Vol. 3 MAY 1930 No. 27 MONTHLY

TELEVISION

TELEVISION FOR THE BEGINNER

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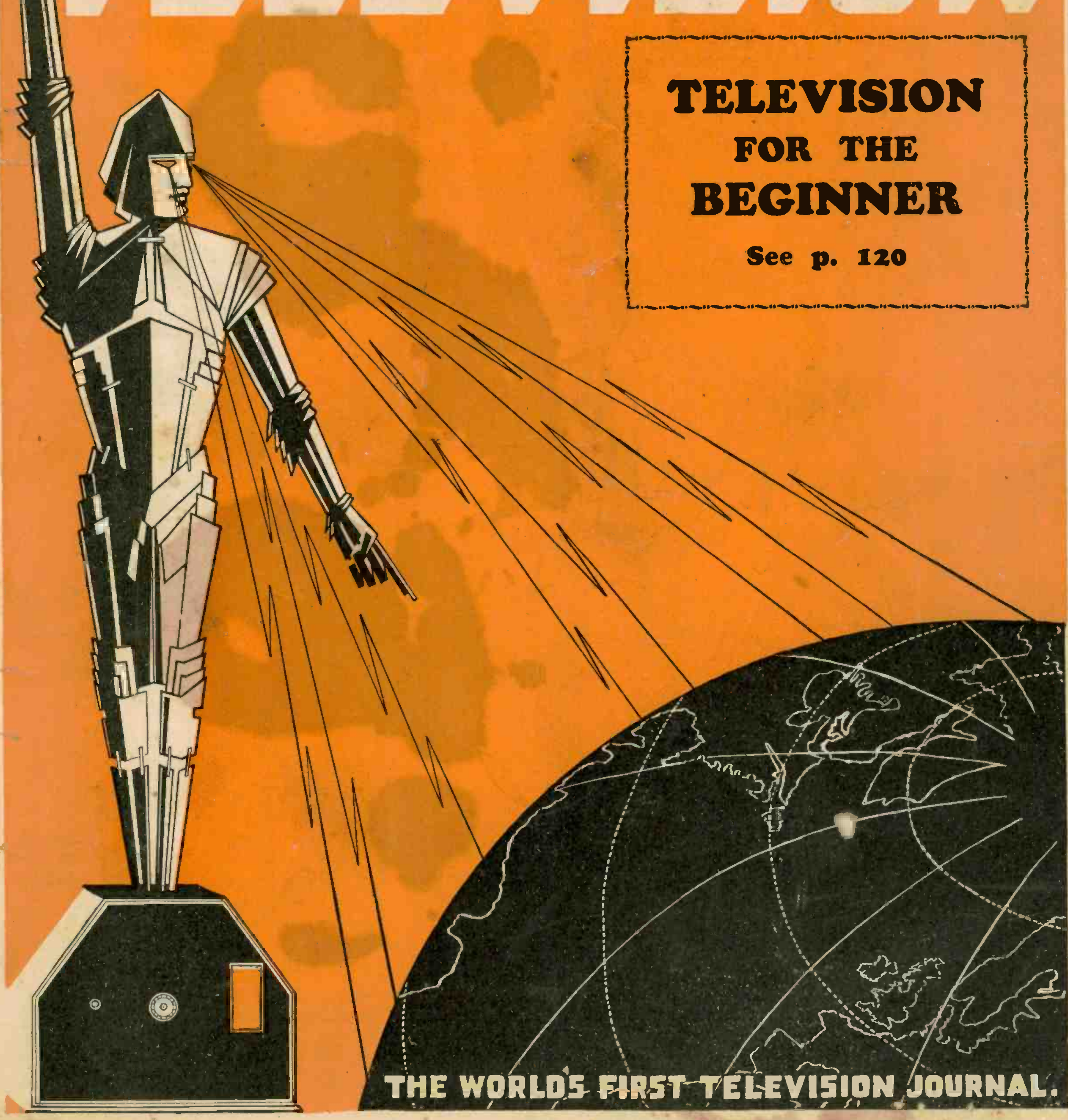

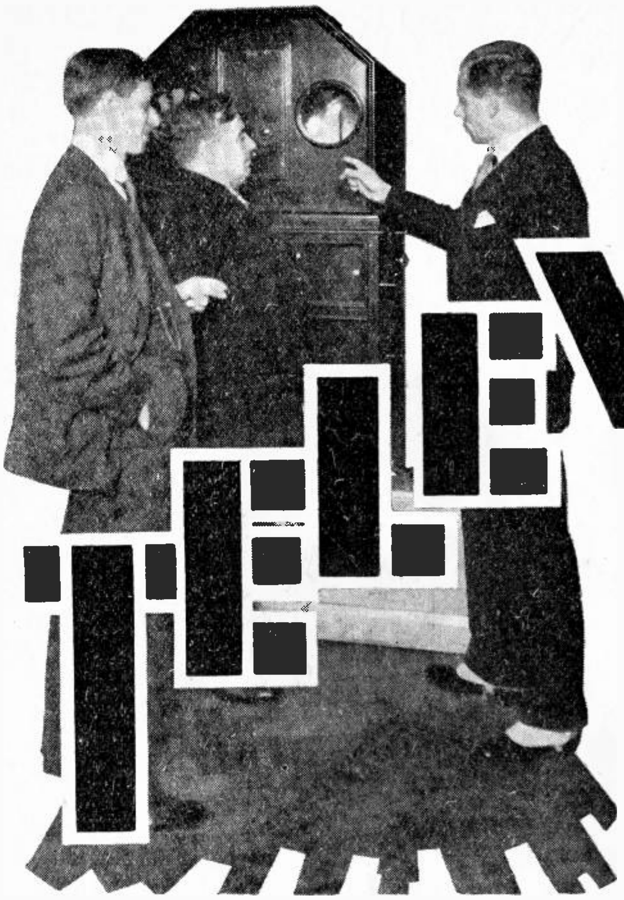

TELEVISION

THE OFFICIAL ORGAN OF THE TELEVISION SOCIETY

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Notes of the Month

Television at No. 10

A Baird receiver was installed at No. 10, Downing Street in time for Mr. Ramsay MacDonald and his household to enjoy the inaugural sight and sound broadcast programme on the morning of March 31st last.

On April 1st a large number of the Delegates to the London Naval Conference, at Mr. MacDonald's invitation, witnessed a demonstration on his instrument. Among those present were the following:

Commonwealth of Australia:
THE HON. J. E. FENTON, M.P., Minister for Trade and Customs.

Canada:
THE HON. J. L. RALSTON, C.M.G., D.S.O., K.C., Minister for National Defence.

France:
MONSIEUR RENÉ MASSIGLI, Ministre Plénipotentiaire, Chef du Service de la Société des Nations au Ministère des Affaires étrangères.

Great Britain:
THE RT. HON. J. RAMSAY MACDONALD, M.P., Prime Minister and First Lord of the Treasury.
MR. R. L. CRAIGIE, C.M.G., Head of the American Department.
MR. MALCOLM MACDONALD, M.P.

India:
SIR ATUL C. CHATTERJEE, K.C.I.E., High Commissioner for India in London.

Irish Free State.
PROFESSOR T. A. SMIDDY, High Commissioner for the Irish Free State in London.

Union of South Africa:
MR. C. T. TE WATER, High Commissioner for the Union of South Africa in London.

Secretary-General:
COLONEL SIR MAURICE HANKEY, G.C.B., G.C.M.G.

Chief Interpreter:
MONSIEUR G. J. MATHIEU.

MISS JOAN MACDONALD.
MISS SHEILA MACDONALD.

Baird Television Merger

On April 7th a series of meetings were held of the various classes of shareholders in the Baird Television Development Co., Ltd., and Baird International Television, Ltd., for the purpose of considering and passing resolutions approving a scheme of amalgamation of the interests of the two undertakings. The full details of the scheme have appeared in the daily press, and it is of interest to note that the necessary resolutions were passed unanimously. The name of the new Company, which will take over all the joint assets and liabilities of the Development and International companies, is Baird Television, Ltd.

During the course of the speeches made by the Chairmen of the Companies it was announced that in order to afford further facilities to those in possession of Baird "televisor" receivers the new Company proposed to build two broadcast stations of its own. The necessary licence to do this had been procured from the Post Office. The two wave lengths employed will be 155 metres for speech and 50 metres for television. The power of both stations will be 1½ kw. By means of these two stations the Company will be enabled to transmit programmes during ordinary broadcast hours without causing any interference to the B.B.C. stations. In addition, by transmitting television on 50 metres the Company will not be limited as at present to a 9-kilocycle wave band, and will thus be able to send larger images and give improved detail.

In answer to questions, Mr. Baird announced that although the light spot transmitter at present employed, using visible light, does not as a rule cause inconvenience to artistes sitting before it, in order still further to eliminate any possible chance of embarrassment it was proposed to substitute infra-red rays for visible light in the near future. Since these rays are invisible, artistes would then experience no embarrassment.

Mr. Baird further announced that work was proceeding in the laboratory on a larger receiving screen, the object of which was to make it possible for a larger number of people to watch to received images.

Television in Manchester

Messrs. A. Franks, Ltd., of Manchester, are nothing if not up to date. Three years ago they approached the Baird Company with a view to giving a practical demonstration in the North. It was felt, however, at that time that television had not advanced sufficiently to give a big demonstration. There was no television broadcast and televisors were not available to the public.

To-day, however, the situation is changed, and Franks, who have kept in close touch with progress all the time, recently gave a particularly good two days' demonstration. A transmitter was installed at their main showrooms in Deansgate, and thus continuous reception was possible at their demonstration hall in Market Street.

Manchester has thus been given its first opportunity of witnessing practical television by the pioneer firm who introduced wireless to that city and, later, were able to give the first demonstration of still picture reception.

Television Broadcasts in America

The Jenkins Television Corporation, acting in conjunction with the de Forest Company, are broadcasting sound and vision simultaneously from their stations W2XCR and W2XCD; the sound signals come from the latter station on 187 metres and the television signals from the former on 107 metres. The vision signals consist of cinematograph films. Horizontal scanning is employed, using a 48-hole disc, and scanning is carried out at the rate of 15 pictures per second. No details are available as to the times of these transmissions.

A New Photo-Electric Cell

The General Electric Co. announce a new type of photo-electric cell known as the Type CM, which is much superior for most purposes than those which have been offered hitherto. The active material on the cathode consists of a thin (monatomic) layer of Caesium carried on a suitably prepared silver conductor. This CM cell, which is in a sense a "Caesium" cell, must not be confused with the old Caesium cells in which the active material was a thick layer of

Caesium ; these old cells were definitely inferior to the ordinary potassium cell for all but a very few special purposes, whereas the older cells gave an emission of one microampere per lumen, the CM cell gives about 12 microamperes per lumen.

Particulars and prices of the new cell, which is made in two types, Vacuum and Gas-Filled, can be had on application to the G.E.C.

A New Loud Speaker Chassis

From the Shaftesbury Radio Co. we have received one of their Wates Double Cone Loud Speaker Chassis. This consists of two cones, one large and one small, connected together at their apices. The whole chassis is so arranged that a number of standard units can be connected to it without difficulty. On test this speaker gives the most pleasing results.

Misleading

We recently came across an item in a newspaper describing the inaugural opening by the National Broadcasting Company of America of a new studio which the Company has built on the roof of the New Amsterdam Theatre in Times Square, New York. This studio really consists of a specially arranged stage at one end of a large auditorium to which the public are admitted. While broadcasting is in progress a huge glass screen weighing six tons is lowered across the front of the stage to prevent noises from the audience reaching the microphone, but at the same time permitting the audience to watch the performers and hear them by means of loud speakers distributed throughout the auditorium.

In describing the inaugural broadcast from this novel studio, the newspaper in question described it as an exhibition of television. Not only was it in no sense a demonstration of television, but the National Broadcasting Company have recently announced that for the time being they do not propose to participate in television broadcast experiments.

Brookman's Park Wave-length Change

According to a newspaper report a plan is under discussion to change the wavelength of Brookman's Park National Programme transmitter from 261 metres to 288 metres. There are two arguments in favour of this step. Many old receiving sets fail to tune down to 261 metres without alteration, whereas 288 metres may just come within their range. The other objection to the existing wave-length is that it is liable to fading. This trouble would be lessened on 288 metres. Before this change can take place, however, a number of the relay stations which are at present operating on 288 metres will have to be given alternative accommodation.

As the 261-metre transmitter is at present used to broadcast television signals, many distant television enthusiasts will benefit by the change.

Television Demonstrations

Between March 24th and April 17th successful demonstrations of television were given at the *Daily Mail* Ideal Home Exhibition at Olympia. These demonstrations were by land line, the transmitter being located at the premises of Major W. H. Oates, at 195, Hammersmith Road. Major Oates is a very enthusiastic wireless and television amateur. It is estimated that about 30,000 members of the public witnessed the demonstrations at Olympia.

Successful public demonstrations were also given at Sunderland from the 8th to the 10th April, and at Manchester on April 16th and 17th.

Further public demonstrations will be given at Southampton from April 24th to May 3rd, and at Bournemouth from May 8th to 17th. under the auspices of the *Southern Daily Echo.*

German Television Society

Recently, due to private initiative, a German Television Society was formed in Berlin with the title "Allgemeiner Deutscher Fernsehverein." Unlike the English Society, which is rather frowned on in official circles, the German Society has as members the German Postmaster-General ; and Dr. Banneitz, Director of the P.O. Television Laboratory, Dr. Feyerabend, Under Secretary of State, Dr. Magnus, who is Vice-President of the Society, and Professor Dr. Leithaeuser, Director Knoepfke of the Berlin Broadcasting Company, while the Broadcasting Companies of Berlin, Breslau, Koenigsberg, and Leipzig have joined as bodies.

The Society aims at assisting in every way possible the development of television in Germany, and is receiving support from all sections of the wireless industry, whether government or trade.

Its immediate task is the checking of television transmissions from the Berlin Broadcast Station with a view to ascertaining to what extent, if any, television can be included as a regular item of the broadcast programme. In this connection considerable attention will be given to the selection of suitable programmes so that public sympathies may not be jeopardised by the inclusion of unsuitable subjects.

At a meeting of the Technical Committee of the Society there were present representatives of the wireless industry, wireless constructors, prominent members of the German P.O., the Technical Research Dept. of the P.O., the Broadcast Companies and Professors of wireless science.

Professor Dr. G. Leithaeuser took the chair and expressed the pleasure of the Society at being able to welcome such well-known men as Dr. Knickow, Director of the German P.O., and Dr. K. W. Wagner, President of the Heinrich Hertz Institute.

The immediate tasks of television were discussed at the meeting and it was generally agreed that caution would have to be used in putting the first televisors on the market lest a reaction likely to jeopardise the ultimate adoption of television be created.

The official organ of the Society is the recently founded monthly magazine, *Fernsehen.*

Television in Scotland

By *Norman Turner,*
Consulting and Radio Service, Ltd., Glasgow.

GREAT stuff this television! At least it would be if we had more of it. Two half hours a week require an enthusiast to enthuse, two half hours that pass like lightning, when people are so keen to look in that you daren't alter a connection or try a new stunt. Of course I'm talking of Scotland, where the morning transmission is totally inaudible and if it *were* audible it would be blotted out by the ghastly induction of all the carpet sweepers that beat as they sweep.

What a thrill to get long-distance vision, not just on your doorstep, but the authentic long distance stuff with all its atmospheric disturbances and its fading and its blot out by the local oscillating fiend. It's funny how accustomed the ear has become to outside disturbances; it's only brought home to us by the criticism of the eye. We *see* the disturbances. We see a lady with a beautiful top knot of extremely black hair, her mouth becomes a most unpleasant gap, her nose a thing of caricature and then for a few moments a perfect picture with every detail down to her eyelashes clearly discernible. Ah, for a local station transmission, what entertainment value there is in sight and sound allied! But what a lot remains to be done; what a field there is for the experimenter with bright ideas, a brighter lamp, a wider projection, a more instant response to speed control.

In Glasgow I have been using a Columbia standard A.C. set, which has three screened grid valves, an anode bend detector and a resistance coupled low frequency valve, this coupled in turn to a single stage push-pull amplifier using two L.S.5A valves with only two hundred volts on the plates. The neon and the synchronising coils are in series with the output transformer and are excited with two hundred volts derived from the same high tension source as the L.S.5A valves. Why this talk about three and four hundred volts I don't understand. I get perfectly clear reception, atmospherics permitting, and good synchronising control with a total high tension voltage of two hundred applied as I have mentioned. The L.S.5A valves are directly A.C. fed and although on a loud-speaker there certainly is a slight hum, the picture only shows the faintest interference bars which in no way mar reception.

What puzzles me, however, is why at the very start of television the Germans, who I presume are using Baird's general system, should use different scanning, horizontal instead of vertical. A divergence of opinion such as this makes television seem very experimental. The Fultograph people were able to standardise the pitch of their thread at the outset, making reception possible from all countries. The merits or demerits of horizontal or vertical scanning I am not able to discuss, but having received both I am very much inclined to favour the Berlin method. The eye does not appear to appreciate horizontal lines nearly so much as the vertical ones, and shadows appear more natural. In any event, after two hours of canting my head to one side to see the Berlin transmission I am greatly in favour of having a standardised system through Europe. If the aperture were at the top of the Baird televisor, two loud-speakers could be fitted, one on each side, giving a better impression of speech or music from the image.

Rome, however, was not built in a day, and no doubt these points are appreciated by the very able Baird staff and we should be extremely thankful to be getting even the small crumbs we are getting. We must not, however, be satisfied; two nights a week, though helpful, are not enough for experiment, and it is most trying to have to wait so long to get the results of any change you may have made in your apparatus, hoping for still better results. If Berlin can steadily pour out television for hours on end, I cannot see why in the country of its origin equal facilities cannot be given. The interest shown in Glasgow in television is clear evidence of the desire of the public to have blind broadcasting unbandaged.

Television *and* Your Wireless Receiver

PART III.

By *H. J. Barton Chapple*,
Wh.Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

IN the second instalment of this series (which by the way appeared in the January issue of TELEVISION, so that an apology is due to readers for the delay in preparing the present article) we concluded by introducing the high-frequency stage suitable for use in a wireless set that is to receive the television signals. While there are several methods for coupling this stage to the detector valve which give good results, I stated that my preference, based on a number of exhaustive tests, was for a choke feed coupled arrangement with the tuned circuit directly in the grid circuit of the detector valve. A skeleton diagram was given, and I now propose to elaborate on this somewhat.

We have traced the advantages of anode bend rectification coupled with an absence of reaction if at all possible. Again, since it is desirable to avoid circuits which are too selective in order to obtain the sideband frequencies, it shows that the wireless receiver calls for a due measure of careful thought and design.

Selectivity.

In Fig. 1 I have indicated the bare essentials for a circuit which has enabled me to receive good television images, and it is hoped that it may prove helpful to some readers. If troubled with problems of selectivity which may arise from the reception of both the Brookman's Park transmissions now that from March 31st both speech and image will be sent out by these stations, I think it by far the better plan to use a wave trap in conjunction with the picture set. If the set is made so selective that it will separate easily the two stations concerned, then you are up against the sideband cut-off problem, but if you arrange to trap out any likely speech interference from the pictures, matters will be quite satisfactory. With this proviso, it will be seen that on the aerial side the circuit is a plain straightforward one, the fixed condenser in the aerial lead being optional according to the type of aerial in use for receiving purposes.

Six-volt valves are used throughout, except for the screened grid valve and this is a four-volt one. The resistance R_1 in the negative filament lead is then adjusted so that the voltage is just four across the filament, and the drop in volts thus acts as a negative bias for the high-frequency valve. While a negative bias is often included in a screened grid valve for

Receiving a Television transmission on a Baird Dual Exhibition Receiver. The apparatus shown contains two wireless receiving sets, one for speech and one for vision. The "televisor" is fitted with a Baird automatic synchronising apparatus.

reasons of selectivity, since one can better tune out a powerful interfering station by reducing any possibility of grid current flow, its use is recommended here, as it is advantageous.

De-coupling.

The resistance R_2 in the screen grid connection should be variable, so that the correct screen voltage can be applied to this electrode without having to recourse to a separate high-tension feed. The maximum value of this resistance will depend upon the main H.T. feed, but assuming this to be from 300 to 400 volts, then a 100,000 ohm variable resistance will suit nicely. Incidentally, this resistance, in conjunction with the 1 mfd. condenser joined up as shown, acts as an effective de-coupler. Another factor which can be borne in mind is that adjustments of the screen grid volts through the medium of R_2 serves as a good volume control.

In the plate circuit of the screened grid valve we have a high-frequency choke of high impedance and possessing characteristics differing from that of the high-frequency choke inserted in the plate circuit of the detector valve. The resistance R_3 serves to drop the plate volts to the correct value and, as in the previous case, acts as a de-coupler with the 2 mfd. condenser.

A High Ideal.

A mica fixed condenser of ·001 mfd. capacity couples the screened grid valve anode to the grid end of the tuned circuit preceding the detector valve, and here we have shown an arrangement about which I discoursed at length in the Part II instalment. It will therefore be unnecessary to reiterate my previous remarks, and we can accordingly pass on to the low-frequency side.

There is one golden rule which must be kept uppermost here, and that is the fact that distortion will be avoided if the increased signal from the output stage differs from the original only in magnitude. In other words, the output plate current of each valve must be *directly* proportional to the input grid volts. This is a high ideal, but unless one aims high you cannot be sure of obtaining even a relatively moderate level of performance.

First of all then, the total input grid volts swing to each valve must operate well within that part of the straight characteristic situated on the negative side of the datum line. This will ensure that the grid does not assume a positive charge and cause grid current to flow. It is therefore obvious that the valves must be chosen with care to see that they can handle adequately the power necessary, and a little time spent in examining the characteristics will be repaid fourfold when it comes to operation.

Resistance Capacity Coupling.

It will be seen from Fig. 1 that I have placed my faith in resistance capacity coupling. This does not mean that any other form of coupling such as transformer, choke capacity, push-pull, etc., is ruled out of court, for from experience I know that good images are obtainable with sets using these types of coupling. What I am anxious to emphasise, however, is that for television work, where the frequency range to be covered exceeds that of the audio-frequency range, it is found that resistance capacity coupling so far meets the case in a really excellent manner.

(*Continued on page* 114.)

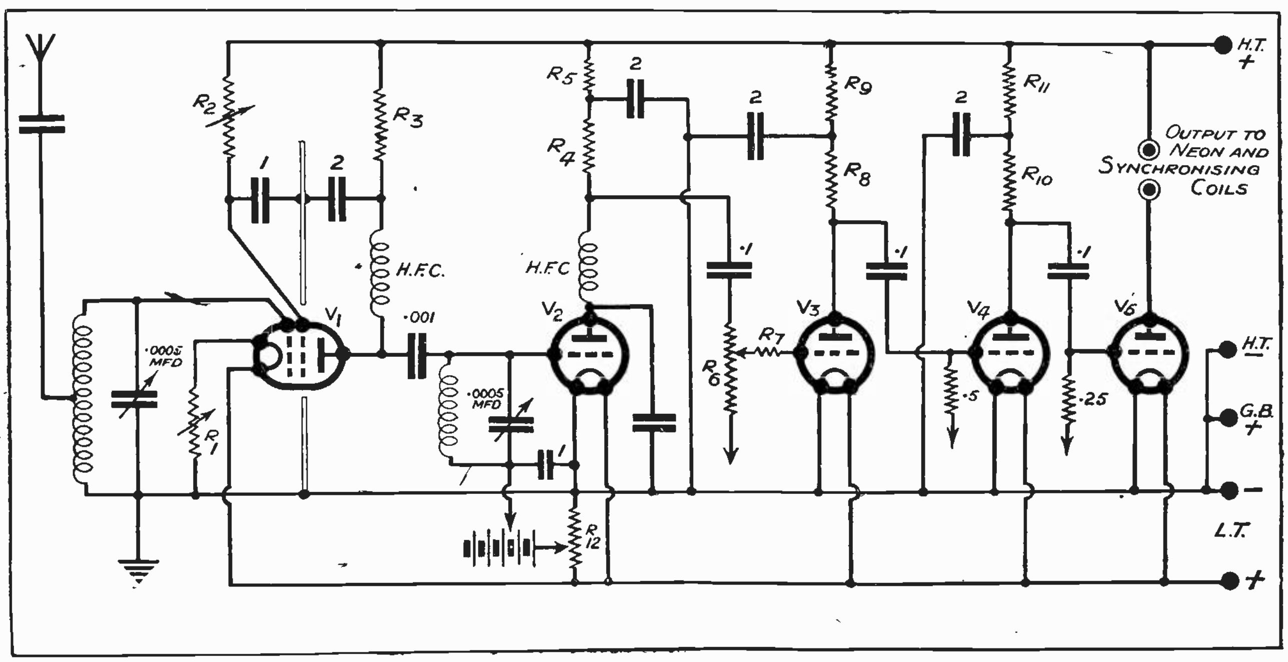


Fig. 1.—A wireless circuit for receiving Television.

