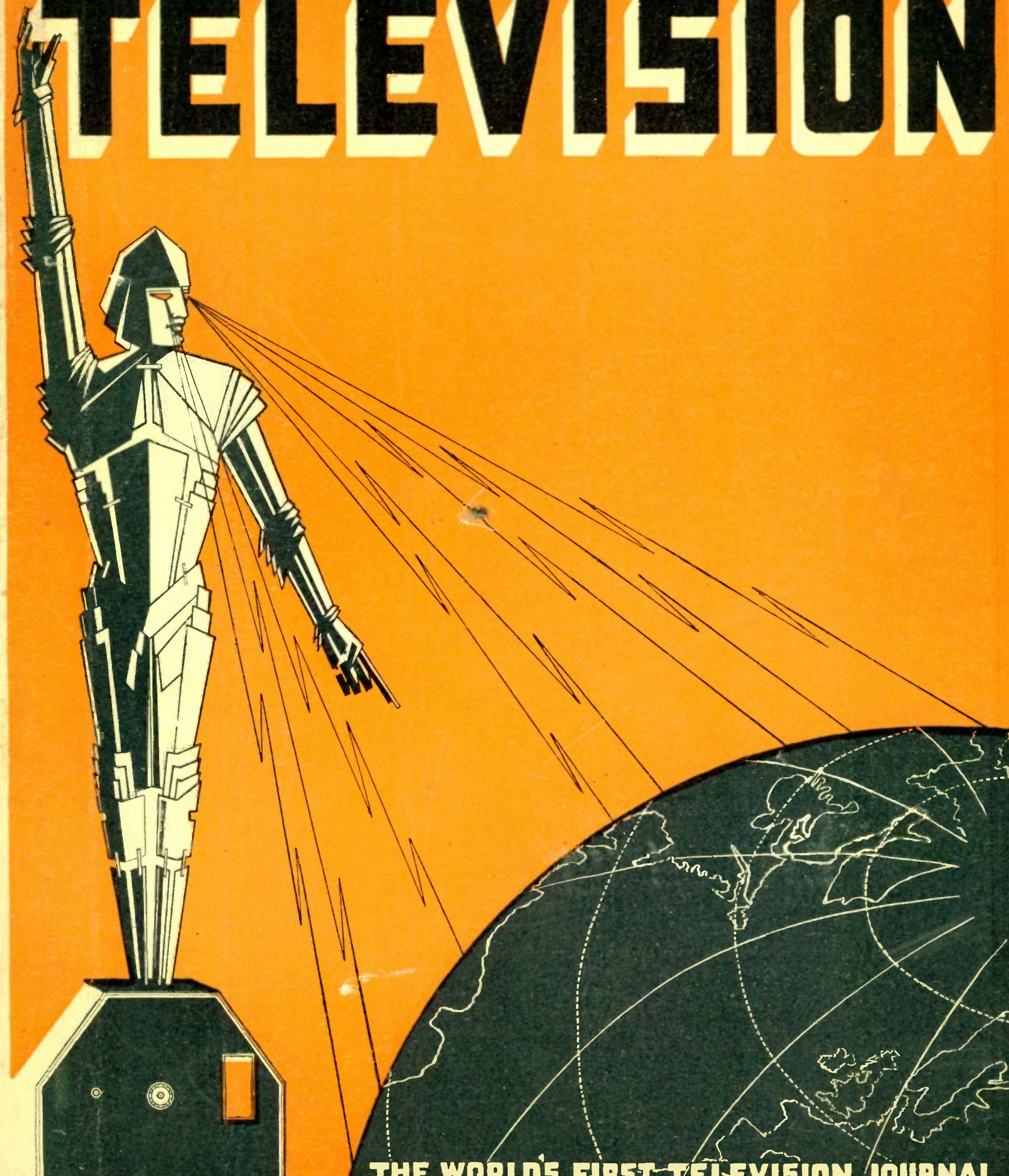
Vol. 3 MARCH 1930 No. 25 25 CENTS MONTHLY

TELEVISION



THE WORLD'S FIRST TELEVISION JOURNAL.

THE TELEVISION SOCIETY

The Television Society was founded on September 7th, 1927.

The Society makes its appeal to those who desire to share in the responsibility of furthering this new branch of applied science.

THE OBJECTS OF THE SOCIETY

may be summarised as follows :

(*a*) The Study of Television and its application in applied science and industry.

(*b*) To afford a common meeting ground for professional and other workers interested in current research relating to Television and allied subjects and to afford facilities for the publication of reports and matters of interest to Members.

(*c*) To encourage the formation of *Local Centres* of the Society in the Provinces, so that by social intercourse and discussion among members these aims may be more fully realised.

The present register indicates a world-wide membership.

ORGANISATION

The Society consists of one Honorary Fellow, Fellows and Associates, and the management is vested in a Council of Fellows, including the President, three Vice-Presidents, and Ordinary Fellows.

FELLOWS.—Ordinary Fellows must be elected by the Council. Candidates for the Fellowship must be proposed by two Ordinary Fellows, the first proposer certifying his personal knowledge of the candidate.

ASSOCIATES.—Any person over 21 interested in Television may be eligible for the Associateship without technical qualifications, but must give some evidence of interest in the subject as shall satisfy the Committee.

STUDENT MEMBERS.—The Council have arranged for the entrance of persons under the age of 21 as Student Members.

SUBSCRIPTIONS.—The annual subscription for Ordinary Fellows is 20s., with an entrance fee of 10s. 6d. ; and for Associates 10s., with an entrance fee of 5s.

The annual subscription for Student Members is 5s., entrance fee 2s. 6d.

LIFE MEMBERS.—Life Membership may be secured at a fee of £10 10s.

MEETINGS.—The ordinary meetings of the Society are held in London at the Engineers' Club, Coventry Street, W.1, at 8 p.m., on the first Tuesday of the month (October to May inclusive). Notices of meetings are posted to all members about seven days before the meeting

Full-size reproduction of the new Television Society Badge, which is available to accredited Members, and may be obtained from the Head Office, price 1s.

The official organ of the Society is "Television," published monthly by the Television Press, Ltd., 26, Charing Cross Road, W.C.2.

A memorandum for the guidance of members wishing to form a Local Centre of the Society may be obtained (gratis) on application to the Joint Hon Secretaries, 4, Duke Street, Adelphi, W.C. 2.

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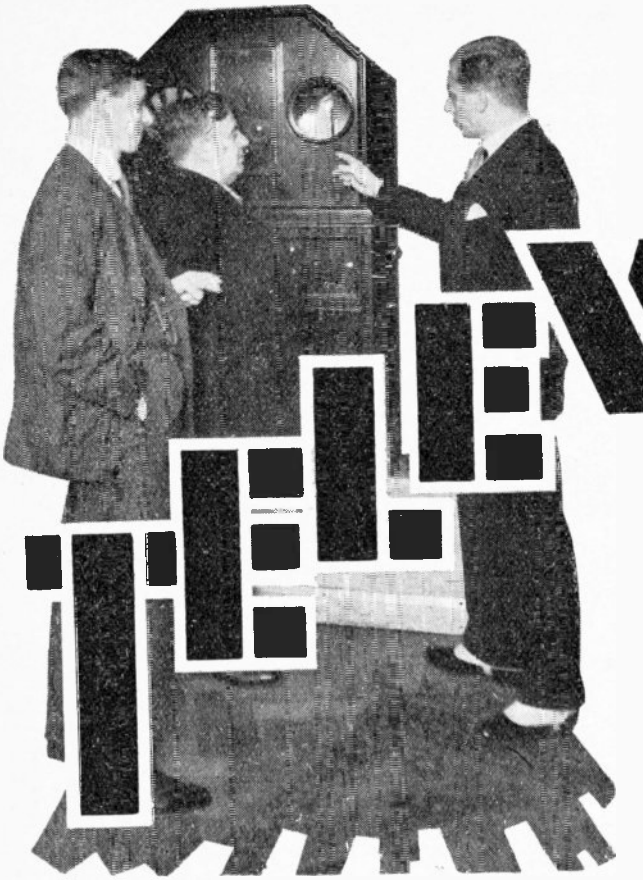

TELEVISION

THE OFFICIAL ORGAN OF THE TELEVISION SOCIETY

SYDNEY A. MOSELEY, *Managing Editor*

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W. J. JARRARD, B.Sc., A.R.C.S., A.I.C.

VOL. III] MARCH 1930 [No. 25

EDITORIAL

WITH this issue we start a new volume, our third. Looking back over the two years which have elapsed since TELEVISION was founded, we have watched and recorded many changes in the television world. Two years ago, while television was still in the laboratory stage of development, it was possible to foresee the tremendous interest which the new science has aroused in the minds of the general public. It has captured the popular imagination.

Sceptical critics of television have abounded, but television has been developed successfully in spite of them. We have from time to time referred to these critics, and answered them in these pages. We feel that we can now refer to another set of critics who, when the first issue of this magazine appeared, stood amazed at our temerity. They shook their heads at our enterprise, and told us we were doomed to failure. We were too premature; we would not get the public to support us; there was not enough material in the science of television to run a magazine on, etc.

Certainly we have had plenty of difficulties to contend with. That is inevitable in any new enterprise. But difficulties are made to be overcome. As to how well or badly we have overcome them, our readers can judge. So much for our part in the matter. To those of our readers who have supported us loyally since the beginning (and they are many) we take this opportunity of expressing our indebtedness. To them our thanks are due for many helpful suggestions and criticisms which have enabled us to attain our objective, which is to provide our readers with what they want.

To our many new readers, and to those about to become regular readers now that television has reached a commercial stage, we extend a hearty welcome. To all those who have not yet written to us we extend an invitation to do so. Send us your criticisms and suggestions. If you do not find what you want in TELEVISION, or if you find something you do not want, write and tell us; we are here to fulfill your bidding and produce a magazine containing what you want to read.

BOUND VOLUMES.

A loose file of magazines is always a nuisance. It is untidy, an odd copy here and there gets lost, it is always difficult to find just the particular article you want to refer to, and pages get torn and dog-eared. The answer to the problem is to keep your back numbers in the form of a bound volume, and for the convenience of those who desire to have their copies bound we can supply binding cases and an index, or we can supply the entire volume ready bound complete. We would advise those who desire to purchase Volume II. ready bound to make early application, for only a limited number are available; such heavy demands have been made for back numbers of our recent issues that some of them are almost out of print.

A limited number of bound copies of Volume I. are also still available.

RAPID PROGRESS.

As we have already remarked, during the two years of our existence we have watched and recorded many developments in connection with television, and much strife (in which we have actively participated) has accompanied these developments. But at last television is about to embark on its commercial career. We understand that the Baird "Televisor" Receivers are to be made available to the public almost immediately. Judging from the tone of certain articles which have appeared recently in several of our contemporaries, some of our critics seem to have become impatient at the delay.

Personally, we are of the opinion that the Baird Company have made extremely rapid and commendable progress. We make no excuse for repeating that this magazine is just two years old, and that when the first issue appeared the Baird system of television was in the laboratory stage. By September, 1928, such rapid progress had been made that the invention had already reached a practicable commercial stage of development. The "televisor" in its commercial form was demonstrated to the public at the 1928 wireless exhibition.

Then began the long fight for recognition, in which we participated, and which ended, after a bitter struggle lasting a year, in the B.B.C. agreeing to broadcast television experimentally for five half-hours a week. The first of these broadcasts took place on September 30th last. But to be able to see and not hear is just as bad as being able to hear and not see, so the Baird Company has been pressing for the use of a second wavelength upon which to broadcast the accompanying speech and music. We are now able to announce that, commencing March 31st next, the use of the second wavelength will be granted. Both Brookman's Park transmitters will then be in operation during the television transmission periods, so that we shall, for the first time, be able to both hear and see what is going on behind the microphone.

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MSS. and other material for Editorial consideration should be accompanied by a stamped addressed envelope, and should be typewritten.

Meanwhile, what of the "televisors"? Obviously, it would have been unreasonable to expect the Baird Company to go to the expense of producing, or arranging to produce "televisors" until they were assured of broadcasting facilities. It was not their original intention to manufacture instruments themselves; they proposed to licence radio manufacturers to incorporate "televisors" in their receiving sets. But when broadcasting facilities were granted last September the radio manufacturers, then holding their annual exhibition at Olympia, had already planned their 1930 programme, and it was too late to incorporate television.

So, rather than keep the public waiting the best part of a year, the Baird Company very commendably altered their whole policy and agreed to manufacture and supply sets to the public. These sets were promised for January of this year, and because they have been a little behind schedule the critics have lost no time on seizing on the delay as an excellent peg upon which to hang yet another attack on television.

It is always hard to be patient, but we think our readers will agree that from the beginning of October until now, five months, is a commendably short space of time in which to suddenly alter a policy and produce a large number of instruments, each one of which has to be made and adjusted with minute accuracy if it is to give entire satisfaction to the user. Countless difficulties had to be overcome. As an example, great difficulty was experienced in getting the right type and number of lenses. It would appear that lenses are scarce in England, and expensive. No British firm could be found who could supply what was required in anything like a reasonable time, or at a reasonable price, so that in the end a foreign quotation had to be accepted.

Then there is the actual broadcasting of television. Five months is little enough time in which to overcome the thousand and one difficulties which inevitably accompany the introduction of something new. Elsewhere in this issue there is an article describing something of the new studio technique which has had to be perfected. After five months of experiment the Baird Company is now in a position to broadcast with certainty a programme of hearing and seeing which will satisfy those members of the public who purchase "televisors."

We shall welcome letters from our readers giving us details of the results which they obtain. In order to secure the best results it is necessary to employ a good amplifier. In this issue Mr. W. J. Richardson describes one which he has built specially to work with the new "televisor," and which, on test, has given the most wonderful results. We can, with the utmost confidence, recommend it to our readers.

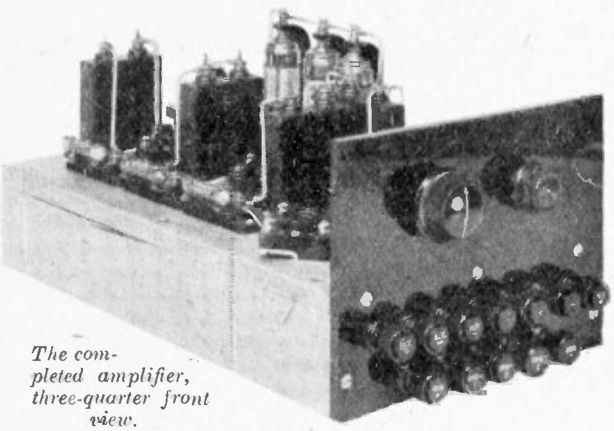
Low Frequency Amplifiers for Television

PART III

By *William J. Richardson*

I SUGGESTED suitable values for the various components shown in the three-stage resistance capacity amplifier last month and we are now in a position to deal with a proper layout, which on test has given remarkably good television images from the Brookman's Park transmissions.

No doubt some of you have wondered why a separate valve has been shown for feeding the synchronising mechanism. This is merely an alternative. As you have already learnt through the columns of this journal, in the latest type of Baird "Televisor" receiver the automatic synchronising is effected through the medium of a thirty-toothed cogwheel and two pole pieces. The wheel itself is mounted on the end of the motor shaft driving the thirty-hole disc and rotates between the two poles which are placed diametrically opposite to one another.



The completed amplifier, three-quarter front view.

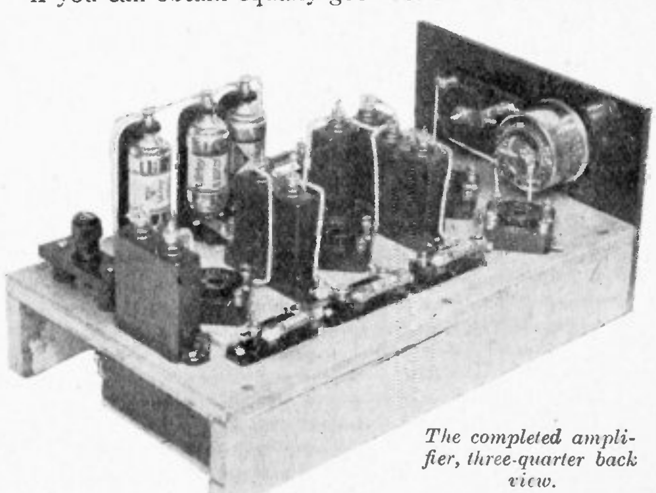
Is There An Advantage?

The synchronising impulses, which actually form part of the picture signal itself, pass through these coils and by this action hold the picture steady without any outside agency. You will notice in Fig. 1, which is the actual theoretical diagram of the amplifier as made up, that this additional valve V_5 is coupled from the plate of the second valve by means of a .1 mfd. condenser and .5 megohm leak. In series with the plate of V_5 must be placed the two synchronising field coils referred to, and the magnitude of the polarising current passing through the valve and coils is controlled by the variable resistance shown.

Now what advantage has this over what may be termed the more orthodox method of joining both neon lamp and synchronising coils in series in the plate of the normal output valve, or valves, if there should be two in parallel? Why, the synchronising control can now be effected independently of the neon lamp and we can strengthen and weaken the sychronising "hold" just as necessity dictates without in any way upsetting the magnitude of the neon current and, of course, the neon glow.

