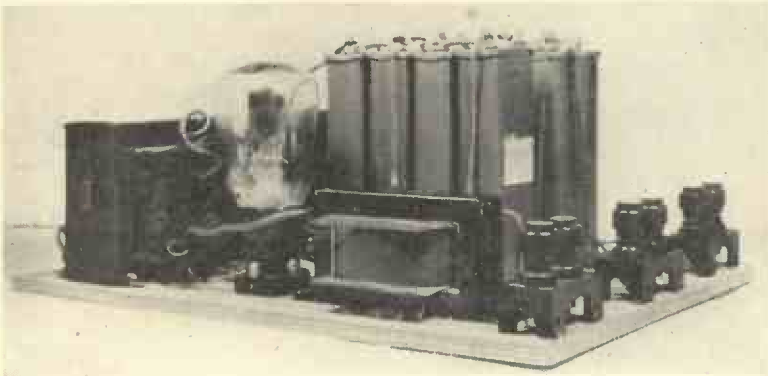
Assembly

After screwing down the two transformers, place the condensers in position and prick the holes for the fixing screws. Similarly mark the holes for the valve holders and the terminal blocks. All the components may now be screwed down. When screwing down the steatite valve holder, be careful that the base ring is not strained or the steatite will snap. Tighten up the screws so that a little play is left to be on the safe side.

The wiring of the components is straightforward and can easily be followed with the aid of the circuit diagram. Use soldering tags wherever possible, and particularly on the terminal blocks to ensure good contact. When the leads are connected to the condenser terminals make sure that they do not touch the metal container and short-circuit the condenser. It is as well to run a systoflex sleeve right up to the terminal nut when making the joint. The 4-volt winding on the 1,000-volt transformer for supplying the heaters of the mercury relays is connected directly to the centre terminal block. The joints between the flex and the transformer leads should be taped and not left bare, as the photograph shows! The condensers in the smoothing circuit are connected in pairs—two 1 mfds. in parallel making 2 mfd. This connection is quite clearly shown in the diagram.



This plan view clearly shows the layout.



Another side view of the exciter unit.

READ TELEVISION REGULARLY

Cathode-ray Nomenclature

The electrodes of a cathode-ray tube are not always called by the same name. The cathode is not given any fancy name and the anode is either called the anode or sometimes the "gun."

The main control of the electron stream, however, is obtained from the small cylinder which surrounds the cathode and is maintained at a negative or slightly positive potential. This has a variety of names. It is called the Wehnelt cylinder or simply the cylinder. Others call it the shield, the control electrode, the modulating electrode and so on.

There is need for an agreement as to the correct name for this electrode. Probably *cylinder* is the most satisfactory. Titles such as control or modulating electrode are not good because in hard tubes two anodes are provided and some measure of control may be introduced on the first anode or gun.—J.H.R.

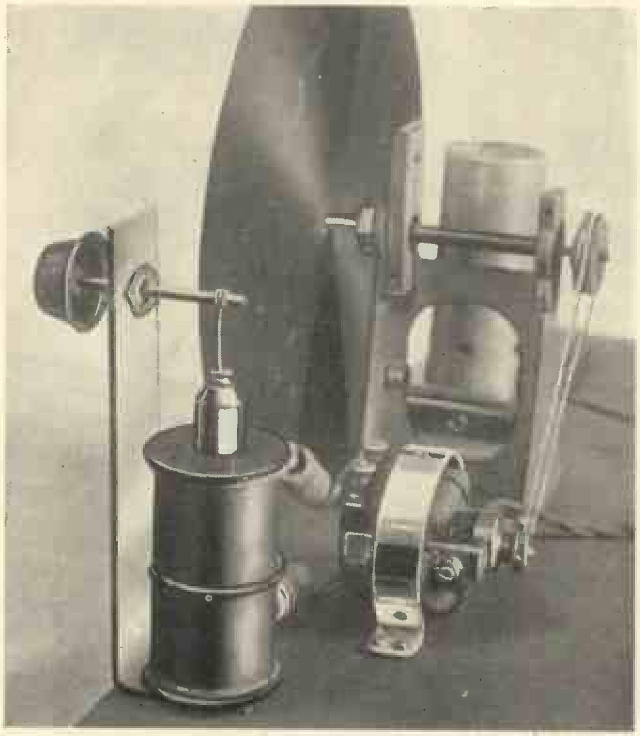
A NOVEL METHOD OF CONTROLLING MOTOR SPEED

By E. L. Gardiner, B.Sc.

ONE of the most important factors which makes for easy handling and enjoyable reception from a home-built television set is the provision of a smooth and effective means of controlling the speed of the motor which rotates the disc, or whatever scanning device happens to be used. Only in the most expensive class of receivers is the synchronising gear sufficiently effective to hold the image stationary for the whole of a transmission period. In most amateur receivers the speed of the motor requires to be adjusted from time to time, and there are many giving good service in which, for the sake of economy or simplicity, synchronising gear has not been fitted. In such cases smooth motor control is particularly desirable.

The conventional method consists in the use of a variable resistance in series with the motor, and as a rule this resistance is made up of two parts—a fixed resistance of fairly high value with a number of tappings to suit different mains voltages or loads, and a variable rheostat of lower resistance value which is used for the actual speed adjustment.

This latter component is sometimes troublesome. A cheap rheostat will generally give trouble owing to irregular contact resistance and rough movement. Also, a rheostat of low resistance gives insufficient range of control to cover all mains and motor variations, whereas one of higher value is apt to give too coarse an adjustment, and also to get unpleasantly hot after a few minutes' use. Thus, the fine control resistance is often something of a compromise, and not altogether satisfactory.



This photograph shows the choke motor control in use in conjunction with a disc machine.

Users of battery or d.c. mains operated motors have little choice but to put up with this state of affairs, or to employ some form of frictional or magnetic break to control speed. But those who employ A.C. mains as their source of supply have at their disposal a very much better method. This consists in the use of a variable inductance choke in series with the motor, the impedance of which can be adjusted by means of a sliding iron core. Such a choke acts exactly like a variable resistance, as far as the motor speed is concerned, but has the advantages that there is no sliding contact to cause variations owing to dirt or bad mechanical construction. Also the variation obtained is delightfully smooth, absolutely continuous and almost frictionless. Less temperature rise occurs, and the choke is quite cheap to construct.

This method of controlling the speed of A.C. motors is not new, but it seems to have been very largely overlooked so far as the television receiver is concerned. As is so often the case, the writer's attention was drawn to it accidentally. A very small and rather high speed motor was being used to drive a ten-inch disc, through a two-to-one reduction belt drive, and no resistance could be found in the laboratory at the time which was of a sufficiently high value and capable of carrying the current. About 3,000 ohms was actually needed, as the motor was drawing about .15 amp. from 230-volt A.C. mains, and running on a very light load.

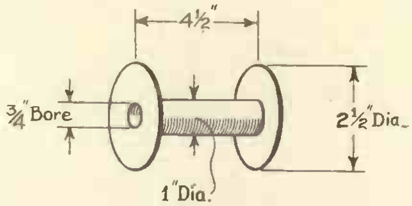
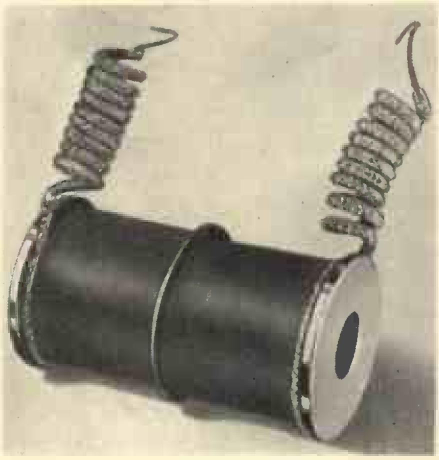


Fig. 1.—Details of the choke former.

A choke, consisting of the "no-volt release" coil taken from an old motor starter, happened to be about, and this was placed in series with the motor to act as a resistance. However, its value was insufficient, and hence a piece of iron was placed inside it to form a core and increase the choking effect, an old cold chisel being actually employed. The motor promptly stopped. A little trial soon showed that by removing the iron partly from the coil, the effect of a correct resistance could be easily obtained, and the smoothness of the adjustment given by sliding the chisel in and out of the coil was so good that the usual series rheostat was not needed, and was subsequently removed from circuit. The extemporised controller in this form worked excellently for some weeks.

The coil used in this experiment weighed about 1 lb. 3 ozs., of which about one pound represented wire, which had a resistance of 900 ohms. From this, with reference to wire resistance tables, it can be calculated that the gauge of the wire was probably 36 s.w.g. enamelled copper wire. Since such a choke would only be suitable for an exceptionally small motor, running on very light load, and most readers will not have a suit-



The completed choke coil.

able coil available, a series of tests have been made to determine suitable windings for typical sets of conditions met with in home television receivers. The results are embodied in the accompanying table.

Unfortunately the sizes and loads of television motors vary so widely that one size of choke is not ideal for all cases. However, a weight of wire of one pound has been found to be near enough for all circumstances, and a standard size of former will accommodate this adequately for all the gauges of wire specified.

Making the Choke

The former must, of course, have a hollow core, made from a piece of tubing ¾ in. internal diameter, 4½ in. long. Paxolin, fibre, bakelite or even strong cardboard will do for this former. Two stout circular or square end cheeks of the same material and thickness are needed, having a circular central hole to fit firmly over the ends of the tubular core, to which they are firmly glued. A sketch of the actual former used is shown by Fig. 1, but a certain amount of variation in size is quite permissible, and should err on the large side if anything, to ensure that sufficient wire can be got on to it.

When the former is finished and dry, the one pound of the gauge of enamelled wire selected from the table can be wound on. A temporary spindle for the coil former can be made from a piece of ¾ in. diameter circular wooden doweling. It is possible to wind the larger gauges of wire by hand without undue tedium, but in the case of the finer wires it is worth while to improvise two bearings.

When the winding is being done, it is a good plan to solder a short length of flex, or heavy gauge wire, to each end of the winding. These are wound in with it, and serve as leading out wires.

For the core, a piece of soft iron will do in the case of the smaller motors. This can be about ½ in. in diameter, and five ins. long, but its exact size is immaterial so long as it is an easy sliding fit within the coil, and not too small to have the desired effect.