Amateurs' Exhibition

New Ideas on Scanning and Receiver Construction

THE second annual exhibition of members' work held by the Television Society at the Gower Street College, University of London, on Wednesday, April 9th, was regarded by all as an unqualified success.

Although called formally an exhibition, it was a most friendly affair. Exhibitors, when they could leave their stands, visited other exhibitors and discussed problems and schemes for getting better television reception—a topic that exhibitors and visitors alike found of absorbing interest.

Although many knobs and dials were on view, there was no "knob twiddling" or a single case of apparatus being damaged by unauthorised handling.

The exhibition was open from 2 p.m. to 9 p.m., and the members showing competed for the Tuke Cup, a silver cup presented by Captain B. S. Tuke, to be awarded to, and held for a year, by the member showing the best apparatus.

The exhibition was staged in the Physics Theatre at the College, a historic and very appropriate spot, for not only did the President of the Society, Sir Ambrose Fleming, work for many years at the College on the measurement of wave-length and the thermionic valve, each of which ultimately made television possible, but other items which play an important part were discovered there.

In the chemical side, Lord Rayleigh worked on argon, an important item in photo-electric cells; Sir William Ramsay in the physics laboratories, due to his work with liquid air, discovered helium and neon. Mr. J. J. Denton, Joint Hon. Secretary of the Television Society, played a part in this work.

In a laboratory not very far away from the Physics Theatre, Professor C. G. Carey Foster, F.R.S., did all his work on extremely fine electrical measurements, culminating in what is now known as "The Carey-Foster" method of electrical measurement.

The apparatus shown by members displayed an ingenuity and determination not to be beaten by difficulties, worthy of the great workers who had used the laboratories.

The judges for the award of the Tuke Cup were Professor F. J. Cheshire, Dr. C. Tierney (Chairman of the Society), and Dr. H. Monteagle. They found the exhibit of Captain R. Wilson, who co-operates with E. L. Gardiner, B.Sc., and A. A. Waters, the most meritorious, and awarded him the Cup, a decision which was approved by all. Honourable mention was awarded to the Southend-on-Sea District Television Society and East Essex Group Centre represented by Mr. R. F. Cowley, Mr. D. L. Plaistowe, Mr. L. Bounds, and Mr. A. F. Knipe for a variety of exhibits, and to Mr. H. J. Peachey who showed an elaborate receiver combining a three-valve set for speech and a four-valve vision set.

Captain Wilson's exhibit consisted of:—

(*a*) A television transmitter and check receiver for supplying a vision signal for testing the television receivers exhibited for the Tuke Cup Competition.

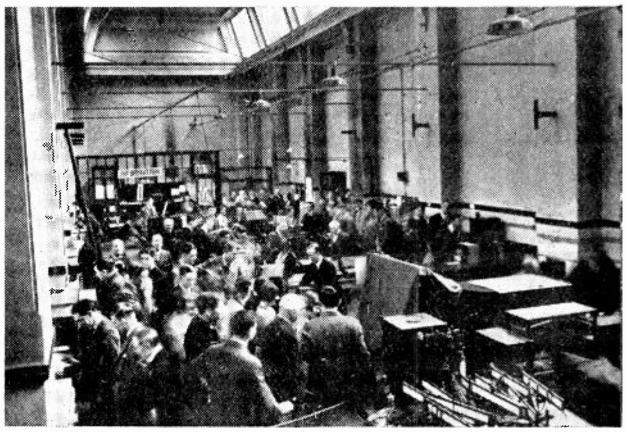
(*b*) An independent television receiver fitted with synchronising device.

(*c*) Horizontally arranged television receiver.

(*d*) Experimental scanning device.

(*e*) Wireless receiver and amplifier specially designed for television reception.

(*f*) Heterodyne beat-frequency oscillator used in designing the transmitting amplifiers.



General view of the exhibition. A very keen interest was taken by members in the various exhibits.

The whole of this exhibit was most workmanlike and professional in finish, but by far the most interesting item was the experimental scanning device.

The mechanism for working this was housed in a small box about 6 in. by 6 in. by 9 in., and driven by a motor, but how it was arranged or worked Captain Wilson would not say.

In effect, the light spot was caused to zigzag over the scanned area, the strips appearing to be closer together at the sides than in the centre.

The idea apparently was to secure even scanning and avoid the jump of the scanning beam from the finishing strip to the starting strip as is usual with the disc. This, if workable, would do much to get rid of

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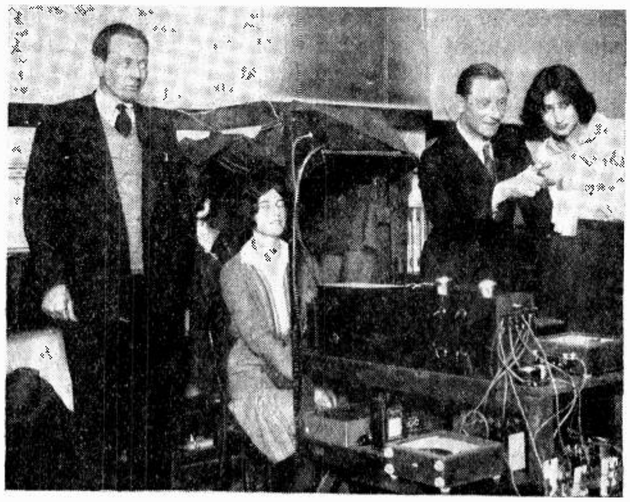
flicker. It can, Captain Wilson explained, be arranged to work with the present synchronising arrangements.

The Southend exhibit included an experimental televisor, complete with magnetic toothed-wheel synchroniser, an automatic jig for marking and cutting discs and discs made by this piece of apparatus. This jig was the subject of a recent article in TELEVISION by Mr. Knipe, who also had on view his



A close-up view of Capt. R. Wilson's transmitter. Capt. Wilson is on the left and Mr. A. A. Waters, our well-known contributor, is on the right.

"water lens"—two clock glasses cemented together and the enclosed space filled with water.

An interesting side-line of this exhibit was a stroboscopically controlled device for measuring camera shutter speeds.

It consisted of a motor-driven drum and a neon tube fed from the A.C. mains. The motor speed is adjusted by a stroboscopic device in conjunction with the neon tube. When the motor speed is fixed, a strip of bromide paper on the drum is exposed to a bright light by the shutter whose speed is being tested. This gives a dark band on the bromide paper, and from the length of this the shutter speed can be calculated.

The most unconventional exhibit was that of Mr. C. E. C. Roberts, who was showing "tubes" for television scanning and receiving.

His "receiver" looked something like a photo-electric cell in that there was a movable backing with a wire mesh grid in front of it.

By applying a suitable potential to these a visible discharge can be made to take place.

The light given out by this is intense and very local. Its size is easily controllable by the voltage applied, while its position can be varied by suitable magnetic fields as in the case of a cathode ray tube.

For his transmitter he proposes to use a large tube containing a photo-electric surface at one end. Some distance away is placed a screen with a small hole in the centre and further away again is the "grid." These three surfaces are all parallel to one another. In use, the image to be televised is condensed by a lens and thrown on to the photo-electric surface, where it gives rise to streams of electrons directly proportional to the light values.

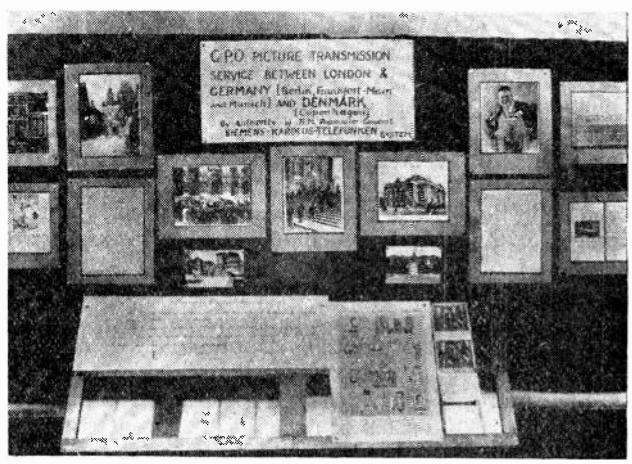
This electron stream is "scanned" by magnets placed outside the tube and so fed as to cause every part of the stream in turn to pass through the centre hole in the screen. Electrons passing the centre hole fall on the "grid" and so give rise to electric variations which can be amplified in the ordinary way.

All this apparatus was very much in the experimental stage Mr. Roberts being hampered by lack of suitable assistance and funds.

Another interesting exhibit on this stand was a television receiver in which the disc was made to act as the diaphragm of a cone loud-speaker. The rod actuating the cone passed through the centre of the motor spindle, while the reed unit was carried on the end of the motor body. This arrangement, Mr. Roberts stated, worked quite well, the rotation of the cone apparently having no effect on the reproduction of speech and music.

Next to this exhibit was that of Mr. Colin P. Garside, who was showing a complete receiver with standard synchronising gear, several forms of scanning apparatus and some models of synchronising gear which he hopes to try out. In one arrangement of this, the inertia of the disc was employed to control resistances to speed up or slow down the motor, the object being to get rid of the "hunting" of the received image.

A "head-phone" receiver was shown by Mr. R. W. Corkling, the complete apparatus taking up very little more space than a couple of ordinary 60-volt high tension batteries placed one above another. It gave a picture about $3\frac{1}{2}$ to 4 inches wide, and in place of a disc a drum was employed. The neon tube is placed inside, and gives an intense line of light the full



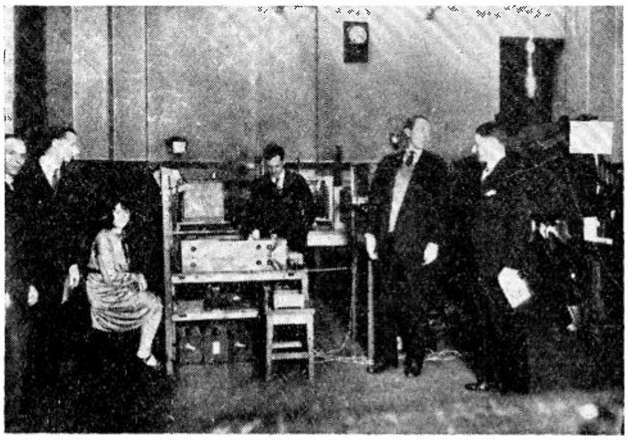
G.P.O. exhibit of photographs received from Germany and Denmark by the recently opened continental photo-telegraphy service.

width of the drum, the image being thrown on a translucent screen.

That a costly workshop with machine tools and power was not necessary to the building of television apparatus was proved by Mr. Ian Vaughan-Jones, a student of Eastbourne College, who showed a "televisor" constructed from Meccano parts and tin sheet. Even the toothed-wheel was made from tin and, what is perhaps more surprising, the apparatus worked.

Mr. G. C. Cato, who had travelled from Aberdeen to exhibit, had an ingenious device which made use of a 29-hole integrating disc working with a 30-hole scanning disc to give apparent motion to any stationary object being scanned. As an object for his demonstration, he had a stationary arrow, but as seen in the "televisor" this appeared as a succession of arrows following one another.

While not connected directly with television, he suggests that his apparatus might be used as a television advertiser for use in shop windows.



General view of Capt. Wilson's exhibit.

Those who found it hard to realise that a varying amount of light is reflected from any surface had all their difficulties brushed away by the exhibit of Mr. T. M. C. Lance, who had a hand adjustable spotlight playing on a photograph. The reflected light was picked up by a photo cell and the output recorded on a meter. With this simple device it was possible to see why the size of the scanning spot-light controls the definition of the received image. (When the spot rested on half black and half white its response was half that of pure white, yet more than that of pure black, and would have given rise to a grey tint in a "televisor.")

These were the original or outstanding exhibits among many.

Sir Ambrose Fleming visited the exhibition and was pleased with the signs of activity and progress which he saw. The time had now come, he said, for teamwork and concentration of groups of workers on a particular line of work.

He indicated as suitable subjects the Kerr cell effect and the measurement of the light intensities reflected from the human features at different angles.

Mr. W. Woodroffe, who was due to show a colour television receiver on mechanical principles, and a talkie film apparatus, flew from Manchester to London for the exhibition, but as his apparatus was damaged in transit was unable to exhibit.

Television and Your Wireless Receiver.

(Concluded from page 110.)

To avoid distortion here it is necessary to select suitable valves and component values which combine in an efficient manner. Although the overall amplification may be less than could be secured with other types of coupling, it is A.1 quality we are seeking.

Without actually specifying exact valves, resistance values, etc., it is impossible to be specific with the low-frequency side of the circuit shown in Fig. 1, and the experimenter is called upon to exercise a certain amount of discretion on his own part. Note the inclusion of a potentiometer as the resistance R_6 (about ½ meg.) to act as an efficient volume control where such is desired, and also the stopper resistance R_7 which may be any value between 100,000 and 250,000 ohms. R_5, R_9, and R_{11} are de-coupling resistances, and it will be noticed that only one voltage is used on the H.T. side.

A Single H.T. Feed.

This form of working is most advantageous, as it does away with eliminator or high-tension battery tappings and ensures a constant and steady drain on the H.T. source. This uniform load is to be preferred always where it is possible to incorporate it, and back coupling effects are avoided, thus promoting stability and overcoming any tendency to motor boating or low-frequency oscillation. The values of the de-coupling resistances are calculated quite easily by using Ohms law.

In many respects the low-frequency side resembles that of the amplier specified in William J. Richardson's constructional article of last month, and the component values suggested there suit this circuit very well. While inclined to be heavy in consumption from the L.T. point of view, valves of the LS5 class should be used if circumstances permit. An LS5B, LS5 and LS5A or LS6A work well in the V_3, V_4 and V_5 positions. As far as the output stage is concerned a choke coupled filter will certainly reduce the total voltage necessary, but even with the neon and cogged wheel synchronising coils in series excellent images can be obtained with 350 volts or even lower. So much will depend upon the efficiency of the synchronising mechanism and the type of motor, the better the workmanship the smaller the power necessary to hold the picture steady.

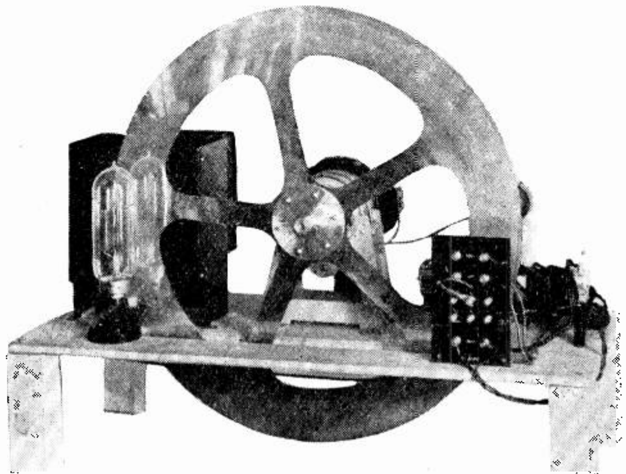
The circuit arrangement suggested will ensure that the resultant image is a positive one with the normal Baird television transmissions now going out through the Brookman's Park Station. In view of this no provision has been made for changing the image from positive to negative or vice versa. While appreciating that the circuit submitted is reasonably straightforward, I shall be glad to hear from any readers who try it out for themselves, so that experiences in different districts may be compared.

A newspaper informs us that "London broadcasts on 842,000 cycles."—No wonder we get "jams."

Assembling *and* Working *a* Baird Kit *of* Components

By *William J. Richardson*

WHEN the kits of Baird branded components became available to the general public a few weeks ago I felt it would be an excellent scheme to obtain one and make up a machine for myself to use in conjunction with the amplifier which I described in the March issue of this magazine. The thought was father to the deed, and it was with quite a thrill that I unpacked my carton of goods to prepare for action. Naturally, out of the complete list which the Baird Company are prepared to supply there are certain items which are either already in the possession of the constructor or, alternatively, in the interests of economy, he can make them himself.

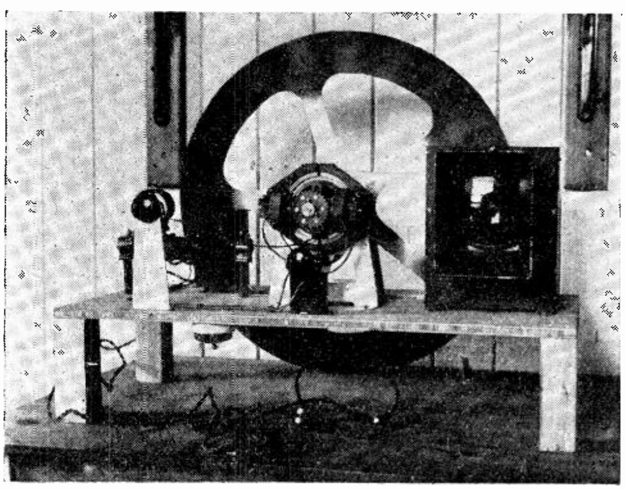


Notice the positioning of the neon lamp and terminal board.

The Items Obtained

The kit which I secured was as follows :—

1 Lens box assembly (six pieces).
1 Spindle assembly.
1 Large lens.
1 Small lens.
*1 Variable resistance, bracket and knob.
1 Zenite resistance and ebonite supports.
1 Graduated receiving disc.
*1 Terminal board assembly.
*1 ·1 mfd. mica condenser.
*1 Flexible lead and adapter.
1 Motor bracket and strops.
1 Flat electrode neon tube.
*1 Neon tube holder.
1 Universal motor, complete with synchronising gear.



The complete kit assembled and wired ready for use.

Of these items, those marked with an asterisk can either be made up quite simply by the amateur himself or he can no doubt unearth suitable substitutes from amongst his own gear at home. In addition to the list just given, a length of rubber-covered flexible wire and sundry screws must be got together as detailed below.

11 ft. 3 mm. rubber-covered flex.
12 No. 6 $\frac{5}{8}$ in. round head wood screws.
2 No. 6 $\frac{3}{4}$ in. round head wood screws.
2 No. 10 $2\frac{1}{2}$ in. round head wood screws.
24 No. 6 BA screws.

One ordinary tumbler switch has been used, as can be seen in the photographs, but if preferred the normal house lighting switch will serve for switching the motor on and off. I felt it was convenient to include one on the baseboard, however, and can recommend this policy to you.

Positioning Components

When the kit was obtained there was no definite information concerning the positioning of the various parts on a baseboard, and a good deal of time was spent on finding the correct places for the motor stand, neon holder, and lens assembly. I understand that these dimensions are now available in a kit brochure issued by the Baird Company, but a complete layout of these important items is given in Fig. 1.

The wooden baseboard is 26 in. by 12 in. by ½ in., and the best wood for this purpose is gettelboard or five-ply. A slot 17½ in. by 1½ in. must be cut out in the position shown to give freedom of movement to the disc, and this should be your first task. The aid of a keyhole saw makes this a very simple proposition.

Now position the motor bracket and neon holder by marking out the baseboard holes to the dimensions given in Fig. 1. Make sure that the holder is correctly placed, so that the flat plate of the neon is exactly parallel to the disc. You must next assemble the lens box, and this is quite straightforward if you examine the accompanying photographs. The small lens is held in place on a partition clipped in the main frame while the large lens is screwed on to the front, convex side towards the observer. All the holes are threaded to take the 6 BA screws, and, when complete, screw this down to the baseboard in the position indicated in Fig. 1.

Allowing for Framing

Clamp the motor and synchronising gear to the bracket with the strops provided, being careful to

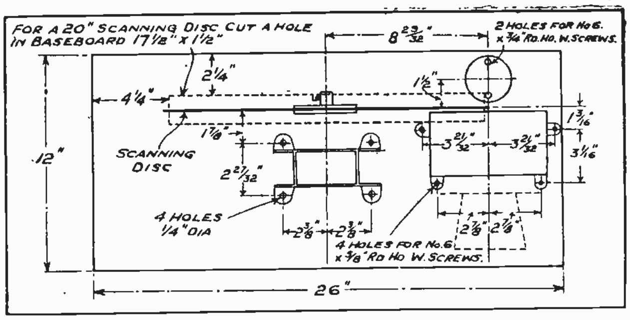


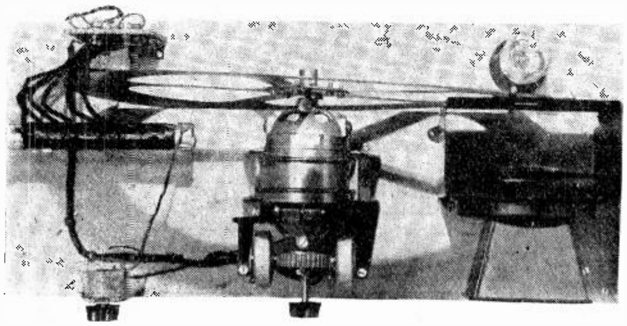
Fig. 1.—Detailed dimensions for the baseboard layout.

insert the spindle with collar and pinion so that the framing of the image is allowed for by rotating the synchronising coils and their holding bracket. The terminal board, variable resistance and bracket, Zenite resistance and ·1 mfd. mica condenser, must now be placed in position and screwed to the baseboard. The *exact* arrangement of these is not very important, and that is why no dimensions are given for them in Fig. 1, but you will gather from the photographs what I have done and can pursue a similar line of action.

The tumbler switch is held under the baseboard about 8 in. from the left-hand end, two holes being drilled through the wood to allow the pair of wires to join on to the switch points. At this juncture it will be advisable to raise the base off the table by four wooden feet, 5 in. long and 1½ in. square. This is essential for the disc passes through the slot you have already cut out, and projects over 4 in. downwards.

Little Wiring Necessary

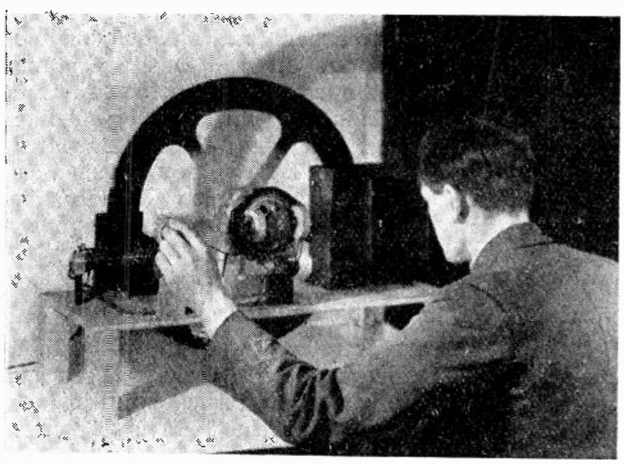
All should now be in readiness for the small amount of wiring up that is required, and Fig. 2 shows you



This plan view will help you to make your connections.

the complete circuit. An actual wiring diagram is unnecessary for the illustrations indicate quite clearly how the various points are connected together by the flexible leads and held in place by small cleats. The only wires passing under the baseboard are those from the lamp terminals to the neon tube holder itself. Beaded leads are joined to the tap points of the Zenite resistance, and you must be careful to attach them to the lettered terminals in the order shown in Fig. 2, and also see that they clear the disc edge.

A point which you should be careful over is in the linking together of the two synchronising coils. The windings must be so placed in series that if one coil acquires a north polarity when a current is flowing, the other coil acquires a south polarity. Before finally making your connections, therefore, just twist a wire from each coil together and apply a small battery voltage, say 4 or 6 volts, across the free ends. Bring a compass needle near each coil, and if the right pair of wires have been linked the coils will indicate



Showing how the motor is run up to speed while watching the image formation.

opposite polarities on the compass needle. If not, then the linked wires must be changed to rectify matters.