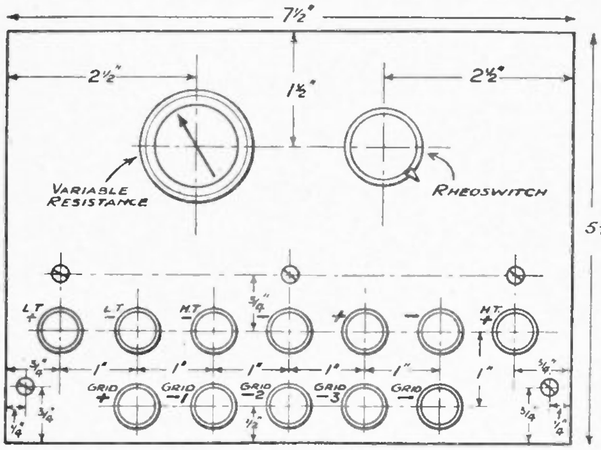
A Possible Drawback

It may happen that in the particular synchronising mechanism with which you are experimenting the current rules high in order to make it hold, whereas the neon can work on a smaller current or vice versa. If this should be the case then the separate synchronising valve permits you to manipulate your television receiver at its maximum efficiency. On the other hand, the addition of this separate control must of necessity demand a higher H.T. consumption, and unless one is working from a mains eliminator supply this may prove a serious drawback. The whole point centres round the design of the synchronising mechanism and its efficiency, and naturally, if you can obtain equally good results with neon and



The completed amplifier, three-quarter back view.

coils in series with the output valve, then adopt this method, for it is more economical from the H.T. consumption point of view. Remember that when neon and coils are in series in this way it is necessary to have a fixed condenser in parallel with the coils, a suitable value for this being .1 mfd. (mica).

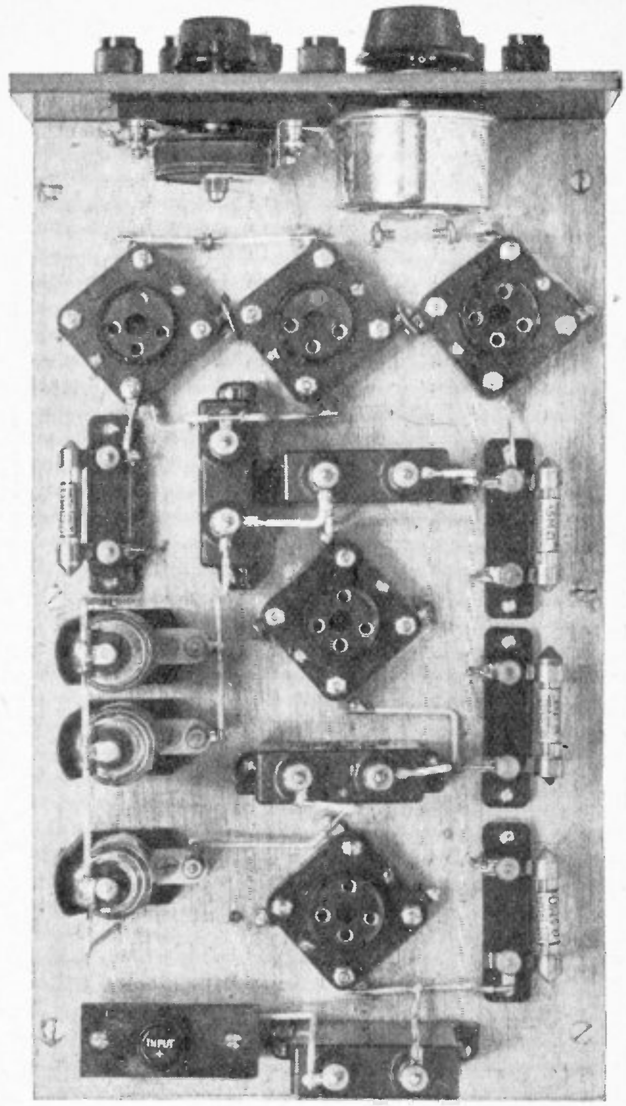


Dimensioned drawing of the front panel of the amplifier.

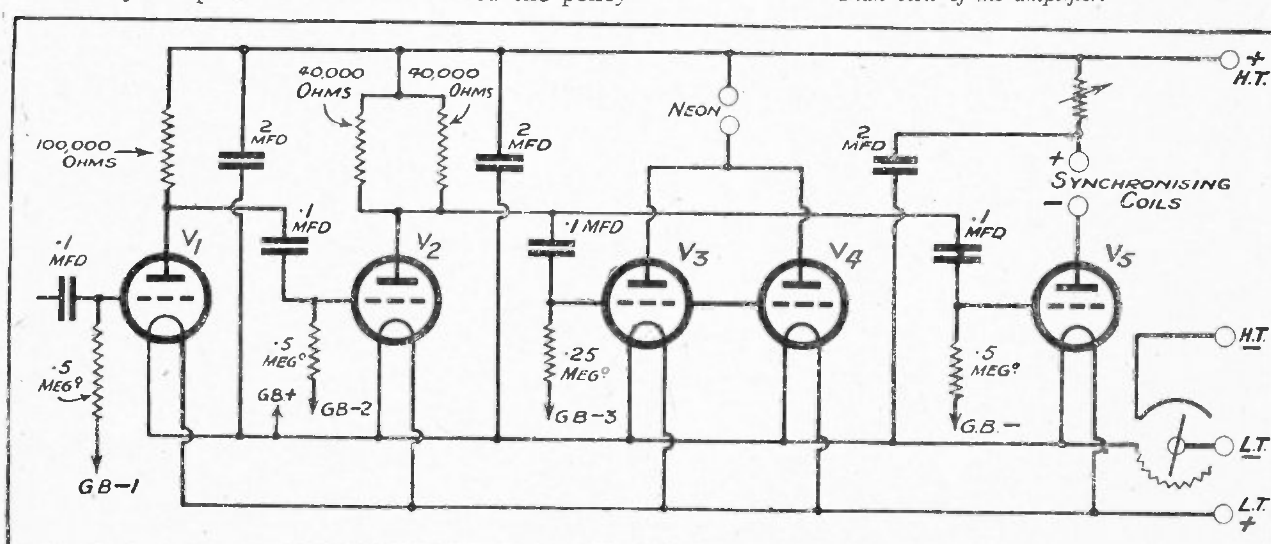
In order to meet requirements and make the amplifier "elastic" in its applications—and after all this is a sound policy when experimenting—the separate synchronising valve control has been included in the layout. Should the potential constructor feel disposed to omit it in his own apparatus, however, it will hardly effect the layout. Of course, there will be an economy in the number of components required, and this may prove advantageous according to the state of one's pocket at the time.

The Components Required

As you will see from the photographs and wiring diagrams, the layout is quite compact and the wiring in no way complicated. I have followed the policy

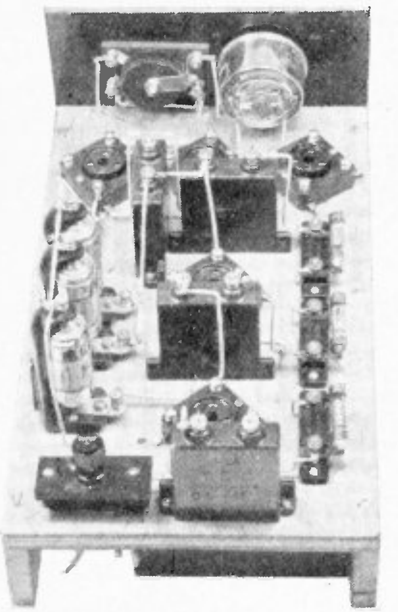


Plan view of the amplifier.



Theoretical diagram of the amplifier described in this article.

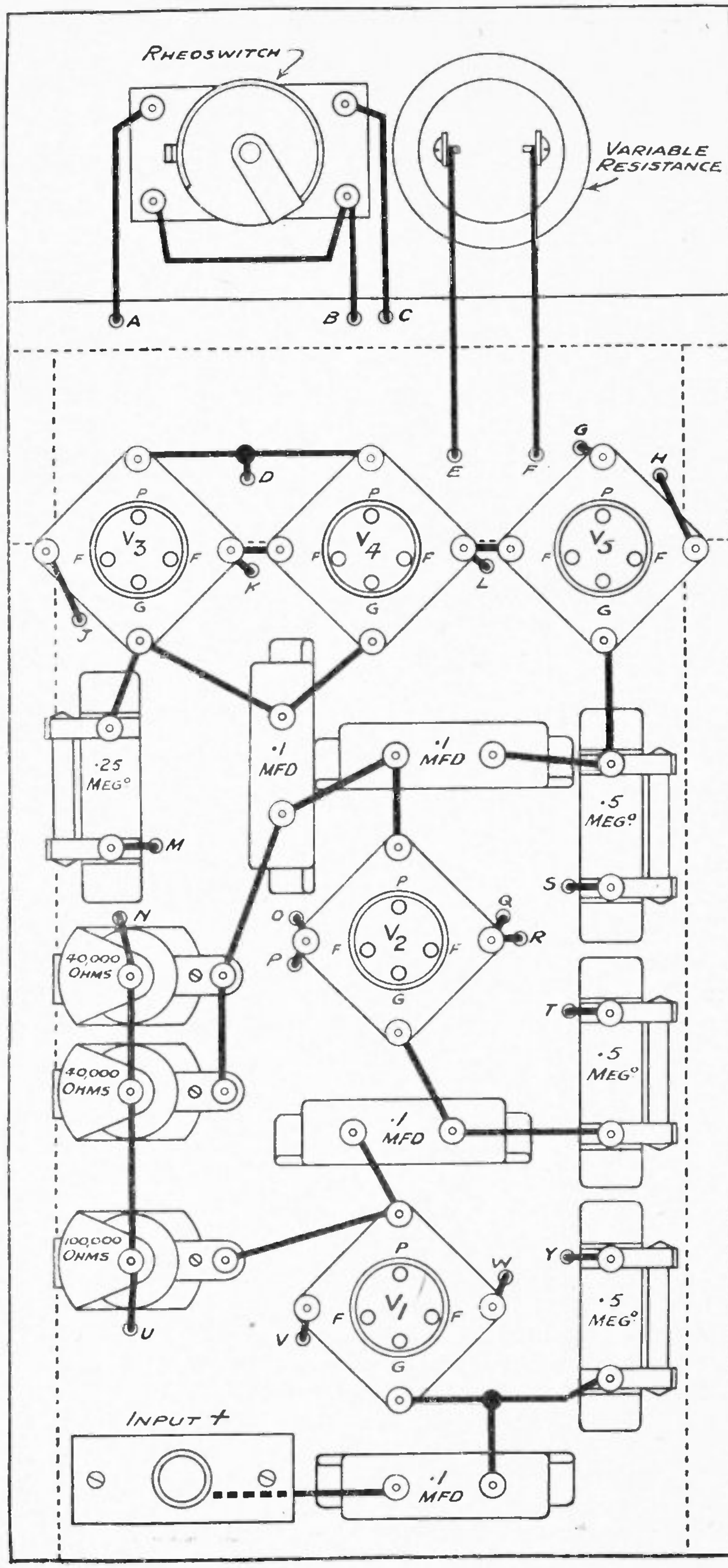
of splitting the wiring above and below the baseboard, as this will separate the leads and avoid confusion. Essentially, it is experimental in form but lends itself to a finished piece of apparatus should you desire to house it in a cabinet. A complete list of the actual components employed, together with the makers' names, is given in tabular form. Alternatives can be chosen, but be sure you use only those products marketed by manufacturers of repute, otherwise the working efficiency of your amplifier is sure to suffer. In addition, when substitutes are used ascertain first whether they will fit in on the baseboard and not foul other components. As to actual constructional work, little need be said about this for it is so straightforward.



View of baseboard and back of panel layout.

The Small Panel

The small ebonite panel can be marked out carefully from the Fig. 2 diagram and the necessary holes drilled. Countersink the screw holes so that the screw heads are flush with the panel face. Mount the twelve terminals in position, being careful to note exactly how they are placed and then add the variable power resistance and rheoswitch. Perhaps you may query as to why the filaments and H.T. are not switched on direct through the medium of a push-pull switch. As was pointed out, however, in the August, 1928, issue of TELEVISION in an article entitled "Essential Factors in High Power L.F. Amplification," heavy surges and other



Plan sketch of the amplifier (baseboard and panel.)

deleterious effects may take place in a high voltage amplifier if the plate potentials are applied or switched off suddenly under certain conditions. Through the medium of this particular type of switch the amplifier is rendered both operative or inoperative in just the right order, and I can recommend its use to all television fans.

The two battens should now be screwed in place on the baseboard and all components laid out exactly as indicated in the wiring diagram and photographs. Notice the input + terminal mounted on its own little ebonite strip. This is raised about $\frac{5}{8}$ inch from the baseboard by means of two ebonite distance-pieces.

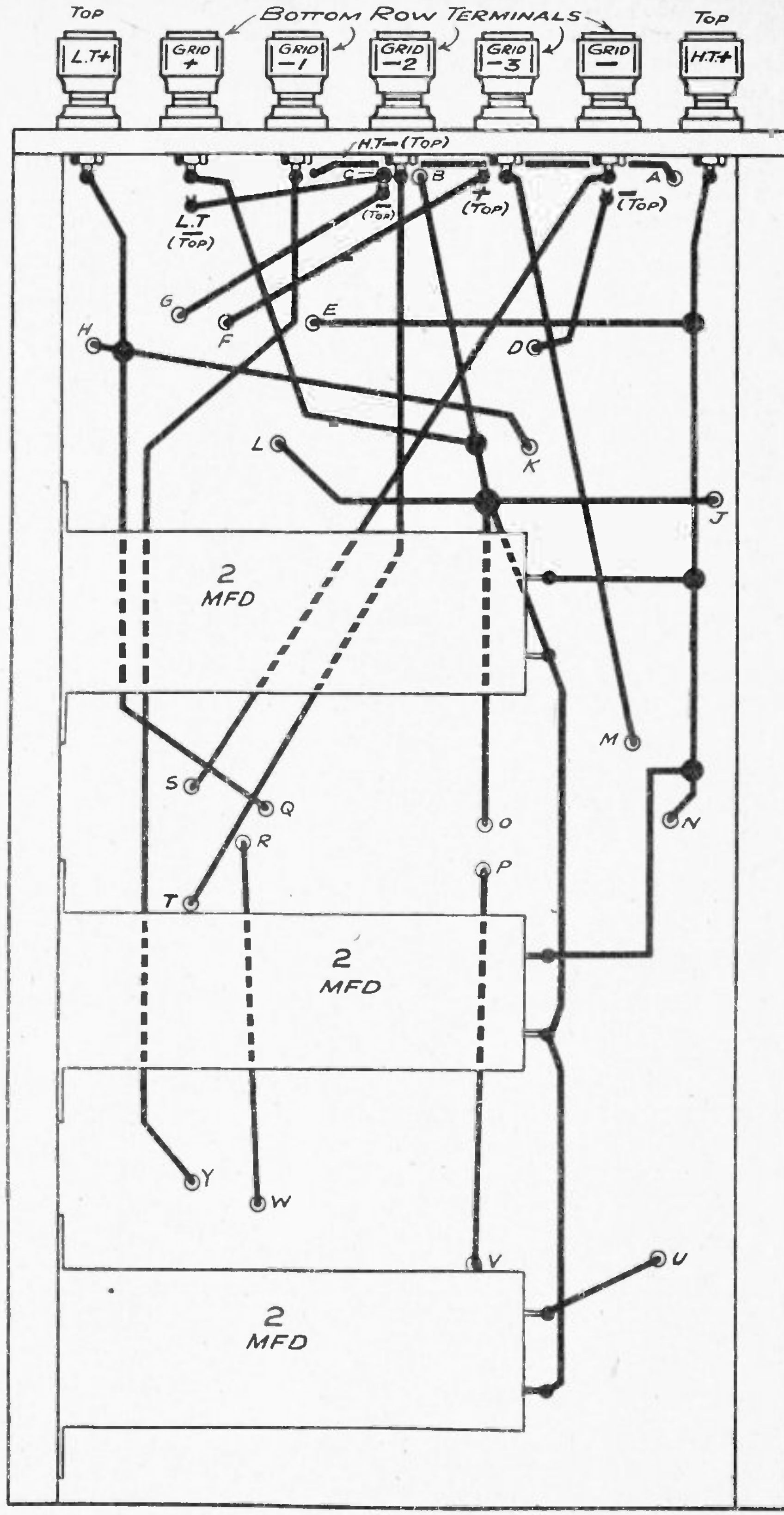
Starting the Wiring

Now proceed to carry out as much of the wiring above the baseboard as possible, following the diagram carefully for this purpose. Make neat right-angled bends where necessary, and if you are capable of using a soldering iron I strongly recommend soldered joints throughout. Failing this, loop all wires and screw down the terminal heads firmly. You will notice on the two wiring diagrams that the holes in the baseboard through which connecting wires have been passed are all lettered, and these should now be drilled and the small ebonite panel screwed into place.