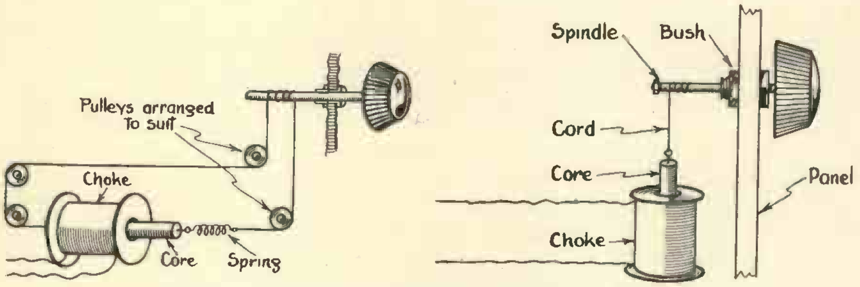


Fig. 2.—Suggested schemes for operating the core of the choke.

	Light Loads, i.e., Discs up to 14 in., Mirror Screws, Small Drums.	Medium Loads, i.e., 16-in. Discs, or larger Drums.	Heavy Loads, i.e., Discs up to 20 in., Heavy Drums, etc.
Very small motors or belt drive	36	34	32
Medium motors ..	32	28	26
Larger motors ..	30	28 or 26	24
Large motors, i.e., from 1/24 to 1/10 H.P. ..	26	About 24	About 22
For vernier control only with fixed resistance	22	22	20

Table showing gauge of wire (s.w.g. enamelled) required to suit various sizes of motor, and loads. Use 1 lb. of wire, and if in doubt use the finer gauge.

Above figures are for 200-230 volts A.C. at 50 cycles. For 100-120 volts use about one-third less wire. For 25 cycle supplies, use 1¼ lbs. of wire.

Heating

After a few minutes use this iron core will get noticeably hot, the temperature which it reaches depending on the quality of the iron, and on the power of the motor being controlled. If it becomes undesirably hot (and in the case of the larger motors) it is advisable to use a core built up of about half a pound of soft iron wires, which can be purchased cut to five-inch lengths. This bundle of wires is bound tightly together by fine twine, or thin insulated wire. A soft iron wire core of this kind should not overheat if the choke is suitably wound.

On trying the choke out in series with the motor, loaded of course, with its working load of disc or drum, it should run too fast with the core removed and be entirely stopped when the core is fully inserted. If the motor should still run a little fast, this means that too heavy a gauge of wire has been used. In this case it is not necessary to scrap the winding since, if a fixed resistance of a few hundred ohms (found by trial) is added in series, the choke becomes an excellent fine control covering the desired range of speed. Alternatively, should the motor run too slowly without the core this means that the resistance of the choke is too hight and too fine a wire has been selected.

In this case it may not be necessary to rewind, since the removal of a little of the winding from the choke will put things right.

It now only remains to consider the means for providing the necessary sliding motion of the iron core. For test purposes, or extreme simplicity, it can, of course, be adjusted by hand. Quite a fine setting is obtainable in this way by a skilful user, but the core may become too hot for comfortable handling. A simple handle can be made from a length of a stout non-metallic knitting needle. This may be driven into one end of the core.

Three more elaborate methods are suggested in the sketch, Fig. 2. The first two operate by means of the

(Continued on Page 34.)

Correspondence

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

What was the Reason? :: *Non-sequential Scanning*
Three-spiral Disc

What was the Reason?

Sir,

The extraordinary phenomenon as witnessed by Mr. Parsons appears to require for its explanation, if any, further details of the apparatus used.

Did the completed images on the screens of two independent receivers have their focal points two feet away from the source, or were no material screens used, and the modulated light from two scanning systems focused at a point in space two feet away.

I would suggest that the phenomenon be due to the momentary retention of vision after looking at the image on the screen.

If an apparition can be produced in this way, then television will be the ideal means of illustrating ghost stories.

A.G.F. (Portsmouth).

* * *

Sir,

The letter published in the December issue from Mr. Parsons, of Portsmouth, certainly raises some interesting questions.

The relative positions of the two instruments suggested to me that the effect might have been produced in the same way as a concave mirror will project an image in front of itself, in which case one would expect it to be upside down. Mr. Parsons did not comment on this, but if the image he saw was upside down, it seems to me to be the most likely explanation. His difficulty in reproducing the phenomenon may be due to the fact that he is too close to the instruments, as the effect would only be visible if he was well outside the focal point of the two.

R.P.C. (London, N.W.)

* * *

Sir,

I wish to thank Mr. Albert Parsons for his letter in the December issue of Television. I am very interested in this, as I have long considered it to be the only way of producing really stereoscopic images—in the cinema or by television—that is, in mid air without any visible form of screen, though I have never had any success in my experiments along this direction using two projectors at an angle to each other. I should be very glad if Mr. Parsons would give a few more particulars of the type of receivers used (cathode-ray or mechanical system). If the latter—what type of light source—polarised or not? Also, was the air clear, or was Mr. Parsons smoking at the time? Were both receivers giving positive images?

L.H.B. (London, S.W.)

* * *

Non-sequential Scanning

Sir,

With regard to G.E.C.'s suggestion that synchronising would be easier if the image was scanned out of sequence, he suggests lines 1, 10, 20 then 2, 11, 21 and so on. The result would be exactly the same as scanning 1, 2, 3 . . . in the case of anything going right across the picture. The truth of this will be realised if one draws out the signal as I did in the article referred to, while anything such a system would avoid, would not make any difference to the synchronising, whichever way it was scanned.

T.S.R. (London, N.)

* * *

Three-spiral Disc

Sir,

With reference to the letter from Messrs. Scophony published in your December issue, the general principle of non-sequential scanning is very old, being disclosed in Hart's Patent No. 15,270, of 1914. Our letter related to the use of the three-spiral disc, pointing out that the first public demonstration of this was given at the British Association meeting in 1928 by Mr. Baird, using the device described in British Patent No. 321,389 (J. L. Baird).

Baird Television, Ltd.
(London, S.W.)

The Modulation Problem

Sir,

Some time ago I wrote to the R.C.A. Company here in America, who, as you know, are doing an appreciable amount of the work in television in this country, and in an effort to simplify the amplification problem, suggested that they modulate the stream of electrons in the scanning tube with a frequency of $N \times N \times P$, where N is the number of lines per picture and P the number of pictures per second. I need not explain the effect of doing this insofar as the make-up of the finished picture is concerned.

They objected to this idea on the grounds of sidebands, and I, knowing nothing about them, accepted their objections.

However, in light of my present knowledge of radio, which is still nothing to boast about, it seems to me, that if the resulting frequency is too high, why not make it still higher by adding more lines per picture, and, since the frequency will always be the same (even though rapidly intermittent) use it for the carrier?

Perhaps there is some factor of which I am not aware which makes that impossible, and since I do not wish to bother the R.C.A. people again, I am writing you instead.

I can see from looking through your magazine that you are years ahead of us over here as regards practical and amateur work in television. I had no idea that the goal was so near.

John I. Alsop
(Hartford, Conn., U.S.A.).

* * *

Sir,

I observe that I made a mistake in the idea that I outlined to you in my letter of a few days ago. The frequency would become distorted just as much as with the present method.

However, the basic idea, that of breaking the picture before scanning into sections so small that no further division were discernible by the mosaic, remains the same. For it stands to reason that if such were done that the output would be a regular series of impulses suitable for direct broadcast. Of course, to prevent these sections from merging into one it would be necessary to separate them from each other by a width slightly larger than the width of the scanning beam. The obvious way, then, would be to separate the globules of photo-electric material from each other, and not to impose an alternating current on the electronic beam, as I first suggested. Still that seems *so* obvious that someone would have thought of it before if it were any good.

Anyway, I refuse to believe we must be content with poor pictures (or else use a much too greedy waveband) and I hope someone will work on the line of effort I have attempted; that of *curing* the basic trouble, instead of giving way before it.

JOHN I. ALSOP
(Hartford, Conn., U.S.A.).

* * *

The Programme Captions.

SIR,

I wish to make the suggestion that the programme captions would be better if a plainer type of lettering were employed, and less ornament. These captions are very useful for checking up results and their usefulness in this respect would be increased were they designed on more severe lines and the lettering kept horizontal with any ornamental effects confined to geometrical patterns. This might mean the sacrifice of some artistic effect but the advantages would more than outweigh this, particularly as when the captions are shown it is, as a rule, an easy matter to keep the machine in synchronism. Alternatively it would be a good idea to show on the screen for a few minutes a number of geometrical patterns, which if always of the same design would be most useful as a check.

B.T. (London, S.W.).

* * *

Projection Lamp Troubles.

SIR,

My experience with projection lamps burning out may be useful to your readers. I may have been particularly unfortunate, but I had three go within a short time. I then happened to notice that in some home-cine projectors a small fan is fitted in order that a current of air can be blown past the lamp and keep it reasonably cool. This was hardly practicable with the mirror-drum receiver which I am using, but it occurred to me that if more ventilation were provided the lamp would have a better chance. The ventilation holes were therefore increased in size, and since then I have had no trouble. Whether these results are due to this or not it is difficult to say as it might be just a matter of chance, but I pass the hint on for what it is worth.

S.R. (Manchester).

* * *

"Still" Television.

SIR,

I was interested in the suggestion made in last month's issue regarding "still" television. It would seem to provide a comparatively easy solution of many of the present-day difficulties until such time as the science is more advanced. The one snag appears to be that of providing a suitable screen which will retain the image for a few minutes after it has been thrown upon it. It would be interesting to have other readers' opinions upon this suggestion.

F.H. (Harwich).

* * *

A Curious Occurrence.

SIR,

I suggest that the explanation of the phenomenon described by Mr. Parsons is that it was due to eye fatigue after watching the screen for some time. Most lookers will be aware that a considerable amount of fatigue occurs, and it seems reasonable to suppose that the experience was similar to that when a coloured light is looked at for some time, when after the source of light is removed one of a complementary colour is seen in its place. Mr. Parsons does not say whether he witnessed a continuance of the programme or what he saw was a repetition of what had gone before.

G.C. (Worthing).

Perhaps Next Year?
A Suggestion for Christmas Day

November 23, 1934.

Sir John Reith, L.L.D.,
Director General of the British Broadcasting Corporation,
Broadcasting House,
London, W.1.

DEAR SIR JOHN,

I should like to make the suggestion that it might be possible to obtain the consent of H.M. the King to be televised when he makes his Empire speech on Christmas Day.