Finding the Correct Tap Point

One of the leads to a mains terminal passes through the *T* hole in the terminal board and finishes off in a spade tag. This enables you to connect on to the appropriate terminal for running your motor at its correct speed according to the house mains supply voltage available. The motor is of the universal type, that is to say, it will run on either direct or alternating current, and is wound to run at 750 r.p.m. at 100 volts 50 cycles A.C. or 45 volts D.C. Thus, the correct Zenite resistance tap must be joined to by the spade tag in order to " drop " your voltage the required amount.

Check over your connections to make sure that one or more leads have not been omitted, and if satisfied that this is the case, place the disc on the motor shaft with the bush portion *away* from the motor carcase. This will ensure that the spiral of scanning holes

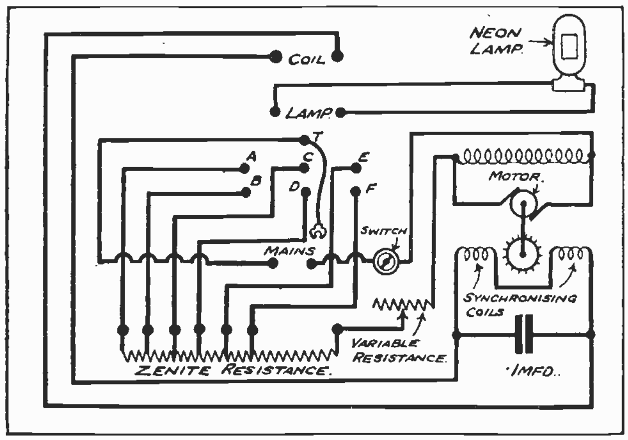


Fig. 2.—The complete circuit for wiring up the Baird kit of components.

moves in the right direction, and gives you an exploration of the neon plate from bottom to top and right to left.

Details to Follow

Next try out the motor and see that it runs by joining the free ends of the flex leads to the appropriate terminals on the board. For a first test join the spade tag under terminal head *A*, place your plug in the electric supply socket, and switch on both at the source and the tumbler switch under the baseboard. If your motor runs smoothly in an anti-clockwise direction then you will be safe in assuming that your motor is satisfactory.

Next month I will give a table to show you which terminal you should join the spade tag to in order to get the speed of the motor approximately correct for your own particular voltage supply. In addition, the results of tests made in conjunction with the amplifier I mentioned previously will be described, together with a suitable detector unit coupled to it.

Simultaneous Sight and Sound Broadcast. *Television Makes a further Advance*

SIGHT TRANSMISSION 261 m.
SPEECH TRANSMISSION 356 m. } FROM BROOKMANS PARK.

ONLY those who have taken a keen interest in, or have been intimately connected with the development of television, can realise the anxieties that assail the members of the staff when an important demonstration is about to be given.

Every weak link, imaginary or real, is known, and due care taken to safeguard it; still the possibilities pile up in the mind to an alarming mountain; tempers, even the most equable, become strained to breaking point, and even the best of friends may quarrel—for a moment.

Knowing these things, yet not suffering from them, TELEVISION'S representative went with considerable interest to the Baird Company's experimental station at Hendon on Monday, March 31st, to see and hear the first complete broadcast of television, *i.e.*, sight *and sound*, from the dual stations of the B.B.C. at Brookmans Park.

To say that nothing happened would, perhaps, be misleading; but it is also correct, for nothing in the way of trouble or disappointment did happen. The transmission was a complete success.

Since the opening of the two B.B.C. stations at Brookmans Park one has read so much in the wireless papers of the difficulties of broadcast fans in getting one station without the other that the question naturally arose: "As the sight and sound signals are to go out from these stations, is it not likely that a little of the sight signal may stray into the loud-speaker, and a little of the sound signal find its way on to the screen of the receiving 'televisor'?"

It has also often been stated by some critics that television wants such a wide band that it would make transmissions on a large number of adjacent wave-lengths impossible, even if only a limited image was being sent.

These doubts made the demonstration additionally interesting and important, for neither image nor sound interfered in the least with one another.

At the request of our representative, first, loud-speaker and associated circuits and then the "televisor" and its associated circuits were cut out. The fact of either being on or off had no effect whatsoever on the other.

Promptly at 11 a.m. the blank screen of the "televisor" showed signs of a signal coming along, and it was synchronised just as Mr. S. A. Moseley,

Miss Gracie Fields and Miss Annie Croft before the Televisor.

who was announced to open the programme, began to say:—

"Ladies and Gentlemen,—This inaugurates an epoch in television transmission. For the first time in history we are putting over television simultaneously with sound. I want to explain, as simply as possible, what is happening. I am seated in the Baird studio in Long Acre before a microphone and the television transmitter. My voice is being carried along one line, and the vision along another line to the B.B.C. control room at Savoy Hill. There both voice and vision are connected to the Brookmans Park Broadcasting Stations, where, in turn, they are radiated through two separate wave-lengths.

"Those of you who are looking-in should be able to see me as I make this announcement."

At Hendon there were a good many who knew Mr. Moseley. Judging by their comments, they had no difficulty in seeing and recognising him—in fact, they found his appearance on the "televisor" screen a "speaking" likeness. But to go back to his remarks:—

"The interest in these proceedings has been very great," he continued. "Several eminent people have some specially to the studio to take part in what they regard as an historic occasion. I now propose to make way for Sir Ambrose Fleming. Sir Ambrose's wonderful invention of the thermionic valve made wireless in the home possible. His interest in television is so well-known that an occasion such as this would be incomplete without his presence.

"After Sir Ambrose has spoken I shall ask the Right Hon. Lord Ampthill, Chairman of the Baird International Television Company, to say a few words. His pioneer work in bringing television before the public will occupy a proud position in the history of this remarkable new science.

"Nor am I forgetting Mr. John Baird, the man who made practical television possible, but whose innate modesty makes it uncertain whether he will appear before you publicly or not. At any rate, I hope I may persuade him to come and reveal himself to you before the end of this transmission.

"In order to balance the experiment, on the entertainment side we have procured the services of the popular stars, Miss Annie Croft and Miss Gracie Fields.

"I have now great pleasure in introducing Sir Ambrose Fleming. . . ."

Sir Ambrose Fleming's Speech.

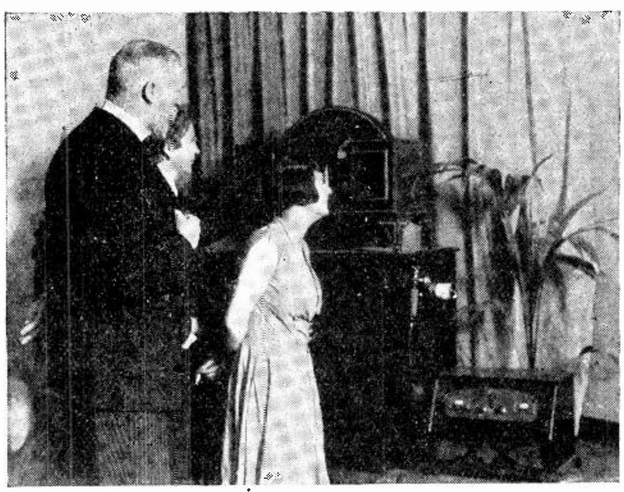
After a brief pause, the head and shoulders of Sir Ambrose appeared, and he said :—

"We are assembled here to-day, in the Baird Laboratories in Long Acre, London, to conduct a very interesting demonstration of a simultaneous broadcast of speech and visible images of the speaker, with two frequencies, as arranged by the British Broadcasting Corporation.

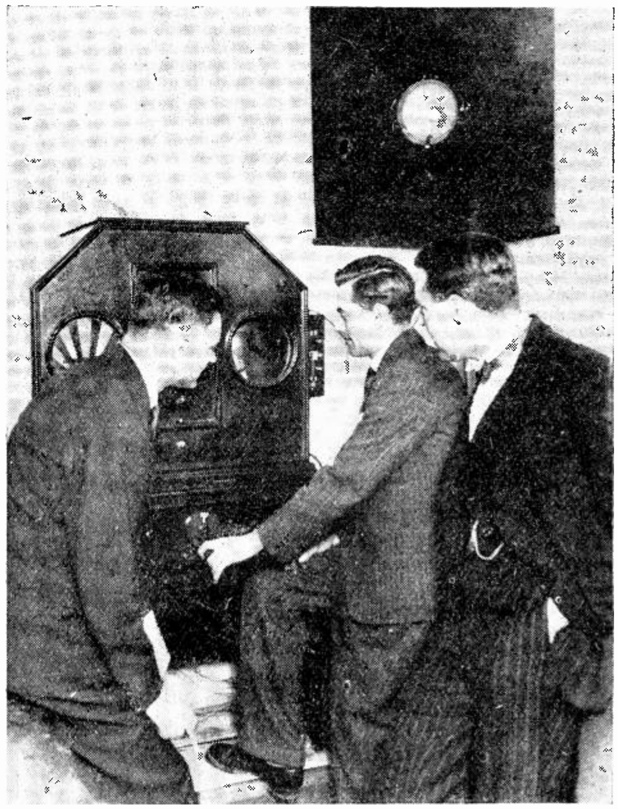
"We have now had, for some time, the broadcast of speech and music, but there is no manner of doubt that appeal to the eye is, in general, more interesting than appeal to the ear alone, and appeal to both eye and ear at once is much more powerful than appeal to the eye alone.

"All advertisers know that a visible image or picture holds attention far better than a mere printed sentence or even happy verbal slogan.

"The celebrated picture by Sir John Millais, called 'Bubbles,' with its curly-headed little boy blowing bubbles, was vastly more successful in capturing popular interest than any mere recitation of the saponaceous virtues of an article in frequent domestic use.



Lord Ampthill, Mr. Baird and Miss Lulu Stanley (one of the artistes) looking-in at Long Acre, on March 31st.



Just before 11 a.m. at the Baird Laboratory at Hendon—waiting for the signal to receive the first simultaneous broadcast of sound and vision.

"To be able to see the speaker adds something to the effect of his speech, not only because we all do a certain amount of lip-reading, but because much meaning can be better conveyed by the looks than by words alone.

"To be able, then, to see as well as hear will add a new interest to broadcasting.

"Most persons gain more knowledge by the eye than by the ear. Anything moving or giving evidence of being alive at once exercises an attraction, and we all know how quickly a crowd gathers round a shop window when there is anything to see in it which is in motion.

"It is, then, one of the latest achievements of applied science to be able to give this simultaneous broadcast of audible speech or song and visible reproduction of images of the faces of living speakers or singers.

"I beg to congratulate heartily all those whose ingenious scientific labours have made possible this remarkable feat."

Sir Ambrose was followed by the Right Hon. Lord Ampthill, who, to judge by his appearance in the televisor, has a remarkably good "television face." His speech, too, was clear and deliberate, and came over well. He said :—

(*Continued on page* 122.)

Television for the Beginner

PART V

By *John W. Woodford*

IT is gratifying to learn from several quarters that this elementary series has enabled many readers to better understand the working of the Baird television system, and I hope that readers not clear on any points will write and let me know so that I can deal with them. At present we are still engrossed with matters at the transmitting end, and saw in our last instalment how it was possible to turn light into electricity.

A Standard Photo-electric Cell.

Undoubtedly the modern photo-electric cell can be looked upon as a sort of wonderful Aladdin's lamp, for its characteristics to the ordinary lay mind border on the miraculous. It would not be in keeping with the aims and objects of this series to examine the photo-electric cell from the scientific point of view and delve into its intricate properties. You will have to take all this for granted and accept the bare statement of facts.

As we have said before, its prime function is to convert light variations into current variations. Some of the best types for this purpose are manufactured by the G.E.C., and one of the accompanying illustrations will enable you to get an idea of the appearance of what is known as their standard type. For television purposes it is easy to imagine that sensitivity is of the utmost importance because of the very small proportion of light which is reflected back from the illuminated areas of the object being televised. Gas-filled cells are therefore preferred, and in these the normal primary current is magnified by the production of secondary electrons when the primary electrons travel through the gas.

Removing a Misunderstanding.

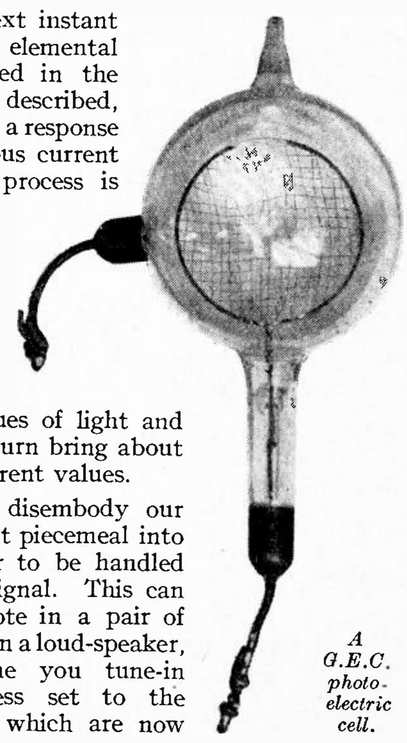
Unfortunately, the non-technical reader is liable to run away with the idea that one or more photo-electric cells, since they transform light into electricity, should be capable of converting an entire scene or image into terms of electrical current variations. Just expose the flood-lighted scene to the active surface of the cells in much the same way as you would a camera, and there you are!

But no, the problem is not such a simple one as that, and a few moments rumination should serve to show why. Any one scene or even a person's head and shoulders if illuminated is found to be made up of countless differing light values spread over the whole area. Now the photo-electric cell gives a proportional current response for every light value to which it is exposed, and our large area would therefore only produce one average light value which, of course, is useless. No, we must split up our subject into elemental light areas, and let the cell deal with each one in turn.

Justifying the Light Spot.

Now we can see the reason for installing our travelling light spot. By imposing upon it a definite movement so that it sweeps over every part in turn, it gives the cells a chance to perform their natural function. At any one instant during the travel of the beam of light passing through the rotating disc, we have a minute area illuminated and the light *reflected* from the subject produces a current variation in the circuit containing the one or more photo-electric cells.

At the very next instant a neighbouring elemental area is illuminated in the light strip being described, and our cell makes a response as an instantaneous current variation. This process is continued spot by spot and strip by strip until the whole of the image has been explored and analysed or "broken up" into definite values of light and shade, which in turn bring about corresponding current values.



A G.E.C. photo-electric cell.

In effect, we disembody our subject and pass it piecemeal into a valve amplifier to be handled as an electrical signal. This can be heard as a note in a pair of headphones or even a loud-speaker, and the next time you tune-in the home wireless set to the television signals which are now

An unretouched photograph of a television image, taken in 1926.

being broadcast by the B.B.C. remember that you are " listening " to some artist's face !

Making Movement Possible.

I can quite imagine the reader saying to himself that this is no doubt all right for subjects which are lifeless or quite steady, but how are you going to take account of movement ? It is fairly obvious that the main source of entertainment at present provided through the medium of television will be from artists who cannot be expected to keep still, even if only their lips move to speak or sing. Quite right, but this is all provided for.

When you patronise the cinema theatre and watch your favourite hero or heroine performing on the screen do you realise that the movement portrayed is actually an optical illusion ? What you really see is a series of still pictures rapidly thrown on the screen, but your eye, owing to the property known as visual persistence, conveys a harmonious movement to the brain. About sixteen complete pictures per second are shown, each one portraying a movement just slightly removed from its immediate predecessor, but the rapidity of the process gives the impression of continuous and not disjointed action.

Of Similar Character.

Exactly the same sort of thing happens with television. By arranging the speed of the transmitting disc it is possible to have as many complete explorations of the subject in one second as desired. In practice twelve and a half pictures per second are catered for, in other words, the disc is driven at 750 revolutions per minute, and this rapid scanning is sufficient to give all the movement that is required in normal practice. The mechanics of the process become lost on the observer, and he sees the vision of the moving image in his television screen, although that movement takes place many miles away.

Now isn't that an intriguing process, and yet so simple when it is shorn of all its technicalities. Many people are under the impression that this method is incapable of producing sufficient detail to give recognisable images, but let me say immediately that this is quite erroneous. Admittedly, the amount of detail which can be put over in the present stage of development of the art is not unlimited, but even so the resultant images are far from being distorted, and resemble the original in a most remarkable manner.

An amateur photograph of a modern television image. The improvement is very apparent.

A Softening Effect.

Where is the method likely to fall short of giving almost faithful replicas of the subject posing before the transmitter? Why, only when an effort is made to televise an object possessing intimate detail which is much smaller in comparison with the travelling light spot which is dissecting it.

For example, objects with sharply defined outlines when televised come over with a somewhat softened effect, but in ordinary television practice this is not noticeable. Most of the characters are undergoing continuous movement during the course of their turn before the "light microphone," and this, coupled with the self-accommodating character of the human eye and its tolerance, impart to the observer an image with quite a wealth of detail. In any case, the position of the hands on a watch can be seen quite readily, so surely this is sufficient to prove that the system is capable of handling quite small things.

Modifications?

Of course, one could increase the number of holes in the disc and thus get greater detail, but this would bring in its train many other alterations, such as disc size, picture shape, etc. Then, again, one must always bear in mind that at the moment television broadcasts are transmitted into space as wireless signals which must conform to regulations drawn up for aural broadcasting, and this artificially imposes a limit of nine kilocycles for the sideband owing to station interference. Once this matter has been dealt with by the authorities on its own merits, then we can look forward to pictures of greater dimensions or more detail.

The light and shade in our received image is distributed throughout its area in the form of a wash drawing or continuous surface. This explodes all those dot theories which were formulated in the past to prove that television was quite impracticable as a commercial proposition. It is necessary merely to see that the frequencies present in the original television signal are maintained.

Progress Made.

As proof of what the image looks like and what progress has been made, witness two of the accompanying illustrations. One shows a man's head, and is reproduced from a photograph of the first real television image ever taken, this actually being in the year 1926. Defects were present then, for the apparatus at both the transmitting and receiving ends had not been properly developed. Now compare this with the photograph of the young lady. Isn't that recognisable? And yet this is only a reproduced photograph of the actual image, and the eye itself would see a much better one than is recorded by the camera, owing to the length of the plate exposure.

This alone should be sufficient to awaken enthusiasm, and next month we shall migrate to the receiving end and see what takes place there, for, after all, to the "looker-in" this is perhaps of the greatest interest.

Simultaneous Sight and Sound Broadcast.

(*Continued from page* 119.)

"This is a very memorable occasion for all those who are interested in television, or, indeed, in the progress of science, as we have reached a goal at which we have been striving for a long time and are actually inaugurating the double-wave transmission.

"I desire to offer my hearty congratulations to my friend, Mr. Baird, and to all those who have assisted him in the development of his wonderful invention.

"As Chairman of the Baird International Television Company, I welcome this opportunity of thanking the B.B.C. for all that they have done to assist us. As you may know, this transmission has been made possible by the close co-operation of the B.B.C. engineers with the engineers of the Baird Companies.

"I greatly regret that my colleague, Sir Edward Manville, cannot be present this morning, as he was concerned with the development of television long before I had the privilege of being associated with the Baird Companies. Sir Edward Manville has a better right than I have to speak about the progress and prospects of television, and I hope that on some future occasion you will both see and hear him with the aid of your televisors.

"Meanwhile, I must not delay you any longer, as there are others who are as proud as I am to be present on this occasion whom you ought to see and hear."

After Lord Ampthill came the variety section of the programme, opened by Miss Annie Croft, who sang a medley of popular songs from musical comedies.

An Entertaining Programme.

Miss Gracie Fields was the next performer; she gave "Nowt about 'Owt'" and "Three Green Bonnets," and left no doubt in anyone's mind that it was Gracie Fields and not a clever impersonator.

Mr. R. C. Sheriff, author of "Journey's End," was to have concluded the programme, but was unable to attend. His place was taken, at a moment's notice, by Miss Lulu Stanley, and so ended the first complete television broadcast.

Throughout the reception was uneventful. The synchronising scarcely varied from start to finish, and did not require adjustment. There was no interference with the picture through fading, local "howlers," or any unwanted atmospherics or other electrical disturbances.

The programme was received on two "televisors" at Hendon, while one loud-speaker served for both. The room in which they were placed was not specially prepared, and might equally well have been any room in any house. The blinds were drawn to cut out excess daylight, and that was all.

Any amateur could have done what was done at Hendon, and, in fact, many did, as reports elsewhere in this issue prove.

The demonstration was but another proof added to the many already given, that Baird television can do what it claims to do, and do it successfully, without any fuss or special attention.

W. C. F.

Enthusiasm in Newcastle

BY

Sydney A. Moseley

FROM the many enthusiastic letters which have been received since the dual transmissions started on March 31st, one of the most interesting comes from Mr. Thomas Payne, of Payne and Hornsby, the radio and gramophone engineers of Gallowgate, Newcastle-on-Tyne, who writes to me as follows :—

" It is with very great pleasure that I write to you with reference to our first reception of television on our premises last evening.

" As one of the pioneer station directors I have followed very attentively the progress of television, and also the great fight you have made for its recognition.

" Allow me to wish you and television the great success which I am now quite sure is coming. Perhaps you would also extend the hearty congratulations of this humble pioneer to Mr. Baird."

Mr. Payne encloses a copy of a letter he has sent to many trade papers and also to Sir John Reith with whom " I was intimately connected at the commencement of broadcasting."

Messrs. Payne and Hornsby were delighted to pick up the first transmission picture ever received in Newcastle. Indeed, they claim that this picture was the first of the northern counties. Their first attempt had been nullified by faults in their amplifier.

The second attempt had been nullified by the fact that the motor in the televisor had not been running at the correct speed.

We used the " G.E.C. Stabilised Six " set, consisting of two stages of H.F., leaky grid detector, one stage of L.F. transformer coupled, followed by two stages of choke coupling with an LS6A in the last stage using 400 volts H.T.

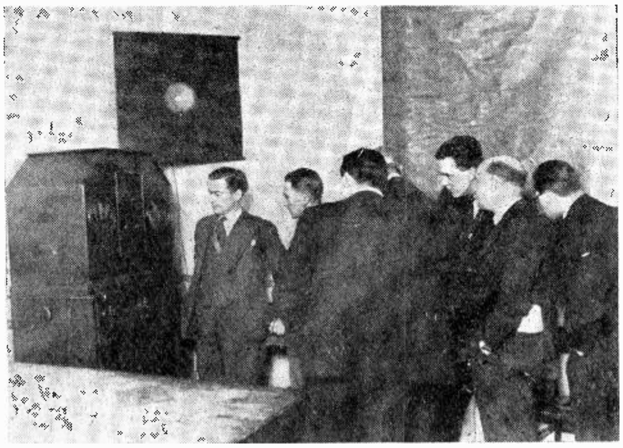
" So far as the detection and amplification side is concerned this is not considered orthodox for the reception of television. Anode bend detection and three stages of resistance capacity coupling is considered the most likely to bring satisfactory results. All the more satisfactory, therefore, to receive television on a standard wireless set."

Television was received on Messrs. Payne and Hornsby's business premises in a notoriously bad part of Newcastle for any sort of wireless reception. They are situated in the business centre, tram wires passing the premises, and screened all round with high buildings. They are 300 miles from the transmitter and can, therefore, say that they are practically 200 miles outside the service area.

This is Mr. Henry Dixon, the secretary's report of the transmission :

The first picture was that of a lady singing, followed by a gentleman, then a lady and gentleman singing alternately. We cannot claim that the picture was by any means perfect, but at times the features were clearly distinguishable, and at these times synchronising with speech and music was perfect.

We were picking up speech and music off the 356 meter wave-length with a 3-valve set and an indoor aerial put up in the same room in which the television picture was being received.



A group of interested journalists looking-in to the first combined sight and sound broadcast on March 31st last.

Fading from the televising transmitter on the 261 meter wave-length was our biggest trouble, this fading was the sole cause of our losing the picture completely at times. A stable transmission would have meant a stable picture.

It was quite thrilling, when the strength of the transmission signal improved, to hear the synchronising impulse from the transmitter effecting the running of the motor of our receiver and pulling our receiver into synchronisation with the transmitter. When this happened the picture was fairly distinct.