The above and below baseboard wiring can then be completed except for the leads to the three large condensers. It is advisable to leave the wiring to all the grid bias terminals until last. Now mount the three large 2 mfd. condensers on one of the side battens as shown and add the remaining one or two wires. Be sure and check your wiring before attempting to use the amplifier, as a misplaced lead may ruin the valves when joined up to the battery supply.

Using the Amplifier

To use the amplifier I strongly recommend the employment of



Under baseboard diagram showing connections.

an anode bend detector unit without reaction for coupling on to the input side. This, of course, is on the assumption that you are within reasonable distance of Brookman's Park and get good signal strength under normal conditions. Failing this employ a high frequency stage and detector.

The same common L.T. and H.T. supply should be used for both units. If you are working without a separate synchronising valve then the ½ meg. grid leak and valve can be left out, but if this side of the apparatus is required, use an LS5A valve in the position. I have used for the first stage an LS5B with a 100,000 ohm plate resistance and ½ meg. leak, for the second stage an LS5 valve with two 40,000 ohm plate resistances in parallel (or one 20,000 ohm power resistance), and ½ meg. leak, and for the last stage an LS5A valve together with a ¼ meg. leak. Only one valve is suggested in this last stage to start with, but should a brighter picture be required then two LS5A's in parallel will meet the case.

The H.T. Supply

For high tension use about 320 volts and the appropriate grid bias according to the valve makers' suggestions; say 3 volts for the first valve, 7½ to 9 volts for the second valve and 18 volts for the last valve. Naturally, these values must be adjusted on test, striking a happy medium between the brightness and quality of the picture, together with the most economical working. If an H.T. eliminator giving a suitable output is available use this by all means, but failing that high capacity H. T. batteries serve admirably.

Remember always to switch off your valves before making any grid bias adjustments, as this will protect them against possible damage. I have had really first-class television results from the Brookman's Park transmissions with a total plate consumption of less than 25 milliamperes, so that it is quite erroneous to

COMPONENTS REQUIRED.

4	·1 mfd. mica coupling condensers. (Telegraph Condenser Co., Ltd.)
3	2 mfd. condensers, 500 volt test. (Telegraph Condenser Co., Ltd.)
5	Valve-holders. (The Formo Company.)
3	·5 meg Dumetohm resistances, with holders. (Dubilier Condenser Co.)
1	·25 meg. Dumetohm resistance, with holder. (Dubilier Condenser Co.)
2	40,000 ohm anode resistances, with holders. (Varley Co.)
1	100,000 ohm anode resistance, with holder. (Varley Co.)
1	Rheoswitch, type A. (A. F. Bulgin and Co., Ltd.
1	Universal power Clarostat. (Claude Lyons and Co., Ltd.)
13	Insulated terminals. Input +, L.T. +, L.T. –, H.T. –, H.T. +, two +, one –, G.B. +, G.B. –, G.B. –1, G.B. –2, G.B. –3. (Belling and Lee, Ltd.)
1	Ebonite panel, 7½" by 5½" by ¼", and one ebonite terminal strip, 2" by ¾" by ¼".
1	Baseboard, 13" by 7½" by ½", and 2 battens, 13" by 2" by ½".
	Quantity of Glazite Wire, Screws, Soldering Tags, etc.

(*Continued on page* 29.)

Brig.-Gen. Russell.

T*elevision*

The Germans have taken up television with characteristic thoroughness and energy. The German State Post Office has, so to speak, taken the chick under its wing, establishing a special department for experimental television and carrying out television transmissions twice daily by the Baird process. These transmissions are sent out from Witzleben (418 metres, or 716 kilocycles) daily from 9 A.M. to 9.30 A.M. and from 1 P.M. to 1.30 P.M., except on Tuesdays and Thursdays, when the morning television broadcasting is omitted and the time thus gained is devoted to radio instructional purposes for school children. These transmissions are occupied chiefly with tele-cinema, as it is considered in expert German circles, that for experimental purposes, this is the most profitable course.

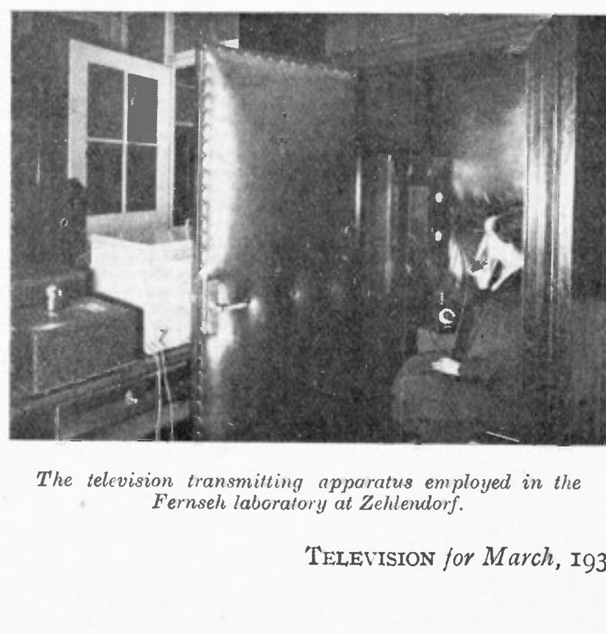
Witzleben's Range

The range of these transmissions from Witzleben is barely 100 kilometres, a fact which is deplored at Dresden, Munich and other important centres in Germany, but a more powerful broadcasting from Döberitz at an early date is foreshadowed.

A German Television Society has been formed, entitled "Allgemeiner Deutscher Fernsehverein" with a very strong technical committee of which the well-known Professor Dr. Leithaüser is Chairman, and Dr. Paul Goerz, the able Managing Director of the German sister concern of the Baird International Television Company, is a member.

This Committee also includes Dr. Banneitz, who controls with great skill the television transmissions and Experimental Department of the German Post Office.

An admirable monthly journal entitled *Fernsehen* (seeing at a distance) has been issued by this Society



The television transmitting apparatus employed in the Fernseh laboratory at Zehlendorf.

I WAS much pleased when I was recently entrusted with a mission to Berlin by the Baird International Television Company, Ltd., as, apart from the interest of the duties to be undertaken, this expedition gave me an opportunity of revisiting the scenes where I had acted as Military Attaché at the British Embassy during the four and a half eventful and anxious years which immediately preceded the Great War.

The last glimpse I had had of Berlin was in the bright sunshine of the morning of August 6th, 1914, when the Ambassador and Staff of the British Embassy, of which I formed part, furnished with the necessary passports and escorted by soldiers and police, left their headquarters in the Wilhelmstrasse in hired carriages to join the train for England. Two days earlier, when the news of the British declaration of war had leaked out in the evening, a howling mob had surged round the Embassy and had hurled paving stones through the windows.

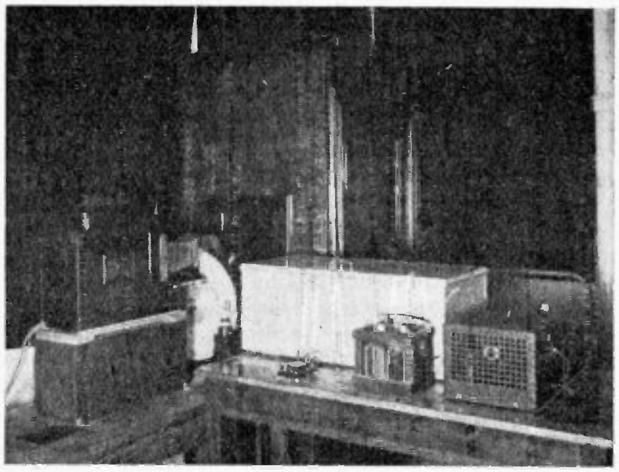
A Contrast

When I returned again after a lapse of nearly sixteen years, everything was peaceful. The snow was falling silently and the stately buildings of the city were enveloped in a thick mist. In the interval much water has flowed under London Bridge and much talk has hovered round Waterloo and Charing Cross Bridges and there has been a deal of conversation at Geneva and at Locarno and other pleasant places where politicians congregate. It will, however, be urged that the Great War has nothing to do with television. This is doubtless true, but it will not be possible to say the same of the next war (if there is one!) as the assistance of this great invention, amongst a host of other scientific developments, will certainly be required in the course of future hostilities.

in Germany

By

Brig.-Gen. The Hon. A. V. F. V. Russell, C.M.G., M.V.O.



Another view of the transmitter illustrated on the previous page.

since the beginning of this year, which is the counterpart of our own esteemed TELEVISION and to which reference has already been made in these pages.

In July 1929 a powerful company was founded in Germany which is known as " Fernseh A.G." This concern, under the chairmanship of Mr. David Loewe, is a combination of the Baird International Television Company, the Loewe Radio G.m.b.H., the Robert Bosch A.G., and the Zeiss-Ikon A.G., which includes the well-known Goerz optical firm. These German firms are all of European reputation and, from the nature of their products and on account of their high standing, form a combine of unrivalled strength for purposes of developing television.

Energetic Work

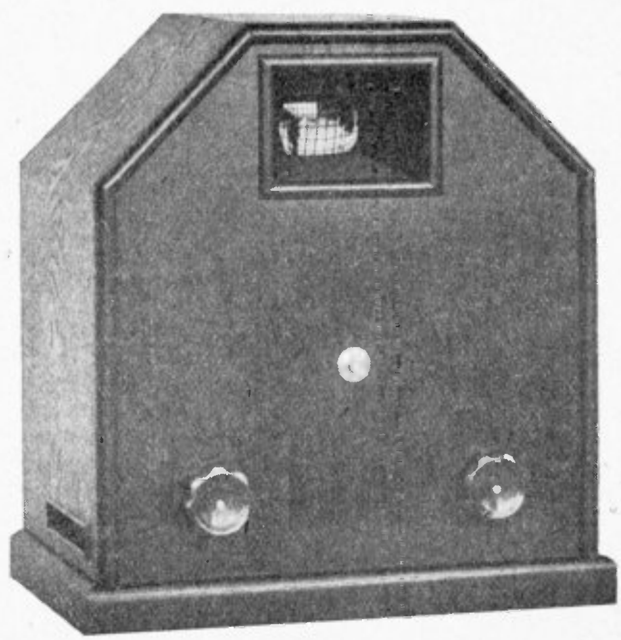
This German Company is working with energy and success, having thrown itself whole-heartedly into the business of developing television, under the skilful guidance of Dr. Paul Goerz, the Managing Director, who is very efficiently assisted by Mr. Möller, in his capacity as Chief Engineer.

The Offices and Laboratory of Fernseh A.G. are established in commodious premises on the top floor of the famous Goerz works, which are now combined with Zeiss-Ikon, at Zehlendorf, in the outskirts of Berlin, and are fully and admirably equipped for their experimental work. Any constructional work which cannot immediately be carried out in the laboratory can be effected in the most competent manner in the Goerz works below, where first-rate and extensive workshops exist.

The great interest taken by the German public in television is evidenced by numerous thoughtful and technical articles in the Press. A lecture was recently delivered in Dresden by Professor Dr. Leithäuser, which was crowded to the full capacity of the hall and was listened to with rapt attention. Fernseh A.G. had arranged for a demonstration of television to accompany the lecture, which was a complete success. Everyone present passed in front of the receiver and was able to inspect the transmitting arrangements. There is no doubt that the audience was profoundly impressed.

In the course of the discussion which followed the lecture, a number of questions were asked by members of the audience with regard to the television transmissions from London. These questions may be attributed partly to the fact that the London transmissions, unlike those from Witzleben, can be received in any portion of Germany, however remote from Berlin, and partly no doubt also to the further fact that, after all, England—or should we say Scotland—is the home of television.

(*Continued on page 29.*)



The televisor manufactured by Fernseh A.G.

Experimental Television Apparatus

By *A. A. Waters*

PART XI

IN previous articles of this series considerable space has been devoted to the construction of simple synchronizing apparatus of the phonic wheel type. The experimenter will do well to realise, however, that the degree of speed control which can reasonably be obtained from such apparatus is not very great, and hence it is a vital factor for success that the best obtainable motor should be used to drive the receiving disc.

Our recent experiments have shown that the plain bearings normally fitted to commercial motors are by no means ideal for television purposes, and that a very real improvement results from the replacement of these by ball races. Plain bearings have to be kept well oiled, and, owing to the change of viscosity of this oil with temperature, it becomes necessary to run the motor for perhaps half an hour before its speed becomes really steady enough to give the synchronizing device a fair chance of success. Apart from this effect, any reduction of frictional resistance is always well repaid in that it renders the problem of synchronization easier of solution.

The standard G.E.C. motors which we have recommended in these designs are not fitted with ball bearings, and although motors so fitted are obtainable from the above and other makers, their prices are somewhat excessive.

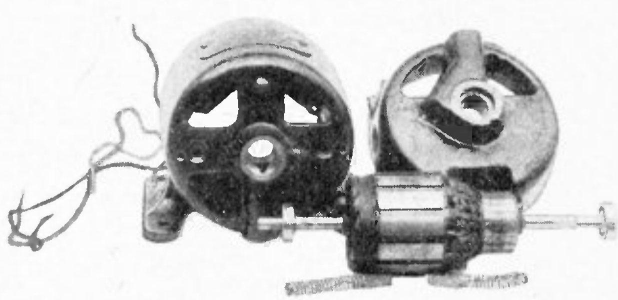
Consideration has shown, however, that it is quite a practicable proposition to fit ball races to the cases of existing motors, and it is hoped that a few details of the methods employed will be helpful to those of our readers who have invested in this type of motor.

The first step in carrying out this alteration is to remove the brushes from the motor casing, and to unscrew the two securing bolts which hold the two halves of the casing together, when these two halves can be slightly separated. The wires connected to the brush sleeves can then be removed, an easy process, because these wires are merely slipped over the sides of the sleeves by means of tags, and no unsoldering is necessary. The bushes should next be removed, this being accomplished by the removal of the $\frac{3}{8}$-in. screw at the base of the oiling system, and a further screw at the base of this $\frac{3}{8}$-in. hole. The latter screw holds the brush in position, and after its removal the bush can be removed with a little persuasion.

The next operation is that of boring out the bosses to take the ball races, and must, of course, be carried out on a lathe. The photograph (Fig. 1) shows how this is best accomplished. The casing is set up on a face-plate, assuming that the machined part of the casing is true with the existing bore. A mandrill should be employed to facilitate trueing up before boring is commenced.

The ball races used are a product of S.K.F., and their type number is EE2AJ. A dimensional diagram is given in Fig. 2, from which it will be seen that the races are $\frac{1}{4}$-in. in bore, and that it will therefore be necessary to reduce the diameter of the armature spindle to this extent. When reassembling the casing it will be found necessary to cut off a portion of the old bush, and to replace it at the back of the ball race at the commutator end of the motor. This is done to prevent dust from the carbon brushes reaching the ball race.

Should any of my readers have difficulty in getting this work carried out, I would advise them to apply

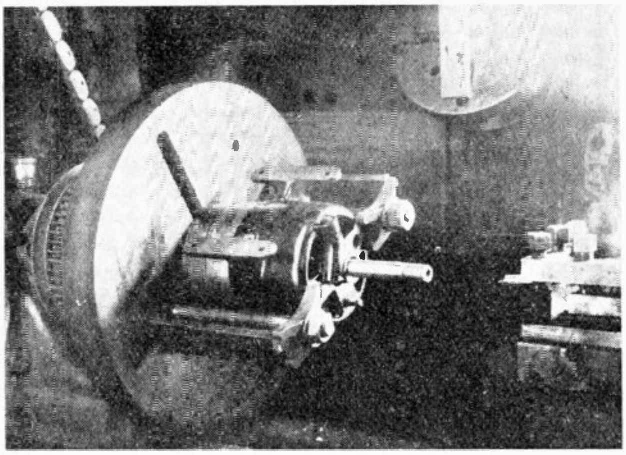


The dismantled Motor.

to the firm who did my own motors, Messrs. O. Field, Engineers, Althorp Road, Luton, Bedfordshire. I think they would be well satisfied with the improvement resulting from the alteration, which might be stated as at least 20 per cent.

Suitable Receivers

Leaving now the consideration of motors, I have been impressed recently with the unsuitability of the receivers which many experimenters are using for



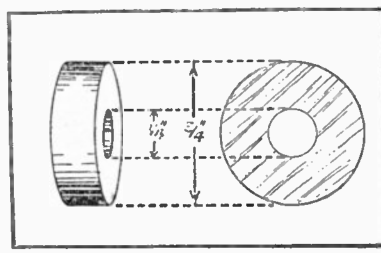
Boring out the bosses to take the ball races.

the reception of television transmissions. Hence, I am including in this article circuit details of the receiver which we have found suitable for this purpose. The set comprises a single screen-grid stage of high frequency amplification, detector, and a three-stage resistance-capacity coupled amplifier, employing two super-power valves connected in parallel in the last stage. This arrangement should prove powerful enough to give good television reception from the London Regional Station in most parts of the country, provided a good outside aerial is used at distances greater than about eighty miles, and that local interference or fading is not experienced. The use of a second screened-grid stage might be necessary, however, at distances exceeding 250 miles or so.

The radio frequency portion of the set is in no way unique, being in fact copied almost exactly from the detector and high frequency stages of the well-known Ferranti S.G.IV. receiver. This was done in order to make use of readily available coils and components, and to reduce the time taken in design; it has proved perfectly satisfactory. Of course, any special precautions in the way of selectivity, necessitated by local conditions peculiar to the experimenter's own situation, must be incorporated in a set used for television reception, as would be done in ordinary broadcast work. From the radio frequency point of view the two problems are exactly similar.