This, I venture to say, would be very greatly appreciated by the many thousands who now own television receivers and it would do much to enhance British prestige in this new science, all over the world.

Your opinion regarding the matter will be appreciated.

Yours faithfully,
H. CORBISHLY,
Editor.

27th November, 1934.

Sir John Reith's reply.

DEAR SIR,

Sir John Reith has asked me to thank you for your letter to him of the 23rd, and to point out that the circumstances of the broadcast from Sandringham on Christmas Day are not such as to make it practical to undertake its televising.

Yours faithfuly,
for THE BRITISH BROADCASTING CORPORATION,
GLADSTONE MURRAY.
(Information).

"A Novel Method of Controlling Motor Speed."

(*Continued from page* 32).

familiar "string drive" so widely used for the slow-motion tuning controls of radio receivers. Of course, ordinary string is not ideal for the drive, catgut or thin stranded flexible wire are more suitable. In the first arrangement the choke is mounted inside the vision receiver cabinet in a vertical position, near the front panel for preference. The core is attached to a piece of the cord, which is wound on to a small spindle, placed horizontally over the choke, and which passes through a brass bush in the panel. This scheme is shown in the photograph.

The second arrangement shows the choke in a horizontal position, and has the advantage that the motion of the core is positively controlled in both directions. A small spring takes up any slack.

The third suggested scheme is the one used by the author. It is made from a blind cord tensioner. This fitting consists of a small pulley mounted upon a non-rotatable collar threaded to move along a threaded spindle. The gadget is mounted behind the front panel of the visor cabinet, with its knob protruding outside, and is screwed to the bottom of the cabinet. The choke is mounted horizontally near the back of the cabinet, being fixed down with brass straps. The core has a long tension spring fixed to its rear end which is secured to the cabinet. To the front end of the core a piece of cord is attached and this is looped round the pulley of the blind adjuster.

THE AMATEUR TELEVISION EXPERIMENTER

TELEVISION APPARATUS FOR THE LAB.

This article is the fourth of a series detailing the complete equipment of a television laboratory. The present instalment concludes the general description of the laboratory and future articles will deal with specific apparatus.

IN addition to the range of meters discussed in last month's article, there are several components which will be found of general use and which will repay making at the start. Variable resistances will be required sooner or later for accurate measurements, and these can be assembled from standard fixed resistances, as shown in the photograph (Fig. 1).

The majority of moulded resistance manufacturers will supply resistances specially picked to an accuracy of 1 per cent. at a small extra charge, and ten of these mounted on a multi-contact switch will form the nucleus of a Wheatstone bridge or inductance bridge, besides enabling quantitative work to be done on valve circuits. The photograph shows a two-dial box made up on the lines suggested. The components used were: 10 Dubilier 1,000 ohm 1 watt resistances picked to 1 per cent.; 10 ditto 100 ohm, and two "Kabi" 11-way multi-contact switches.* The box originally held a wave-trap unit, and was fitted with a new top. The engraving (a luxury) cost 1s. 6d., and the total cost of the component did not exceed 25s., which is very reasonable compared with the price asked for precision boxes of the same type. A variable megohm, by 100,000 ohm steps, is another useful accessory, and is constructed on the same lines.

Fig. 1.—A resistance unit made up as shown in these photographs will prove very useful.

* F. W. Lechner & Co., 61, Spencer Street, E.C.

Variable capacity boxes are not so easily constructed, or rather, are more expensive. Ten capacities increasing in steps of 0.1 mfd. require more than ten condensers since some of the values are not obtainable commercially, and have to be made by joining two in parallel. A cleverly designed variable capacity box made by the General Radio Co., of U.S.A., gives a range of .01 mfd. to .1 mfd. by .01 steps using only four condensers, but the intricate cam switching mechanism is beyond all but the experienced instrument maker. A simpler alternative to the multi-contact switch is to mount each condenser on a small ebonite strip fitted with two plugs, and to provide a socket strip to match with three pairs of sockets wired in parallel to a pair of terminals. This enables a quick change to be made in capacity without upsetting the circuit.

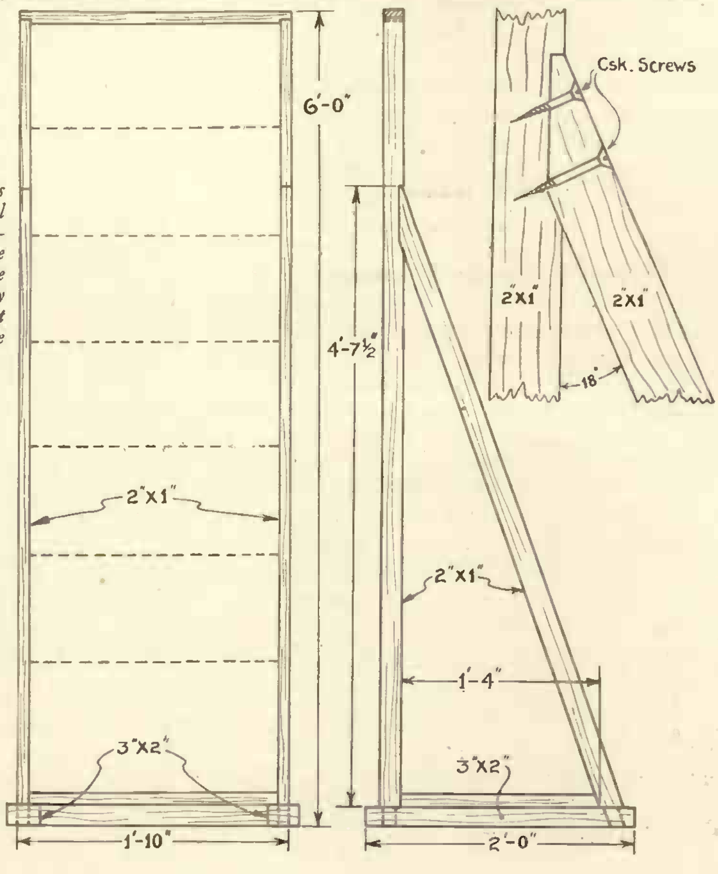


Fig. 2.—Details of meter panel rack. The dimensions given are suitable for the panels already described. Inset is a detail of the frame joint.

Amplifier Racks

Mention was made last month of screening arrangements for oscillators and amplifiers which will form part of the experimental equipment. These should all be designed on the rack principle in order that they may be accommodated against the wall of the laboratory and at the same time be easily accessible for alterations. A suitable rack for the standard size of panel is shown in Fig. 2, the framework being made from iron strip for greater rigidity, although wood is quite suitable with the dimensions shown.

Each unit has a front panel of ebonite or paxolin and is completely screened in the following way: At the back of the ebonite panel the baseboard is fixed about 1 in. above the lower edge of the panel, held in place by screws through the panel and stiffened by two angle brackets. Before this baseboard is mounted, the lid of the screening can is fixed to the back of the panel and secured by nuts and bolts. The screening box is then slid over the baseboard from the back and pushed home into the lid. This completely screens the whole of the layout, but at the same time makes it easily accessible from the back of the rack.

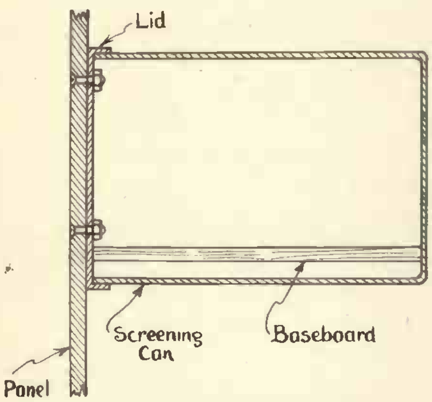


Fig. 3.—Details of simple screening arrangement.

Any connections between the panels can be brought to the back of the baseboard, and through holes punched in the screening can, or they can be connected through terminals in the front panel. The screening cans themselves can be made of copper or aluminium sheet (16 g.) but if domestic biscuit boxes are available they can be impounded and used successfully, with a coat of grey paint to make them look smart! The drawing, Fig. 3, shows the general arrangement of the screens.

Requirements for Television

The apparatus detailed in these articles up to now has been that common to all research laboratories, or radio experimenters, and we can now consider the needs of television research.

Light Sources

Television covers an extensive field—optics and electronics. Various devices are used which depend on the movement of electrons, such as photo-cells and cathode-ray tubes, to say nothing of valves; communication engineering, both line and radio links, also enters into the subject. Nor must one forget the mechanical side of the science—or is it an art? The experimenter will have already decided which section is to form the subject of his own individual research.

Starting with the generation of a signal, the first thing one must have is light. This essential must have a high intrinsic value from a small area, such as the crater of an arc, and it must be steady. By steady, we mean there must be no flicker, as for example, in the ordinary electric lamp filament when run off A.C. mains (or D.C. mains for that matter).

It is surprising how much ripple can get into a television transmitting system from a lamp running on D.C. For the amateur experimenter a lamp of low voltage and high current, with a bunched filament, is the best source of light, since an arc lamp is expensive in power consumption, and bulky. Such bulbs can be run off A.C., and owing to the thickness of the filament the light does not fluctuate with the voltage. A very good point source of light is the "Pointolite" lamp made by the Ediswan Co., but although the lamp itself is inexpensive it requires special control resistances. For special work, however, it approaches the theoretical point source more nearly than any other type of lamp, and can be obtained for either D.C. or A.C. operation, it is very suitable.

The optics of television are principally tied up with those of scanning and can be relatively simple, or complicated, as in the Scophony system, for example. Photocells and cathode-ray tubes are from the constructional point of view rather above even the more advanced experimenters, though they offer a relatively virgin field for research. It would be interesting to know if any readers have ever tried to construct them.

Communication Channels

Most experimenters will no doubt, however, be more interested in the electro-communication section which is bristling with problems, mostly of design. Those of you who are amateur radio transmitters should turn your attention to the generation and modulation of the 30-100 mega-cycle band.

The design of a communication channel which will pass frequencies from as near zero as possible to at least mega-cycle, calls for a lot of experimental work, especially as the frequency delay must be constant throughout the band. Of course, the present broadcast television signal requires nothing like the suggested band, but we must be prepared for it in, we hope, the not-too-distant future.