For distant reception of television fading must remain the bugbear for some time to come. On top of this our picture was affected by the distortion from the tram wires and perhaps an isolated motor or so still running in the vicinity of our premises.

Our electric current here is D.C., which, we think, is not helpful.

Speaking from the general interest point of view, since receiving our televisor we have found that there is a tremendous amount of public interest, and we have had hundreds of inquiries as to when we will be able to demonstrate to the public.

The journalists who looked-in on March 31st, taken outside the Baird Laboratories at Hendon.

We envy the people of the south who now have a transmitter on their "door step." Considering our experiences of last evening in the north with all our disabilities, we think that the reception of television in London and its immediate vicinity should now be easy. For the sake of the many thousands of north country experimenters who are anxious to take up television for its extreme interest from the experimental point of view, we are hoping that we will soon have a northern transmitter in operation working on twin wave; until this is going the north will be placed at a great disadvantage.

Naturally the well-known northern firm is very proud of the fact that the first television picture ever received in the north was tuned-in by their managing director, Mr. Tom Payne, better known as "Uncle Tom." "Uncle Tom," by the way, is becoming a notable personage in the North of England, being able to claim the honour of being :—

The first director of the first B.B.C. station (5NO).

The first to broadcast speech from 5NO.

The first to broadcast music (on his violin) from the same station, and now

The first in the North to tune in a television picture.

Congratulations to "Uncle Tom."

"*Television To-day* and *To-morrow*"

Reviewed by Dr. Clarence Tierney, D.Sc., F.R.M.S.

IT has been said, and said quite truly, that television as we know it to-day is as yet in its infancy, though it is equally true to say that our knowledge of the problems involved in this subject and of their practical solution is infinitely in advance of our knowledge of wireless signalling when that first started.

On the subject of television there is, too, a certain paucity of authoritative publications. We welcome, therefore, this present work as indicating in a comprehensive and readable manner the present state of development and future expectation of television upon the lines of our present knowledge.

The work deals at length with the system of Baird, which, after all, is the only practical system known, and which it must be frankly admitted is alone in surviving both scientific and commercial tests and application. It is the authors' declared intention to place in the hands of readers "the most up-to-date, first-hand information concerning the Baird system of television," and in this they have admirably succeeded.

A chapter is devoted to the transmitter, in which such problems as the scanning disc, the number, shape and disposition of the holes, their relation to the available frequency band and to the problem of flicker, are discussed, while in a chapter on the receiver helpful and experienced suggestions are given as to the types of components best suited to accomplish good results. The all-important problem of synchronism is adequately dealt with in a special chapter, giving a well-illustrated description of the magnetic toothed-wheel system of synchronising, which for wireless reception has proved to be the most effective method of steadily holding the received image.

Photo-electric cells and their couplings are also well described, while in a chapter devoted to the wireless receiver for television the reader will find much helpful information, with diagrams of tested and successful circuits.

In a chapter on the cinematograph and talking film the authors describe the latest and far-reaching application of television and the development of what is called the "tele-cinema," by means of which the film, either silent or talking, is televised and transmitted for wireless reception.

The more specialised applications of television, such as television of objects in total darkness by the utilisation of infra-red rays, and also the television of objects in natural colours, as well as phonovision, the method of recording and storing the televised image, are all fully dealt with, while in a concluding chapter a brief review is given of the efforts of other workers in Europe and America, and of the results achieved.

The book is prefaced by an excellent foreword by J. L. Baird, in which he indicates the utilisation and development of short wave-lengths for the transmission of extended scenes. The whole work is well written and profusely illustrated and contains a helpful index. It should be read by all desiring an instructive and authoritative account of the recent advances and development in this all-important subject of television and its practical application.

C. T.

"TELEVISION TO-DAY AND TO-MORROW." By Sydney A. Moseley and H. J. Barton Chapple. With a foreword by John L. Baird. 1930. xxiii+130 pp., 86 plates and figures. Published by Sir Isaac Pitman & Sons, Limited. Price 7s. 6d. net.

Some of the famous Artistes you will see on your Television Screen during the month of May.

No. 1. Miss Cecile Maule Cole. No. 2. Miss Dorothy Dickson. No. 3. Miss Jean Colin. No. 4. Reginald Stewart.
No. 5. Miss Mercia Stotesbury. No. 6. Ben Lawes. No. 7. Miss Madeline Carroll. No. 8. Miss Mary Brough.

Baird Studio Topics

By *Harold Bradly*,

Studio Director

"HULLO, everybody! Baird Television calling." Yes, I feel I want to start this article on a cheerful note—and why not?

The interesting event of television, combining sound with vision, is going on merrily, and day after day the interest in our transmissions increases.

I want here, however, to tell you, not about the technical branch of television, which more able pens than mine have set down on the other pages of this magazine, but about the artistes who have given lookers-in so much pleasure during the short time the dual transmission has been in operation.

First, there is charming Miss Annie Croft, whose voice is as sweet as anything to be heard on the London stage to-day. Miss Croft, who was the first artiste to appear in these new programmes, gave a delightful rendering of numbers from popular musical comedies. And Gracie Fields—who could resist the temptation of investing in a televisor in order to take an admiring peep at such an electrical personality? Miss Fields, who gave up the first day of her well-earned holiday to appear in our initial programme, "blew in" shortly before 11 a.m., with hat on the back of her head, and said, in best Lancashire dialect, "Ee, I've coom!" Then she sang "Nowt About Owt" and "Three Green Bonnets." When I asked her later to describe her feelings while being transmitted, the typical reply was: "I was unconscious."

Lookers-in have had an opportunity of seeing and hearing Sybil Thorndike. Miss Thorndike, who is a great worker, as all real artistes are, gave a perfect rendering of three of Robert Louis Stevenson's poems. I was with her once under Mr. Charles B. Cochran's management at the Pavilion Theatre during the time that Morton, the French comedian, was a raging favourite over here. I well remember how, during a scene with her, Morton would often grimace at us from the wings in an effort to "dry us up." To the best of my belief Sybil was quite impervious, but it was a great effort on my part to keep a straight face. I imagine she was too intent on her part to give a moment's thought to anything outside her work. Wasn't her performance in "To Meet the King" a gem?

I had an interesting talk with Miss Désirée Ellinger during a visit she paid to our studio. It appears that she had been filming at Elstree the day before, and had had a really strenuous time before going on to the Dominion Theatre, where she is appearing so successfully in Herbert Clayton and Jack Waller's "Silver Wings." It was only natural that she should feel the effects of her efforts of the previous day, but in spite of this she insisted upon being televised, and even sang a few bars of some of her songs. Those who were looking-in when she appeared on the televisor a few days afterwards beheld a dainty picture singing enchantingly.

Mr. George Clarke is surely the funniest "dude" comedian we have to-day. He appeared, complete with monocle and minute moustache, and put over a very amusing number. He is in "Darling, I Love You," at the Gaiety.

Pretty Miss Mamie Watson and Neta Underwood, both charming people who sing delightfully, have already given enjoyment to lookers-in.

Mr. De Groot, than whom there is no more popular violinist to-day, played excerpts from his extensive repertoire in his own inimitable style.

Miss Jean Colin, who made a successful first appearance as leading lady in "The Five O'clock Girl" at the Hippodrome a short time ago, sang her way into the hearts of lookers-in, on April 15th.

Mr. Bransby Williams, that great character actor, appeared on April 9th, and put over one of his famous impressions. It was a splendid test for television, which came out with high honours, every movement of the face and the gestures of the hands being perfectly reproduced.

Miss Dorothy Dickson, who has a personality and charm all her own, gave a singularly delightful performance here. I met her first at the Winter Garden Theatre in 1924 when I joined the cast of "The Cabaret Girl" during Mr. George Grossmith's absence in America. It was a great pleasure to dance with her in that big number, "Dancing Time." She is a perfect and graceful dancer with a wonderful sense of rhythm.

How Television is being Received

Reports from Czechoslovakia, Birmingham, Manchester, Leeds, Glasgow and Sunderland.

TELEVISION is steadily marching on and growing. Not that any amateur needs to be reminded of or told that fact, but it is pleasant to be able to record it, and at the same time pay tribute to those who have fought the battle for television.

Up to last month it was the amateurs who were doing all the receiving of television. Now the wireless agents all over the country are getting "televisors," and they are as keen as the amateurs and write just as enthusiastically.

Before dealing with them, however, there is another long-distance reception of television to record.

Mr. František Pilát, who lives at Brno in Czechoslovakia, and is a representative of the firm of Transradio, writes to say that the English television signals are received at good strength in his country. He says:—

> "Towards the end of December we began with tests of receiving television from London. These tests were most satisfactory, and it can be stated that London television can be received daily in Czechoslovakia."

Mr. Pilát sends photographs of his apparatus, but does not give a description of it (in English).

Not content with receiving television, however, he has been busy with his pen writing about television in a number of Czechoslovakian wireless papers, and, from a diagram given in one of these, it appears that he uses in the output stage of his receiver a screen grid valve, choke fed, and couples his neon to the plate by a couple of 2 m.f. condensers, one in each lead, with a 500,000 ohm variable resistance in series to regulate the voltage. He apparently uses about 250 v. H.T.

In addition to his other activities, he gave a broadcast talk on "Baird's Television" from the Brno station, 342 metres; from 19.55 to 20.10 (Continental time), on "*Útery, ríjna*, 1929."

As none of my friends and acquaintances have any knowledge of Czechoslovakian, it has not been possible to translate the date, but when shall we have a lecture on "Baird's Television," or even "Television," from a B.B.C. station? Czechoslovakia has stolen a march on us.

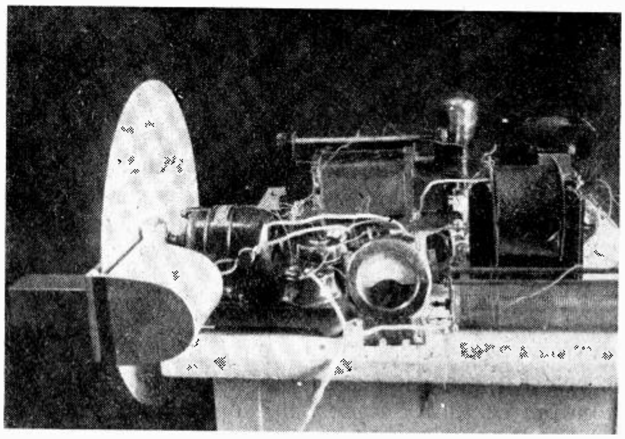
We congratulate Mr. Pilát on his good work on behalf of television, and wish him every success.

A student member of the Television Society, Mr. E. H. Traub, living at Brondesbury, has been getting into domestic hot water—with a friend—through his television experiments. Needing a motor to drive their disc, the domestic vacuum cleaner was raided. This was the cause of somewhat strained domestic relations. Unfortunately, the motor was not suitable. It sparked badly at the brushes and caused interference with the image. They next got a 110 A.C. fan motor which behaved better, as far as sparking was concerned, but ran somewhat uncertainly. Their disc is of cardboard and the neon a simple commercial beehive. With this, fed from an S.G. Det. and 1 L.F. set, results were obtained on April 9th "after many setbacks," as Mr. Traub puts it.

Their neon, through its beehive construction, gave a very uneven field of illumination, and having tried mirrors, ground glass, lenses and other expedients, they finally got over the difficulty by coating one-half of the bulb with silver paper and "frosting" the remaining half.

The "frosting" was done with fine emery paper, turpentine being used as a lubricant, and took about half an hour's careful papering to complete. This arrangement gave a nice flat field of illumination and did not lose too much light.

Like many other experimenters, they have learned that "volts" is another term for "cash," and they find themselves hampered by a shortage of both.



This photograph of his amateur-built television receiver has been sent to us by one of our readers, Mr. František Pilát, of Brno, Czechoslovakia. In his covering letter he claims that this is the first experimental television apparatus used for receiving television from London in Czechoslovakia. He says: "These tests were most satisfactory. London television can be received daily." We congratulate our reader on his success.

Also, like most other experimenters, they do not let a small thing like that upset their work, and so, to make use of the dual transmissions, they are fixing up a crystal set for speech reception. They have the sympathy of all true amateurs in their struggles with adversity.

Birmingham has been mildly excited since the dual broadcasts started from Brookman's Park, for Mr. J. B. Kramer, working a Baird "televisor" at the University, Bournbrook, succeeded in receiving the London transmissions.

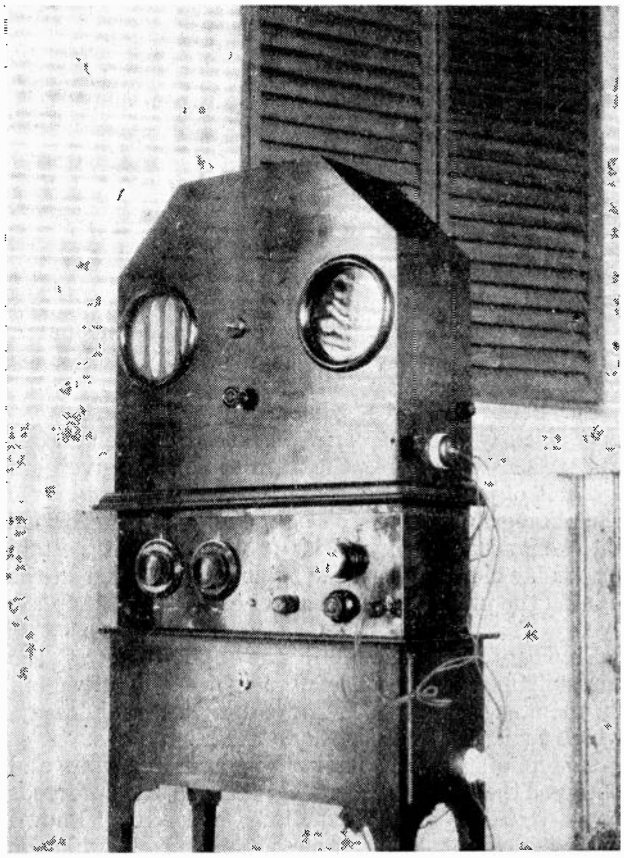
Mr. Kramer is a keen television experimenter, and in his present experiments is being helped by Messrs. L. G. A. Sims and T. Havekin, lecturers in electrical engineering at the University.

The Birmingham newspapers claim the 100 miles reception as a record, but close on the heels of their claim comes the Manchester papers with a "Home-made Television Set Triumph." A Manchester journalist saw Mr. A. E. Kay's apparatus and was present at a morning reception. Like his colleagues in Birmingham, he was impressed, and had no difficulty in recognising what he saw, or realising that television was genuine and of definite interest.

Birmingham and Manchester, however, are hopelessly beaten, for at Newcastle Mr. Tom Payne, of the firm of Payne & Hornsby, wireless dealers, using a "G.E.C. Stabilised Six" in conjunction with a Baird "televisor," has had consistently good television reception and demonstrated it to his customers.

The G.E.C. set consists of two stages of H.F., leaky grid detector, one stage of L.F. transformer coupled, followed by two stages of choke coupling, with an L.S.6A in the last stage and 400 v. on the plate. An indoor aerial and a three-valve set in the same room as the "televisor" looked after the speech and music. Despite the fact that Messrs. Payne and Hornsby's business premises are in the heart of Newcastle and very badly situated from a wireless reception point of view, they had little or no trouble with their television and could recognise the people televised.

Mr. Tom Payne is becoming a unique personage in the North of England, for he was the first director of the Newcastle Station (5 NO), the first to broadcast speech from it, and the first to broadcast music from it. He now claims to be the first to tune-in a television image in the North, and if he bases his claim on having done it all on such commercial apparatus as can be purchased by anyone, he would seem to be justified; but he must look to his laurels, for Mr. Norman Turner, of Hope Street, Glasgow, of Consulting & Radio Service, Ltd., reported on March 26th that he had received Baird television transmissions, and proved the accuracy of what he had seen by describing all that had been transmitted. Mr. Turner used a Columbia Three, a screened grid set with anode bend detector and a P625 raw A.C. fed power valve. The output went to a push-pull L.S.5A amplifier raw A.C. fed filaments with 200 volts on the plates. Later he succeeded in getting the Berlin transmissions, a length of cinema film of two girls, and so takes his place beside Mr. Hewel, of Berlin, as a long-distance amateur.



The television receiver built by Mr. Wraight, of Funchal, Madeira, a letter from whom appears on our correspondence page.

He describes the definition as very good.

In addition to these firms, wireless dealers in Leeds, Bristol and Lincoln have reported commercial reception of television, and in each place there is the same tale of tremendous enthusiasm among the local wireless amateurs.

Sunderland, thanks to the enterprise of the *Sunderland Echo*, has had a demonstration of Baird television all to itself, for a transmitter and receivers were installed at the Festival of Youth Exhibition in the Victoria Hall, and people visiting the exhibition were able to talk to and see their friends in front of the transmitter in another part of the building. Their only trouble seems to have been an insufficiency ot words with which to describe their surprise and wonderment at this latest achievement of science.

The *Sunderland Echo* has done its best to help them, and devoted a considerable amount of space to describing the demonstrations. There should be no excuse for Sunderland residents asking, "What is television?" or saying, "It cannot be done."

The *Echo* has earned the gratitude of all amateurs for having come out so boldly in the cause of television.

W. C. F.

Faithful Images

By *W. F. F. Shearcroft*, B.Sc., A.I.C.

THE process of Television resembles to some extent that of photography, and encounters similar difficulties which the photographer has faced and solved.

In both processes something, which we may conveniently call the *object*, is placed before suitable apparatus. Energy, in the form of light, is given out by this object and collected by the apparatus. On the photographic plate this light energy is transformed into chemical energy, which brings about certain molecular changes of the substances imbedded in the film on the plate. These changes are not visible to the eye.

Similarly in Television, the apparatus at the transmitting station collects the light energy given out by the object and transforms it into electrical energy, which again has no effect upon the human eye.

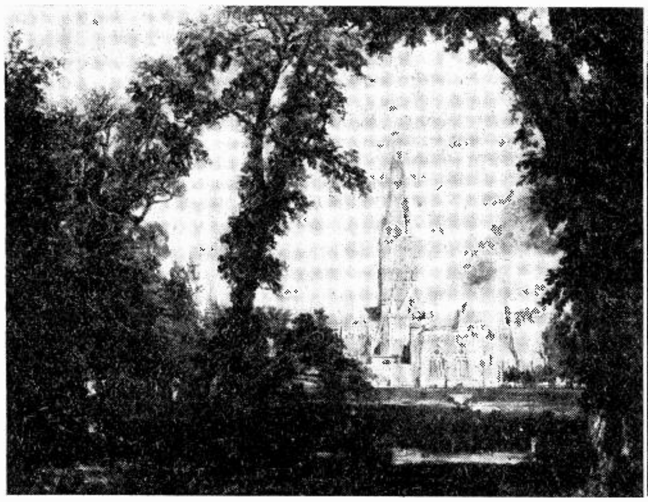
The photographer, having exposed his plate and obtained the necessary chemical changes, then proceeds by a series of chemical actions, collectively known as development, to produce a final result which is visible to the human eye. Similarly, the receiving station in television transmision collects the electrical energy and converts it into results which are visible.

In both cases the final result is seen and judged by the human eye. It would be more accurate to say that the result is judged by the process of *human vision*; because the eye is only concerned in receiving physical stimuli which are transmitted as nervous impulses to the brain, where what we call our intelligence proceeds to interpret them in the light of past experience and education.

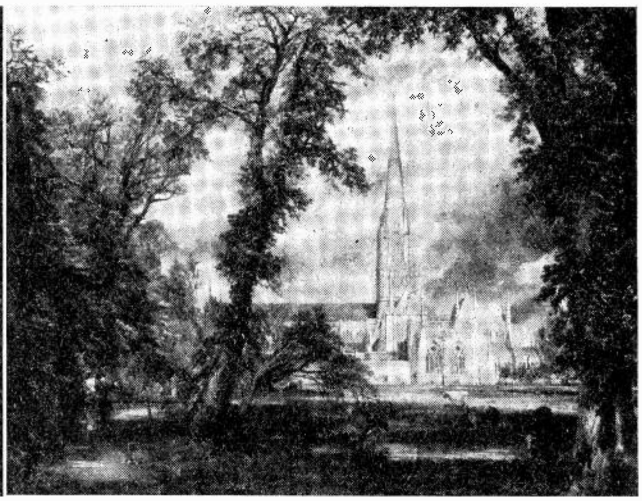
The value of the final result obtained in both cases obviously depends upon the correlation which we are able to obtain between the various transformations which take place. The camera, without proper control, lacks this co-ordination to a marked extent. Thus, for example, if we view a bunch of scarlet poppies besides a bunch of violets then we see the former as "flaming" while the latter are "modest." Red is, to our vision, a bright colour; violet a dull one. Any representation or image of these must reproduce this brightness or dullness, or by some means must suggest it to give us a true impression of the real thing.

A simple unaided photograph will reproduce the poppies as "modest" and the violets as "flaming." The light energy given out by the violets is capable of producing more chemical change on the plate in any given time than can be produced by the light from the poppies. This is an inherent defect in the process of photography, a defect very evident in the majority of amateur snapshots. The camera does not "see" things as we do.

In Television the same holds true. The receiving apparatus does not "see" the object as the human eye would. Normally, the object is illuminated by white light, and only light reflected by the object reaches the photo-electric cells. All natural objects exhibit selective reflection. Seldom do they reflect just the light which they receive. A red object absorbs most of the components of white light, and reflects a preponderance of red. Thus the lips of a human face will send a message to the receiver in red light. The electrical impulses, set up by the light received, depend

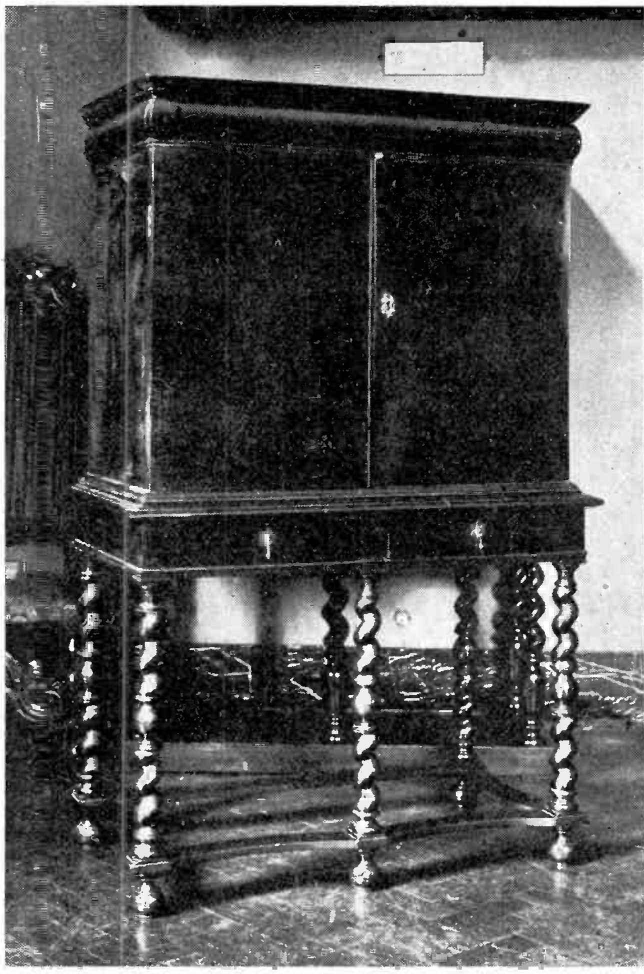


Photograph of a picture taken with ordinary film.