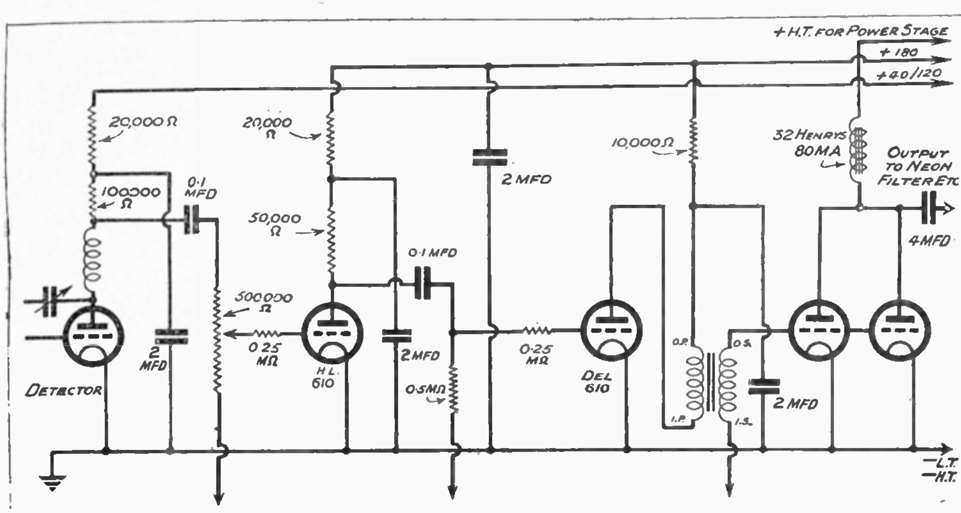
Turning to the low frequency side of the set, however, rather more care is desirable in its design than is frequently found in broadcast receivers, since the characteristics desired are not quite the same. In particular the use of transformer coupling is not in general satisfactory, although often excellent in the reproduction of speech or music. This is due to the introduction of phase relationship alterations which are apt to occur through the use of transformers, and have a very detrimental effect on television results, although unimportant in audible reception.

It is quite good practise to employ one transformer or dual impedance coupling between the power stage and last L.F. stage, since the difficulty of grid paralysis in the power valves (which is such a source of trouble when R.C. coupling is used to feed large power valves which exhibit the effect of secondary grid emission) is thereby overcome. The effect referred to is caused by the accumulation of a positive charge on the valve grids due to secondary emission, which is unable to escape fast enough through the relatively large grid leak resistances used in R.C. coupling, unless this resistance is reduced to a point at which amplification suffers seriously. This naturally has an effect similar to that produced by the use of insufficient grid bias, and causes apparent over-loading and consequent distortion. Luckily, only certain large dull emitter power valves are subject to this effect; but when it occurs the low resistance path provided by a transformer secondary effectively cures it.



Dimensional diagram of the ball race.

The detrimental effect due to the use of several transformers in a television receiving apparatus is not so pronounced as theory and experiment would suggest, although it can be readily detected, and the writer is inclined to suspect that some distortion of this type has already occurred in the modulating circuits of the radio transmitter where iron-cored transformers are customarily employed. Hence the additional defects



Circuit diagram of the amplifier.

introduced in the receiver do not appear in their true proportions, since the bulk of the damage may already have been done. However this may be, such distortion is much more apparent when receiving a locally generated television transmission, in which case the use of transformer coupling is often fatal.

For this reason primarily resistance-capacity coupling has been used throughout the amplifier described here. The values of the components chosen, after the usual considerations of uniform frequency response had been taken into consideration, are given in the accompanying diagram of connections. Care must, of course, be taken to maintain the amplification of the extreme high and low frequencies, which are even more important in television than in audible reception.

The use of a liberal power stage is necessary in order to operate synchronizing apparatus in addition to the neon tube. If only a neon tube is to be used, good results can be obtained from valves of the P625 class, operating on about 200 volts H.T. The larger class of valve, such as the LS5A or LS6A, used with 300 to 450 volts H.T. is desirable if a phonic wheel has also to be actuated from the same amplifier. The use of a separate power stage to feed this device can be recommended, as was suggested in a recent article in this journal, and this system has the advantage that since neither stage has to handle as much power as one required to perform both functions simultaneously, lower H.T. voltages will suffice in each case. The experimenter should remember, however, that a home constructed phonic wheel will require considerably more power for its successful operation than can be obtained from an average set, and, in particular, will require more power than is needed to give good results from a neon tube.

This amplifier can be used for many purposes for which the push-pull amplifier described in detail in an early article of this series was intended, but it must be remembered that the total amplification given by the R.C. coupling is less than that obtained in the first case, and therefore an additional stage of amplification will be necessary if it is to be used for shadowgraph or simple television transmission experiments. The results obtained will be superior in most cases, however, and the use of R.C. coupling is well worth while on this account.

I would warn intending constructors that the quality of reproduction given by this amplifier when used for broadcast reception may not come up to the standard given by the original push-pull arrangement, which has characteristics better suited to the average loud speaker, although the results will easily surpass those often heard. The total amplification is also quite excessive for this purpose.

The other day a lady arrived in Savoy Hill, asked for her favourite announcer, and tried to carry him off in an aeroplane. The poor girl should have waited for television.

* * *

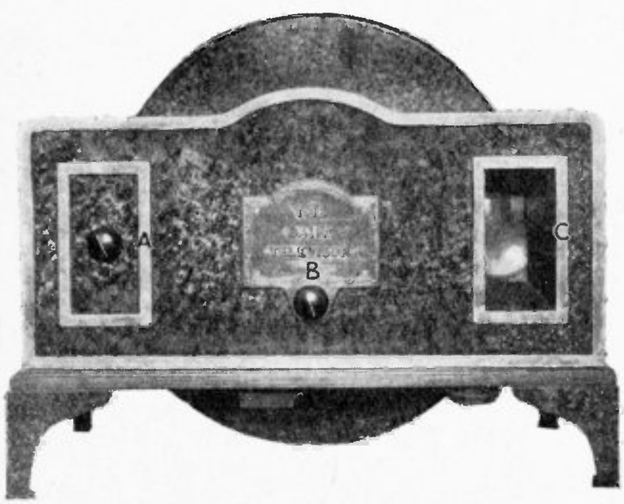
"Before the advent of radio, millions of people lived and died without hearing a sovereign." Television may help us to see a golden one.

Sydney A. Moseley on Good News

I AM able to announce several items of good news to readers of TELEVISION this month. In the first place here is the definite date when the second wave length is to be placed at the disposal of the Baird Company by the B.B.C. That date is March 31st. Put it in your note-book, as it marks a red-letter day in the history of television.

We move slowly but surely. Television, like any other science, needs patience and trust. The fact that we are not only maintaining our band of followers, but are actually increasing its numbers, has always been of the happiest augury, and has encouraged Mr. Baird in his darkest moments; and now television comes into its own. For while it is true that the one wave-length has been used to excellent purpose for the past five months it is equally true to say that without the second wave-length the story was only half told. To use a simile that we may have heard before, and which we will no doubt hear again, television without its aural sister is like a modern film without a "talkie."

On March 31st, therefore, and afterwards, the redoubtable band of experimenters will not only see but hear. Recently, as Mr. Bradley, the Studio Director, points out in another article, there have been some interesting experiments in putting over a series of character studies, head gear and period dress, and Mr. Bradley has been able to show lookers-in how easy it is to recognise National portraits. Now these images will be able to talk to you. March 31st! Do not forget!



The commercial Baird "Televisor" Receiver now on the market.

And that is not the only news. Simultaneously with this announcement comes the news that the first "Televisors" are now actually on sale. What a long fight it has been, but only those who have been in the inner councils realise the obstacles, and the heart-breaks that are attendant upon any epoch-making venture of this character.

It is, of course, a tremendous step to go from the laboratory into the world of commerce. Where it is possible to supervise and make perfect a score or so sets under one's own immediate superintendence, it is another matter when you come to deal with hundreds and possibly thousands. But to cut a long story short, and without detailing the extraordinary and inevitable difficulties to which the first venture into the commercial field was exposed, I am able to say that the first hundreds of "Televisors" have been placed successfully on the market, and these hundreds are rapidly growing each week.

Now comes the time when the amateurs of this country will be able to work in co-operation with the laboratories at Long Acre. Mr. Baird tells me how greatly he is looking forward to hearing the results from those who will be co-operating with him in this fashion. The picture of the commercial "Televisor," which is reproduced on this page, represents the decision of a committee that examined a number of

(Continued on page 41.)

The Nature and Properties of Light

PART III.

By *H. Wolfson*

IN the two previous articles it has been shown that light consists of waves of extremely short length, moving in a medium which we call the "ether," with a velocity of 186,000 miles per second.

In the present article I shall endeavour to explain some of the properties of this wave motion, light, and will start with the subject of polarisation, since use has been made of this phenomenon in connection with various systems of television, phototelegraphy and talking-picture recording.

Ordinary light we imagine to be a wave motion vibrating in every possible plane, at right angles to the direction of transmission. It is possible by various methods to cut out the majority of these planes of vibration, leaving one plane only, and the light which is obtained is called "plane polarised."

The simplest method of polarising light was discovered in 1808 by Malus, who found that if light is reflected from the surface of a piece of glass it became polarised. Three years later, Brewster carried out a series of experiments, to determine the conditions under which light becomes polarised by reflection from the surface of various media. He found that light is almost completely polarised in the plane of incidence when it is reflected at a particular angle which he termed the *angle of polarisation*. Further, he was able to enunciate the law that "the tangent of the angle of polarisation is equal, numerically, to the refractive index of the reflecting medium." In other words, we can say that $\tan i = \mu$, where i is the angle of incidence, and μ the refractive index of the reflecting surface.

Now, Snell's law states that the refractive index of a medium is equal to the sin of the angle of incidence divided by the sin of the angle of refraction, i.e. $\sin i / \sin r$. By trigonometry, we can show, $\tan i = \sin i / \cos i = \mu = \sin i / \sin r$.

Therefore, $\cos i = \sin r = \cos (\pi/2 - r)$.

Hence, $i = \pi/2 - r$, and $i + r = 90°$.

That is to say, the angles of reflection and refraction are at 90°, that is, at right angles. This is illustrated in Fig. 1.

The refractive index of a substance depends on the wavelength of the incident light, and it follows in accordance with Brewster's law that substances will possess different angles of polarisation according to the different components of the light, and polarisation will only be complete for one particular wavelength. Experimental enquiries have shown that Brewster's law is obeyed in practice, so long as the reflecting surface is absolutely clean. Lord Rayleigh used a water surface, which was freed from contaminating dust particles, etc., by blowing air along the surface.

With a single glass plate, the greater portion of the light is transmitted, and the light reflected at the polarising angle is very faint. This defect is overcome by using a pile of plates, and Stokes showed that about 90 per cent. of the incident light is reflected at the polarising angle from a pile of 24 plates. Further increases in the number of plates yielded no material advantage.

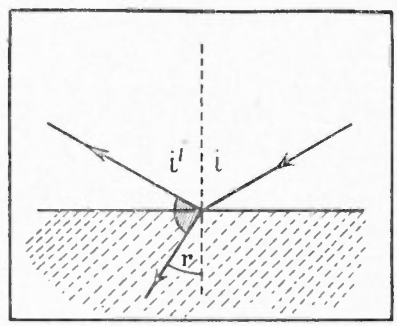


Fig. 1. *Illustrating Brewster's Law.*

NOTE.
Angle i = angle i', $\sin i / \sin r$ = refractive index of medium.

For those who wish to perform experimental work, say, with a Kerr cell, of which mention will be made later, the description of a pile of plates polariser, which can be constructed for a few pence, will not be out of place.

Procure a number of microscope cover glasses of thickness No. 30 and place a suitable number, say 3, or so, in a cardboard tube, of such a diameter that the cover glasses are inclined at an angle of 33° to the axis of the tube. A couple of corks with clean bored half-inch holes should be cut at the same angle, and used to clamp the glasses in position. If two similar piles are made, the reader will have at his disposal a very efficient polariser and analyser, costing but a fraction of the price of Nicol prism apparatus.

In the year 1669 Erasmus Bartholinus discovered that a ray of light, incident on a crystal of calcite, instead of being refracted according to the ordinary law, forms two refracted rays, one of which does not lie in the same plane as the incident ray and the normal to the surface. This is termed the *extraordinary ray*, to distinguish it from the ordinary refracted ray. Calcite is a form of calcium carbonate, $CaCO_3$, also known as Iceland spar, since it occurs in great transparent crystalline masses in that country. Its shape is that of a rhombohedron, bounded by six similar parallelograms with angles of 101°, 55′ and 78° 5′. I have attempted to draw this crystal in Fig. 2. The two opposite angles, *a* and *b*, are contained by three obtuse angles while the remaining solid angles comprise two acute and one obtuse angles. The line joining *a* and *b*, and any line parallel to it, is the *axis of the crystal*.

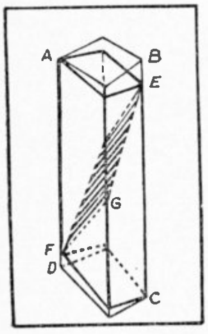


Fig. 2.
Construction of a Nicol Prism.

These crystals are easily obtained from mineral dealers and chemical suppliers, though really perfect ones are few and far between unless a big price is paid.

If such a crystal be placed over a black dot on a sheet of paper, the formation of two images will be noted, and on rotating the crystal, one image, viz., the extraordinary, will rotate also.

Before dealing with the theory of polarisation or of double refraction, we will discuss the construction of the Nicol prism of which we read from time to time in various connections. In Fig. 2 the crystal end faces *AB* and *DC* of the calcite are inclined at an angle of 71° to the edges *AD* and *BC*. The crystal is cut at right angles to the principal section, so that the faces *AE* and *CF*, inclined at 68° to *AF* and *EC*, are formed. The prism is then divided into two parts by the cut *EGF*, and the two surfaces are then ground flat, and carefully polished. They are then cemented together by a thin film of Canada balsam, whose refractive index is 1·55. This value of refractive index is intermediate between the values for the ordinary and extraordinary rays in calcite, and the result is that the ordinary ray, if the light is incident on the blasam surface at the correct angle, can be reflected to one side and only the extraordinary ray will be transmitted. Hence the elaborate method of cutting the crystal, to which I have just referred. In Fig. 3 I have shown the path of the rays through the crystal. The incident ray is shown at *HK*, and this divides into the reflected *ordinary* ray *KO* and the transmitted *polarised* ray *KMN*.

The mechanism of polarisation is most easily grasped by means of an analogy. Suppose that the planes of vibration of ordinary light are represented by a number of sticks, of equal length, for convenience, which are all jumbled together, and point in every conceivable direction, and suppose that we try to drop these through an arrangement consisting of a box with parallel equidistantly spaced bars in place of a solid bottom. It is easy to see that only those sticks in a direction parallel to the bars would fall through, the others being retained by the bars.

We imagine the polarising crystal to act in much the same way. The crystal is built up of a lattice, the distance apart of the layers being something of the order of the wavelength of light. On passing ordinary light, with its infinite number of vibration planes, through the crystal, only that part which vibrates in the correct plane will pass through. If, now, a second filter arrangement be placed below the first, with its bars at right angles to the bars in the first box, it is obvious that those sticks which succeeded in passing through the first box will fail to pass through the second. This part of the analogy explains how the placing of a second Nicol prism, with its axis at right angles to the first, completely extinguishes the light passing through the system.

There are a large number of substances, mostly liquids and solutions, which are capable of rotating the plane of polarisation of the light. We speak of these substances as optically active. Some turn the plane of polarisation to the right, and are termed dextrorotatory, while those which turn the plane of polarisation to the left are called lævo-rotatory. A solution of cane sugar forms a good example of a dextro-rotatory substance, and its specific rotation (i.e., the amount of rotation which would be produced by a solution containing one gram of substance in one cubic centimetre of liquid, and contained in a length of one decimetre) is 66·5°. If a solution ten times as weak were substituted for this, the rotation would be only one tenth as great, viz.,: 66·5°. Also, if the length of the column is changed, the rotation will increase or decrease directly as the length of the column.

While discussing the rotation of the plane of polarisation mention might also be made of the Kerr cell. This was discovered about 1875, by the English physicist, Dr. Kerr, and consists simply of a glass cell, containing either carbon disulphide or nitro-benzene. The latter chemical is to be preferred, on account of the nauseating smell of carbon disulphide. If, now, an intense magnetic field be applied to the cell, it will be found that it hasthe property of rotating a beam of polarised light.

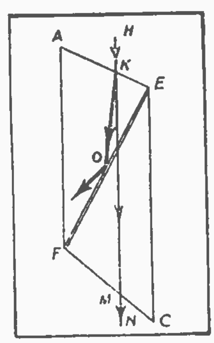


Fig. 3.
Section view of Nicol Prism
Reference letters as for Fig. 2, see text.