Obviously the television experimenter will first be anxious to pick up the present 30-line broadcast signals and perhaps the first essential to construct is an L.F. or post-detector amplifier, the construction of which must be considered with regard to whether it is to operate a current or voltage operated device, that is to say, a glow lamp or Kerr cell or a cathode-ray tube. For the beginner a glow lamp and disc are undoubtedly the best to start with, as it is the simplest and cheapest form of receiver and easiest to operate.

Several types of disc receiver have been described in this journal from time to time, and the choice can be left to the reader. In order that the whole of the experimenter's apparatus can be as flexible as possible, the amplifier should not form part of the scanning gear, but should be assembled as a separate self-contained unit.

RECENT DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS
Specially Compiled for this Journal

Reducing Scanning Frequency :: Superimposed Television :: Magnifying the Image :: Fluorescent Screens :: Line Scanning and Picture Ratio :: Film Transmitters.

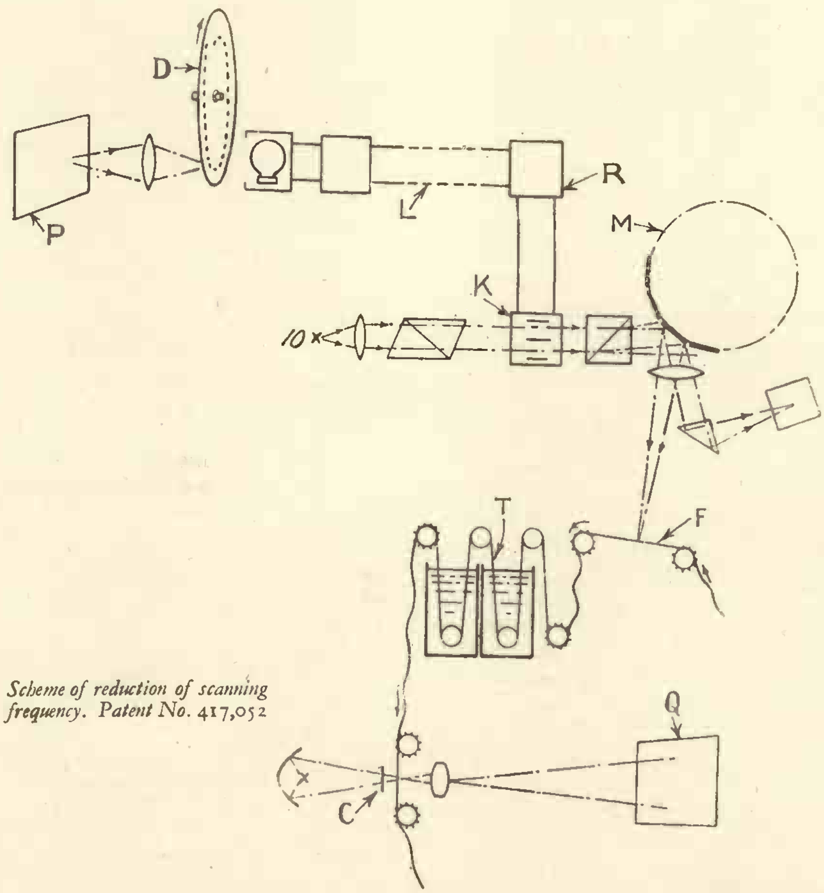
Scanning Systems

(Patent No. 417,052.)

Under certain circumstances the amount of movement in a scene to be televised may be comparatively small—or at least it may be such as not to sweep rapidly over a large angle of the total field of view. Under these conditions the total number of pictures transmitted in each second may be cut down to a low number, say, four per second instead of the usual 12-20, provided suitable steps are taken to avoid "flicker" at the receiving end.

According to the invention the picture P, after being scanned at the low "repetition" speed by the rotating disc D, is transmitted over a wire or radio link L. At the receiver R, the signals are applied to a Kerr cell K, and are then distributed by a rotating mirror M, over a photographic film M. This is then passed through developer and fixing tanks T, so that it carries a permanent picture, which is then thrown by a cinematograph projector C, on to the viewing-screen Q.

The projector is arranged to throw each picture four times in succession on to the screen, so that the original picture repetition frequency of four is increased to 16 per second. In this way the observer's eye is fed at the speed necessary to produce persistence of vision, whilst the total band of frequencies required to be transmitted through the ether is greatly reduced.—(*L. C. Martin.*)



Scheme of reduction of scanning frequency. Patent No. 417,052

Scanning Systems

(Patent No. 417,282.)

The background of the picture, which may be a tropical scene or one otherwise difficult to reproduce in the studio, is taken on one film. A second film is then taken of the moving characters in the studio proper, and the two films are superposed. In order to prevent "ghost" effects when the two films are combined, the studio performance takes place against a "black" background, which automatically prevents the scanning tube from recording anything outside the line of movement of the actors.

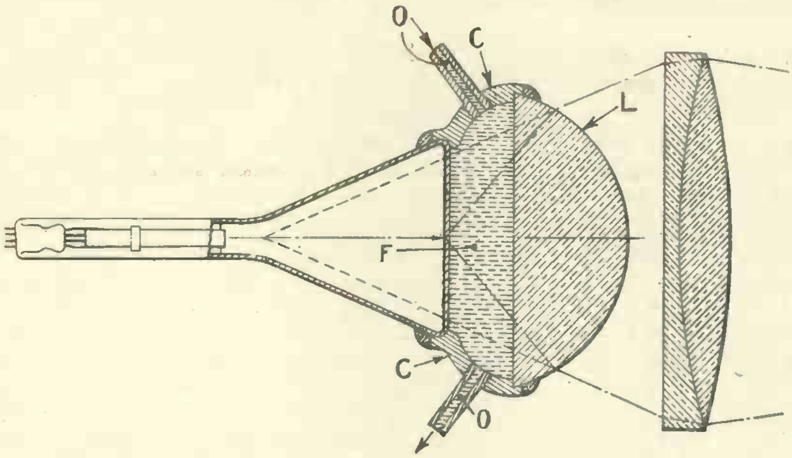
In transmitting the performance, one cathode-ray tube is used to scan the already-prepared "background" film, whilst a second tube is scanning the actual studio performance, both tubes being controlled by the synchronising frequencies from a common pair of saw-toothed oscillators. The output from both scanning tubes is combined in a common amplifier and modulator, and is then fed to the transmitting aerial.—(*Marconi's Wireless Telegraph Co., Ltd.*)

Magnifying the Image

(Patent No. 417,435.)

Any attempt to magnify the image formed on the fluorescent screen of a cathode-ray tube by using an external lens results in a considerable loss of light, owing to total internal reflection at the outer surface of the glass bulb. This effect is quite distinct from the apparent loss of intensity due to the extra area of the enlarged picture.

The figure shows the method adopted to overcome the difficulty. A spherical lens L is attached to the end of the cathode-ray tube by a collar C, and the space formed inside the collar and between the inner surtace of the lens and the outer wall of the tube is filled with a fluid F, having the same refractive index as the glass of the tube. Preferably the glass used for the lens is also of the same refractive index. The fluid F, is introduced through openings O, and may be suitably coloured to compensate for the greenish or bluish light normally produced by the fluorescent screen.—(*Marconi's Wireless Telegraph Co., Ltd.*)



Method of magnifying the image on a fluorescent screen. Patent No. 417,435.

Fluorescent Screens

(Patent No. 417,679.)

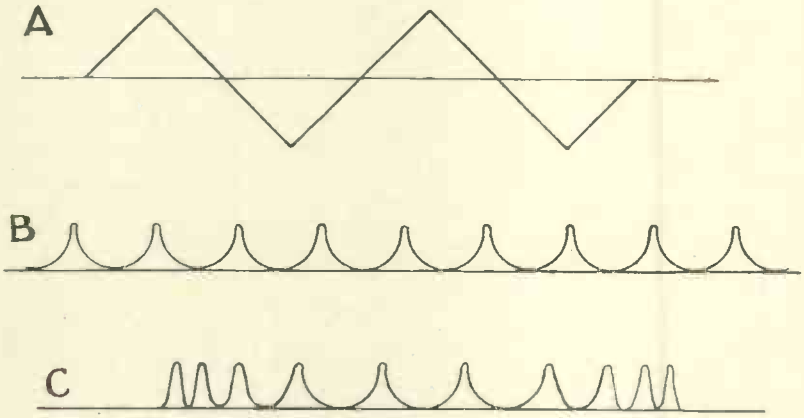
The screen is formed by mixing a metal tungstate with a metal phosphate in such proportions that the resulting fluorescence is mainly white in colour. Cadmium tungstate, for instance, produces a light-blue fluorescence, whilst zinc phosphate gives a bright-red effect. If, however, these substances are mixed in the proportion of 75 per cent. of the former with 25 per cent. of the latter, by weight, the emitted light, for voltages between 600 and 2,000, is substantially white. At the same time the intensity of the fluorescence remains high.—(*A. C. Cossor, Ltd., and L. H. Bedford.*)

Scanning Systems

(Patent No. 417,932.)

In order to maintain a constant fixed ratio between the line-scanning frequency and the picture-repetition frequency, the former is derived from the latter, at the receiving end, by a process of frequency-multiplication.

The lower or picture repetition frequency A, is alone transmitted through the ether. At the receiver it is passed through a series of full-wave rectifiers which are arranged to produce " harmonics " B, corresponding to the required line-scanning frequency. For certain types of scanning, line-scanning harmonics of the form shown at C may be produced. The frequency-multiplier may consist of a series of differently-saturated inductances, or differently-biased valve-rectifiers may be used.—(*Telefunken Co.*)



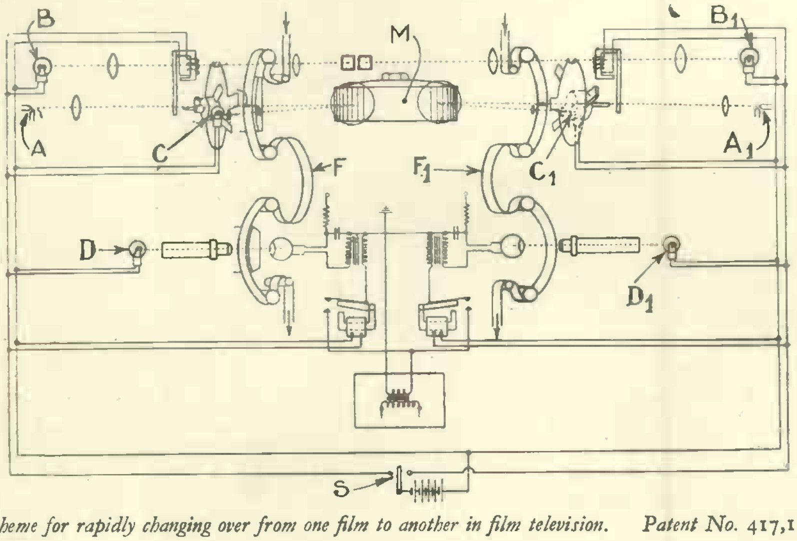
Scheme for maintaining fixed ratio between line-scanning frequency and picture frequency repetition. Patent No. 417,932.