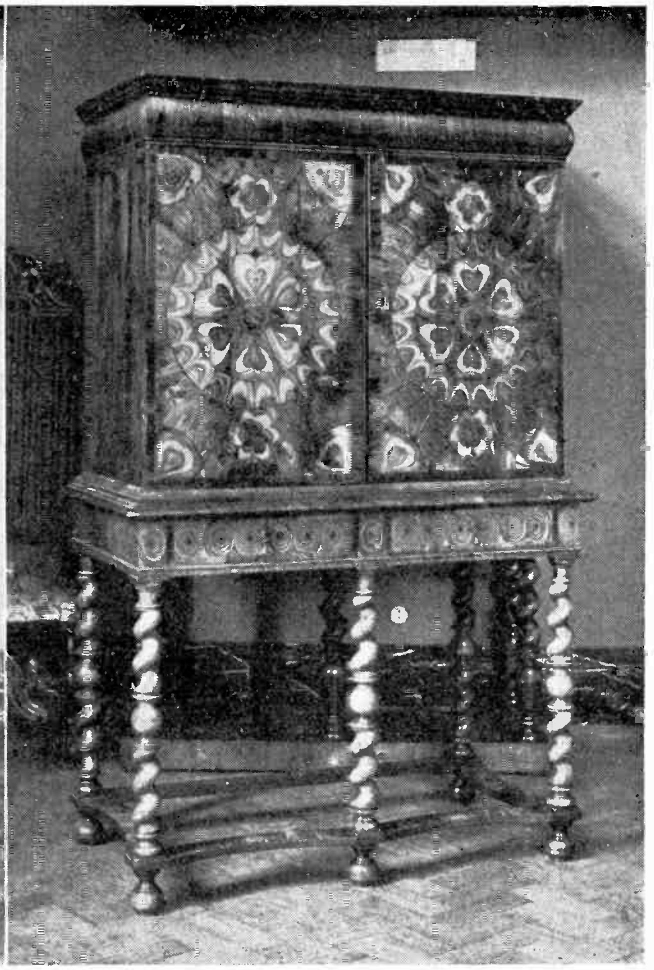


[Photos by Kodak

Photograph of same picture, using special colour sensitive film and appropriate screen.



Photograph of a cabinet taken with ordinary film, without screen.



[Photos by Kodak

Photograph of same cabinet taken on special colour sensitive film, using appropriate screen.

upon the portion of the spectrum which gives rise to them. These differences will be faithfully reproduced at the receiving end of the transmission—reproduced as the transmitter "sees" them, not necessarily as the human eye would record them.

Short of reprodution in natural colours, the only differences observable at the receiving end are differences of intensity of light. For faithful reproduction we should require that the things we call bright should be represented by intense light, and the dull things by dimmer light. Actually the reverse is quite possible in Television as in photography.

The photographer has solved this difficulty by a process of screening. Transparent screens are placed between the object and the plate. These screens are tinted so that they "filter" out some of the more chemically active rays of light coming from the object They impose a handicap on these rays, and thus permit the less active rays to compete successfully with them during the time which the image is acting on the plate. The illustrations show the difference which is obtained in this way.

In work in the studio much is possible by variation of the composition of the light used to illuminate the object, and in the case of the human face by suitable make-up. This, however, will be impossible when the televisor is taken into the open. There the natural objects will have their natural colours and selective reflections beyond the control of the operator. They will be lighted by daylight normally, which is what it is and again beyond the control of the operator.

Screening alone is not the only possibility as far as photography is concerned. The nature of the photographic plate can be altered, and it is possible to produce plates which are more sensitive to the less active rays than the ordinary plate. The sensitivity is produced by various means. Similarly, it will be possible to produce photo-electric cells that will react to various parts of the spectrum in such a manner as to produce a true image.

This aspect of the production of true images will have to receive much attention, because human vision is much more critical and much more highly trained than human hearing. The vast majority of us do not miss the finer points of music which are lost in the average bad reception on wireless outfits, and we are content with what we suppose is reality. We shall not tolerate beyond the experimental stage visual images which are similarly lacking in faithful reproduction.

Where are the Sidebands?

By *R. S. Spreadbury*

AFTER having several pet theories upset by the sideband theory of modulated carrier frequencies, the writer determined to try and overcome the difficulties, but succeeded in proving that sidebands are mythical, being only a mathematical theory advanced to explain certain defects in radio engineering. A great deal has been written on the subject from both sides, but to date no conclusive experimental corroboration has been put forward. Below is a brief explanation of two experiments performed by the writer, which leave no reasonable excuse for the continuance of the sideband theory.

The First Experiment.

In the first experiment a radio frequency of 6,000 kcs. was modulated by another radio frequency of 500 kcs., the circuit used being given in Fig. 1. The medium and high frequency oscillators (shown at *A* and *B* respectively) are conventional tuned grid-tuned anode circuits, their outputs being led to the modulator and output valves as shown. A high frequency choke (H.F.C.) is connected in the anode circuit of the modulator valve, the choke consisting of thirty spaced turns on a two-inch former. This prevents the 6,000 kcs. frequency from reaching the anode of the modulator valve, whilst offering little impedance to the 500 kcs. frequency. The modulated 6,000 kcs. frequency is fed direct to the aerial terminal of a short wave receiver, through an adjustable neutrodyne condenser.

The formula for sideband frequencies is given as $n-m$ and $n+m$, where n is the frequency in cycles per second, modulated by a frequency of m cycles per second. If, therefore, sidebands exist, a signal should be picked up in the receiver when tuned to either 5,500 kcs. or 6,500 kcs.

The first trial produced signals on the tuning scale at two points, one of these signals being, however, very weak. The frequencies for these settings was ascertained, being 6,000 kcs. for the stronger signal and 5,500 kcs. for the weaker, no signal being coaxed out of the receiver at 6,500 kcs. Having presumably discovered one sideband, the absence of the other was puzzling, until finally the discovery was made that whilst the 6,000 kcs. was modulated by 500 kcs., the two frequencies were superimposed, and partial rectification of these superimposed frequencies by the output valve of the oscillator produced an intermediate frequency equal to the difference of the two individual frequencies (as in superheterodyne receivers). A readjustment of circuit values remedied the error, no signal remaining at the 5,500 kcs. setting of the receiver.

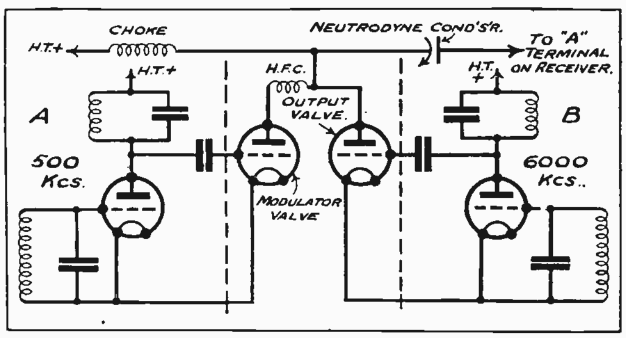


Fig. 1.

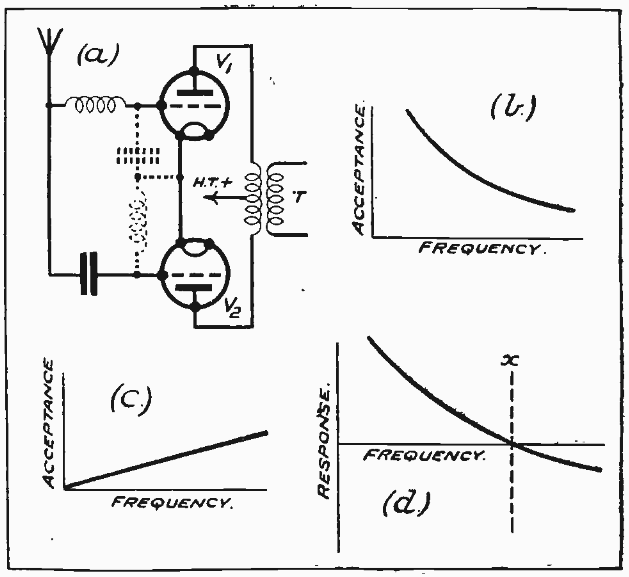


Fig. 2.

Another Experiment.

Not content with one proof, work was started on another experiment, this time to test the existence of sidebands in a carrier frequency modulated by audio frequencies, by neutralising the actual carrier frequency.

Fig. 2*a* shows a circuit in which two high frequency valves are energised by a common aerial, one through an inductance, the other through a capacity. The acceptance of a circuit containing inductance varies inversely as the frequency (see Fig. 2*b*)—acceptance being the reciprocal of impedance—whilst the acceptance of a circuit containing capacity varies directly as the frequency (see Fig. 2*c*), from which it will be appreciated that as the frequency increases, oscillations from *V*1 decrease, whilst those from *V*2 increase in strength, the two being equal at one critical frequency, this frequency producing no response in the secondary of the transformer *T* in the anode circuit, since the individual signals in the primary are opposed to each other. Fig. 2*d* shows the response produced in the secondary of *T*, plotted

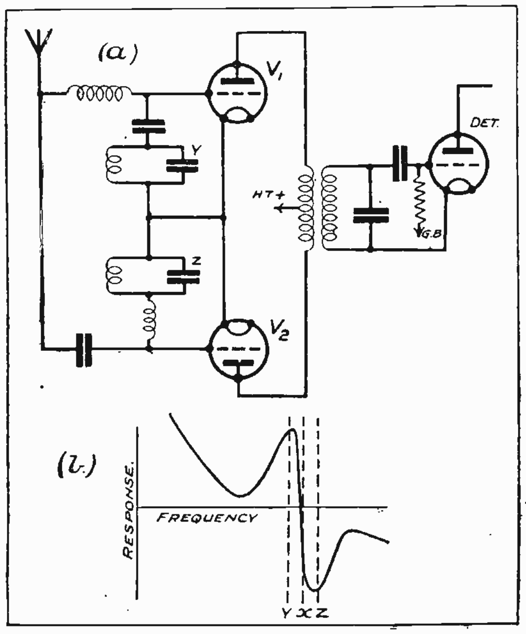


Fig. 3.

against frequency, where *x* is the frequency at which there is no response.

Phase Reversal.

A further increase in frequency results in an increasing response in *T* secondary, but the phase is reversed as signals from *V*2 now predominate. In Fig. 2*a* a capacity and inductance are shown dotted, connected between the grids and filaments of the two valves, their inclusion serving two purposes: firstly, to by-pass unwanted frequencies, thus making the circuit characteristics more pronounced; and, secondly, to adjust the phase, counteracting any lag or lead in other parts of the circuit.

Fig. 3*a* shows the same circuit but with the inclusion of the detector valve, *DET* and the addition of two tuned circuits *y* and *z*, *y* being tuned to a frequency 2 kcs. lower than the carrier wave (*x*), whilst *z* is tuned to a frequency 2 kcs. higher than *x*. The response-frequency graph for this circuit is given in Fig. 3*b*, whence it will be seen that, whilst the carrier frequency is neutralised, sidebands having a separation of a few cycles from this frequency will be received at good volume.

When the receiver was tested on the local broadcast it was found that the signals were impossible to cut out completely, as presumably the modulator valve at the transmitter varied the carrier frequency. A modulated carrier frequency from a crystal-controlled oscillator was next tried, but even this produced the same trouble. Finally, a special crystal-controlled oscillator was designed in which the modulator did not upset the carrier frequency. Part of the circuit of this oscillator is shown in Fig. 4, a very brief description of which will be given.

Special Modulator.

The circuit was designed so that as far as possible no variations of circuit constants resulted from modulation. The two tuned circuits, *p* and *q*, are tuned to the exact carrier frequency, but whereas the current in *q* is in phase with the applied voltage, the current in *p* lags approximately 90° behind the applied voltage, this lag being a characteristic of such parallel tuned circuits. Thus there is a phase difference of approximately 90° between the currents flowing in *r* and *s*, these currents being fed to the modulator *M*. This modulator may be described as a capacity microphone where the diaphragms—of which there are two—are vibrated mechanically. There are altogether five plates, three stationary, between which are the two vibrating plates or diaphragms. The scope of this article does not permit of a detailed explanation of this modulator, and it suffices to say that the amplitudes of the oscillations in the two respective phases are not appreciably affected, but that the phase relation varies in response to the vibration of the diaphragms. For instance, with a modulation ratio of 50 per cent. the phase difference of the two currents would alternate between 45° and 135°, in step with the diaphragm vibrations. The output circuit combines these phases, producing an extremely constant frequency of varying amplitude.

On tuning-in the receiver described beforehand to the frequency from this oscillator, difficulty was found in cutting out the signals, but when the exact values were found no signals could be heard, proving that no sidebands existed in the transmission.

It is thought that the foregoing proves the non-existence of sidebands, but still inherent defects of present-day receivers remain to be eliminated. Possible lines of research may form the basis of a subsequent article.

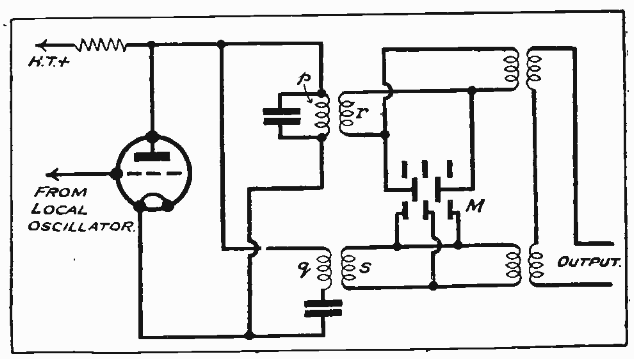
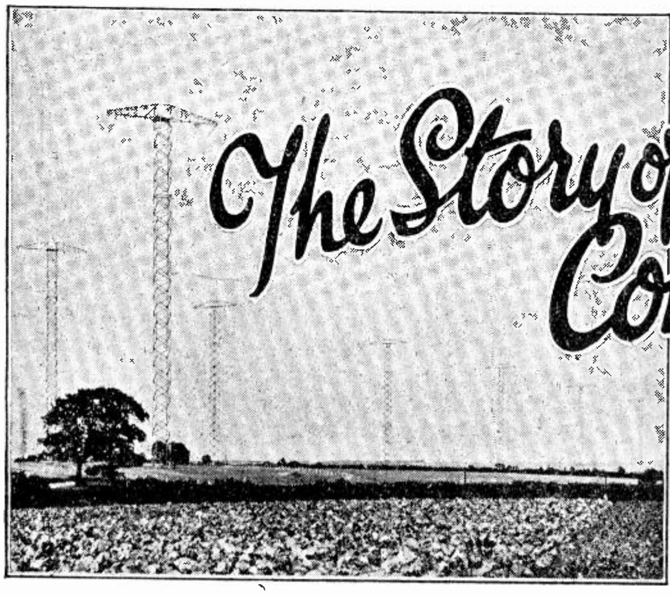


Fig. 4.



The Story of Electrical Communications

by

Lt. Col. CHETWODE CRAWLEY, M.I.E.E.
(*Chief Inspector of Wireless Telegraphy, G.P.O.*)

PART XVI.

WIRELESS TELEPHONY (2)

THE last article outlined the development of wireless telephony from its birth to its present proud position in the commercial field of long-range communications, but the outline was far from complete, as must have been obvious to all who are interested in broadcast programmes; and are there any who are not? There may be, but none of them at any rate can be a reader of TELEVISION. He would have to read something else, and indeed avoid reading most things published within the last seven years.

The Birth of Broadcasting.

But even seven years is not nearly far enough back to search for the birth of broadcasting. We must more than treble the seven, and get back as far as 1907. In that year tests of broadcasting by wireless telephony were carried out in our Navy, and the first song then broadcast, possibly the first song ever broadcast, was "God Save the King." But we cannot by any means take all the credit for the birth, as our friends across the Atlantic were broadcasting songs and music in the United States Fleet when they made their world tour in 1907–8.

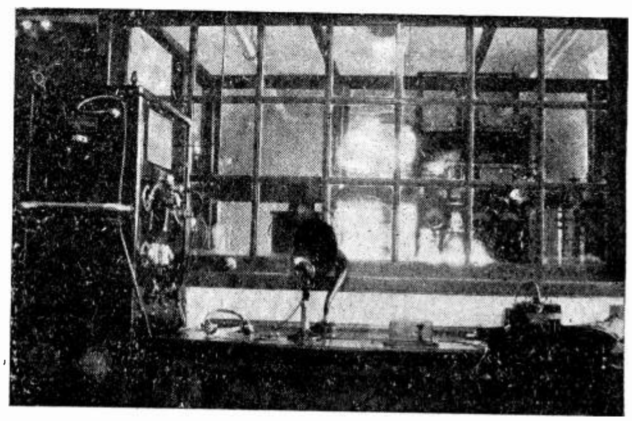
In those early days, arc transmission was the only suitable arrangement, or it would be more accurate to say, the least unsuitable; and in America, de Forest, as usual, was well to the fore. In 1909 he installed a microphone in the Metropolitan Opera House, and broadcast the finest voice that has ever been broadcast, the voice of Caruso.

With such a start as that, is there any wonder, one may ask, that broadcasting took the world by storm? But there was no use trying to storm from an arc, and nothing was heard of broadcasting until the possibilities arising from de Forest's addition of a third electrode to Fleming's valve were more fully understood than they were in 1909. It was, in fact, another ten years before sufficient data had been collected for broadcasting to have any chance of being reckoned as a possible competitor with other forms of entertainment.

Many of the readers of this journal are impatient with the growth of television, and it might be well for them to reflect a little on broadcasting, which most people think grew up in a night. Successful experimental broadcasting took place in 1907, but it was not until 1920 that a start was made with broadcasting as an entertainment for the public. It looks as if the growth of television may not be so slow after all when compared with its elder brother who is always held up as a perfect marvel of rapid development.

The Commencement of Programmes.

So many individuals of so many countries claim to have been the first to introduce broadcasting pro-



½ kw. wireless telephone set installed at Humber coast station for communication with fishing craft.

grammes that it is impossible to give a generally accepted name, but one which is accepted by some, though unknown to most, is Steringa Idzerda, of The Hague. Idzerda gave a public demonstration in 1919 at the Third Dutch Trade Fair in Utrecht, certainly one of the first successful public demonstrations of broadcasting as we know it to-day.

In November, 1920, the Westinghouse Electric and Manufacturing Company at Pittsburgh obtained a Government licence to broadcast information and music. This is generally taken as the beginning of broadcasting, though as a matter of fact the Dutch concerts had become a weekly feature earlier in the same year, and a time-table of them appeared in a British journal in June. There is little doubt but that the Dutch have a fair claim to the kick off, though the American forwards at once dominated the game. About the same time there were our own famous broadcasts from the Marconi Company's station at Writtle, inseparable from the name of Captain P. P. Eckersley, and in the spring of 1922 the company were giving regular broadcasting programmes from Marconi House in the Strand.

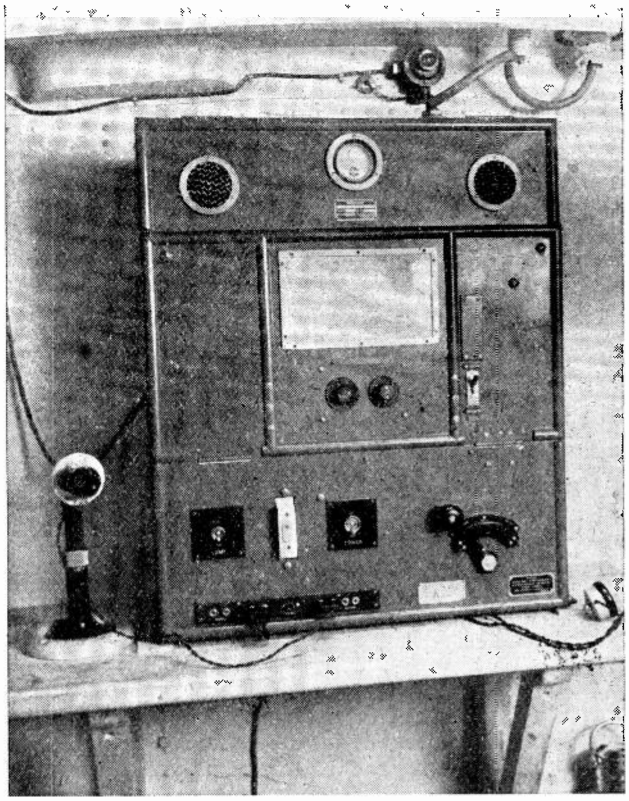
In the United States broadcasting was let loose all over the country, and the more cautious attitude of the Post Office here came in for a lot of adverse criticism, not unprecedented, from those who were not fully informed of the circumstances. But the conditions in the United States were totally different from those in this small thickly-populated country, and it was not really sensible to consider that the best lines of development there would be necessarily the best here. Development was far more restricted here than in America, but the net result was that both countries soon obtained what best met their needs, while retaining enough elasticity to allow for change, not only in needs but in technical development.

The B.B.Cs.

In the summer of 1922 some of the leading British manufacturers of wireless apparatus approached the Post Office for permission to commence a service in this country, and the result was the formation of the British Broadcasting Company. The agreement was finally executed on January 18th, 1923, but broadcasting services had actually commenced on provisional permission from the Postmaster-General in November, 1922. At first there were two forms of receiving licence, the broadcast and the constructor's, but on January 1st, 1925, the uniform 10s. licence was introduced for the listener, a word first suggested by Sir Henry Norman as a compromise between what some called a listener-in, and others a listener-out. The company's licence expired at the end of 1926, and the British Broadcasting Corporation, incorporated by Royal Charter and operating under licence from the Postmaster-General, took over the business on January 1st, 1927.

When the company started broadcasting in November, 1922, there were about 20,000 licences, and now there are about 3,000,000. During the last four years there have been about 3,500 prosecutions against persons receiving without a licence, so that we are not yet in the happy position of some other countries where there are no "pirates"—and no fees. But, after all, we are spared advertising by broadcasting, and that is well worth "pirates" and fees. (Is it ?—Ed.)

In considering the phenomenal growth of broadcasting during the last seven years it is interesting to note that there are already about 20,000,000 sets in use, of which nearly one-half are in the United States. The number of broadcast receiving sets has thus reached in seven years a total of nearly half that attained by the ordinary telephone which started on its career over fifty years ago.



Marconi wireless telephone transmitter type XMB1 installed on the new Dover lifeboat of the Royal National Lifeboat Institution. This lifeboat (which is the fastest in the world) has been specially designed for the rescue of aeroplanes which have fallen into the sea.

It would be superfluous to say anything here of the technical development of broadcasting in these last seven years, as the details are well known to readers of this journal, so we shall pass on now to another important development of wireless telephony.

Ships' Telephony.

This is a development which bids fair to loom large in the immediate future. Here, as in the wireless telegraphic communications of ships, there is a free field for development, as there is no other method by which conversations can be held between ships, or between ships and the shore. Indeed, the need

(*Continued on page* 146.)

The Proceedings *of* The Television Society

April 8th Meeting, held at University College, Gower Street, London

Photo-electric Cells and their Applications

By *T. H. Harrison*, Ph.D., B.Sc., A.Inst.P.

Introduction.

LIGHT manifests itself through the agency of matter in many different ways. Perhaps the most important property of matter with respect to its behaviour when light impinges on it is its power of reflecting the light. Without such a property, matter would be invisible, and a state of affairs would exist which would be very difficult to imagine. But only a part of the light impinging on matter is reflected. The remainder is absorbed, and it has been known for over two thousand years that light absorbed in this way is largely converted into heat and raises the temperature of the absorbing substances. In fact, nearly all the light energy which is absorbed is converted into heat. But some substances react in a special manner with respect to light, and exhibit other phenomena than that of a rise in temperature. Phosphorescence and fluorescence are both properties of certain substances which are activated by light and which have been known for centuries, although nothing was known of the mechanism of the process. A further important action of light on matter was discovered by Willoughby Smith in 1873, when he accidently found that whilst selenium was under the influence of light its electrical resistance underwent considerable variations, the higher the illumination the less being the resistance. Then, again, the existence of photochemical actions has been known for centuries; chemical actions are, in some cases, considerably accelerated by the action of light; certain mixtures of substances which do not react with each other whilst in darkness will explode with great violence when exposed to light. Besides this catalytic, trigger-like photochemical action of light, there are slower photochemical actions in which the progress of the change depends largely upon the rate at which light energy is being received by the substance—*i.e.*, upon the flux of light impinging on the substance—and in which the total change gives some measure of the total light energy that has been acting, such cases being exemplified by the processes in ordinary photography, and particularly in photographic photometry so largely used in astronomical research. Another property of light with respect to matter which was theoretically predicted during the last century, and which was experimentally verified in 1900 by Lebedew and independently by Nichols and Hull, is that it exerts a pressure. It is true that this pressure is much too small to be of practical utility, but the experimental proof of its existence was of considerable theoretical interest, since it confirmed the electro-magnetic theory of light.