The amateur can test this for himself, making use, however, of slightly different technique. In place of the intense magnetic field, an electric field, which, as we know, is very similar, is made use of. Two clean, well-polished metal plates are immersed in the nitro-benzene, and their terminals connected to the output of, say, a three-valve amplifier, such as is used for television. The cell is placed between two Nicol prisms, or two polarisers of the type described above for home construction. The polarisers are arranged initially so that no light is passing through. The light source can be a pinhole illuminated by an electric lamp or torch. On switch-ing on the output from the amplifier it will be observed that light is now able to pass through the system.

An interesting experiment, but one which I have been unable to try at the moment, would be to feed the cell with television signals, either received from the B.B.C. transmissions of Baird television, or from a simple televisor, such as has been described in this magazine. The light which succeeds in passing through the apparatus is allowed to fall on a spiral receiving disc in place of the neon lamp, and with reasonable care, it should be possible to receive black and white television images. The higher the plate voltage on the last stage of the amplifier, the more likely is the experiment to be a success.

The Kerr cell is being used at the present day in the Klangfilm-Tobis apparatus for sound film recording. The principle is exactly as stated above. Sound is picked up by a microphone, and the electric current so produced is passed to a powerful amplifier, and thence to the plates of the Kerr cell, which is situated inside the recording photographic camera. The light reaches the film through a narrow slit, and is photographed as a "ladder" or variable density record, the width of which is between 70 and 80 mils. (A mil is a thousandth part of one inch.)

We now come to the most difficult part of the topic which we are discussing, namely, circular and elliptic polarisation. We have already seen that in the case of calcite there is one particular plane which we term the optic axis, in which all waves are transmitted with a uniform velocity. In any other plane there are two distinct wave velocities, giving the ordinary and extraordinary rays, polarised perpendicular to one another. The same is true of quartz and a number of other crystals, and these, as a class, are termed *uniaxial*. There is another class of crystal in which there are two separate and distinct directions of uniform single wave velocity. These directions are the optic axis, and the crystal is said to be *biaxial*.

If a plate of a uniaxial crystal be cut parallel to its optic axis, it is found that no separation is produced when a ray of light strikes it normally. The velocities of the ordinary and extraordinary rays are equal to $(V/\mu_o=v_o)$ and $(V/\mu_e=v_e)$ respectively, where μ_o is the refractive index of the crystal for the ordinary ray and μ_e the extraordinary refractive index. The vibrations of the ordinary ray are perpendicular to the optic axis, and those of the extraordinary ray are parallel to the axis of the crystal.

Suppose the incident ray to be polarised, and to have an amplitude a, and that it makes an angle θ with the principal plane, i.e., the one containing the normal and the axis of the crystal, we can write down, from a knowledge of Malus' work, that the amplitude of the ordinary ray is $a \sin \theta$, while that of the extraordinary ray is $a \cos \theta$. These two amplitudes will always be unequal, unless the angle is 45°. During transmission through the plate of calcite, since the velocities and amplitudes are different, an ever-increasing phase difference will be introduced. We have here conditions suited to the combination of two simple harmonic motions at right angles, which, though of the same period, differ in amplitude and in phase.

The result of this combination is to produce elliptic polarisation, and, in the limiting cases, circular and linear polarisation. This limiting case is easily realised from a knowledge of conic sections, a circle being produced when the major and minor axis of an ellipse become equal to one another, and a straight line resulting from the one axis disappears altogether. In Fig. 4. some examples of the composition of two S.H.M.'s at right angles, which differ in phase by $\pi/4$ each time. Any crystalline plate which changes the phase difference between the two rays by $\pi/4$ is termed a *quarter-wave plate.*

In order to detect circularly polarised light, which is made up of two perpendicular vibrations differing in phase by $\pi/2$, we must resolve it by means of a Nicol. This is, in itself, insufficient, as one ray only is transmitted, the other being totally reflected by the balsam layer. A rotation of the Nicol thus produces no alteration in the intensity of the ray passing through the system. This is a feature of similarity between circularly polarised and ordinary light. If, however, an additional phase difference of $\pi/2$ be given to the circularly polarised light, the components of the circular motion will differ in phase

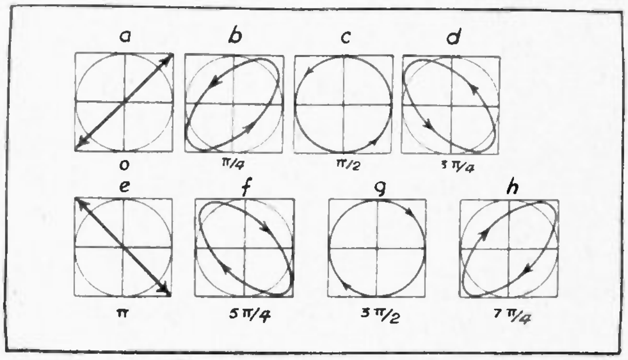


Fig. 4.

Composition of Simple Harmonic Motion at right angles. Phase differences as shown.

by O or π, and a single rectilinear vibration will result. If this is examined by means of a Nicol it will bef ound that the light will be extinguished on rotating the Nicol so that its principal section is perpendicular to the direction of the rectilinear vibration.

Elliptically polarised light, when examined by means of a Nicol prism, resembles a mixture of plane polarised and unpolarised light. On rotating the prism, the intensity of the light alternately increases and decreases. The distinction between the two is achieved by the use of a quarter-wave plate, but it is unnecessary to enter into this here. The intensity of light transmitted through the Nicol is a maximum when the principal plane of the Nicol is parallel to the major diameter of the ellipse.

Next month we shall proceed to a discussion of interference effects, and later on I shall deal with the subject of diffraction.

Behind the Scenes with the *Baird Studio Director*

By *Harold Bradly*

Mr. Harold Bradly.

IN this article I propose to give you a general impression of the work that is being carried on at the Transmission Studio in Long Acre, and the part it will play in the future of television. Experiments we have recently made have gone to show the great possibilities of this new branch of scientific entertainment. The enthusiastic reports we continue to receive commenting upon the results obtained by " lookers-in " have conclusively proved this.

Subjects of all kinds, character studies, etc., have been " put over " the " ether " with a purity of finish and detail that is little short of amazing.

Synchronisation of sound and movement go hand in hand. Those people whose business it now is to appear before the transmitter are able to do so without the discomforting heat or glare of the modern Sound Film Studio. Their " image," too, is certainly more faithfully reproduced without the use of make-up, and, ladies please note, the use of lip-stick and rouge is discouraged. It will be seen, therefore, that the colour red is never used during our transmissions, the reason for this being that light is composed of various colours and the predominant one is red and infra-red, and these striking a red surface are reflected much more than are those of other colours; thus the " tone" becomes too light or indefinite. At present our artistes are drawn from the staff at our Head Office, typists, engineers, and so on, and we have to thank them for the keen efforts they have displayed in this direction.

When, later on, we produce plays, every act or scene will be transmitted in perfect sequence. This is a distinct advantage over a talkie or silent film, where sections of a story are " taken " in the particular " setting " to which they belong. This always presents difficulties to the artistes, as it necessitates breaking up the sequence of the character they are portraying.

Our broadcast experiments even now are being flashed across the " ether," the subjects being instantaneously reproduced on the receiving instrument.

Looking ahead, is it not possible to visualise on the screen of your " televisor " at home a famous character such as Stephen Donoghue, arrayed possibly in his jockey's silk, telling you all about some of his sensational Derby victories? Or a great political figure making an historic speech? Of Abe Mitchell teaching us the correct swing of a golf club. Of thrilling sporting events, plays and great functions.

There opens up before the imagination an intriguing vista of wonderful and potential significance. Cannot one well imagine what a prolific source of production television is bound to attain.

Shadows

Their Effect upon the Appearance of Objects

By *Cyril Sylvester*, A.M.I.E.E., A.M.I.Mech.E.

MY recent series of articles in this journal on "Light—The Essential of Television," has brought me many letters from readers who have been experimenting with the illumination of objects by means of artificial light. Difficulties have been experienced chiefly in the production and elimination of shadows; shadows which are essential for objects to be seen in their three dimensions. To those unacquainted with the principles of light projection, it is no easy matter to illuminate an object so that its shape and details can be clearly seen. A few words on this subject will assist those who are studying the artificial illumination of objects as applied to television transmission.

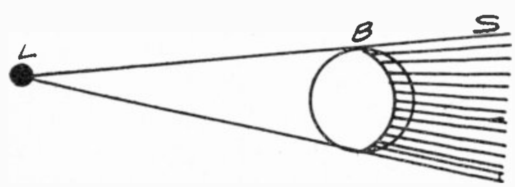


Fig. 1.

The production of shadows of the right quality is an essential. A bare light source must produce shadows by virtue of the fact that, relative to an object, it is what may be termed a luminous point. This is illustrated in Fig. 1, where *L* is a bare light source, *B* is an object, and *S* is the resultant shadow. The latter is the result of the interception of light rays by *B*. The object, *B*, will appear in light and shade to an observer according to the position from which it is viewed. If seen from the front an effect of light and shade is apparent; from the light source side the object will appear flat but very light; if seen from the shadow side it will also appear as a flat surface, but dark.

The density of the shadow will depend upon the intensity of the light source, and upon the reflection factors of the objects in the vicinity. I would point out that we are dealing with a bare light source and not with a lighting unit with a reflector which can be adjusted to produce, within certain limits, light of various intensities. If, therefore, the shadow is too dense, it can be lightened so that the proper effect of light and shade is obtained by merely "bending" back on to the shadow side of the object some of the light rays which are passing by the object into space.

This is accomplished through reflecting media as illustrated in Fig. 2. Here two sheets of paper are placed at certain angles so that some of the light rays are intercepted and redirected on to the back of the object. The quantity of light redirected in this way will depend upon the reflection factor of the material used; here it many be said that the experimenter has ample means of controlling the intensity of the redirected light to very fine limits. The reflection factor of white paper, for instance, is 84 per cent., that of grey 70 per cent., buff 60 per cent., tan 28 per cent. and cardinal red 16 per cent. The use of proper reflecting media should result in the production of shadows of the correct intensity.

This, up to the moment, is fairly simple. The matter becomes more complicated when more than one object is to be illuminated from one light source, and when reflectors are used to collect the light rays. In the lighting of objects the latter is most necessary; otherwise the majority of the light rays, which emanate from a bare light source into space, would be wasted.

When a light source is controlled by means of a reflector it is no longer a luminous point; it becomes a luminous body. The effect upon an object is illustrated in Fig. 3. Here it will be seen that a cone of shadow is produced as before, but it has two densities; these are known as the umbra and penumbra. The umbra is the central shadow and the penumbra is the partial

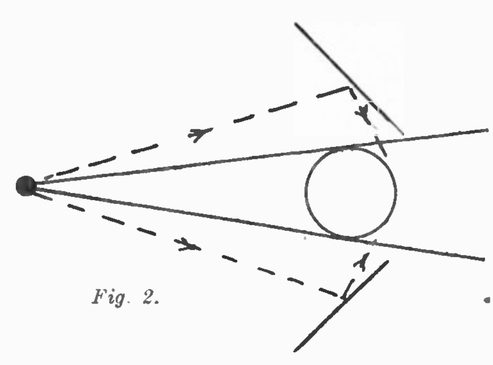


Fig. 2.

or outer shadow. The luminous body is visible from any part of the penumbra, but the density of the latter is not the same over its entire area. Towards the fringe the shadow is very light, but as the outer boundary of the umbral cone is reached it becomes very dense.

Now if an object is placed in the shadow it will be illuminated with two intensities of light; this since the shadow has two densities. But these intensities are very low, so much so that if the object is one of detail, much of the latter could not be seen. Here

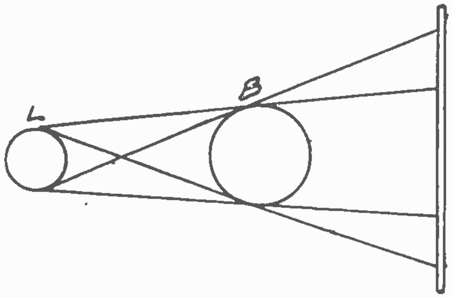


Fig. 3.

there are two methods which can be adopted to enable the second object to be clearly seen; one is to increase the area of the luminous body, and the other is to illuminate the second body through the medium of a separate light source. This accounts for the use of multiple lighting units in film studios; units which can be focussed to produce various intensities of light, and which can be moved so that light can be projected in any direction.

In an installation which is to illuminate every object perfectly, lighting units of various shapes and sizes must be employed. Variation in intensity of light on various objects is an important factor; that is, two objects situated at different distances from a light source will be illuminated at different intensities. This variation is considerable, since the intensity of light is not proportional to the distance of the light from the object, but to the *square* of the distance. This variation in intensity not only affects the quantity of illumination on the objects but also the density and shape of the shadows. It is, therefore, possible for two objects of the same size and shape to appear different when illuminated by the same light source. In one case the object would appear to be perfectly illuminated; in the other it would be shapeless—clear evidence of bad illumination.

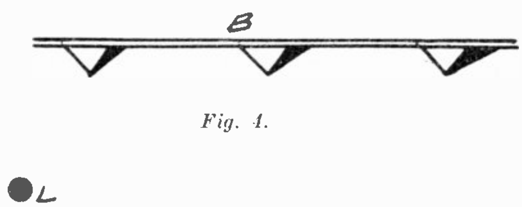


Fig. 4.

This can be illustrated by consideration of Fig. 4. Here a board, *B*, is shown with three triangular battens (in section) fitted on it. The board and battens are painted white, and light is projected upon the arrangement from the light source, *L*. The shadows produced are of different densities and length. Those nearest the light source are more dense than those situated at points furthest away from the source; they are also shorter.

By adjusting the position of *L* it is possible to illuminate perfectly one of the triangular pieces. If, therefore, the remainder are to be well illuminated, it is necessary to project light of high intensity upon them, and this without affecting the illumination of the piece which is correct. By fitting additional lighting units with "spill shields" the desired effect can be obtained. Spill shields, it may be said, are narrow strips of metal which are fitted to a reflector for the purpose of cutting off certain light rays which would, in the ordinary way, be reflected from the sides of the reflector. In other words, they control the beam within certain limits so that it is more directional than is the case with ordinary units. Such a method, however, results in low efficiency since the light which is cut off cannot be utilised; it is more or less "boxed up," so that, through cross reflections, its illuminating power is practically zero.

The use of concentrating type reflectors is an essential of sound illumination. With their aid, light of very high intensity can be projected through space to illuminate objects situated at some distance from the light source. The beams of light may be narrow; useless in fact for the illumination of any object alone. With the aid of a simple device, however, good results can be obtained. This is illustrated in Fig. 5. Here a beam from a lighting unit fitted with a concentrating type reflector is projected through space. Fitted near the object to be illuminated is a diffusing glass screen; this diffuses the light over the object so that the latter is illuminated. The intensity of light can be controlled within certain limits by twisting the screen so that varying areas are presented to the beam; in this way different effects of light and shade can be obtained.

I would advise those who are interested in this important subject to obtain a small box and, in its interior, fit a white object of peculiar shape. A cube fastened to a cone would be a suitable object. If small lighting units are fitted in certain positions in the box, and each one is arranged for independent control, various effects of light and shade can be obtained. The effects and their cause should be noted, so that correct principles can be applied to the illumination of larger settings when necessary. One thing is important: the light sources should be concealed from view, since a light source in the line of vision prevents one's ability to see. This applies equally as well to television apparatus which is to broadcast any scene or setting.

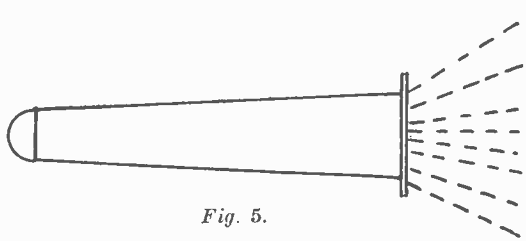


Fig. 5.

The Photo-Electric Cell

By *C. G. Lemon*, A.M.I.R.E., St.I.E.E., A.M.T.S.

(Radio Dept., Tungsram Electric Lamp Works (Gt. Britain) Limited.)

THE increasing use of the photo-cell has made it desirable to give a short description of its operating characteristics and general principles. The photo-electric effect was discovered by Hallwachs in 1888, and up to a short time ago the photo-cell had only been used to any great extent in scientific laboratories and for research work. For an understanding of the elementary principles of light, a brief description of the units that are most commonly used will be given.

The total visible energy emitted by a source of light per unit time is called the total luminous flux from the source.

The unit of luminous flux is the lumen. It is equal to the flux emitted in unit solid angle by a point source of one candle luminous intensity.

A uniform point source of one candle intensity thus emits 4π lumens.

Luminous intensity or candle power of a point source in any direction is the luminous flux per unit solid angle emitted by that source in that direction. The accepted unit of luminous intensity is the international candle.

Illumination on any surface is measured by the luminous flux incident on unit area. The units in use are: the lux, one lumen per square metre; the phot, one lumen per square centimetre; and the foot candle, one lumen per square foot.

* * *

The emission of electrons from metals when suitably illuminated is most marked in the case of sodium, potassium, rubidium, cæsium, lithium, strontium and barium. The oxidisable nature of these metals makes it essential not only that they be enclosed in a sealed bulb, but they must be prepared in it; the metal cathode cannot be made in the air and then introduced into the cell.