Television Transmitters

(Patent No. 417,181.)

In a system for televising a cinematograph programme, special provision is made for rapidly changing-over from one film to the next. As shown in the figure two cinematograph films F, F1, are arranged symmetrically about a common scanning drum M. A lamp C, for producing line-synchronising frequen-

(*Continued in first col. of next page*).



Scheme for rapidly changing over from one film to another in film television. Patent No. 417,181.

THE FRAME AERIAL AND TELEVISION

By Robert Desmond

Interference is being experienced with the London National vision transmissions and this article explains how this can be obviated by the use of a frame aerial.

IT is surprising that with the present congestion of the ether (to the extent of some 189 stations between 587.7 and 200 metres) and the consequent amount of interference of the heterodyne type more use is not made of the frame aerial, especially in the case of television where the problem of reception is considerably increased owing to the receiver having to be *not* too selective.

If more than some twenty miles from the only British television transmitter, that is to say, Brookman's Park, considerable interference is generally experienced from stations on the adjoining wavelengths, namely, Turin 1,140 kc., Hörby 1,131 kc., Kosice 1,158 kc. and Monte Ceneri 1,167 kc., for their geographical position (see Fig. 1). Sometimes Kosice changes wavelengths with Moravska-Ostrava (see map).

Now the television signal side band is of the order of nearly 15 kc width either side of the carrier (1,149 kc.) which means 1,149 ± 15; this, of course, includes the carriers of Turin and Kosice to say nothing of the side bands of Hörby and Monte Ceneri, though the interference from Kosice is of rare occurrence (see Fig. 2).

The frame aerial, when properly designed, has a very definite property of receiving signals in some directions better than others, so much so that ships and aeroplanes make use of such devices for finding their position.

A frame or loop aerial consists of a metal loop, generally rectangular, or three-sided as in a and b, Fig. 3, rotating about the horizontal plane on the vertical axis YZ. A loop aerial will receive signals from the direction to which its plane is oriented, while those arriving at right angles will have no effect.

The loop 1, 2, 3, 4, Fig. 4, of which 2-3 is a plan view, will receive full strength signals from stations D and E, weaker signals from B, C, F and none from A or G.

Suppose the wave from the station E, Fig. 4 (represented by the curve A B C D, Fig. 5) cuts the loop 1, 2, 3, 4, and further consider it as a magnetic field, which by Lenz's law will induce a voltage in a vertical conductor; the conductors, 1, 2 and 3, 4 will have voltages induced in them, but as the field only affects part of 3, 4 for the part Z4, a current will flow in the loop proportional to the difference of the voltages induced in each side.

Obviously if we made the loop so

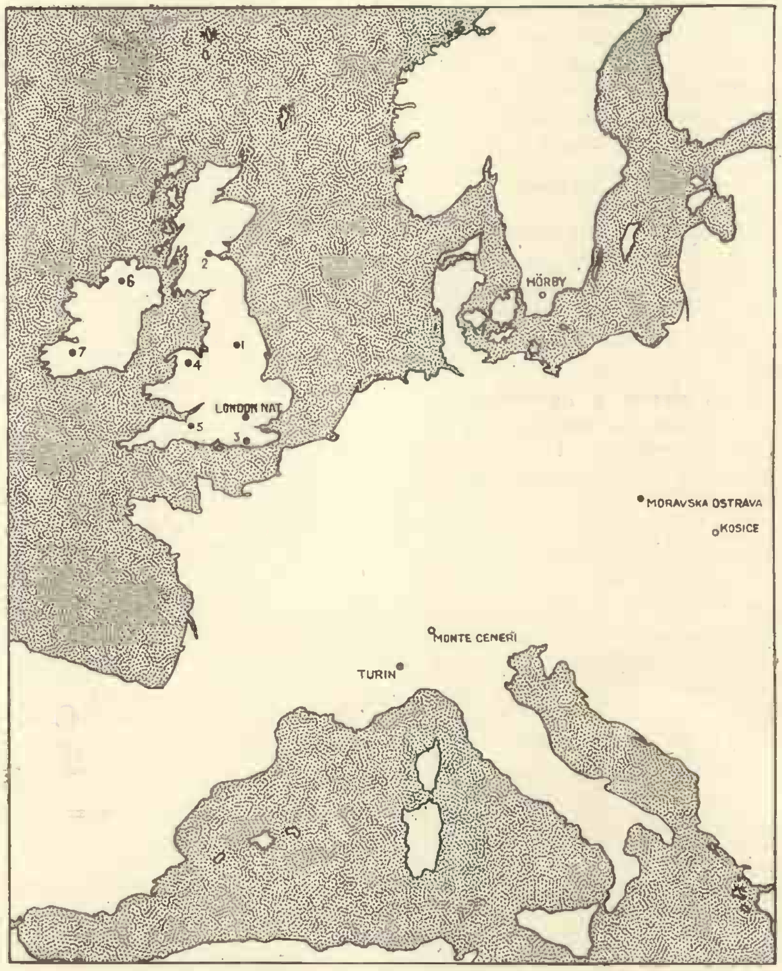


Fig. 1.—Map showing the positions of the stations which are likely to cause interference with London National.

"Recent Developments"

(*Continued from preceding page.*)

cies, a lamp B, for the picture-synchronising frequencies, and an arc lamp A for illuminating the first film F, are duplicated by corresponding sources of light marked A1, B1, C1 respectively. Other lamps D, D1, are provided for scanning the sound trace, if the films are of the "talkie" type.

The arrangement is such that the operation of a single switch S, is sufficient to cut off all the lamps required for transmitting one film, and to bring in those required for televising the second film, when the moment comes for changing-over from one item in the programme to the next.—(*Electric and Musical Industries, Ltd.*, and *C. O. Browne.*)

(*A summary of other patents is given on page* 48.)

that the vertical sides are a half wavelength apart, such as 5, 6, 7, 8, Fig. 5, the maximum effect would be obtained. If the loop is turned at right angles to the direction of the wave, it will be apparent that similar voltages are generated in the vertical sides which cancel out and no signal is received.

A loop aerial is bi-lateral, that is to say, it will, if rotated, through 360 degrees, have two maximum and

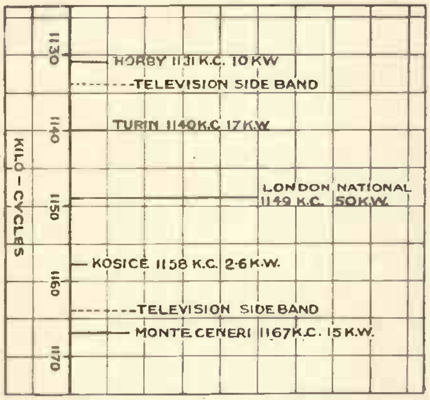
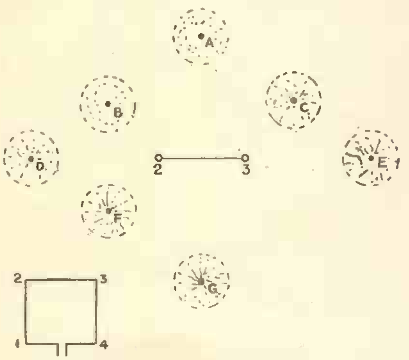


Fig. 2.—Chart showing the frequencies of the interfering stations.

minimum positions. Fig. 6 is an attempt to explain this graphically. FF_1 is a frame or loop pivoted at O. In the drawing it is lying in the plane of incoming waves; the strength of the signal will be maximum and is represented graphically by O1 positive. Rotate FF_1 through 180 degrees so that F will be the first to



be cut by the waves, the current then flows in the opposite direction round the loop but at maximum strength, and is represented by O1 negative.

Now consider FF_1 rotated 90 degrees so that FF_1 lies along NS. As equal and opposite voltages are induced, the current is zero. Next consider FF_1 lying along B_1B, that is to say making an angle of 30 degrees with the incoming wave; with F_1 facing B the signal received will be equal to O2. It will be positive, while if F_1 faces B_1 it will be O2 negative. The terms positive and negative are only arbitrary, just to show that the current does not flow the same way, though, of course, one must not forget that it is an H.F.-A.C. current which is being generated in the loop.

The diameter of the positive and negative circles are also arbitrary. The strength of the signal received is expressed by

$$E = EM \cos \Theta$$

EM is the maximum signal, as when FF_1 lies along WE. Θ the angle the loop makes with the incoming wave which is the case of FF_1 lying along B_1B is B O E.

Fig. 6a shows graphically the signal from three stations obtained by rotating the loop through 180 degrees.

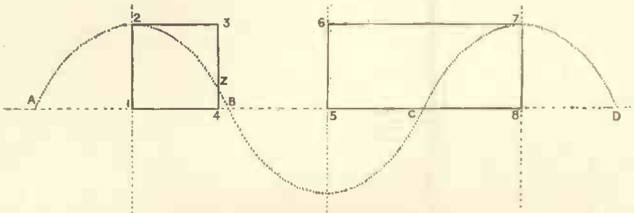
Having briefly explained the properties of the frame or loop aerial, let us see how we can make use of it for television reception. As already pointed out, television must be received on a circuit which is generally described as flat or broadly tuned.

Modern conditions have made sets with this type of circuit obsolete; but old sets come into their own again on television reception, that is to say, the pre-detector part does.

Reverting to Fig. 1, the British Isles has been roughly divided into seven zones. Table 1 shows approximately the effects of using a frame in these zones. Four positions of the loop are given, 1 maximum signal from London National, 2 zero signal from Hörby, 3 zero from A, an imaginary position between Turin and

Fig. 4 (left).—This diagram explains the operating principle of the frame aerial.

Fig. 5 (right).—Curve showing the maximum and minimum positions of the aerial.