It was in experiments in which "wireless" electro-magnetic waves radiating through space were first realised and measured, and in which the identity in the nature of such waves and of visible light was proved, that Hertz[1] in 1887 came across an unexpected and undesired effect which caused him to digress from the normal course of his work. He was investigating the effects of spark discharge electric circuits upon each other, and found that when the electrodes of one gap were illuminated from the spark of another gap, the sparking potential of the first was reduced. Not being able to explain the effect in terms of the ordinary electrical reactions of the circuits, he sought an explanation elsewhere and finally traced the effect as being due to ultra-violet radiation. Having satisfied himself that this bore no direct relation to his main investigation, he merely recorded his observations and returned to his wave experiments, leaving his newly-discovered effect to be further explained by other people. These explanations were soon forthcoming. Hallwachs in the following year published a detailed account of the phenomenon, and concluded that when a negatively electrified metal plate is illuminated, negatively electrified particles travel away from it and follow the lines of the electrical field. In view of the newly-discovered fact of the

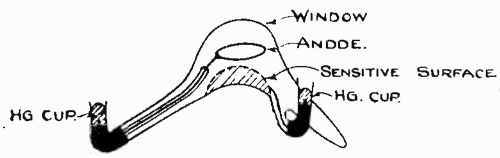


Fig. 1.

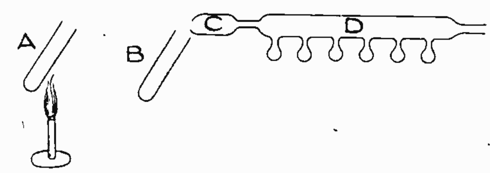
electrical nature of light, it was not considered strange that it should effect the electric nature of matter.

All these properties of light are being utilised either directly or indirectly, and in particular the photo-conductive and photo-electric properties have been the subject of much work during the last twenty or thirty years. There are also other effects, such as the changes in refractive index or in conductivity of certain liquids when they are illuminated, which are capable of practical application. The photo-electric cell is, however, the subject of this lecture, and I will turn now to a record of its development, only delaying in order to give in a few words a definition of what is generally meant by the term "photo-electric" effect, in order that there shall be no confusion in the use of terms. This is rendered specially desirable since, in spite of the fact that photo-electric cells have become so much more in evidence during the last few years, there are still many people who are by no means clear as to what a photo-electric cell is, and as to its manner of functioning. Some of this confusion is due to the existence of its old but rather inconstant friend, the selenium cell. The selenium cell is really a sort of resistance box or rheostat whose electrical resistance varies according to the degree of the illumination falling on it, and the methods of measurement of light with the selenium cell are identical with those used for measuring moderately high electrical resistances. The photo-electric cell, however, operates in an entirely different manner. If the analogue to the selenium cell is the resistance box, then that to the photo-electric cell is the two electrode thermionic valve. In fact the photo-electric cell is a valve, and the term photo-ionic valve would be far more appropriate to it than its present name. The thermionic valve and the photo-electric cell are almost identical in their action, construction and appearance, and the only fundamental difference is that whilst in the former the electrons are ejected from the hot filament by the action of heat, in the latter the electrons are ejected from the photo-sensitive surface by the action of light. There is also unfortunately a further difference in that the photo-electric current is only about 1/1,000 of the thermionic current given in a valve of about the same size. This, however, is only to be expected, since the rate at which energy is supplied to the photo-sensitive surface by the light is very much smaller than the power used to heat the filament of a valve. The main point to notice, however, is that the methods of dealing with photo-electric cells are identical with those with thermionic valves.

Development of the Photo-electric Cell.

The discovery of Hertz was taken up with great interest by several workers, and in the following year (1888) there are papers describing the effect by Arrhenius,[2] Hallwachs,[3] Hoor,[4] Righi,[5] Wiedmann and Ebert.[6] The papers by Hallwachs were the most complete, with the result that the photo-electric effect has often been termed the Hallwachs effect. Until about 1900, or even later, the real nature of the photo-electric effect does not appear to have been grasped, the general view being that the action was analogous to that in an electrolytic cell with the air in between the electrodes acting as an electrolyte. The misleading and rather unfortunate name "photo-electric cell" is an inheritance from these early false ideas.

The earliest photo-electric cells usually consisted of a metal plate which acted as one electrode, and which was exposed to ultra-violet radiation surrounded by a metal case which was the second electrode. The intervening space was, of course, filled with air at atmospheric pressure, there being no glass or quartz bulb container. The real nature of the photo-electric effect seems to have been grasped to some extent by some workers. The statement by Hallwachs, for instance, already referred to was quite correct, and Hoor in 1888 used the type of cell just described, together with an energising battery and galvano-

Fig. 2.


meter in exactly the same way as the photo-electric cell is used to-day. Again, Righi in 1888 experimented with a primitive photo-electric cell at low pressures of air, but he used no energising battery so that his results are complicated on account of the contact potential effect, the real nature of which was not properly understood until 1912, when K. T. Compton and O. W. Richardson[7] for the first time correctly interpreted its action, and when O. W. Richardson gave a correct theoretical interpretation of its mechanism on the basis of the electron theory of matter. J. Elster and H. Geitel, who are almost solely responsible for the development of the photo-electric cell, commenced their extensive researches in this direction, which continued for more than thirty years—a wonderful record—in 1889.[8] In their first research they found that freshly polished zinc and aluminium were effected by ordinary visible radiation, whilst rubidium was sensitive to the light from a glass rod just heated to redness. Stoletow [9] in 1889 gave for the first time curves showing photo-electric current as a function of applied potential on a photo-electric cell at pressures of air ranging between 2·5 and 96·5 mm. of mercury, and Hallwachs in the same year published an account showing that several organic dyes are photo-electric. Much work has been done on the photo-electric effect of dyes, metallic compounds, and many other non-metallic substances, but since this has not much bearing upon the photo-electric cell as developed for purposes of utility on account of the fact that they are only affected very slightly, and then only by ultra-violet radiation, it

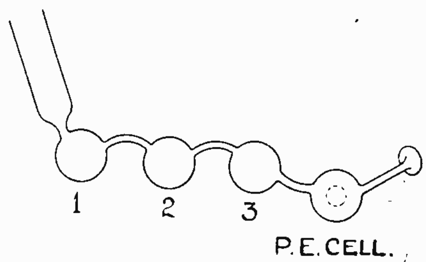
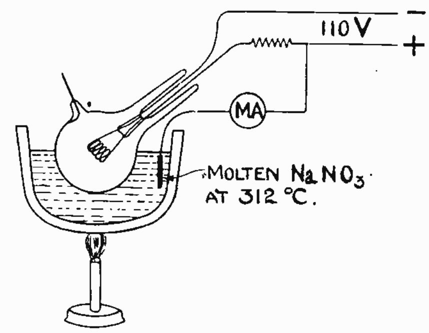


Fig. 3.

will not be described in this paper. Elster and Geitel [10] in 1890 found that the application of a transverse magnetic field to a photo-electric cell operating at low gas pressures diminished the current, thus paving the way for the establishment of the identity of photo-electrons and cathode rays in 1899 by J. J. Thomson,[11] and a little later by Lenard.[12] The order of sensitivity of the more sensitive metals to sunlight was given by Elster and Geitel in 1891 [13] as follows: rubidium (the most sensitive), potassium, sodium, lithium, magnesium, thallium and tin (the least sensitive). Elster and Geitel made a potassium photo-electric cell filled with hydrogen at a pressure of 0·3 mm. of mercury in 1893,[14] and made the very important discovery that the current was proportional to the amount of visible illumination falling on the sensitive surface. In no type of light-sensitive instrument other than the photo-electric cell is the response linearly proportional to the illumination. In the following year they [15] found that the following metals (given in order of decreasing sensitivity) were affected by sunlight—rubidium, potassium, sodium-potassium alloy, lithium, magnesium, thallium, zinc—whilst other metals such as copper, platinum, lead, iron, cadmium, carbon and mercury require ultra-violet radiation. They also found that with the alloy of sodium and potassium, which is liquid at atmospheric temperatures and with oblique incidence of light, there was a difference between the photo-electric behaviour when the light was polarised with the electric vector parallel to the plane of incidence, and that when the electric vector was perpendicular to the plane of incidence. The former was called the selective effect, and the latter the normal effect. These phenomena are very interesting, and have been the subject of much research, but in the utility photo-electric cell they are not of practical significance, since the surfaces are in general too rough when considered in relation to the wave-length of light to show any differences due to light polarised in different directions, and both effects are superimposed upon each other. In 1898 E. von Schweidler,[16] using a potassium photo-electric cell made by the Elster and Geitel method, investigated the voltage sensitivity curve and found that from 0 to 2 volts the current was proportional to the voltage; from 2 to 70 volts, the current increased more slowly, but could not be said to approach saturation, and that above 70 volts the increase in current was much more rapid, until finally a glow discharge was obtained. He continued his experiments later, and made an extensive investigation of the effects of ionization by collision with the consequent magnification of the primary photo-electric current which are made use of nowadays in nearly every cell. In 1899, J. J. Thomson [17] and Lenard,[18] working independently with transverse magnetic fields acting on specially designed photo-electric cells, definitely proved that the photo-electric effect was due to the emission of negatively changed particles

Fig. 4.



which have a mass equal to 1/1,800 of that of the hydrogen atom and a charge equal to that of the simple ion in electrolysis. The particles were found to be identical with those occurring in the cathode ray discharge, but on account of the lower potential applied across the photo-electric tube they possessed velocities of about 10^7 cm. per second, which are much smaller than those for cathode ray or β particles. These particles of negative electricity, whose mass is entirely due to their electric charge, have come to be known as electrons. These experiments have been subsequently repeated with various modifications by several investigators. A systematic and comprehensive investigation on the effect of gas pressure in photo-electric cells, some containing platinum cathodes with air and others having zinc cathodes with either hydrogen or carbon-dioxide, was made by Varley in 1904.[19] Such cells, of course, require to be illuminated with ultra-violet radiation. In this case an arc discharge between iron terminals in an atmosphere of hydrogen to prevent burning away of the electrodes was used. A convenient and fairly steady source of ultra-violet radiation is the quartz mercury vapour lamp, but this, though much more steady than metallic arc discharges, is not nearly so rich in the shorter wave-lengths. Einstein [20] in 1905 propounded his quantum law for the photo-electric effect, that the energy of a photo-electron which can be represented either by the product of its electrical charge and the potential required to reduce its velocity to zero (eV), or by the product of half its mass and the square of its velocity ($\frac{1}{2}mv^2$), is equal to the frequency of the exciting radiation times a constant ($\nu \times h$), less the energy required for the electron to escape from its position inside the surface of the substance to just outside this surface (p_0). Expressed in mathematical symbols, this loss is given by the equation $eV = h\nu - p_0$. The quantity "h" is a universal and very fundamental constant which occurs in Planck's radiation law (propounded in 1901), and is, therefore, known as Planck's constant. The Einstein law was not definitely experimentally verified for some years, and there was another one, known as Ladenburg's law, that the photo-electric energy varied as the square of the frequency of the light which seemed equally well to fit the observed facts to the degree of experimental accuracy that was at that time obtainable. Both of these laws make the tacit assumption that the energy of the photo-electrons is independent of the intensity of illumination; an assumption which is quite contrary to the ideas involved in classical mechanics which would make one expect the energy of the photo-electrons to be proportional to the intensity of illumination.

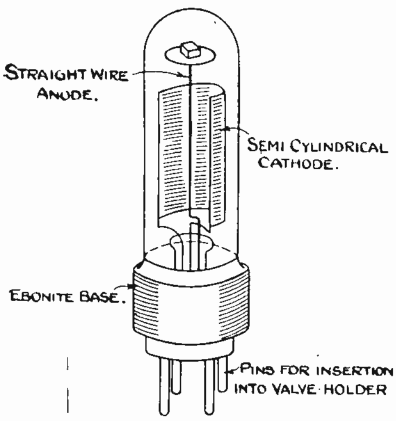


Fig. 5.

The above-made assumption, however, was the outcome of Planck's ideas upon the mechanism of light, and had some justification in the cumulative results on photo-electricity that had been obtained at that time. Special tests upon this question were made in 1907 by R. Ladenburg,[21] by R. A. Millikan and G. Winchester,[22] and by Mohlin,[23] whose experimental results proved conclusively that the energy of a photo-electron was independent of the intensity of the light concerned in causing its emission. The first experimental work definitely establishing the Einstein law and disproving that of Ladenburg was made by A. Ll. Hughes[24] and by K. T. Compton and O. W. Richardson[25] in 1912, and since then the Einstein energy equation has been generally accepted. To return from this digression to the chronological order of events in the development of the photo-electric cell and the discovery of its properties, we find that the well-known fact of the independence of the photo-electric effect of temperature was first suggested in experiments by Lienhop[26] in 1906, where it was observed that the velocity of photo-electrons was independent of temperature within the region between 20° and 180° C. (temperature of liquid air). Another useful result was obtained in 1907[27] by Bergwitz, who, despite the existence of the much-talked of photo-electric fatigue due to almost infinitesimal chemical changes at the surface of the sensitive material, found that for sodium potassium and rubidium in hydrogen at a pressure of 0·3 mm. of mercury, the rate of fatigue was inappreciable—a result which paved the way towards the belief that photo-electric cells could be constructed to give reliable results in the measurement of illumination. In the same year H. Dember[28] found that for potassium, sodium and potassium sodium alloy in vacuum, the photo-electric current was independent of temperature from 15° to 110° C., notwithstanding the fact that the change from the solid to the liquid state occurs within this range, and furthermore that the sensitivity of a sodium potassium vacuum photo-electric cell was constant during a period of twelve months. It was at about this time that the controversy commenced as to the accuracy of the linear relation between the number of photo-electrons emitted per unit time and the intensity of illumination. F. K. Richtmyer,[29] with a sodium cell, verified this linear relationship over a tremendous range of illuminations, and suggested several photometric applications.

Fig. 6.

Nowadays it is generally accepted that the photo-electric emission i is proportial to the illumination I, except when disturbing influences which unfortunately occur only too frequently render this proportionality approximate rather than exact. For good specimens of well-made photo-electric cells, this proportionality is accurate enough for all purposes providing the cells are used under suitable working conditions. The effect of producing a glow discharge in a photo-electric cell was studied in 1908 by Chrisler,[30] who found that this produced pronounced permanent changes in the sensitivity, a result which led the way to the sensitising process introduced by Elster and Geitel[31] a year later. The theory held by some physicists of the photo-electric effect being due to chemical action produced by light rather than to direct action of the light itself, as also that of the photo-electric cell operating in a sort of electrolytic manner, received a severe blow from the discovery by Dember[32] in 1909 that photo-electric currents were produced under the best vacuum conditions. The Elster and Geitel sensitisation process for alkali metal cells was described in 1909[33] and 1910.[34] The cells were filled with hydrogen at a pressure of about ¼ mm. of mercury, heated to 350° C, and then a glow discharge passed through them. The hydrogen was left inside the cell to provide amplification by ionisation. Unfortunately, in such cells the hydrogen was

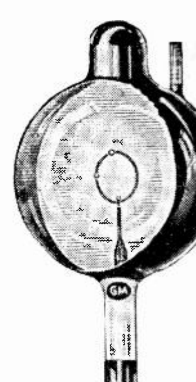


Fig. 7.

gradually absorbed by the metal surfaces. In 1911, however, Elster and Geitel[35] described a means of overcoming this effect by pumping out the hydrogen and filling with either argon or helium, which are not cleaned up in the same manner. This completed the development of the alkali metal sensitised gas-filled photo-electric cell, and no further marked improvement in design took place until three or four years ago, when attention became directed upon the high sensitivity of thin invisible films of metal only a few molecules thick. Work on thin films of metal commenced in 1910 when Kleeman[36] experimented with thin films of platinum.

Fig. 8. *Visitron 53* (*Actual size*)

Hughes[37] in 1913 described a special design of cell in which he found errors in proportionality between photo-electric current and illumination were reduced to a minimum, and in the same year J. G. Kemp,[38] who was using an Elster and Geitel cell for the purposes of stellar photometry, calculated that the cell he was using would give a detectable current of 10^{-15} amperes when illuminated by a candle over two and a half miles away. This statement has led many people to the impression that the photo-electric cell is more sensitive than it really is. Such calculations are very often misleading, since they assume conditions of maximum sensitivity, which in practice are often unrealisable on account of instability and unreliability. In addition, in this case, while 10^{-15} amperes can be detected under really good conditions, it is at the very limit of practical measurements and far from the region where results of precision can be obtained. Marx and Lichtenecker[39] found that there was no sign of lag in a photo-electric cell even when exposed to light for such a short period as 10^{-7} seconds. H. E. Ives[40] described methods of making photo-electric cells in 1914, and gave diagrams of some that he made of special design in order to avoid surface leakage of electricity over the glass. He found that even with the use of long glass tubes and earthed guard rings, ordinary soda-glass allowed the passage of leakage currents. The use of cobalt glass was, however, entirely satisfactory. That common soda-glass is an insufficiently good insulator is also the experience of the author, who, however, finds that pyrex and other similar hard glasses are quite satisfactory. J. Kunz and Stebbins[41] in 1916 gave a method of making photo-electric cells improving upon the technique of Elster and Geitel, cells of this type having been used very successfully in many practical applications even up to the present time, and in 1917 Kunz,[42] who mentioned that photo-electric cells had already been applied to stellar photometry and to researches on plant physiology, phosphorescence, transmission, absorption, reflection and radiation of light in various forms, first described the thermionic valve method of amplification of photo-electric current, and stated that with this method cells could with advantage be used with potentials higher than that required in the ordinary way to produce a glow discharge. Methods of making use of this fact have been developed by N. R. Campbell.[43] In 1920 Miss Seiler[44] made a detailed and extended investigation in the colour sensitivity of alkali metal photo-electric cells. The wave-lengths for maximum sensitivity were as follows for the unsensitised pure metals, and the sensitisation process in each case moved the position of the maximum towards longer wave-lengths.

	li	*Na*	*K*	*Rb*	*Cs*
$m\mu$	405	420	441	473	539

Thus in the authors' experience a potassium sensitised cell has a colour sensitivity almost identical with that of a rubidium unsensitised one. All of these photo-electric cells already discussed are really of the Elster and Geitel type. An entirely new type of cell, sensitive to visual light, was discovered by Case[45] in 1921 while working with oxide-coated valve filaments. After glowing, these filaments were decidedly photo-electric, and it was found that by using the plate of these valves as a photo-electric cathode considerable sensitivity to light was obtained. Apparently calcium, barium or strontium, according to which oxide is used for coating the platinum filament, is under good vacuum conditions and at certain temperatures sputtered on the nickel plate, which plate then becomes photo-electric. The strontium cell is stated to be quite stable, but the others are not. The colour sensitivities are about the same as that for a potassium hydride cell, and the sensitivity is stated to be 100 micro-amperes in bright sunlight. Cells of the Case type do not appear to have been used very much, but they have been used by J. E. Ives[46] for daylight recording. The author unfortunately has no experience of them, and considers it strange that cells of such high sensitivity and ease in construction should be rather neglected. I. Langmuir and Kingdon[47] in 1923 discovered that caesium has the remarkable property of adhering to other metals in a thin invisible layer even above its melting and boiling point, which discovery, together with that in 1924 by H. E. Ives,[48] that thin layers of potassium, only a few atoms or molecules thick, are very photo-electrically sensitive, and particularly so at longer wave-lengths, has led the way to the modern highly sensitive thin film alkali metal cells.

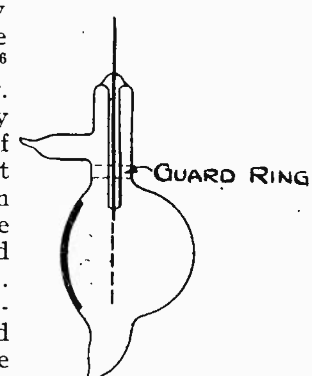


Fig. 9.

Another method of making photo-electric cells was discovered in 1925 by R. C. Burt,[49] namely, that in which sodium is passed through the walls of a hot soda-glass bulb by a process of electrolysis. For potassium, a potash glass sodium-free bulb has to be used as described by

V. Zworykin [50] in 1926. Such cells are very sensitive and reliable.

In 1927 N. R. Campbell [51] developed four methods of using gas-filled cells above their arcing potentials, using a thermionic valve in series for the purpose of limiting the current flowing. Such methods lead to a very high sensitivity, but are more suitable for the detection of faint illuminations or for operating relay circuits than for measurements of precision. In 1928 N. R. Campbell [52] introduced thin film potassium cells with a high red-sensitivity, and more recently the caesium thin layer cells described by L. R. Koller have been introduced, both in America and in England. In these cells the thin film of alkali metal is formed on a metal plate, such as silver or copper or silver-plated copper. The production of a suitable surface condition is an intricate matter, since very slight, almost imperceptible, variations in the various sensitisation processes lead to very large differences in the final total and in the colour sensitivity. V. Zworykin and E. D. Wilson [54] have recently described a caesium-magnesium photo-electric cell in which a layer of caesium is formed on a freshly evaporated layer of magnesium on the internal surface of a glass bulb. This cell is highly sensitive, more particularly in the green and blue region. In addition to the different forms of cells with respect to the nature of the photo-sensitive surface and to the methods of preparation of the same, there are also many different forms with respect to the geometrical design of the electrodes. Differences in geometrical design do not appear to affect very greatly the ordinary behaviour of photo-electric cells, but certain forms are preferable for special purposes—for instance, a double convex collapsed sphere form as recently described by Kunz and Shelford,[55] and which is shown in Fig. 1, is stated to be particularly useful in investigations upon the effect of sun and daylight on plants and animals.

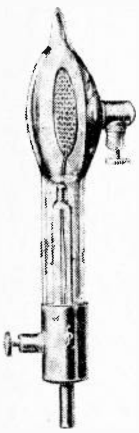


Fig. 10. *Grid, Type G.E.*

Methods of Making Photo-electric Cells.

Only those cells will be discussed here which are reasonably sensitive to visible light. This restricts one to alkali metal cells, except for the alkaline earth cells made by Case in which these metals appear to have been given an exceptional "long wave" sensitivity in a manner perhaps similar to that obtained in the potassium and caesium thin film infra-red sensitive cells. With the exception, then, of these alkaline earth—calcium, barium and strontium cells which have already been sufficiently described—there are three main types of photo-electric cell.

(1) The ordinary alkali metal hydride Elster and Geitel cells as developed by Kunz, Hughes, Richtmyer, H. E. Ives, The Telefunken Co. of Germany, and many other makers.

(2) The Burt cell.

(3) The thin film alkali metal cell as developed by N. R. Campbell and others.

In the first type, and sometimes perhaps for the third type, the alkali metal is purified and sealed under vacuum conditions in small glass capsules, in the following manner. The alkali metal, which can be purchased commercially, contained in bottles and immersed in paraffin, naphtha or some other non-oxygen containing liquid, is taken out, dried with blotting paper, scraped to remove the surface film of oxide and the mixture of this with the naphtha and cut up into small pellets. These are inserted into a tube of pyrex or some other hard heat-resisting glass, *A* (Fig. 2). It is then gently warmed to remove excess of naphtha, and until the metal is just molten. The molten metal is then poured into another tube, *B*, which is then sealed on to *C*. The combined tube, *B C D*, is then joined to evacuating apparatus, and the metal is distilled from *B* to *C*, after which the junction between *B* and *C* is sealed off and *B* removed. The metal is then distilled into *D*, and finally into the little bottles which are suspended from *D* and which are about 1½ inches long. The little bottles which then contain the fairly pure silvery metal are finally sealed off.