The process which is most generally used to obtain a clean film of the metal in the cell is the introduction of the metal as a vapour, which is then condensed in the required position. In a certain type of vacuum cell the metal sodium is admitted into the bulb by electrolysis, whereby the sodium is deposited on the inside of the cell after it has travelled through the glass wall of the bulb.

To increase the photo-electric emission current, the metal layer is sensitised by passing an electric discharge between the anode and the light-sensitive cathode, at the same time filling the cell with pure hydrogen at a pressure of a few millimetres. Of course, different processes are in use for different types of cells.

The maximum photo-electric emission current for any light sensitive metal at a given intensity of illumination is dependent on the threshold characteristic of the metal used, that is, the photo-current reaches a maximum when it is illuminated by a single wavelength light of a certain frequency or colour, which corresponds to its threshold characteristic. After sensitisation, the threshold is shifted up towards the longer wavelengths. Fig. 1 shows the increase in emission and the alteration of the colour sensitivity of a potassium cathode cell.

Table I. gives the characteristic threshold and relative emission of the photo-active metals.

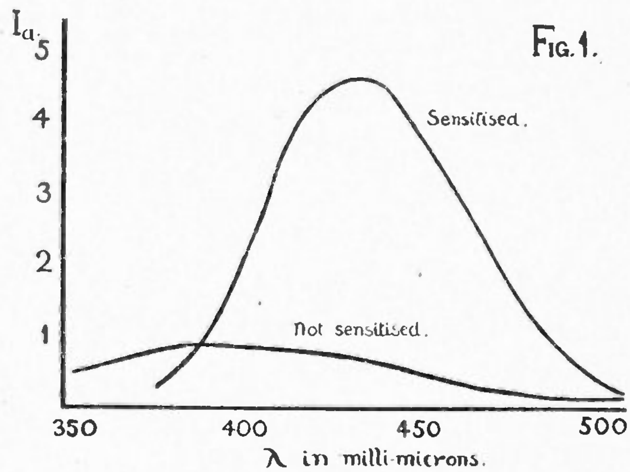


Fig. 1.

TABLE I.

Metal.	Threshold. λ in microns.	Emission current amps. per lumen.
Sodium ..	·340	6×10^{-7}
Potassium ..	·425	10× ,,
Cæsium ..	·540	1·7× ,,
Rubidium ..	·480	4·0× ,,
Potassium on Copper Oxide	·420 max.	8× ,,

From the point of view of characteristics and performance there are two distinct types of photo-cells—the vacuum and the gas-filled cell. The first, as its name implies, is highly evacuated, while the gas-filled type contains an inert gas (generally argon) at a pressure ranging between 20 to 150 microns.

The object of introducing gas into the cell is to magnify the initial photo-current through ionisation by collision.

A collision between an electron and a molecule of

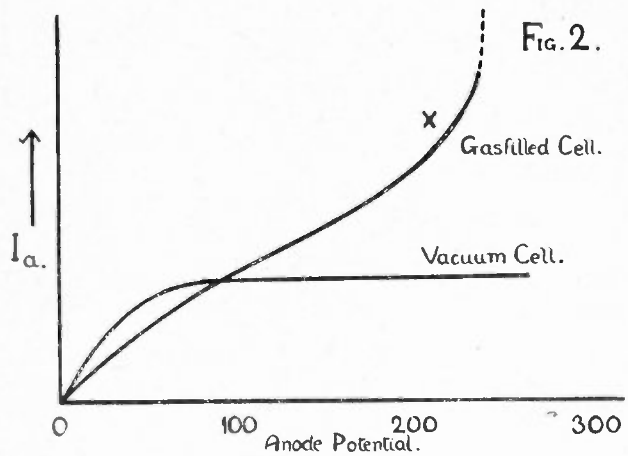


FIG. 2.

gas results in the molecule being broken if the electron is moving fast enough. This collision ejects an electron from the molecule, leaving the remainder, which is a positive ion. The electron which caused the impact and the detached electron both travel to the anode, while the remaining positive ion moves to the cathode. The increased number of electrons which travel to the anode, due to the collisions, constitute the magnified photo-current.

The energy required to detach an electron from a molecule, or to *ionise* it, is a property of the molecule, called the ionisation potential of the gas.

It can be seen that, should the ionisation be of sufficient intensity, the number of positive ions that travel to the cathode is detrimental to the light sensitiveness of the metal in certain types of cells, by positive ion bombardment.

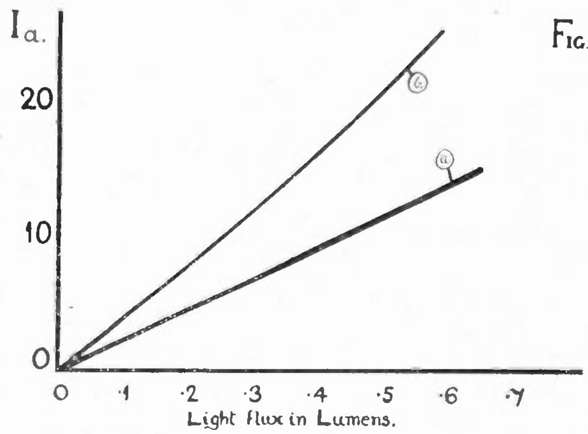


FIG. 3.

The main disadvantage of the gas-filled type of photo-electric cell is the definite potential that is required on the anode in order that it may give its greatest output. The most sensitive operating part of the curve shown in Fig. 2 is *X*. This is just below the ionisation potential of the cell. By keeping the anode potential constant and varying the illumination, or vice versa, a point is reached at which the cell is filled with a purple glow. The current at this point rises suddenly to a very high value, and if allowed to continue it will reduce the sensitiveness of the cathode by positive ion bombardment.

The glow continues until the anode voltage is reduced to what is termed the "stopping potential." At this point the glow ceases and the current again determines itself in accordance with the degree of illumination from the light source. The limit to the emission with a given light source is, therefore, set by the glow potential, and for the greatest emission the voltage must be adjusted to a point just below this value.

The anode voltage–anode currents characteristic curve of typical vacuum and gas-filled cells with a constant value of light flux incident on its cathode is shown in Fig. 2.

For scientific measurements, such as light photometry, the vacuum type is the best to use, as wide variations of anode potential above saturation voltage do not materially affect the output for any given degree of illumination. The saturation part of the curve is strictly proportional to the light intensity falling on the cathode, so long as the quality (or wavelength) remains unchanged.

Fig. 3 shows the linear relation between incident light flux and photo-emission (*a*) for vacuum and (*b*) for gas-filled cells.

The colour sensitivity and range of the human eye (*a*), together with typical colour sensitivity curves of a vacuum type sodium cathode cell (*b*), special activated sodium cell (*c*), and gas-filled rubidium cell (*d*), are given in Fig. 4.

The characteristics of the photo-cell are more easily understood if the essential characteristics of the triode are known.

The slope of the light-flux-anode current curve at a given point is the cell's sensitivity. This slope may be compared to that of the grid voltage-anode voltage curve of the triode, where the incident light flux is comparable to the grid voltage and the sensitivity to the mutual conductance. This is expressed as:

$$S=\frac{\delta I\alpha}{\delta l}\ \mu A\lambda$$

where S is the sensitivity in micro-amperes per lumen, and

$$l=\frac{c\times A}{d^2}$$

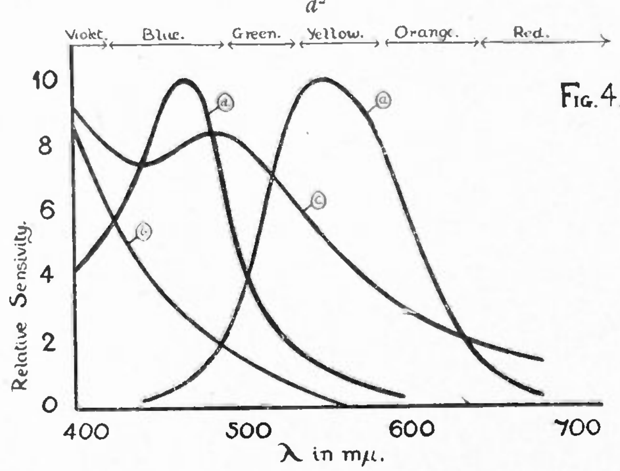


FIG. 4.

where l=light flux in lumens on a given area A,
c=candle power of the source in the direction considered,
d=distance from illuminating source.

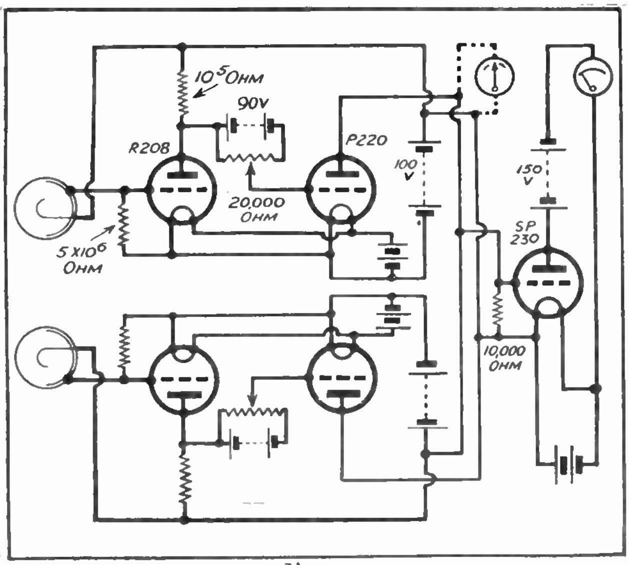


Fig. 5.

Conductance per Lumen

The slope of the anode voltage-anode current curve divided by the light flux is the conductance per lumen (G) at the point considered. This is expressed as:

$$G=\frac{\delta I_a\ I}{\delta E_a\ l}$$

This factor determines the maximum voltage output for a given condition of fidelity, and may be compared to the plate conductance of the triode, but it should be noted that G is a direct function of the light flux.

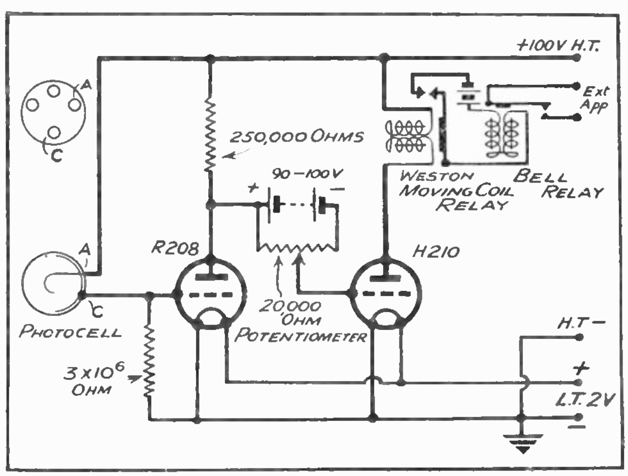


Fig. 6.

Application

The use of photo-cells for grading cigars has often been stated, although possibly not believed. However, it is quite true, and the circuit used is similar in operation to that of Fig. 5. In this circuit two photo-cells of different colour sensitivities (such as b and c in Fig. 4) are used in a balanced circuit.

Taking a colour, such as blue, it will be noted that the respective outputs for b and c in Fig. 4 are 3·75 and 7·5 respectively, thereby upsetting the conditions for balance and giving a certain indication on the milliameter (see Fig. 6). Or it may be again balanced by readjustment of the potentiometer and the needle brought back to zero. It can now be seen that should the colour of the blue vary it will instantly unbalance the indicator. Thus two pieces of material may be accurately matched.

In certain cases, where the colour change is very slight, the introduction of a special coloured light filter may greatly increase the change indicated.

The circuit shown in Fig. 5 can also be used to determine the temperature of the filament of electric lamps, as it is the variation of quality (colour) that affects the balance of the circuit and not the intensity of the illumination.

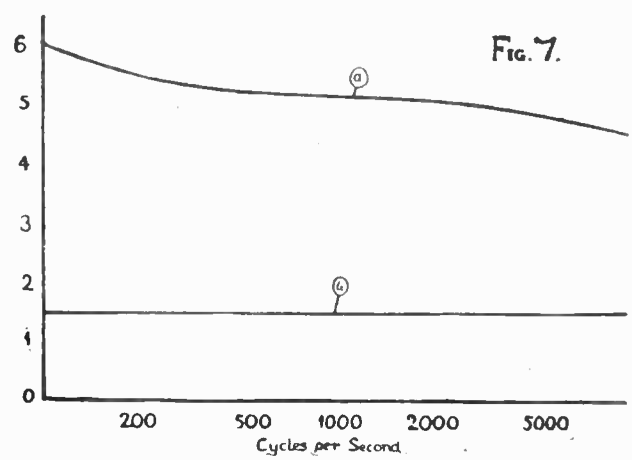
Fig. 6 illustrates the circuit that may be used as an automatic daylight switch. When the incident light falls below a certain value the relay comes into operation and controls a compressed air or other type of switch which is able to carry the necessary current.

By using a cell that is sensitive to the infra-red part of the spectrum, this arrangement may be used as an invisible burglar alarm, where the breaking or interrupting of the beam of invisible light immediately operates an alarm.

In talking films it is the intensity of the light, varying at a frequency controlled by the strip at the edge of the film, that gives rise to the speech currents, etc. This is suitably amplified and passed on to the loud-speaker.

A gas-filled cell is generally used in this position, although the output, at a given light intensity, is not proportional to the impressed frequency, but varies, as shown in Fig. 7, curve (a). The vacuum cell, however, does not suffer from the defect, curve (b), but needs further amplification.

This variation of photo-emission with impressed frequencies ranging from 50 to 10,000 cycles per second is not due to time lag in the cell itself, but it is probably caused by the positive ions generating secondary electrons on impact with the cathode, these secondary electrons again colliding with gas molecules and producing more positive ions, and so on, until a steady state is reached.



Television *and*

The Survival of the Quickest!

ALL kinds of things are appearing in the press about television and all kinds of extreme views are being expressed. How genuinely the writers believe in the things they say must be left for individual readers to judge. In these days it is amusing to observe the facility with which critics will change their views when there is the chance of a change in their source of income!

In the case of television criticism, it is curiously noticeable that though so much has been written in the open, and so much said behind the scenes, the *real* mission and potentiality of this new means of communication have been entirely *overlooked*. This may be intentional, for the matter they have disregarded does not lend itself to dispute.

The big guns of television are now rapidly manœuvring into position, but few have suspected the range and nature of their fire. For the most important influence which television is about to exercise on the world does not lie, as is so commonly supposed, in the broadcast of entertainment.

Influence on Communication.

Television plunges into our midst and presents its credentials as *the fastest means of communication yet known to man*. The time is ripe, therefore, for some very clear, constructive thinking as to the way in which this immediate increase in the speed of communication may be utilised and controlled. The problem is a big one and should receive the attention of the finest minds in business and Parliament.

We do not question that the radio industry of this country, as well as abroad, will wish to encourage the broadcasting of *entertainment* by television. We know only too well that, if that end of the business is handled rightly, there is a lot of money to be made by the manufacture and sale of television receivers, just as surely as the public will enjoy the benefits of "looking-in" by their means. From this standpoint television is providential, for it will give the radio industry that new lease of life it so desperately needs.

But the moment one catches a glimpse of what television can accomplish in the speeding up of existing lines of communication, both by cable and wireless, then its value to the world must be considered on an entirely different basis, and one compared with which the entertainment factor becomes at best *incidental*.

There are many aspects of the situation which will demand, and in the course of time receive, proper attention. The one with which we propose to deal in this article is, as we feel, of paramount importance. It is summed up under the heading *Empire Development*. During the time that this problem has exercised His Majesty's advisers many inventions have come to their aid. Most of them have consisted of new methods of electrical communication, of which the telegraph, the telephone, and more recently wireless, are the outstanding examples. Side by side with this scientific development there has been a commercial and psychological one, too. The close of the Victorian era marked the dawn of a new epoch in the development of industrial relationships within the Empire. We, at home, became growingly conscious of the amazingly difficult task that lay ahead in developing and safeguarding Empire resources. We became faced, as never before, with the titanic task of combating the progress of *foreign* commerce and *foreign* industry which was on every hand springing to new activity—entering and demanding its share of markets in which, hitherto, we had operated without undue interference or extensive competition.

The fight for economic supremacy literally resolved itself into "the survival of the *quickest*," thus the importance of fostering the lines of communication throughout the British Empire, recognised by all thinking citizens in some measure, presented itself to our statesmen as a definite challenge which Great Britain, of all Powers, dare not any longer ignore.

Bureaucratic Control.

Protective measures were put in operation which led inevitably to the establishment of a *bureaucratic* control of all new forms of electrical communication within Great Britain, and *semi-bureaucratic* control throughout the Empire. To what extent this system benefited or harmed business and other interests in this country and the Dominions it is not the purpose of this article to discuss, but it is significant to contrast the position here with that in the United States where private enterprise was still left in control of electrical communication and thereby offered a more lucrative field to the ever-growing army of inventors.

the Empire

By *Howard Havelock Cox*

To-day, as ever, the British situation gives much food for thought. Television comes on the scene at a significant moment, and we may well ask in the light of past experiences how this new weapon of communication will be handled.