Monte Ceneri, and 4 zero from B. another imaginary position between Kosice and Moravska-Ostrava. Occasions often arise when it is best to turn the loop so as to produce zero level from an interfering signal even at the expense of reducing the wanted signal.

It is unfortunate that the position A and Hörby are nearly at right angles to the British Isles, though, luckily, interference rarely comes from both directions at once.

One disadvantage of a loop is that it requires more amplification after it than an average out-door aerial owing to its smaller pick-up effect; this, however, is somewhat offset by less damping than the usual aerial.

The theoretical circuit is shown by Fig. 7. It will be noted that the loop is centre tapped and earthed. The inductances LL are not always necessary as the frame may have enough inductance in itself. If required, however, LL and the leads must be carefully screened to avoid their acting as the ordinary aerial. Though

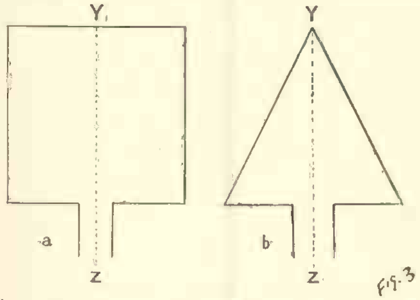


Fig. 3.—Outlines o frame aerial construction.

V_1V_1 are shown as triodes, valves of the screen grid type can be used. V_2 may be either detector or a further H.F. stage; nor need push-pull H.F. amplification be used.

So far we have only discussed the use of a frame with regard to stations on adjoining wavelengths; if, however, one is near a broadcasting transmitter and difficulty is found in removing the unwanted signal, the circuit of Fig. 8 can be used with certain success. The ordinary aerial circuit CL is tuned to London National, while the loop in series with L_2L_2 tuned by C_2, is tuned to the interfering station, both these circuits being magnetically coupled to L_3C_3 circuit, which is, of course, tuned to London National.

Now the phase of the voltage induced by L_2L_2 in L_3 depends upon which side of the loop is first cut by the oncoming wave; by turning the frame in such a position that the unwanted signal from the outdoor aerial can be balanced out, the wanted station be cleared of interference.

(*Continued on next page.*)

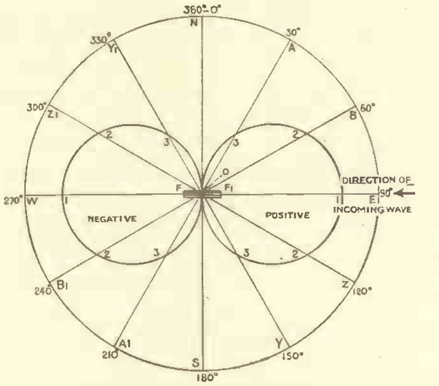
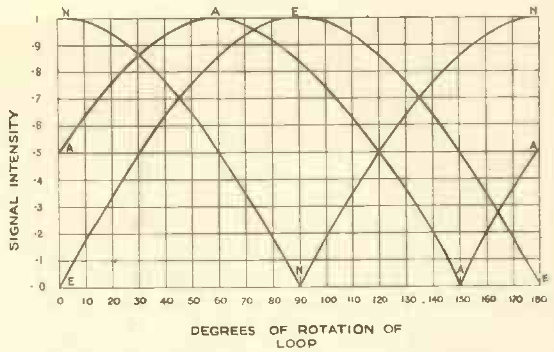


Fig. 6.—Graphic illustration of the bi-lateral action of the frame aerial.



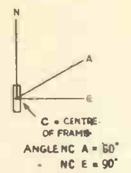


Fig. 6a. — Diagram showing graphically the signal obtained from three stations by rotating the loop through 180 degrees.

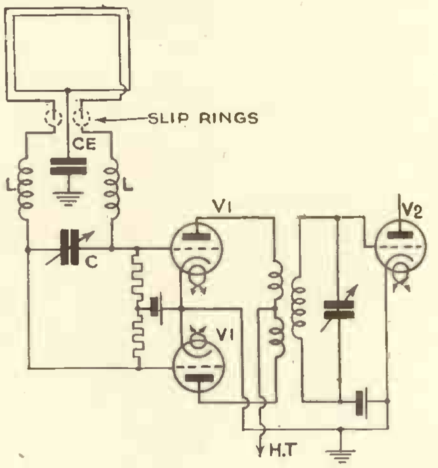


Fig. 7.—Theoretical circuit of frame aerial.

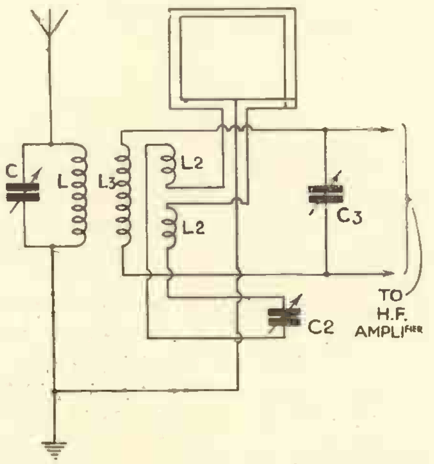


Fig. 8.—Circuit arrangements for eliminating a near-by transmission.

TABLE I.

Frame in Line with London National.

Zone.	London National.	Horby.	"A."	"B."
	Signals at			
1	1	·06	·93	·52
2	1	·29	·95	·61
3	1	·48	·69	·06
4	1	·55	·99	·87
5	1	·97	·65	·97
6	1	·69	·99	·89
7	1	·89	·94	·99

Frame at Right Angles to Horby.

Zone.	London National.	Horby	"A."	"B."
	Signals at			
1	·99	0	·9	·46
2	·96	0	·83	·37
3	·97	0	·96	·57
4	·87	0	·87	·45
5	·22	0	·88	·48
6	·73	0	·76	·34
7	·46	0	·73	·35

Frame at Right Angles to "A."

Zone.	London National.	Horby.	"A."	"B."
	Signals at			
1	·35	·91	0	·60
2	·30	·83	0	·57
3	·74	·96	0	·64
4	·08	·87	0	·55
5	·74	·88	0	·52
6	·05	·75	0	·48
7	·32	·73	0	·43

Frame at Right Angles to "B."

Zone.	London National.	Horby.	"A."	"B."
	Signals at			
1	·84	·48	·60	0
2	·78	·37	·55	0
3	·99	·57	·64	0
4	·48	·45	·55	0
5	·29	·5	·61	0
6	·43	·34	·48	0
7	·12	·37	·42	0

Signal in terms of maximum equals unity and assuming that all stations signals are equal strength at receiver. In practice, most of the intervening signals will be weaker than given above.

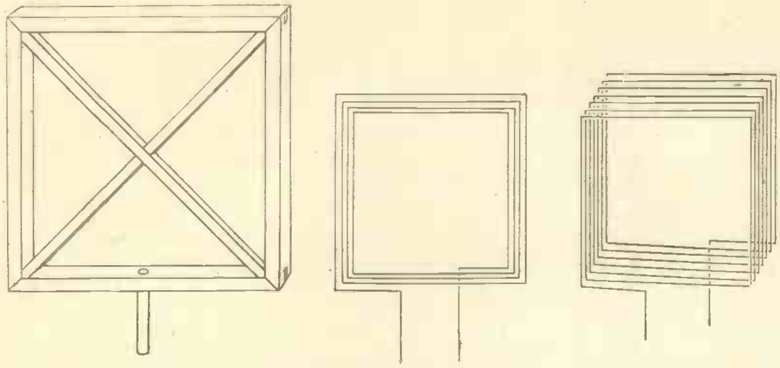


Fig. 9.—Construction of frame and types of frame aerials.

TABLE II.

Size of Each Side.	Turns of 22 D.C.C. Wire.	Minimum Wavelength, Approx.
4 ft.	5	220
3 ft.	6	212
2 ft.	8	225
1 ft.	14	225

The above allows for no spacing between turns. Spacing reduces self-capacity, therefore lower minimum wavelength.

In conclusion, a few notes on the construction of frame aerials may not be amiss. The frame should be as large as possible, the writer uses one four feet square. The wooden structure is shown A, Fig. 9.

Frame aerials which are used for direction finding have generally only one turn, as such aerials have more marked directive properties but for our purpose more turns will be an advantage as the pick-up properties are increased. Table II gives a rough idea of the number of turns for different sized frames. The windings can be put on as " box " or " pancake " (see Fig. 9), the former being easiest to centre tap for earthing purposes. Remember this centre tap is most important, otherwise the frame acts as an ordinary aerial as well and its directive properties are marred.

Another thing to remember in using a frame is that large masses of metal, such as a steel-frame building, may appear to alter the direction of the incoming waves. Experimenters should also not forget that frame aerials on the 5-10 metre band are very efficient.

LIGHT WITHOUT HEAT

THE general term to describe the production of light without heat is luminescence and this covers five groups, as under.

Photo-luminescence, which includes fluorescence and phosphorescence; it relates to the emission of light under the action of light.

Electro-luminescence, all cases where the light is excited by such causes as cathode-rays, X-rays, positive rays, and radio-active substances.

Cryo-luminescence, light is emitted during the crystallisation of certain salts from solution.

Chemi-luminescence, light generated by chemical action.

Tribo-luminescence, light due to friction or crushing, such as is observed by rubbing together crystals of sugar, quartz, etc.

It is chiefly the first group with which we are concerned in television, particularly fluorescence.

By fluorescence we mean the emission of light which commences and ceases with the stimulus; luminescence which continues after the stimulus (light) has ceased is termed phosphorescence.

There are various theories which have been propounded to account for luminescence and it is evident that the removal or displacement of electrons from the luminescent substance must play a very important part in the process which takes place when light is emitted. In all the five groups there is abundant evidence of this taking place.

One theory is that there is a limited number of valency electrons on the surface of the atom, which can, of course, become detached from the surface. These valency electrons may leave one atom, and become attached to others. This explains the formation of positive and negative ions, as in ionisation by collision. According to this theory, the valency electrons form the characteristic band spectra, and that the carrier of the band spectrum is a molecule composed of several atoms.

The carriers in the case of the line or series spectrum are single atoms which have lost valency electrons, and are thus positive ions.

Fluorescence or phosphorescence which is connected with band spectra is supposed to be that emission of light accompanying the restoration of valency electrons. The difference between the two is not basic, but dependent only on the time during which the separation of the electron continues. With fluorescence this time is an infinitesimal quantity, with phosphorescence, a finite quantity, depending on the electrons of which the material is composed.