The bulb of the photo-electric cell is made with a heat resisting and high insulating glass, according to the particular shape required, and the leads to the electrodes are sealed in to it. Different kinds of glass require wire of different metals for the glass to metal seal, *e.g.*, soda-glass which is no longer used owing to its poor insulation properties and its great liability to crack in the process of making the cell requires platinum leads to be sealed in to it, since the coefficient of expansion of soda-glass is equal to that of platinum; while pyrex glass, which is very suitable for photo-electric cells, requires the sealing in leads to be of tungsten. It will be assumed that pyrex glass is being used. When the bulb of the cell with the desired electrodes and seals is complete, it may be desired to silver part of the inside surface to form a conducting layer upon which the alkali metal is to be deposited, and in order in some cases to prevent too large an area of insulated glass surface which in the finished cell may become charged, influencing in an undesired manner the electric field inside the cell. This silvering is, therefore, the next process, and is effected chemically by the reduction of silver nitrate with rochelle salt. The now complete cell bulb is then joined to the purifying bulbs 1, 2 and 3, shown in Fig. 3, and this set of tubes is joined to evacuating apparatus by means of a ground-glass joint, this being convenient for joining the hard glass of the cell to the soft soda-glass usually used in the vacuum

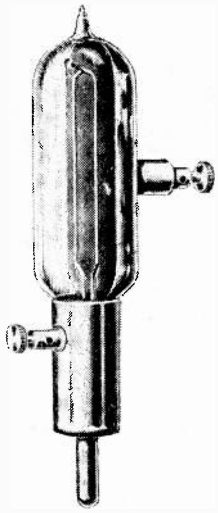


Fig. 11. Type S.

apparatus. The ground-glass joint also allows the set of bulbs to be rotated about an axis passing through the joint and perpendicular to the plane of the paper. One of the little bottles containing the alkali metal is then opened by breaking off the tip and inserted upside down into the wide tube above the bulb 1. This tube is then sealed off at the upper end, the whole series of bulbs evacuated and the tubes 2 and 3 and the cell itself are heated to drive off occluded gases. The tube above 1 containing the alkali metal is then heated, and the metal runs down into 1, after which the upper tube is sealed off. The alkali metal is then distilled from 1 to 2 and so on, and can either be distilled or poured into the photo-electric cell, the side tube of which must be provided with a small electric heater in order to prevent deposition of the metal on the insulating glass surfaces which would make the cell susceptible to electrical leakage. If the cell were now sealed off, we should have a vacuum unsensitised photo-electric cell which would be quite satisfactory in its behaviour, but whose sensitivity would be rather small. In order to increase the sensitivity, hydrogen is introduced at a pressure of about 1 mm. of Hg. using a palladium tube attached to the evacuating system for this purpose. A glow discharge is then passed for several seconds through the cell with the alkali metal surface acting as the cathode, a small induction coil or high-voltage generator being used for this purpose. The alkali metal becomes coloured during this process, and this coloured surface is about four times as sensitive to light as that of the pure metal. The hydrogen is then pumped out, and an inert gas such as argon, neon or helium introduced at a pressure of about ½ mm. of mercury. The cell is then sealed off from the apparatus and is complete.

The Burt Cell.

The method of making the Burt cell is illustrated in Fig. 4. The cell, which is in the form of an electric

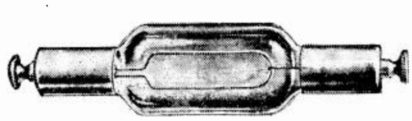


Fig. 12.
Type T.

lamp made of soda-glass, but with an additional lead sealed into it, is placed in a vessel containing molten sodium nitrate. A positive electrode is immersed in the sodium nitrate, and the filament of the cell is heated to white heat. The filament emits electrons which charges the inside surface of the bulb negatively. The glass of the bulb under the conditions obtained here does not act as a perfect insulator, but allows the outside surface to become also negatively charged. The bulb therefore acts as the cathode in an electrolytic action in the sodium nitrate, while the above-mentioned positive electrode is the anode. In this action, sodium ions pass to the glass bulb and replace sodium atoms in the glass which diffuse inwards, finally reaching the inside of the cell which becomes filled with sodium vapour. This vapour can be made to condense on any desired part of the cell by cooling this part.

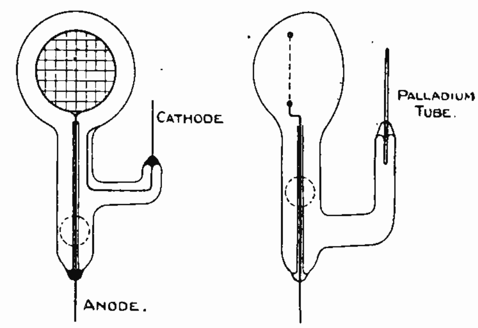
The Thin Film Cell.

The caesium thin film infra-red sensitive type of cell, which is also extremely sensitive to visible light, possesses a silver-plated copper plate upon which the sensitive layers are deposited, and an anode which may be of any metal which does not react unfavourably with the caesium or with the gases used in the sensitisation processes. The caesium is most easily introduced in the form of a chemical compound, and released in its metallic state by such reactions as

$$2Cs\,Cl + Ca = Ca\,Cl_2 + 2Cs$$

or that occurring when a mixture of caesium dichromate and silicon is made red hot *in vacuo*. In cells

Fig. 13.



made at the B.T.H. lamp works at Rugby, a diagram of one of which is shown in Fig. 5, a mixture of caesium dichromate and silicon is introduced into the small metal capsule at the upper end of the stiff straight wire which forms the anode. The cell is attached to the vacuum system and evacuated. The cylindrical plate is then made red hot by means of an electric induction heater as used in the manufacture of thermionic valves, in order to drive off occluded gases. Oxygen at a pressure of a few mm. is then introduced, and an electric discharge from a small induction coil passed between the plate and a coil which is placed over the bulb, this discharge passing through the walls of the bulb and producing a glow discharge inside it. This process oxidises the silver plating of the cathode plate, a coat of this oxide being necessary to secure the adherence of the caesium. When the coat of oxide has been formed the oxygen is pumped out, and the capsule containing the caesium mixture is heated to red heat until a violent action occurs, releasing caesium vapour which condenses on the walls of the bulb. The bulb is then heated in an oven for about a minute to a temperature of about 300°C. and the caesium is driven from the walls of the bulb on to the cathode. Argon is then introduced at a low pressure and an arc discharge passed from the cathode to the straight wire anode. The cell is then sealed off leaving a suitable pressure of argon inside it and mounted as shown in the figure on a valve base. The temperatures, intensities of the various discharges, the pressures of the gases, and the lengths of time allowed for each process are all rather critical and slight variations lead to enormous differences in the behaviour of the finished cell. Considerable experience is therefore necessary in order to make satisfactory photo-electric cells of this type.

Types of Photo-electric Cells now encountered.

There are several varieties of the older Elster and Geitel type of cell met with at the present day, and most of them are very efficient. Three different designs of such cells made by one firm are shown in Figs. 6, 7 and 8. Cells such as that in Fig. 7 can be obtained in sizes up to 12 inches in diameter. The sensitivity of these cells is about 5 micro-amperes per lumen, which gives for a small cell with a window of about 1¼ inches diameter 5×10^{-9} amperes for a candle at a distance of 1 metre. The sensitivity of the 12 inch cell should, according to these figures, be about 0·5 μA for a candle at a distance of 1 metre. Of course if the cell is operated at a potential nearer to that for the glow discharge the sensitivity is considerably higher, but in general this is a state to be avoided. Another manufacturer makes cells of the type shown in Fig. 9. These have a gauze anode which allows the field inside the cell to be more uniform than is the case for the spherical cell, and is for some purposes to be preferred to the other type. They are made with sodium, potassium or rubidium, and can be obtained either gas-filled or evacuated.

A third manufacturer supplies photo-electric cells as shown in Figs. 10, 11 and 12. These cells are of potassium, and can be obtained either evacuated or filled with neon. There is also a choice of three different kinds of glass used for the bulb:

(*a*) Ordinary glass for work in the visible region.

(*b*) Uviol glass for work in the near ultra-violet.

(*c*) Fused silica for work in the ultra-violet.

The Burt cell is procurable and is advertised in *Science.*

The red and infra-red sensitive cells of various types are now also obtainable.

Red sensitive thin film potassium cells are made at the G.E.C. research laboratories at Wembley, and a diagram of one of these is shown in Fig. 13. They are filled with hydrogen, since neon, helium or argon seem to destroy the red sensitiveness of the surface. Unfortunately hydrogen, as mentioned before, is cleaned up (*i.e.*, absorbed) gradually by the metal surfaces, and in order to keep the pressure of hydrogen at a convenient value, the cell is provided with a palladium tube which, when heated in a bunsen flame, allows the passage of hydrogen into the cell. Highly efficient caesium infra-red sensitive cells are also made by the same manufacturers according to the design shown in Fig. 14. A description of a caesium thin film cell as made by the B.T.H. Co. has already been given and a diagram of such a cell given in Fig. 5.

Application of Photo-electric Cells.

(1) *To Photometry and Stellar Photometry.*

The measurement of variations in intensity of monochromatic light of sufficient intensity is a very simple procedure with the photo-electric cell. For light which is not monochromatic, however, it is to be borne in mind that the colour sensitivity of the photo-electric cell is generally far different from that of the eye, and that in consequence any results obtained by the photo-electric method must be viewed in the light of this fact. To obtain results in photo-electric photometry for illuminations of different colours is perfectly simple; to interpret them correctly or to design the apparatus in order to obtain directly results which agree with those of visual photometry is a matter of considerable difficulty. The measurement of the photo-electric current is quite simple: for higher illuminations (at any rate with gas-filled cells which in the writer's experienc are practically as reliable as vacuum ones) a sensitive galvanometer is used, for lower illuminations either an electrometer or a valve amplifier must be used. As early as 1906 a photo-electric cell was used for studying changes of intensity of light during a solar eclipse. The methods used in stellar photometry are simple. The photo-electric cell is placed at the focus of the objective of the telescope and the current measured with an electrometer. In order to avoid capacity effects in the leads to the electrometer, the latter is usually of the string type, or else that designed specially for the purpose by Lindemann, which are both capable of functioning when attached to the movable telescope. A thermionic valve could also be used as an electrometer, and a special valve has recently been made for this purpose by Philips which has special quartz insulation and to which they have given the name "the electrometer triode."

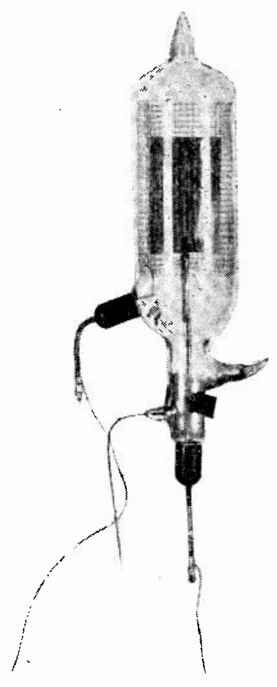


Fig. 14.

The problem of measuring the candle powers satisfactory of electric lamps run at different colour temperatures has now been solved fairly satisfactorily, the advent of the red-sensitive cells having helped the process considerably, since the older type had insufficient sensitivity in the red to allow the use of a coloured filter which would reduce the colour sensitivity to that of the eye without cutting out an undue amount of the active light. It is impossible here to go further into details, but two recently described automatic photometers are of particular interest.

(2) *Automatic Photometers.*

A diagram of a "recording photo-electric colour analyser," designed by A. C. Hardy,[56] is given in Fig. 15. This instrument is designed to measure on a graphical record the variation of the reflecting power for all wave-lengths of light of a sample of material. The photo-electric cell is alternately exposed to light reflected from a surface of known reflecting power, such as magnesium carbonate, and that from the sample to be tested. The frequency of alternation is about that of low sound waves. In general, the two light intensities are not equal, and the photo-electric cell gives an intermittent current effect which, when greatly amplified with valves, produces an alternating current sufficiently large to operate a small electric motor through its field coil. This motor controls a shutter in front of the standard sample, and continues to operate until the shutter is sufficiently closed (or open) that the light received by the cell from the standard reflection material is equal to that from the test sample. When this condition is realised, the photo-electric current ceases to be of an intermittent nature, and the output from the amplifier ceases, with the result that the motor stops.

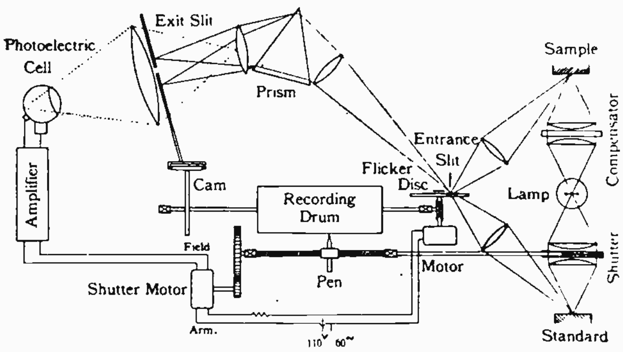


Fig. 15.

The shutter is connected with a recorder pen, and the design is such that the position of the pen to which it is driven by the motor gives a measure of the reflecting power of the sample of material used. Another motor worked from the same source of alternating supply as that used for the armature of the first operates a recording drum and the wave-length changing mechanism. In a period of time of about one minute a complete chart is produced showing the reflecting power of the sample throughout the visible spectrum.

Another interesting automatic photometer is one designed by M. Horioka [57] for giving a visible record showing the candle powers of an electric lamp in different directions. Fig. 16 shows the apparatus diagrammatically. Light from the lamp l, the distribution of candle power from which in all directions given by the radii of a circle with centre at l and in a plane perpendicular to the paper is required, passes to the mirror M_1 from which it is reflected to the photo-electric cell d. A screen B prevents light passing directly from the lamp to the cell. The mirror M_1 is connected to a system which also has another mirror M_3 attached to it. This system is caused to rotate as suggested by the pulley wheels and belt shown in the figure. The current from the cell is amplified by the valve amplifier j which operates the oscillographic galvanometer, the mirror of which is shown as M_2. The deflection of the galvanometer is obtained on the frosted glass screen S. The screen S showing the galvanometer deflection is observed in the direction indicated by the eye shown in the diagram through the rotating mirror M_3. The velocity of rotation of the system is made to be about 12 revs. per second in order to avoid flicker effect, and the trace shown in the revolving mirror is a polar curve of the distribution of candle power from the lamp l in the plane indicated by the diagram.

(3) *Control of Printing and Textile Machines by means of Stencils.*

This, together with control of chemical reactions (*e.g.*, titration) of smoke production and colour changes, also with optical alarm systems, automatic street light control, picture gallery blind control, illumination control in buildings and with burglar and fire alarms, is performed by making the current from a photo-electric cell, when the illumination passes through a critical value, operate a relay whereby a large electric current is brought into operation in order to control any taps, bells or motors that may be required to be automatically controlled. If very large illuminations are available and very sensitive cells can be used the cell may be made to operate a galvanometer relay directly, but generally speaking the use of a thermionic valve or a discharge tube relay is required. If a valve is used, it may be used in the ordinary way as an amplifier, or it may be used as a current limiter with the photo-electric cell operating above its normal glow potential in the manner described by N. R. Campbell.[43] The General Electric Co. manufacture a photo-electric cell relay on this principle and designed specially for the automatic control of street lighting.

In the control of machines by means of stencils, a beam of light passes through the stencil on to a photo-electric cell. The stencil moves along as the work is being done until the end of it intercepts the beam of light, when the photo-electric current ceases, thus operating a relay which effects the required adjustments to the machine. In the control of titration, the beam of light passes through the solution and adjustments are so made that when the solutions attain the required colour the illumination on the cell reaches the value at which the relay operates.

For detection of smoke or dust in the air a strong beam is made to pass through the air. If there is dust or smoke present, the path of the beam is visible. A photo-electric cell is placed so that it views part of the beam, so that it receives the light scattered from the dust particles.

The measurement of colour temperature of electric lamps and the automatic rating of them are really identical. Two photo-electric cells of different colour sensitivity are exposed to the same source of illumination and are connected so that the current from one is in opposition to that from the other. By suitably adjusting the apertures of the cells, a balance is obtained for a certain colour. For bluer light than this the balance will be upset in one direction, and for redder light in the other direction. For changes of intensity, without change in colour, the balance is unaffected, since in this case the changes in current in one cell are equal to those in the other.

The measurement of absorption of light in lamp bulbs can also be measured conveniently by the photo-electric method. The bulbs to be tested—left open—are placed in succession over a small electric lamp and the measurements made by any of the methods used in ordinary photo-electric photometry.

Measurements of spectroscopic plates can be conveniently made, using a photo-electric microphotometer as designed in the first place by P. Koch.[58] A point source of light is focussed on the plate from which it diverges on to the cell, and in this way the photographic density of a spot of exceedingly small area can be measured.

The methods of using photo-electric cells for the transmission of pictures for television, for transmission of signals by light, for talking pictures and for gramophone recording all involve the same principles. A flux of light of oscillating intensity affects a photo-electric cell which is capable of responding to extremely high frequencies, and the response is amplified with an ordinary valve amplifier. In some cases where the quantity of light available is very small, or where the time of illumination is very small indeed, it may be desirable to use the larger cells (up to 1 foot in diameter) obtainable nowadays in order to collect a sufficient quantity of light, but in most cases the

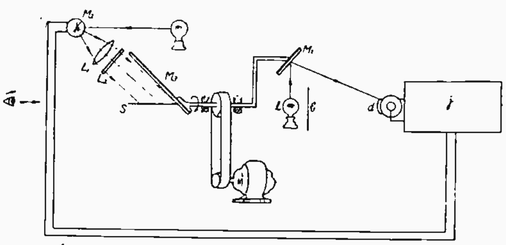


Fig. 16.

same quantity of light can with advantage be collected by lens or mirror systems and concentrated on a smaller cell. Of course, the larger size cells are capable of dealing with a much larger flux of light, and will give very large photo-electric currents, but the electrical capacity of the cathode is rather large, and unless a very large flux of light is to be dealt with it is better to use lenses or mirrors to collect it. For transmission of pictures and television, light selected from a small area of the object to be transmitted is passed to the cell. The small area is made to traverse the whole object, and when this is complete the object can be said to be recorded in the form of a series of electrical oscillations. These oscillations are amplified and transmitted by telephone or wireless, converted again into light oscillations with the aid of a discharge tube such as the neon lamp or of the Kerr cell or of some sort of light valve, and the light oscillations are directed on to a plate or screen by means of an apparatus similar to that used for collecting the light and working synchronously with it. No special type of photo-electric cell is required.

In the talking pictures, gramophone recording and transmission of signals by light, there is a variable illumination falling on the cell, and this produces a variable current which is amplified and passed to a loud speaker. Some sort of microphone is used in the first place in producing the oscillations in the light, and of course in the talking pictures these are recorded at the side of the ordinary film.

In conclusion, it may be remarked that there are, no doubt, many further applications of photo-electric cells which will come to mind as new problems arise. The photo-electric cell, as at present made, is quite a robust little instrument; if not required to work at the very maximum of its powers, it is very constant, responds instantaneously to fluctuations of light, has a response proportional to the quantity of light affecting it, and will give good service for many years. The fact that its sensitivity is not quite so high as some people would wish is no real detriment, since with the aid of a single thermionic valve this can easily be amplified several thousand times without appreciable loss of accuracy.

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57. Horioka, N.: Researches Electro-Tech. Lab., Tokio, No. 268, 1929.
58. Koch, P.: A. d. P., xxxix, p. 705, 1912.

The Story of Electrical Communications.

(*Continued from page* 135.)

is so obvious, and the field of action so apparently free, that we must first explain why this development has lagged so far behind that of wireless telegraphy.

The main reason lies in the phenomenal success of wireless telegraphy for ships' communications. We have seen that this was the first application of wireless telegraphy for commercial purposes, and we have seen how rapidly it was developed for these purposes, as well as in connection with the safety of life at sea. So rapid and successful were these developments that telegraphy was established in an extraordinarily strong position before the invention of the thermionic valve made telephony a practical proposition.

Technically, telegraphy had several important advantages. It was in a high state of development, it was cheaper to install, was more economical of power, and used a universal code which to a great extent disposed of the language difficulty inherent in telephony. Many people were obsessed with these advantages of telegraphy, and even thought that telephony would never find a strong commercial footing for ships' communications. It has not done so yet, but there is really no doubt now, and there never should have been any doubt, that the overwhelming advantage of the spoken word for communication must eventually break its way through all difficulties.

Early Experiments in Ships.

Experiments with wireless telephony for ships' communications commenced immediately after the war, and in this country the Marconi Company were soon in the field. In the summer of 1920 they arranged for conversations with the shore to be held by press delegates in s.s. "Victorian" when proceeding from England to Canada, and conversations were held at distances as great as 1,000 miles. In August, 1923, the company fitted a cross-channel boat, s.s. "Lorina," belonging to the Southern Railway Company, and, in co-operation with the Post Office, conversations were held between passengers on board and telephone subscribers in England. This was probably the first time that conversations took place between passengers in a ship and telephone subscribers on shore. The system was then improved so that ordinary duplex telephone working could be maintained, and another steamer, the "Princess Ena," was fitted. There proved, however, to be little demand for telephone facilities at that time, and the whole scheme was abandoned.

Short Waves for Ships.

Later, the company fitted a number of whalers and lightships, etc., with telephony, and these installations have proved of great value, but it was only within the last year or so, when short wave working had become better understood, that ship and shore telephony has showed signs of seriously entering the commercial arena.

On December 8th last year the "Leviathan," when one day out from New York on her way to Southampton, opened a commercial telephone service on short waves with the United States, and Sir Thomas Lipton in the "Leviathan" was the first to use the service by 'phoning through to Mr. Rankin in Atlantic City to express his [and our] hopes of bringing home the yacht race cup when he visited the States again this summer. Satisfactory working was maintained up to a range of 2,600 miles.

The Post Office here opened a service with the "Majestic" on February 14th, and has since arranged that a service is available to and from any ship on the North Atlantic route which is fitted with suitable apparatus. The minimum charge is £4 10s. for three minutes' conversation with £1 10s. for each additional minute or fraction thereof. In place of the normal charge a report charge of 10s. is payable when for any reason beyond the control of the Post Office the person asked for cannot be found.

The Post Office, indeed, has been fully alive to the possibilities of telephone services for a long time, and its station at the Humber has been fitted with wireless telephony, in addition to telegraphy, for some years, but very little use has been made of it by the shipping community. Germany and some other countries have also recently fitted a few ships and stations; in fact, it is now at last generally recognised that telephony, in spite of its inherent disadvantages for ship-and-shore work, has made a real start, and before long will settle down on ordinary commercial lines.

Long Range Services.

Since the last article (which dealt with long range commercial wireless telephone services) appeared, the Government has announced its policy with regard to the development of these services. As already mentioned, the late Government transferred the Beam wireless telegraph services, which work overseas, to the Imperial and International Communications Company, but left the development of wireless telephone services in the hands of the Post Office, and the present Government has now decided that these services will be worked from the Post Office transmitting station at Rugby in conjunction with its receiving station at Baldock.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents. Correspondence should be addressed to the Editor, TELEVISION, *26, Charing Cross Road, W.C.2, and must be accompanied by the writer's name and address.*

A CORRECTION.

To the Editor of TELEVISION.

DEAR SIR,—I should like to point out one or two slight typographical errors in your issue of April, 1930. I refer to an article entitled "Reproduction and Amplification in Television Receivers," by Dr. Fritz Schroter; page 72, second column, line 10 from the bottom:

"intensity for $t=I$" should read "intensity for $t=T$."

Page 73: equations (1) and (2) should read respectively:—

$$H=Ci\int tdt=\frac{Ci}{2}(T-\tau)^2 \ldots\ldots\ldots\ldots (1)$$

$$\text{and } H=Ci\int_{\tau}^{T} tdt + Ci\tau T=\frac{Ci}{2}(T^2+\tau^2+2\tau T) \quad \ldots (2)$$

instead of:—

$$H=Ci\int tdt=etc. \text{ and } H=Ci\int_{\tau}^{T} tdt+etc.$$

Similarly, on page 74, first column, the equation on line 9 from the top should read:—

$$Ci\int_{\tau/2}^{T} tdt=Ci\,T^2\left(1-\tfrac{1}{4}\right)=\frac{3H}{4}.$$

Yours faithfully,

C. WILSON,

Technical Department,

Baird Television Development Company, Limited.

April 1st, 1930.

HOW IT HAPPENED.

To the Editor of TELEVISION.

DEAR SIR,—Just happen to be looking around for some sort of a magazine on television, and just happen to run across your magazine, TELEVISION; sure did enjoy it very much.

Although I have just started to experiment on television, I find it more interesting than radio.

I will be looking for your next issue.

Yours faithfully,

M. DEPPS.

4149A, Grove Street, St. Louis, Mo., U.S.A.

March 21st, 1930.

CO-OPERATION WANTED.

To the Editor of TELEVISION.