Business men everywhere are making a concerted effort to throw off the Government control of industry, and the recent Cable/Marconi Merger gives a good indication as to the way the wind is blowing.

It may be of value to consider something of the influence which this new means of communication will bring to bear upon modern life.

Relation of Speed to Cost.

For the benefit of those who are unfamiliar with the subject, we would point out that the cost of sending a message by wireless or cable is governed by the speed at which it can be sent. Competition, scientific experiment, and other factors have already brought about an extraordinary speeding-up of transmissions by existing methods. The quicker a message can be transmitted the less money it will cost to send. Cheapness makes for wider use, and by becoming available to the man in the street helps to make the world smaller and thereby cultivates prosperity. But although much has been done to cheapen the various facilities for long-distance communication, there has until now been no factor which could in any way compare with television, which gives promise of placing the whole business of communication on a different and infinitely more *economical* basis.

The energy hitherto required for the sending of *a single letter* of the alphabet across the ocean is by television sufficient for the transmission of *a whole message* of almost any length, and in *less time.*

To the *citizen* the cheapness of the service will make possible closer and more active contact with his friends and relatives overseas, and in consequence they will get to know each other better. To the *business* man it will go a long way towards substituting the bulk of his foreign correspondence, at present carried on through the mails, thereby bringing him business which in the past may often have gone to vendors, a post or two nearer the wholesale consumer. Imagine, if you will, the general speeding up of business as it becomes possible to transmit from the originals *living pictures* of the goods offered for sale, instantaneously with the written message and at little or no extra cost!

Television peculiarly lends itself to advertising of all kinds, but if its advent is properly controlled it bids fair to become an instrument of continued British supremacy by giving the Empire market preferential facilities for seeing Empire products.

Then there is the wider question of Empire associations in general. The picture which we, in the Mother Country, get of Empire conditions and activities through the perusal of isolated newspaper reports is, as the writer knows well, often far from the reality. But if this limited knowledge and lack of understanding is true of us at the hub of Empire, how much more so must it be of those whose lives are spent in the British Possessions beyond the seas?

We at home are already awakening to a new Empire consciousness and are anxious to understand the difficulties, often of a parochial character, which make Dominion and Colonial development so burdensome. Equally we recognise how vital it is that the splendid people who are occupying these widely separated fields of operation should on their part realise more fully our problems here at home.

During the last few months a movement has been afoot in this country to provide the provinces with daily newspaper facilities comparable with those enjoyed in the metropolis. It is an admirable scheme and one which is long overdue.

The Empire and the Press.

Link this thought with the fact that the coming of television will make it possible to reproduce instantaneously one of our great national newspapers in all the principal cities of the Empire and you will realise, in a flash, the valuable possibilities opened up by television for the dissemination of publicity and news throughout its length and breadth.

Just lately we have been hearing a great deal about the aims of a new political party, fostered by our national press. Is it necessary, in the light of what we have said, to do more than *hint* at the potential power and influence of a *United Empire Party* held together and backed up by a *United Empire Television Press*? It is significant, therefore, that these interests should be forging ahead at the very moment when television is being launched as a commercial proposition. One would be justified in

(*Continued on page* 48)

British Television in 1930

By *W. Barrie Abbott*, B.L., C.A.

THE February issue of *Modern Wireless* contains an editorial article entitled "Television in 1930." The article is really an analysis of a letter which I wrote to the Editor, appealing to him and Capt. Eckersley to join the ranks of those who are trying to help British television to win in the race for world supremacy.

"Methods used by Politicians."

In analysing my letter the writer adopts the methods sometimes used by politicians or by lawyers in Court. He repeatedly creates impressions which I never had in mind, imputes them to me and then proceeds to knock down his own "creations." For example, here is an extract from my letter: "As regards technical qualifications, it by no means follows that if one has a sound knowledge of ordinary wireless (such as I believe you and Captain Eckersley have), one must also have a technical knowledge of television. I honestly believe that neither you nor Capt. Eckersley has had either the inclination or the opportunity to become experts (*Modern Wireless* changes the words 'to become experts' into 'to perform experiments') in television . . . .". Instead of replying to what I *do* say, *Modern Wireless* puts new words into my mouth which I never thought of, and then tries to prejudice my case for British television by unfairly attempting to create the impression that I am so conceited as to even compare my technical knowledge with that of Sir Oliver Lodge and other eminent scientists. He must assume that his readers are very easily gulled! I deplore this smart method of misrepresentation.

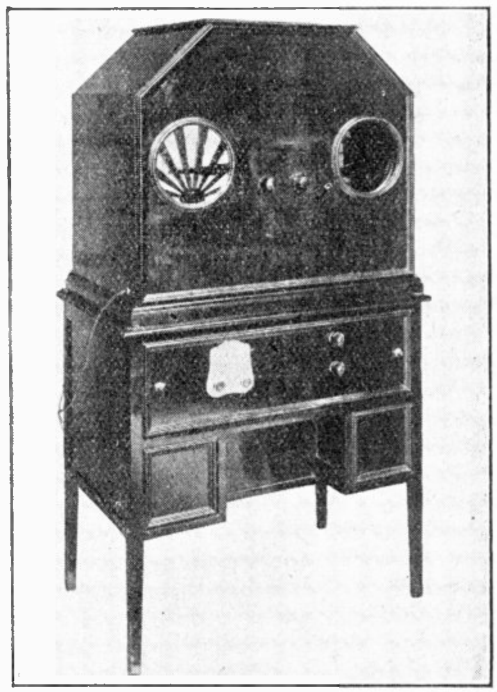
"Capt. Eckersley's Style."

In my letter, I further say: "The technical truth of the matter, so far as I know it, is that at present Baird television is the only system in the world which has actually reached the commercial stage, because it alone has automatic synchronism and it alone gives real worth-while television within the existing waveband." Contrast with this the views of the Editor of *Modern Wireless* as follows:—"Mr. Baird is not the sole inventor of television. He is the inventor of one particular television system, which may or may not be the best television system . . . . We know that Mr. Baird's experimental research work has entitled him to be regarded as a *bona fide experimenter* (the italics are mine) . . . . If, as we believe, his system has definite limits, he must invent another one—or if he can't, somebody else will; if not to-day, to-morrow; and if not to-morrow, in a hundred years time, or more —or less." (This looks very like Capt. Eckersley's style, does it not?)

Contrast this with—

(1) The description placed by the authorities on the apparatus with which Mr. Baird first demonstrated true television in 1926. It reads as follows: "This is the transmitting portion of the original apparatus used by Mr. J. L. Baird, in experiments which led him from wireless transmission of outlines in 1925 to the achievement of true television nine months later, when on January 27th, 1926, the transmission of living human faces with light, shade and detail was demonstrated before members of the Royal Institution; *this being the first demonstration of true television ever given.*"

(2) The statement by Dr. Tierney: "Television, therefore, is fundamentally a British invention, acknowledgement of which none but an unscrupulous person would attempt to suppress." (Why should the Editor of *Modern Wireless* and Capt. Eckersley seek to be included in this category?)



The Baird Dual Exhibition Receiver.

(3) The declaration by the *New York Times* of 11th February, 1928, namely, "Baird was the first to achieve television at all over any distance . . ."

Even America confesses, while patriotic Englishmen seek to deny!

Mr. Baird's "Enthusiastic Friends."

But the Editor of *Modern Wireless* does not stop here. He actually ventures to warn Mr. Baird against his enthusiastic friends, who, he says, do more harm than good. He tells Mr. Baird that he has very great respect and admiration for the work he has done. He seems to say in effect: "I am your real friend; Mr. Moseley and Mr. Barrie Abbott are not. But I must ever point out to the public that you are not the inventor of television, you are only a *bona fide* experimenter!"

In my letter I further stated "There is no doubt whatever that had the British wireless authorities given long ago those broadcasting facilities without which no system of television can function, British television would have been much more developed than it is. The fault does not lie with Baird, but with those who have withheld transmission facilities."

That is the main reason why television receivers were not put on the market long ago. I agree with the Editor when he says, "We advise Mr. Barrie Abbott and all those connected with him in this matter of television to exercise every effort they can in securing an early market delivery of television receivers. Nothing would settle the problem quicker than the delivery of television sets to the public." The Baird Company is pressing forward with such delivery, but they will be well advised to devote sufficient time to the perfecting of the new instruments and also to delay putting them on the market until the B.B.C. grant facilities for both speech or music and vision. Here *Modern Wireless* can help by putting in a plea for such facilities. It is quite unfair to deny the combined service and give facilities only for vision.

Glasgow's Enthusiasm.

In conclusion, I would like to point out that at the Television Exhibition held in Glasgow recently it was proved beyond all doubt that the public is clamouring for television. Every day long queues of people waited patiently to gain admission to the television concerts. I understand that over 15,000 people passed before the televisors—University professors, actors, officials of the B.B.C., distinguished men of business all waited their turn to see television; and the general feeling of those who witnessed the combined service of singing, speech *and* vision was one of great surprise at the advanced state of the science, and of resentment at the fact that it had received so little encouragement from the B.B.C. Such exhibitions will soon be held all over the country, and the B.B.C. will be supplied with overwhelming evidence of the fact that the British public demands British television.

Low Frequency Amplifiers

(Concluded from page 9.)

imagine that the amplifier is "extravagant." If the separate synchronising valve is wanted, adjust the variable resistance to the highest value so as to keep the polarising current as low as possible, consistent with satisfactory picture hold.

Further Points

Note that the terminals marked + and —, third and fourth from the left-hand end, are for joining to the synchronising coils. The output should be connected between H.T. + and — on the extreme right of the top row of terminals. The grid bias terminals are as indicated in the theoretical diagram, 1, 2 and 3 being for the amplifier itself and — for the separate synchronising valve. Knowing the extremely good results that have been achieved with this amplifier, it is hoped that they will be duplicated by the constructor himself without difficulty.

Another point to bear in mind is that valves other than the LS5 class are quite capable of giving excellent pictures. Those known as power and superpower have been tried and produce a good image. The amplifier, as was mentioned earlier, is elastic and will, I trust, form a basis for the experimenter whereby he can carry out a few experiments for himself. Aim at quality in your received image coupled with the most economical working, and I know you will be surprised at the relatively low drain on your H.T. source.

Television in Germany

(Concluded from page 11.)

The successful receptions of the midnight transmissions from Brookmans Park by a young German student engineer, Mr. Hewel, with a receiving set of his own construction, have already been alluded to in the columns of this journal. The writer of the present article did not fail to visit Mr. Hewel whilst in Berlin and witnessed a most successful reception. He was able to recognise perfectly the features and portions of the forms of his colleagues at Long Acre, as well as photographs, printed matter, etc. The pips of the playing cards shown could be seen and counted with ease. And this with an amateur receiving set some 800 miles from London!

It is thus clear that the stage is well set in Germany for the development of television. We wish our German friends every success.

An objecter to television says it will never be able to send out "music movements". It contains a frequency "band" anyhow.

* * *

"Jenkins in America uses 48 holes, the G.E.C. in America 24 holes, the Radio Corporation 60 holes and Baird 30 holes." The finals will be played on the Disc.

The Proceedings *of* The Television Society

Meeting, Tuesday, February 4th, 1930

LECTURE ON

"The Photo-Conductivity of Selenium and Various Other Substances"

By *George P. Barnard*, Grad.I.E.E.

ABSTRACT.

THE object of this paper is to review the recent experimental work on the photo-conductivity of selenium and various other substances from a theoretical standpoint, and to state clearly the fundamental physical processes involved. The paper is divided into four sections, of which the first two give a brief outline of the characteristic light-sensitive properties of photo-conducting crystalline aggregates, upon which it has been customary to make observations. The necessity for making observations on single crystals is emphasised, owing to the complications arising from the use of heterogeneous crystalline masses. The third section deals with the physics of photo-conduction and discusses the primary and secondary effect of the light in pure crystal materials having a refractive index greater than two. Attention is called to the connection between photo-conduction and phosphorescence in "coloured" crystals.

Only by the investigation of the phenomena limiting the practical utility of light-sensitive cells, such as the selenium cell, is it possible to elucidate their mechanism and hence to overcome these limitations.

CONTENTS.

3.5—" Coloured " crystals—connection between photo-conduction and phosphorescence.

3.6—Another type of photo-electrically active crystals—photo-active cells with fluorescent electrolytes.

§ (4) CONCLUSION.

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§ (1) INTRODUCTION.

The history of television is linked up with the history of selenium. Indeed, it would be very nearly true to say that the history of television dates from the announcement of the discovery of the light-sensitive properties of selenium in 1873 by Willoughby Smith.[1] The production of inertialess light-sensitive apparatus is essential to the solution of the problems of distant electric vision ; and while it is but one of a multiplicity of problems presented by a subject which embraces many branches of engineering and physical science, none will deny that it is a very important one.

The development of television has necessitated the substitution of the photo-conducting cell by the photo-electric cell ; this has, however, involved many experimental complications, the elimination of which would be welcomed. The supersession of the selenium cell does not mean that its possibilities have been exhausted, but rather that the time has come to realise that the surest means of development of its practical utility is by the attainment of a complete understanding of the physics of the processes involved in photo-conduction.

The phenomena of photo-conductivity are comparatively unfamiliar to a large number of readers, and, moreover, it is not generally realised that the light-sensitive properties of selenium are by no means only characteristic of that element alone. While the importance of recent work on photo-conduction will be clearly evident, it will be noticed that only a few of the problems may be regarded as solved, whilst many are still awaiting solution. Thus, much of the work can only be presented in a somewhat preliminary fashion ; nevertheless, even in this incomplete state, it is felt that a review of the work may be of considerable use to those interested in this subject.

§ (2) THE OBSERVED LIGHT-SENSITIVE PROPERTIES OF SELENIUM AND VARIOUS SUBSTANCES.

2.1.

The light-sensitive properties of selenium form a convenient starting-point for a brief review of the early work. The discovery of the fact that the electrical resistance of selenium was changed by light incident upon the element soon led many to seek for similar properties in other elements and poly-crystalline bodies ; now it appears that these properties are common to most semi-conducting solids.

The property of photo-conduction in selenium was first noticed in an allotropic variety of selenium known as grey, metallic selenium, and it was found that the general effect of exposing to visible radiation a thin strip of this substance, attached between metallic electrodes, was to decrease the electrical resistance by an amount dependent upon a variety of factors ; the exact influence of each was not precisely understood.

2.2.

The apparatus used for the study and application of this property has been termed the " selenium cell," in which selenium simply forms the junction between two metallic electrodes, which are otherwise insulated from each other. It is not proposed to deal with the methods and types of construction of selenium cells, for this subject has been adequately dealt with elsewhere ; it is, however, necessary to emphasise some salient features.

The various types of cells generally fall into two classes :—

(*a*) Those in which the illumination is in a direction perpendicular to that in which the resistance is measured.

(*b*) Those in which the illumination is in a direction parallel to that in which the resistance is measured.

Examples of Class (*a*) cells are those of Siemens, Bell, Bell-Taintor, Townsend, Bidwell, Prior and Riley, Ruhmer, Lindner and Replogle, Presser, Fournier d'Albe, Wein, Berndt, Morgan, Mercadier, Gripenberg, Thirring, and the Radiovisor Parent Co., Ltd. The cells of Fritts, Hammer, Martinez, and Lasinski are typical examples of Class (*b*).

In all these cells, the selenium is subjected to a process known as annealing, which merely consists in maintaining the selenium for several hours at a temperature of a few degrees below the melting point (220° C.). Exactly what the annealing process does is not very well known, but there is little doubt that without this heat treatment its resistivity is extremely high and its light-sensitivity very small. It should also be noted that, in the transformation of vitreous selenium into metallic selenium at 220° C., there is a very considerable diminution in its volume, which tends to cause rupture at any contact-surface and to introduce microscopic air cavities everywhere throughout the material ; in other words, it adds to the heterogeneities of a somewhat heterogeneous crystalline aggregate.

Finally, we may note that the ratio of light-to-dark conductance for a given illumination and set of experimental conditions is greater for Class (*b*) than for Class (*a*) cells.

However perfect the construction of the cell, the selenium prepared in this form must remain a heterogeneous conglomeration of minute crystals. Thus there can be no precise relation between the resistance and the energy of the light, since it cannot take into full account the effects of varied orientations and intra-molecular strains, and of the differences in molecular spacings at different levels of the surface-region, and again it must be noted that, with the possible exception of specific crystal facets in homopolar crystals, solid surfaces are not uniform either in texture or in surface energy. It is, therefore, not surprising to find that the extensive literature of the subject gives the impression that there has been much wandering in the dark amongst a confusing and complicated set of phenomena.

2.3.

The dark-to-light resistance ratio of a selenium cell for a given illumination is a function of the dark resistance. As the dark resistance increases, so this ratio increases. Empirical formulæ for the relation between the increase of conductance and the intensity of the illumination, purporting to represent the observations of different observers, range from the linear relation to the fourth-root law. Recent experiments[2] have shown that, under definite experimental conditions, the change in conductance, G, is in every case directly proportional to some power of the illumination, E, over the range 0–100 f.c., *i.e.* :

$$G \propto E^x \qquad (2.31)$$

Although each cell has its own particular index value, x, this value, for the same cell, is found to persist even after a lapse of several months. It is to be noted that, even amongst cells of the same type, small variations in the index occur. In general, no two cells of any one type have the same quantitative reaction towards a given intensity of illumination. The results for a "Fournier d'Albe" type and "Thirring" type of cell are shown in Fig. 1.