Fluorescence, therefore, does not necessarily imply photo-electric activity but phosphorescence is associated with photo-electric emission.

Easy Lessons in Television, by R. W. Hutchinson.—This is a small handbook, priced at 1s. 9d., of 171 pages. Included in its contents are elementary ideas about electricity, simple optics, television transmitting and receiving systems and the radio link. The practical side of the book is almost entirely devoted to wireless considerations in television and details of the disc receiver. It will be found excellent as a simple introduction to the subject and can be recommended. The book is being sold by H. E. Sanders & Co., 4 Grays Inn Road, London, W.C.1.

"An Iconoscope Experimental Television System" (*Continued from page 26*)

constants makes possible not only a flat frequency response but a response free from phase distortion at the lowest desired frequency.

Racks contain the circuits for amplifying and mixing the picture signals, blanking signals, and synchronising impulses. They contain the deflecting and control circuits for both studio and motion picture iconoscope, a monitor for checking the operation of the system, and all switching facilities to change the input to the radio transmitter from studio to motion picture or to the radio receiver used to receive the signals from a remote pick-up point. All sound circuits are also provided in these racks.

The picture frequency signal generated in this portion of the system is at a level of approximately two volts across 30 ohms. The low impedance output is such as to match the impedance of a special cable. This cable carries the signal underground from the control room to the radio transmitter, a cable distance of 1,500 feet. In order to make the switching of the output of the picture frequency amplifier practicable, it was necessary to prevent the direct current from flowing through the cable. This requirement made capacity coupling into the cable necessary.

Since the line impedance and distant termination were only 30 ohms, the problem of coupling into such a low impedance was unusual. The circuit arrangement is shown in Fig. 9. Here again the filter in the plate circuit was made to have such a value that, as the drop across the coupling condenser increases with decreasing frequency, the impedance in the plate circuit also increases, maintaining the voltage across the cable a constant. Even with this circuit arrangement it was necessary to use coupling and filter condensers of 1,000 microfarads each in order for the phase shift at 24 cycles per second to be unobjectionable.

Both sound and picture radio transmitters were crystal controlled. The spacing between carriers was accurately maintained at 1,000 kilocycles. The power amplifier of the sound transmitter consisted of a pair of RCA-831 tubes in push-pull. These were modulated by means of a high fidelity class B amplifier. A carrier power of 600 watts was obtained.

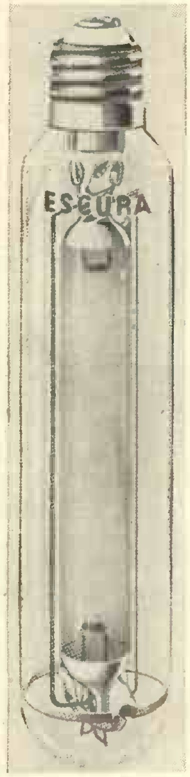
The picture transmitter contained a pair of RCA-846's in push-pull as the final power amplifier. The modulator was a conventional plate modulator containing a pair of RCA-848's, which had sufficient power to modulate the four-kilowatt carrier. Because of the high input capacity of these tubes, it was necessary to use six RCA-831's in parallel to maintain constant voltage over the required frequency range, on the grids of the RCA-848's. These in turn required three RCA-860's in parallel to maintain constant voltage on their grids. The modulation reactor was designed to maintain a fairly uniform impedance over the entire frequency range.

Operating the complete installation for a considerable time gave much valuable and practical information. The installation involved all of the elements of a flexible and practical television system. Souces of programme material were studio, motion picture film, relayed pictures from the Empire State Building in New York, and remote pick-up of a street scene located a mile from the main control room. All signals were carried by cable a reasonable distance from the control room to the radio transmitter. Our principal problems were those concerned directly with terminal facilities.

THE "ESCURA" LAMP

An interesting gas-discharge development.

THERE is a limit to the efficiency at which it is possible to manufacture, for a given economic life, incandescent lamps which employ a filament of tungsten wire operating in an inert gas, owing to the operating temperature of the filament approaching the melting point of tungsten.



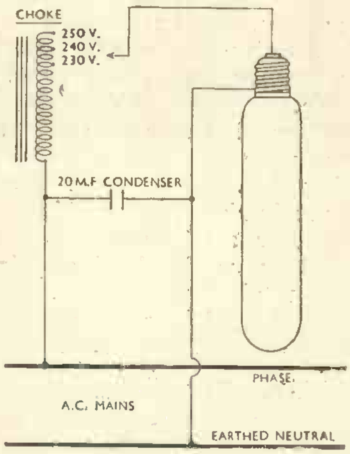
The "Escura" Lamp.

A more suitable metal having a higher melting point and suitable electrical characteristics has yet to be discovered and therefore research in other dierctions has led to the development of a lamp which employs the phenomenon of an electrical discharge through a suitable gas or vapour producing artificial illumination.

The " Escura " lamp, as will be seen from the photograph, departs in many ways from the conventional form of electrical incandescent lamp; it has no filament and is tubular in form instead of pear-shaped. In general, it consists of two bulbs, the one being contained within the other. The inner bulb is of hard glass which has been specially developed to withstand the high temperature attained when the lamp is in operation. This bulb carries at its extremities electrodes which are treated in such a manner as to provide sufficient electronic emission to start an arc through the rare gas contained in the bulb immediately the lamp is connected to an alternating current supply, and are so active that auxiliary heating transformers are not required.

In addition to the small quantity of rare gas, the inner bulb also contains a quantity of mercury, which begins to vaporise as soon as the discharge takes place by reason of the rise of temperature, and becomes luminous, the light source after about three to five minutes assuming the form of a cord of light about six inches long and a quarter of an inch in diameter.

The space between the inner and outer bulb is evacuated in order to secure easy vaporisation of the mercury and to minimise loss of heat which is essential to the successful operation of the lamp.



Method of connecting the "Escura" Lamp to the mains.

The lamp is connected to the mains, as shown in the diagram, through a choke which has been specially designed for use with it. This choke is tapped at intervals of 10 volts and connection is made to the tapping corresponding to the voltage of the supply. The condenser of 20 microfarads capacity is for the purpose of improving the power factor, and if employed, must be connected across the leads to the choke and lamp.

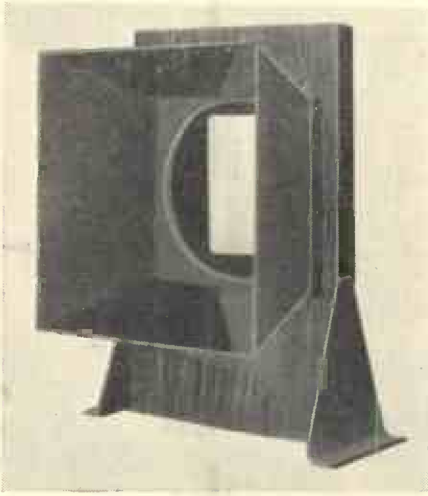
Upon switching on, the gap between the electrodes is momentarily subjected to a potential corresponding to the full pressure of the supply. A discharge immediately takes place, accompanied by a sharp drop in voltage, and an initial current of 5 amperes flows. The potential across the electrodes then gradually rises, the light output steadily increasing until, after about three to five minutes, the arc narrows down to a cord of light approximately 6 ins. long and $\frac{1}{4}$ in. diameter. The normal operating current is about 2.7 amperes. Should the lamp be switched off it will not light again for about fifteen minutes.

The lamp is designed to operate on alternating-current circuit voltages of 200 to 250. One size is manufactured at present, rated at 400 watts, and having an overall efficiency of approximately two and a half times that of a tungsten filament gasfilled lamp of similar wattage, hence giving a light output approximately equal to that of a 1,000 watt tungsten filament lamp of similar mains voltage.

It consumes 400 watts, a further 20 watts being absorbed in the choke and its initial light output is approximately 16,000 lumens. Its efficiency, therefore, is approximately 40 lumens per watt. The light emitted by the lamp is deficient in red rays, but blues and greens are accentuated. The average life of the " Escura " lamp is approximately 1,500 hours.

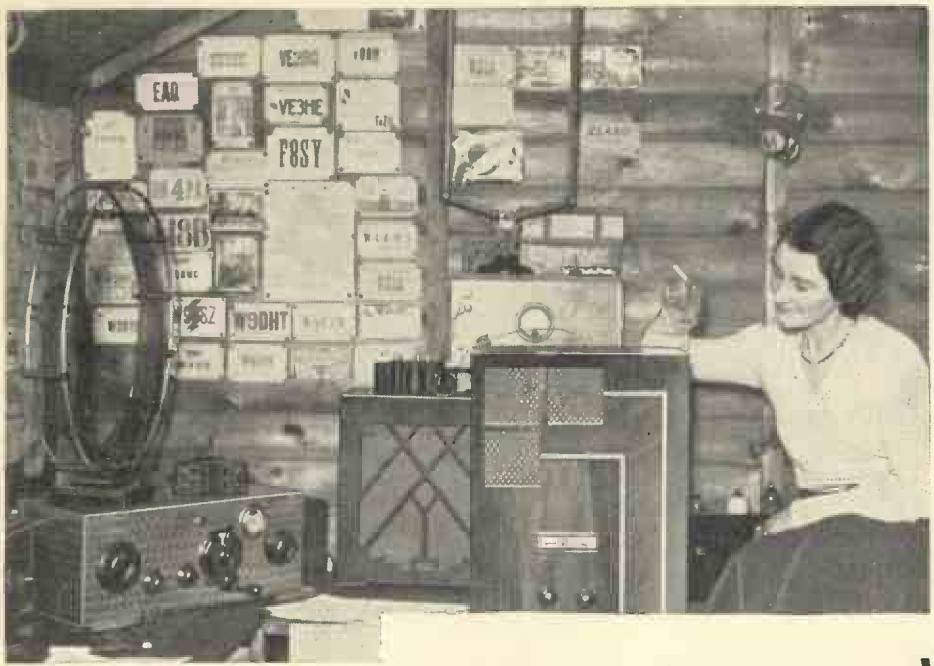
Viewing Tunnel for Disc Machines.

The photograph shows a new lens mount which has recently been introduced by the Bennett Television Co., Station Road, Redhill. It is of



metal and wood construction and is fitted with a super-quality 4-in. lens. The finish is entirely black and it is a component which will enhance the value of any disc machine. The price complete is 10s.