DEAR SIR,—About five weeks ago I started to construct a televisor, which took me about three hours to build, and since then I am almost regularly seeing in to the night transmissions. A Metro-Vickers fan motor (1/16th H.P.) is used to rotate the disc, synchronising being maintained by a variable resistance. The disc is made of aluminium, being drilled with thirty round holes. An Osram "Osglim" is used as a neon lamp, and I have had the bulb frosted (cost, about 3d.) to obscure the filaments.

Last night (April 4th) the images did not come through as clear as on previous occasions, as I had trouble in maintaining synchronism, but after "National" had closed at 12.30 p.m., and I had connected the loud-speaker to the set, I was surprised to hear television signals on a wave-length of about 400 metres. Naturally I reconnected the televisor, and with the disc revolving at about 600 r.p.m., succeeded in seeing what appeared to be a rather beautiful lady. This picture appeared to be slightly coloured. The images altered every few minutes, but unfortunately they were not clear enough to distinguish any detail. At 2.45 a.m. pictures were still coming through. Can you please tell me which station was doing this transmission and the correct speed for disc?

Up to the present I have been unable to get in touch with any other television enthusiasts in this district, and as it would be very useful to compare notes with someone, should very much appreciate any help you could give in this direction.

With the hope of more frequent and earlier night transmissions and best wishes for the success of your magazine,

Yours faithfully,

A. J. STAINES.

"Aghancon," Kingsfield Avenue, Harrow, Middlesex. *April 5th,* 1930.

[The station picked up by our correspondent was probably Witzleben, Berlin, which operates on 418 metres, and broadcasts cinema films regularly from 9 to 9.30 a.m. and 1 to 1.30 p.m. On Tuesdays and Thursdays the morning transmission is omitted.

Witzleben uses a 30-hole disc and scans at the rate of 12½ pictures per second, as in this country, but employs horizontal scanning and a 3 to 4 picture ratio.—ED.]

PROGRAMME CRITICISMS.

To the Editor of TELEVISION.

DEAR SIR,—I have constructed a televisor mainly from Baird parts and get splendid results using the amplifier described in TELEVISION by W. J. Richardson.

I find that by using two L.S.5A valves in parallel in the last stage and running the neon and synchronising coils in series the synchronism is all that can be desired, and when once adjusted the image can be held for the whole of the half-hour transmission periods; in fact, it is rather difficult to *gently* speed up or slow down the motor with the rheostat when it is required to get the image properly centred. The neon glows very brightly with about 350-volt H.T.

I have a few criticisms to make with regard to the dual wave transmissions. First and foremost, the transmission periods are far too short. Then the speech part of the transmission is of very poor quality compared with the B.B.C. transmissions from their studios, and gives people a very poor opinion of the receiving apparatus when giving demonstrations.

Yours faithfully,

A. A. KEEN.

48, Broad Street, Chesham, Bucks.
April 4th, 1930.

TELEVISION MAGAZINE IN AMERICA.

To the Editor of TELEVISION.

DEAR SIR,—Television with us in the U.S.A. is "just around the corner." At least so they tell us. At any rate we have several systems and as many types of scanning discs. There are some twenty visual broadcasts on in various parts of the country, but we have not reached the stage where a magazine devoted to television is evidence of a widespread following. I am sure that there are many here, like myself, that eagerly look forward to the appearance of TELEVISION on the news-stands.

Yours faithfully,

M. E. EISENBERG.

9333 Main Street, Kansas City, Missouri, U.S.A.
March 25th, 1930.

AMATEUR RESULTS.

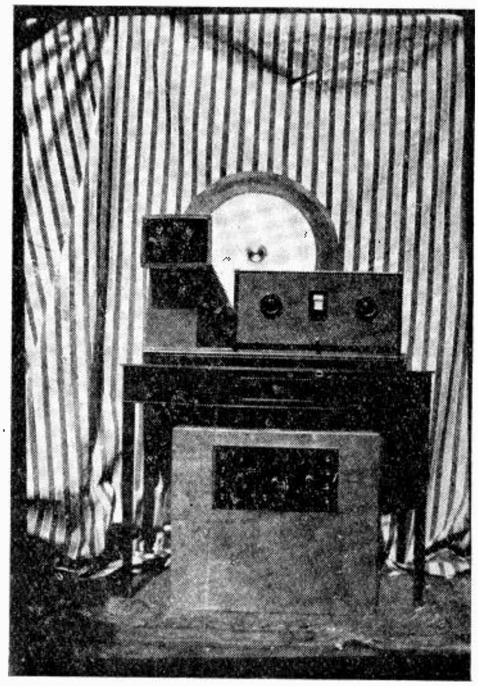
To the Editor of TELEVISION.

DEAR SIR,—We have pleasure in sending you a photo of our latest televisor in the hope that you will see fit to publish same in May issue of TELEVISION. You will doubtless notice the likeness to your first televisor. All the parts of this apparatus have been made from the old model published in your first March, 1928, issue.

The motor stand is as original, but the baseboard is cut to half width, as all the back portion was wasted space due to the taking away of the transmitter, projector lamp, etc., whilst the viewing tunnel is cut to almost half length, as we found that not more than two people could see the image at the same time with the tunnel at the original length.

Cutting down the transmitting motor stand we found made quite a good and solid job as a stand for the viewing tunnel, whilst a reading glass inserted in the tunnel brings the image up to quite good dimensions. At the disc end of the tunnel we inserted a piece of cardboard with a hole to the shape of the picture, as this cuts out all unwanted illumination, as we found that all stray leaks of light, no matter how small, tended to make the image less bright.

Our next problem was the neon stand, etc., as we found that unless this was mounted on a solid base the received picture suffered owing to vibration set



up on the neon by the disc pulling itself to true whilst revolving.

A crate formerly used for housing one of the small type 20-volt wet H.T. accumulators was cut down to size and mounted on end with a baseboard about 6 inches by 6 inches screwed to it as a platform for the neon, mirror, etc. The neon (Commercial Osglim) is then screwed to the platform well to one side (the left) so that no part of the glass can be seen through the holes when the disc is revolving, after which the mangin mirror (as specified in the old televisor) is mounted in a picture frame and screwed to the same base at an angle, so that the projected light from the neon falls on the holes in the disc. After this is completed the whole is boxed in, and a piece of cardboard pinned on the front by drawing pins with a hole cut out slightly larger than the received image, so that no unwanted illumination can escape to interfere with the operator's vision.

We found also that tin foil on the back of the neon tended to brighten the image to a certain extent, although this is not absolutely necessary. We went to all this trouble with the neon box, as we found that the more illumination one can keep out of one's eyes was all to the good of the image brightness.

At present we are using a discarded fan motor, regulated by hand, but are busy on a simple synchronising gear, with a standard hole aluminium disc. The disc, as you will see, has been painted black for 2 inches round the circumference, which prevents light leaking across the image due to the polish on the disc.

Our radio receiver is a standard "Music Magnet," with a further two stages of L.F., one transformer and one R.C., with 350 volts H.T. We are at present using two L.S.5A's, and find these quite suitable.

Results.

April 5th was the first time we had a chance to try out the new apparatus, and the results were astonishing, considering that this was the first time we had tried this new idea. Making slight adjustments during the Baird transmission accounted for at least half of the transmission time, but later the antics of the Moustache manipulator made it well worth the trouble. After the Baird Co. closed down we succeeded in picking up the transmissions from Berlin, and were very surprised to find that we could make out the images being transmitted, this during a burst of atmospherics which, however, faded away and left the image almost as clear as the one we saw at the Baird demonstration last year.

Our results were so good that we have written the German station offering to pick out the artistes from as many portraits as they care to send. A overheated motor forced us to close down at 3.45 a.m. after holding the film transmission for 3¼ hours.

Since writing the first part of this letter we have had a visit from the wireless correspondent of the *Daily Dispatch*, with which paper is incorporated the *Sunday Chronicle* and *Empire News*, *Manchester Evening Chronicle*, etc., and we enclose report of his visit. Although we are situated on what we think to be the worst car track in the country, we can during intervals of the interference bring up the images to recognisable proportions.

We mention the visit of the above correspondent to prove that others beside ourselves have seen images in daylight under worse than average difficulties. May I mention at this point that we are also surrounded by hills of the Pennine Range.

Further Results.

Saturday, April 12th (12 to 12.30 a.m.). Better results than before from B.B.C. transmissions, every detail of both announcer and lady artiste being visible. Interference from our own motor cut down to nil with condensers and resistances similar to the ones specified in your article on Cutting out Interference. We have not as yet received a reply from Berlin, but are expecting one daily.

We shall be pleased to report further results as they come to hand.

Yours faithfully,

FRED AND FRANK B. PARRY.

58, Church Street, Littleborough.

P.S.—Please understand that car interference is only in daylight, as they finish at 11.45 p.m.

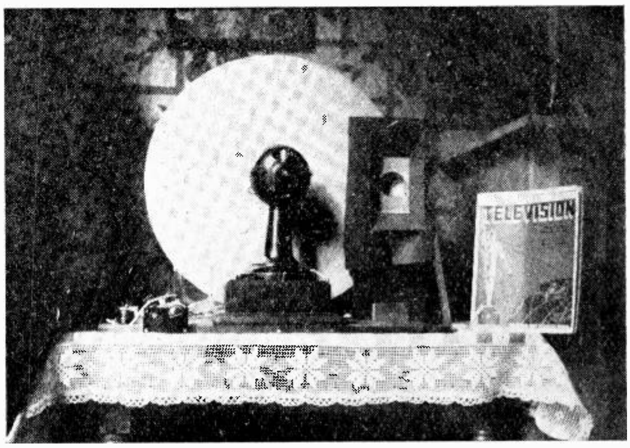
To the Editor of TELEVISION.

DEAR SIR,—I hope to interest you and the readers of TELEVISION by giving you the results of my first experiments in television which started three weeks ago.

My receiving set is of the superhet type without reaction, two valves in the last stage, and Ferranti equipped, fed by accumulators 160 volts or 220 volts D.C. from the mains, giving the necessary output power.

I started with a disc as described by Mr. Knipe, but with holes of 1 mm. square and a bad electric motor. The disc is of zinc and as thick as 1/16 inch, weighs 235 grammes, but is easily punched. No difficulty was encountered to make the drift with a gasoline motor valve.

My neon lamp is a commercial one, similarly arranged to that of Mr. Neal. When I started three weeks ago, at my second trial I was able to see black shadows, but as the picture was so small, the great difficulty consisted in holding the picture steady. My only speed and synchronising controls were my two finger tips, one for speed and the other one to keep the image steady.



I made a speed-regulating device of my own. Experimenting succeeded in keeping the picture still simply by an occasional adjustment of the regulating nut. (The speed of the electric driving motor must of course be regulated by a resistance and made to run a little faster than required, to be able to adjust the adjustment of the regulating nut.) This device acts as a frame and is not subject to variations caused by heat like a resistance; the motor must be run a little bit before the "look in" to make resistance and oiling system uniform.

By night I always had a good reception, but in the daytine the reception suffers from atmospherics, and mostly from interference caused by big industrial motors in the vicinity as well as tram lines. During the transmission of Friday, March 28th, I saw distinctly two arms and hands on the screen doing what appeared to me like playing with little cards and letting them fall one after the other.

persons moving about in the background. At the beginning of the transmission of April 1st I saw the profile of two heads moving and facing each other. Afterwards I think I saw a group of persons playing musical instruments. I could never read the letters.

My bad reception is, of course, due to a leaky grid rectification and transformer coupled L.F. amplification, which gave some distortion. I think a superhet is not the ideal set because of the abnormal atmospherics produced when giving the power required to light the neon lamp. The small image is also due to the fact that I am using 1 mm. holes instead of 0.75 mm. holes.

I am busy now making a well-designed set with screened grid, and anode bend rectification and a proper R.C.L.F. amplifier like that described in your April number; *I am sure to have fine results with this transformation.* I make also a new disc. *I say openly that it is thanks to the interesting articles of your magazine that I was able to realise reception.*

I would feel obliged if you give me the address of a British manufacturer or dealer of neon lamps with a flat plate, because here in this country none are available, and let me know the hours of transmission, as I have been disappointed more than once after having waited till midnight, to get only Fultograph transmission or no television at all.

I avail myself of this opportunity to congratulate you on your very interesting and well conceived magazine.

Yours faithfully,

GEORGES VERDUN.

9, rue du Moulin, Anvers, Belgique.

April 10th, 1930.

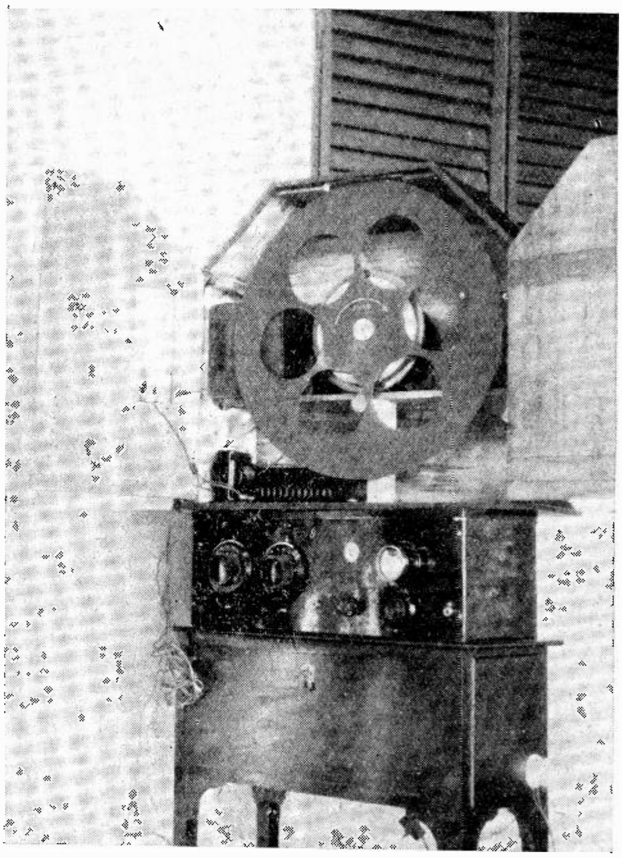
[The night transmissions are from midnight to 12.30 a.m. (Summer Time) on Tuesdays and Fridays.—ED.]

To the Editor of TELEVISION.

DEAR SIR,—In the April issue of TELEVISION, which I have just received, I note you publish extracts from a report I sent to Messrs. Baird's with reference to my reception of the London transmissions. I thought the enclosed photographs might prove of interest to you and perhaps to your readers. Full plate enlargements of these are, incidentally, being exhibited at the annual exhibition of members' work at University College on April 9th.

The four photographs illustrate the complete televiser, radio receiver, etc., and I give below a general specification of the instrument.

Televisor.—Disc, 20 inches diameter, 30 apertures of 033 inches square, ratio approximately 7 by 3. Constructed of thin sheet tin. Motor, G.E.C., series wound, 230 volt D.C., 1/17 h.p. Series resistance, G.E.C., 500 ohms, fitted with micrometer adjustment for fine control. Synchroniser, standard tooth wheel type, constructed in accordance with the articles published in TELEVISION. Coils wound to 2,000 ohms each. Operates very efficiently indeed with 15 m.a. current from separate power valve. Neon, G.E.C. plate type Osglim, chole coupled to output of receiver.



Rear view of Mr. Wraight's receiver.

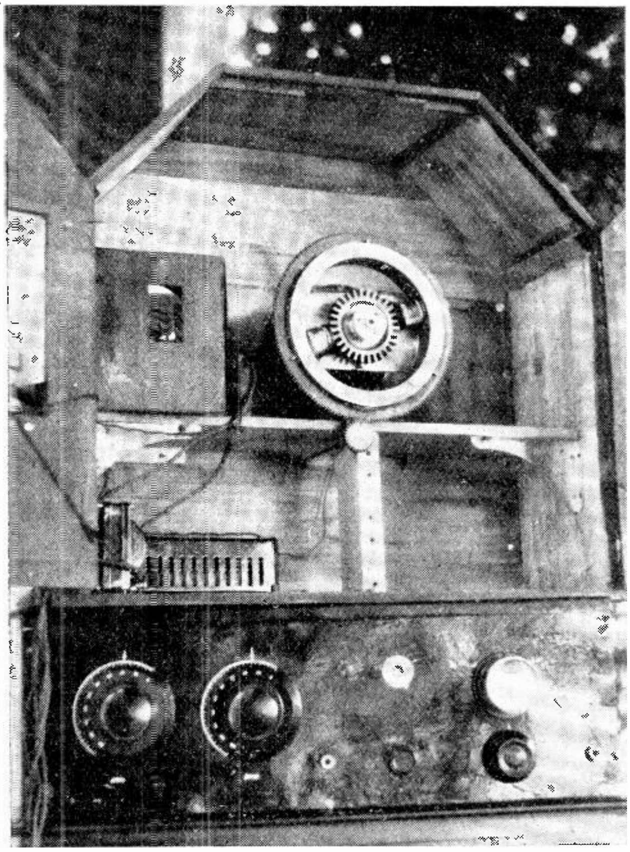
Television Receiver.—Four-valve receiver, comprising one screen grid H.F., anode bend detector coupled to three resistance capacity valves. This amplifier built according to details published in March issue of TELEVISION. Have not got this to function properly yet owing to grid paralysis effects.

Telephony Receiver.—One screen grid H.F., leaky grid detector, coupled to 2 L.F., transformer coupled, choke capacity output.

Both receivers are capable of working on a range of 10–5,000 metres. Until recently the latter receiver has been used for the reception of the television signals and within reason has given quite good results.

Reception in these latitudes is, of course, largely a combination of hope and despair. Static is very prevalent and interference from passing ships extremely bad. One has sometimes to wait weeks before a favourable Tuesday or Friday night rolls along. It is strange to note how the transmissions on the other nights of the week, which you have not much use for, come through so clear and strong. Seriously speaking, however, the present two half-hours a week are ridiculous for such a subject.

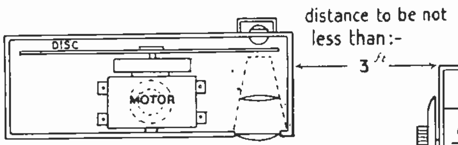
Heads and shoulders appeared frequently on the screen during the transmissions, as well as several

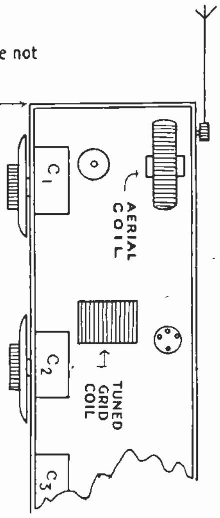


Showing Mr. Wraight's synchronising gear.

I should much appreciate the help of your contributor or your readers on the following.

I have tried all the various combinations of circuits possible to endeavour to cure the interference from my televisor motor. I have found unfortunately that any additions in the way of filter circuits tend to make matters much worse. The series of remedies published in TELEVISION a couple of months back have all been tried, of course, and gave no results.





I find, however, that I can completely cut out the interference if I place the televisor at right angles to the wireless receiver. It must also be at the aerial end of the receiver. In fact its exact position is quite critical. In this position I can bring in the interference by touching the motor casing or shaft. Perhaps these details will help towards a solution of the trouble. Any other position will immediately bring in the interference.

Wishing TELEVISION continued success,

Yours faithfully,

W. L. WRAIGHT,
Associate Television Society.

c/o The Madeira Eléctric Lighting Co., Ltd.,
Campo do Almirante Reis, Funchal, Madeira.

9th April, 1930.

To the Editor of TELEVISION.

DEAR SIR,—On March 31st I witnessed, at Major Oates' Works at Hammersmith, the reception of television pictures combined with broadcast speech, and I wish to congratulate the Baird Television Development Company on the excellent results and the distinct and successful step forward in their venture.

The whole arrangement and layout of this receiving station gave one at once the impression that the art of receiving broadcast television pictures and speech combined was not any longer an amateurish or experimental attempt, with untidy apparatus and a maze of wiring and all sorts of instruments, but a clean-cut, tidy and well-arranged equipment, which at once gave one confidence that what we were about to see and hear was of first-class and high quality.

Right from the tuning signal, throughout the programme and until the 30 minutes' transmission was over, everything worked splendidly and apparently with ease and simplicity of control.

The announcer came through very clearly and was heard at the same time most distinctly.

His place was taken by Sir Ambrose Fleming, whose familiar face was at once recognised, and you could see distinctly every movement of his face when he looked down upon his notes and up again, and one was almost touched to see and hear this great man, who had already given much to the world by his previous work, and to hear him propound the cause of television with all sincerity, and which made him our trusty friend right from the inception, when Mr. Baird started out in his early days in his pioneer work.

Lord Ampthill, who came next, was as distinguished and dignified as he ever is, and again you could observe every detail and movement in his face.

The two lady artistes—Miss Gracie Fields and Miss Annie Croft—were as charming to look at through the television lens as they are in reality, and their great vivaciousness in their expressions was quite wonderful. But I also wish to speak, and I do so in the interests of development, of a few points which still require improvement.

We could observe a kind of white halo on top of the heads and the appearance of which I could not account for.

Then there was similarly strong reflected white light on the lower part of the face, particularly of Miss Field's face, which looked like shaving soap lather on that part of her face. Perhaps there is a particular way of holding your head when being televised to avoid those reflections as mentioned, and that artistes, who are accustomed to appear on public stages, usually tilt their heads upwards, I believe, slightly, so that they can be more easily seen and heard by people in the galleries. I am quite certain, however, that these few defects will be detected and cured before very long.

There was also a kind of "V" shaped darkish part in the middle of their foreheads, which seemed to persist in everyone's pictures.

Apart from these, I do not think, in all honesty, one could criticise any other details.

The television apparatus was a standard Baird Television Receiver and the amplifiers employed were simple and unpretentious. The pictures and the speech were, I believe, received from one and the same aerial.

Major Oates has rendered, undoubtedly, signal service to the cause of television to have given us such a pleasant and well-arranged performance of an almost historical event.

After the performance I left immediately for Birmingham, with ardent intentions and inspired by what I saw, to repeat a similar reception here, 112 miles away from the London station.

With the permission of Professor W. Cramp, I endeavoured, at the Birmingham University, two days later, to pick up the London television transmission and speech, and I am glad to inform you, although I was not so completely successful as Major Oates, who by now is an "old hand" at it, that I was successful in receiving the pictures and speech with a standard Baird Television Receiver and a special amplifier which was hurriedly constructed at the university.

Ever since that date we have improved every day, and before long I hope to report to you that we will have a successful appliance working here, as at Major Oates' place on that memorable day.

I shall then give you more technical details about the difficulties experienced, and which I am overcoming from day to day with greater success. I have no hesitation in firmly believing that broadcast television and speech will, before very long, become a practical success, and with a little more patience be a valuable adjunct and an indispensable means of interest in the home.

I only wish that those "thirty minutes" can soon be doubled by the B.B.C.

Yours faithfully,

J. B. Kramer,
M.R.I., M.I.E.E., M.I.Mech.E.

Witton, Birmingham.

Table of Principal Contents

TELEVISION IS HERE!

At last tne greatest Radio achievement of the era—the Baird Televisor becomes a " home " proposition. Everyone has been eagerly awaiting the advent of this apparatus, at a reasonable price, and its coming heralds the commencement of the greatest radio boom in history.

The wonder of ordinary radio is now amplified by the additional wonder of the Baird Televisor. To SEE and HEAR is the expressed desire of everyone interested in radio, and only the Baird Televisor with its actual reproduction of every movement of living things can solve the problem. No laborious building up of " still " pictures can ever be more than experiment of limited interest. The Baird Televisor Home Reception Set *alone* can give permanent satisfaction.

Daily broadcasts both from the National and Regional Stations at Brookman's Park have been a feature since March 31st.

The Baird Television Company has given great thought and care in producing a Kit of Parts bearing the BAIRD brand. This will interest the Home Constructor and Experimenter, and will open up a new wonder to tax his ingenuity. Ample " Service " is arranged for.

Prices for the complete Receiver and Televisor, Televisor only, and Kit of Baird branded parts will be sent on application to:

THE BAIRD TELEVISION DEVELOPMENT COMPANY LTD.
133, Long Acre, London, W.C.2

the birth of a wonderful radio era

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