A demonstration of the E.M.I. high-definition television was recently made before H.M. the King at Windsor Castle. The transmission was by ultra-short waves from the Hayes laboratory.



A corner of the author's short-wave laboratory. Note the QSL cards which adorn the walls!

What You Should Know about Short-wave Design

THE first of a series of articles explaining the difficulties that occur with short-wave listening and showing clearly how to rectify them appears in the December WIRELESS MAGAZINE. K. Jowers, the well-known short-wave expert, is writing this series, which will cover every aspect of short-wave reception and will be written in a simple way so that the beginner will be able to get the best out of short-wave listening. There are over thirty other articles in the December issue, something to interest every radio enthusiast. Just look at the list of contents on the left—it will show you what a splendid shillingsworth the WIRELESS MAGAZINE really is.

SOME OF THE OTHER CONTENTS OF THE DECEMBER "WIRELESS MAGAZINE"

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ANSWERS to QUERIES

Electrical v. Mechanical Control

I am running a disc machine without any synchronising gear and have been in the habit of controlling the speed frictionally. This, however, is tiresome and I shall be glad of any other suggestion which does not necessitate any alteration to the wireless receiver as would be the case if I were to add a special synchronising valve. B.T. (Brighton).

As it is assumed that you have A.C. mains available, your simplest course would be to fit an 8-tooth wheel to the motor, and feed the coils with the 50-cycle A.C. supply direct from the mains, independently of the motor supply. This arrangement will give you a steady speed of 750 revolutions per minute, provided that the frequency of the mains is constant.

Building a Mirror Screw

In building a mirror screw is it better to make the edges of the plates slightly concave or have them perfectly flat? I propose making the plates myself.—R.B. (Bradford).

In the latest mirror screw produced by the German Tekade concern, the edges of the plates are slightly concave, the advantage being that the viewing angle is increased with this construction. The correct formation of the plates of this description would be very difficult for an amateur—in fact, we should say impossible without speciail grinding machinery—and plates incorrectly shaped would have an adverse effect upon results. We recommend that you make the edges of the plates flat.

Low-power Amplifier

I wish to build an amplifier suitable for use in conjunction with the Universal receiver described in the November issue and shall be obliged if you will let me have a circuit and specification. —D.R. (Brighton).

You do not say for what purpose you require the amplifier. If for mirror-drum reception then that described in the June issue will be very suitable and work with the Universal receiver excellently. If, however, you require the amplifier for a disc machine or even the disc-projection apparatus, then that given in this issue will be the most suitable.

Connecting the Neon

I am at present running a three-valve receiver of unknown make and wish to use it with a disc receiver. Can you tell me how this should be connected to the neon lamp?—C.A. (Bristol).

The method of connecting the neon lamp depends upon the output arrangements of the receiver and without particulars of these it is not possible to give the exact connections. In the October issue, however, a complete series of circuits was given and if you study these you will have no difficulty in selecting a method of connection which will suit your receiver. Generally, it is possible to connect the neon across the speaker terminals (the speaker connections being removed) and place an extra H.T. battery in series with it in order to bring the high-tension up to the required figure of 185 volts.

Disc-screen Projection

I have made up the disc-screen projector but have failed to get sharply defined images and the illumination is poor. Can you tell me where the fault is?—D.M. (London, N.).

Apparently you are not using the correct type of condenser lens and a good deal of the light is being wasted by covering too great an area on the disc. The object should be to get the light to cover an area just a trifle in excess of the area formed by the scanning holes. This may be checked up by blowing cigarette smoke into the path of the beam and noting its path. Any light which comes outside the area mentioned will be wasted and the brightness of the screen will suffer accordingly. The same remarks apply to the other lenses through which the light passes. Try altering the distance between the lamp and condenser lens and the latter and the disc; it is probable that you can find positions which will allow of all the light being used.

Projection Lamps Burning Out

I have been troubled with the projection lamp burning out in my mirror-drum receiver. Can you tell me what life these lamps should have and what is the probable cause of the trouble? —F.R. (Woking).

As you have had several lamps go after a few hours' use it would appear that the transformer is giving more than the 12 volts at which the lamps are rated, or that there is some defect in the transformer which is allowing surges of current to take place. If the transformer has a tapped primary make the mains connection to a higher voltage tapping than that of the mains. Alternatively, you could connect a resistance in series with the filament; about a yard of No. 18 Eureka wire would be suitable. It is, of course, important that these lamps be burnt in the correct position as specified by the makers: failure to do this is practically certain to result in short life.

Neon Lamps

Are the ordinary Osglim neon lamps suitable for television? —M.T. (Leeds).

Yes, these lamps are quite suitable: they have the slight disadvantage that the field of illumination is not even as is the case with lamps which are made specially for the purpose. This defect can be overcome by frosting the bulb, though there will be a slight loss of light.

Receiver for Mirror Drum

I have a seven-valve super-het. Will this be sufficiently powerful to use with a mirror-drum? —C.B. (Huddersfield).

An output of four to five watts at 400 volts is necessary for the operation of a mirror drum and it therefore calls for a specially built amplifier. Moreover, it is essential that this should be resistance-coupled throughout if distortion is to be avoided. Generally speaking, it may be said that no ordinary wireless receiver is suitable for mirror-drum reception.

FLUORESCENT COMPOUNDS

THERE is now available a range of fluorescent compounds which are of interest to research laboratories and those engaged in the development of television apparatus. These compounds meet the need for uniform light reflection and can be supplied to fluoresce green, yellow, orange, crucible-red, deep-red, purple-red, without discernible "after-glow," and blue-green, blue, violet, with faint "after-glow," when subjected to the rays of a mercury lamp or cathode-tube. They are made at the electro-chemical laboratories of J. D. Riedel-E. de Haen, A.-G., and are supplied in the form of fine free-flowing crystalline powder to aid uniform application and provide maximum light emission.

Formerly it was generally thought desirable that fluorescent compounds for television should show a certain amount of "after-glow" in order to obviate flicker by bridging the transitory gap between one picture and another. For this reason, De Haen's fluorescent compounds Nos. 55, 60 and 70 have been made to emit some "after-glow."

Latterly, however, "after-glow" has been considered unnecessary, and De Haen's process has been developed to produce fluorescent compounds without "after-glow"; compounds to meet this requirement are now available. De Haen's fluorescent compound No. 60, which is excited by slow cathode-ray bombardment emits an agreeable colour-tone. The pictures are almost white, with sharp sepia-toned shadows, free from flicker and, despite strong contrasts, pleasing to the eye. This compound has been developed for anode-voltages of 2,000-4,000 volts. With an output of 1 watt, and a beam diameter of 0.1 millimetre, the results achieved have been most satisfactory. Prolonged tests have also proved its durability. About 20 grammes are sufficient for one tube.

De Haen's fluorescent compounds are distributed in the United Kingdom by J. Sherman & Co., Ltd., Downham Mills, Chesnut Road, Tottenham, London, N.17.

A television company has been formed in Copenhagen. The name of the concern is the Dansk Radio-Fjernsyn, and it is proposed to acquire foreign television patents for Denmark.

Summary of Other Television Patents

(Patent No. 417,182.)

Improvements in the construction of cathode-ray tubes.—(*Standard Telephones and Cables, Ltd., W. T. Gibson* and *D. H. Black.*)

(Patent No. 417,420.)

Arc-discharge arrangement for applying synchronising potentials to the control electrodes of a cathode-ray tube.—(*British Thomson-Houston Co., Ltd.*)

(Patent No. 417,590.)

Method of controlling the rapid "return" lines in cathode-ray scanning.—(*M. von Ardenne.*)

(Patent No. 417,713.)

Arrangement of focusing anodes for cathode-ray tubes.—(*Radio Akt. D. S. Loewe.*)

(Patent No. 417,714.)

Preventing rear and lateral electron emission from the cathode of a cathode-ray tube.—(*Radio Akt. D. S. Loewe.*)

(Patent No. 417,850.)

Improvements in the electrode structure and control of cathode-ray tubes of the gas-filled type.—(*Radio Akt. D. S. Loewe.*)

"Modern Physics and Television Research"

(*Continued from page* 28.)

notoriously do not like to know what they are talking about, that they invented a new direction for the fourth. They derived it from the statement:

$$u^2 = -c^2t^2$$

by taking square roots, thus:

$$u = \sqrt{-1}\,ct$$

so that u is measured along the "root-of-minus-one" axis, or the j-axis as it is sometimes called. From this point of view, the square root of minus one is no more mysterious than a vulgar fraction, and the fact that it it not expressible in decimals is no more shocking than that 2/3 is not a whole number.

The peculiar properties of the four "dimensions" x, y, z and u on the Einstein view (that is to say, when the transformation (B) is used between the dimensions chosen by relatively moving observers) are best illustrated by one or two specific examples.

Let us suppose that a large projectile is shot out into space with half the velocity of light, and that inside it a man (magically prevented from a violent death on departure!) fires a revolver, of which the bullet travels with half the velocity of light, in the same direction as that in which the projectile is going. An observer on the earth, measuring the velocity of the bullet would find it was only moving at 0.8 of the velocity of light.

Moreover, if the bullet exploded, and the nose-cap of it was thrown forward at half the velocity of light with respect to the centre of gravity of the exploded bullet (which, of course, by D'Alembert's principle, would still be going at half the velocity of light with respect to the man who fired it), the net velocity of the nose-cap to a man on the earth, would still only be about 0.93 of the velocity of light.

In fact, no amount of juggling with stupendously swift projectiles containing men with incredibly powerful guns would ever produce a bullet going as fast as light.

Again, suppose that through some unfortunate catastrophe I were forced to leave the world with very nearly the velocity of light; quite apart from my increase in mass (if I were travelling with 99 per cent. of the velocity of light I would have a mass corresponding with well over 77 stone!) an altogether novel effect would manifest itself. Suppose I travelled round some arbitrary path in space and returned to the earth after, by my reckoning, about five minutes: I would find on my return, probably the second generation* of my grandchildren reading about my hurried departure at school in their history books. In fact, the only thing that puts this convenient arrangement of Providence beyond the reach of embezzling financiers appears to be the trifling initial difficulty of accelerating their bodies to 670 million miles per hour or thereabout.

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* This consequence of the Lorentz transformation was pointed out as long ago as 1911 by Einstein in "Vierteljahrschrift der Naturforsch Gesellsch. in Zürich," vol. 56, 1911, p. 12 (Zürich, 1912).

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