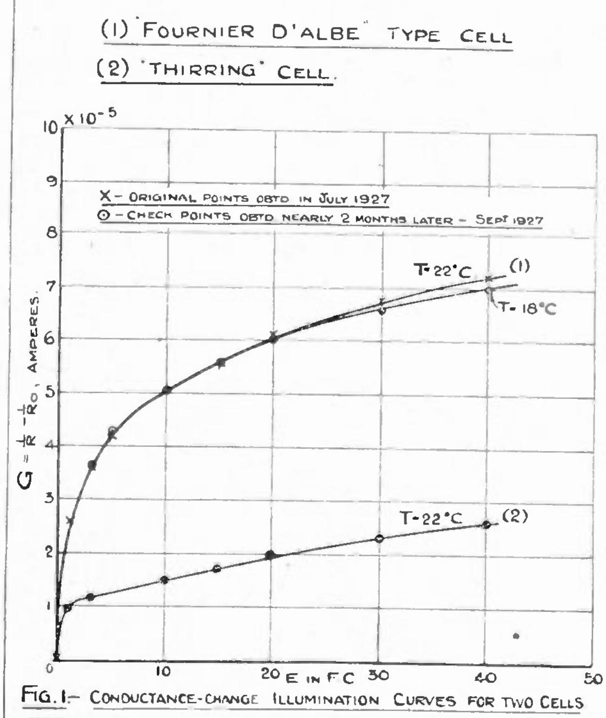

Fig. 1.—Conductance-change Illumination Curves for Two Cells

2.4.

The remanence and inertia effects of selenium and other light-sensitive substances have always been a considerable source of trouble in any of the practical applications. The maximum conductance of selenium on exposure to light is attained much more rapidly than is the reduction to minimum conductance on cutting off the light, but there is a considerable lapse of time in the attainment of each. In the latter case, this may amount to several hours. The initial and final inertia depends upon the heat-treatment of the selenium, the duration and strength of the illumination, the thickness of the selenium layer, previous illumination, the colour of the light, the purity of the selenium, the nature of the electrodes, the applied voltage, and the temperature. Taking the analogy of an ionised gas, there have been many endeavours to explain the inertia by taking into account the energy of recombination and assuming a low finite velocity of migration of the ions, but without any real measure of success.

2.5.

In selenium and other light-sensitive substances, *e.g.*, Stibnite, Bismuthinite, Molybdenite, Argentite, Acanthite, Galena, Pearceite, Meargyrite, Stephannite, Polybasite, Jamesonite, Cuprite, Silver Oxide, Proustite, Boulangerite, Thalofide, Bournonite, Pyrargyrite, Iodine, and many others, the observed spectro-photo-electrical response clearly depends upon the experimental conditions. There is great variety in the curves according to the manner of construction of the cell, the heat-treatment of the selenium, previous exposure, the duration and strength of the illumination, and the applied voltage (*vide* Fig. 2). The long and extended researches of Brown and Sieg[3] have led them to the conclusion that there can be *no* characteristic spectro-photo-electrical sensitivity curve for selenium cells, since the heterogeneous mass of crystals contained in a selenium cell must consist of crystals having many different shapes and crystallographic anomalies. Each of these crystals has its own peculiar spectro-photo-electrical response, and results obtained with selenium cells merely give the average response of the many diverse crystal forms. The resultant curve must, therefore, depend upon the manner of construction of the cell, the annealing of the selenium, and the experimental conditions under which the curve is obtained. Often there is a decided maximum between 0·6μ and 0·8μ, but, as Gudden and Pohl[4] point out, by varying the experimental conditions, the curves can be laterally displaced or flattened out, until they vanish or divide into two parts. In other cases, maxima may even arise in the short wave part of the spectrum.

2.6.

It may be briefly mentioned here that the resistance of these substances decreases with increase of the applied voltage (*i.e.*, there is a departure from Ohm's Law). An increase of temperature or the application of mechanical pressure to the substance produces a decrease of resistance. The effect of light has been shown to be transmitted along a crystal and may even be transmitted from the crystal illuminated to a crystal in contact with it but in the dark.

§ (3) The Physics of Photo-conduction.

3.1.

The phenomenon of photo-conductivity is due primarily to a liberation of electric charges inside the crystal material by the absorbed light. Those crystals in which the primary ionisation takes place in the pure crystal material will be considered first. Selenium, cinnabar, zincblende, diamond, sulphur, and numerous others are common examples. Gudden and Pohl observed that all these crystals possessed a refractive index greater than two, and, conversely, that all crystals with a refractive index greater than two possessed photo-conductivity. The value two has, however, at present, no definite theoretical significance. Apparently the only recorded exception is an observation on the photo-conductivity of Willemite (Zn_2SO_4) by Miss Levi.[5] As the index of refraction N_D for Willemite is equal to 1·71, Miss Levi expresses the view that the cause of photo-conductivity cannot necessarily be attributed to the high index of refraction.

The primary effect of exposure of these crystals to light is a liberation of electrons or negative charges inside the crystal lattice, but this internal photo-electric effect does not ordinarily lead to an external effect. Additional work is required for external electron emission in vacuo after removal of these electrons from their normal quantum orbits in the lattice, so that, according to the usual view of the photo-electric effect,

$$\nu_p - \nu_c = \nu_l \quad \ldots\ldots\ldots\ldots (3\cdot11)$$

where ν_p=minimum frequency of the light able to produce an external photo-electric effect, and ν_c= minimum frequency of the light able to produce an internal photo-electric effect, and ν_l=minimum frequency able to pull electrons out of the surface.

The limiting refractive index $n=2$ may be ascribed to some characteristic atomic arrangement which determines the threshhold value of the external photo-electric effect, so that internal liberation of electric charges will occur without any appreciable external emission.

If we have a single, uniform crystal which has been placed for a long period in the dark to attain a state of atomic and molecular equilibrium, a balance of pressures must exist between lattice cells. In other words, the external pressure upon each lattice cell, together with its affinity pressure, must exactly balance the intrinsic distending pressure in addition to the thermal pressure. This will be the state of affairs in a single, uniformly-built crystal, but within the heterogeneous crystalline mass in a selenium cell, or other light-sensitive cell of this type, conditions will be very far different, for all sorts of cracks and irregularities with varying tensions between the bounding surfaces of unitary crystals will conduce towards the manifestation of unsteady electrical properties, even with the cell in the dark. It is these complications which render it almost impossible to provide any quantitative explanation of the problems of the light-sensitivity of these cells.

3·2.

Every quantum of light absorbed by the crystal results in an ionisation process. The experimental results of Gudden and Pohl[6] show that the number of electrons N produced by light of energy E is given by the equation

$$N = \frac{E}{h\nu} \quad \ldots\ldots\ldots\ldots (3\cdot21),$$

where h is Planck's constant, and ν the frequency of the light. The proof of this equation was provided by a

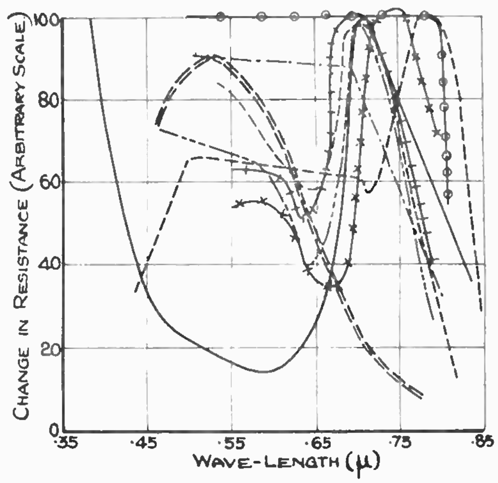

FIG. 2.—THE VARIATION OF THE SPECTRO-PHOTO-ELECTRICAL SENSITIVITY CURVES (BROWN.)

Sign	Cell	Energy × 10⁸ Watts/mm²
————	Ruhmer	150
--------	Giltay	150
— — —	Giltay	?
—·—·—	D-5	1800
—··——	Giltay	110
═══	D-10	1040
+++++	D-18	7800
-×-×-×-	Sublimation	1000
-⊖-⊖-⊖-	Giltay (Short Exp)	

complete and conclusive investigation on diamond, zinc sulphide and selenium. In crystals of these substances, a complete saturation current was observed, so that the absolute number of electrons could be determined. Measuring the absorbed energy E, and the number of electrons N transferred by the saturation current, Gudden and Pohl found that one electron was liberated per absorbed light quantum. There are a number of apparent exceptions to this law, but, in general, they may be traced to the complications raised by the secondary processes following the ionisation by the absorbed light. Kurrelmeyer[7] has explained a number of the apparent inconsistencies. For example, in coloured* rock-salt the charges produced move through only a small fraction of the crystal thickness; hence the actual current yield and the wave-length distribution of the yield depart

* See later.

from the quantum equivalent rule; the one departure may be explained by the apparent absence of a saturation voltage, the other by the existence of peculiarities in the absorption properties of the crystal.

3·3·

Yet the number of electrons, liberated internally by photo-electric action of the absorbed light accord-

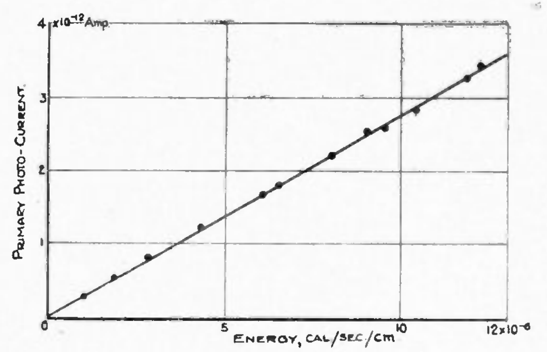

FIG. 3.—THE RELATION BETWEEN THE PRIMARY PHOTO-CURRENT AND THE ENERGY OF THE LIGHT (GUDDEN AND POHL)

ing to the quantum equivalent rule, is alone insufficient to account for the increases of conductance observed in selenium cells. One can, of course, make the assumption that each electron creates a sufficient number of secondary electrons, but there is no experimental support for such an assumption, and, moreover, the general phenomena of electrical conduction in these crystalline aggregates lead to the view that the nature of the conduction must be essentially different from the normal electronic conductivity observed in metals. Bragg [8] has shown that the atom of a crystal of an electro-positive element, such as sodium, consists of an assemblage of the stable "inert gas" shells with an additional electron associated with each, in order to neutralise completely the nuclear charge. These electrons have no fixed positions in the structure; they move under the action of an applied e.m.f. and convey a current of electricity through the metal. On the other hand, a crystal in which the atoms are bound together by sharing electrons, so that there are no free electrons, is a non-conductor, if there is no thermal agitation. This is the case for a typical electro-negative element such as selenium. Electrical conduction in these semi-conducting crystals, which lie between pure dielectric crystals and normal metals, must be different from that observed in normal metals. The temperature has an opposite effect, the resistance decreasing with increasing temperature, and, as Kapitza [9] has observed, the change of resistance in a strong magnetic field does not obey the general laws obtained for normal metals. Kapitza concludes that in these semi-conductors the bonds between the atoms are of such a character that an electron is not free to move under an applied electric field. The non-uniformity of the crystalline structure enables some atoms to approach much closer to their neighbours. The difference in distance between the atoms probably makes the binding of the closest atoms very "tight" and quite different in character from that of the atoms farthest apart, which Kapitza calls "loose." The tight bonds are probably the result of the closest atoms being bound together by sharing pairs of electrons, *i.e.*, having common electronic orbits, as was suggested by Ehrenfest. The "tight" bonds account for the comparatively large diamagnetism of selenium, for Heaps, in some experiments on the photo-magnetic effect in selenium, concludes that the diamagnetic susceptibility must be due to electrons "bound" to the atom, electrons which can take no part in the processes of electrical conduction at any time.

3·4·

Gudden and Pohl have expressed the view that in a selenium cell the secondary effect, which is all that is observed, due to the primary liberation of electrons, was to reduce the resistance of the conducting paths in the crystalline material, so that the bounding crystal surfaces were bridged over in coherer fashion by the photo-electric effect forming transitory conducting paths. This statement is, of course, scarcely capable of direct experimental proof.

Crystals having the property of photo-conductivity may or may not be good insulators in the absence of light, but in either case the primary mechanism of photo-conductivity is the same. If the crystal is a poor insulator, *i.e.*, it passes a comparatively large "dark" current (the case for selenium), secondary processes affect the light current, and the relation between the current and the other variables of the system becomes very complicated. The primary ionisation by the light produces positive space charges in the crystal. In opaque, crystalline aggregates, this brings about a general loosening of the crystal structure, and a secondary current follows the primary current. By heating the crystals or illuminating them with infra-red light, the secondary current is increased. Presumably, thermal agitation augments the process of disintegration of the atomic lattice structures caused by the liberation of photo-electrons therefrom. A liberation of positive ions follows upon the breaking down of the lattice structures, so that in selenium cells the increase of conductance upon illumination is due to an actual mechanical flow of the crystalline structure. Thus we see that the charges produced by the light are of two kinds, electrons and positive ions. The primary electrons are inertialess, instantaneous in their action, and, further, their number is strictly proportional to the intensity of the absorbed light. They are free to move in the field through the whole thickness of the crystal and are not materially impeded by the atoms of the space-lattice. But they are caught or slowed down by all kinds of cracks, irregularities or impurities, which, in the heterogeneous crystalline aggregates in selenium cells, are so numerous, that the primary photo-current disappears altogether; all that is observed is a secondary current, electrolytic in nature, due to the heavy, positive charges. In selenium cells an increase of voltage produces an increase of current in excess of that demanded by Ohm's law; further an increase of temperature produces an increase of current. It appears, therefore, that in these crystalline aggregates, the factors, applied voltage and temperature, may have a direct influence on the lattice bonds in removing some of the units of the lattice from their equilibrium positions to a distance at which the elastic force is zero or very small.

Joffé[10] has advanced two hypotheses to account for the mechanism of the transfer of ions in crystals: (1) the free ions move between the ions of the crystal lattice subjected to some frictional resistance, due to the irregular heat movements and collisions, or (2) the ions only move to refill the empty places vacated by the ions ahead of them, so that rows of ions replacing each other are built between the electrodes. Experiments on the transfer of foreign ions through a lattice appear to indicate that the first hypothesis is the more probable one. The formula,

$$\sigma = DNev \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3{\cdot}41),$$

where σ=specific conductivity, N=number of ions of one sign/cm.,[3] e=charge of the ion, D=degree of dissociation, and v=mobility, is given by Joffé for ionic conduction in these crystals. The hypothesis of ionic (electrolytic) conduction in these crystals, as opposed to electronic conduction in metals, now appears to be firmly established.

3·5·

The mechanism of photo-conductivity in semi-dielectric crystals, having a refractive index greater than two, has been briefly discussed. The high refractive index indicates a low ionisation energy of electrons in the crystal lattice. A second type of photo-conductivity has received a considerable amount of attention on the continent, mainly in Germany and Russia, and this is the photo-conductivity of coloured crystals. Regardless of the refractive index, certain crystals were found to be sensitive to light, if they were previously exposed to X-rays. The effect was first noticed in rock-salt in 1903 by Joffé,[11] and the subject has since been carefully studied by Röntgen,[12] Lukirsky,[13] Arseneva,[14] Pohl,[15] Gudden,[16] and Gyulai.[17] The conductivity of rock-salt is not appreciably increased by X-rays, but a certain state of activation is acquired by the crystal such that it becomes sensitive to visible light and absorbs light. The sensitivity and the absorption for visible light increase with the amount of X-ray energy absorbed by the crystal. After exposure to X-rays, the crystal takes on a brown colouring, from which the term "coloured crystals" is derived. Besides rock salt, the same effect was found for sylvine, fluorite, and many other crystals. After removal of the exciting radiation (X-rays), the sensitivity to visible light gradually decreases. The crystal only persists for a limited time in the excited condition, although Joffé kept a crystal of rock-salt at room temperature in the dark for as long as 21 years after treatment with X-rays, and a high sensitivity and brown colouring was still found to persist. In the case of one crystal, however, Gudden and Pohl found that loss of sensitivity occurred a few seconds after excitation. They found that a movement of electric charges through the crystal occurred, if the excitation took place in an electric field, the resumption of the initial unexcited condition in an electric field being accompanied by a movement of electric charges of the same amount through the crystal in the opposite direction. Thermal agitation accelerates the return to the initial condition. It is interesting to note that the return of the charges (produced by X-rays) by diffusion is accompanied in many of these crystals by the emission of phosphorescent light. Gudden and Pohl have emphasised the close connection between photo-conduction and phosphorescence, and they distinguish between two kinds of crystals in their treatment of the problems involved. In the first type, *e.g.*, Na Cl, we have photo-electrically conducting crystals with "foreign absorption," and in the second type, *e.g.*, selenium, photo-electrically conducting crystals with "self-absorption."

In the case of photo-conductivity, the absorption of light is accompanied by the emission of electrons, and in the case of phosphorescence the absorption of electrons is accompanied by the emission of light. The quantisation of the optical energy transferred in these processes of absorption and emission furnishes further evidence of the similarity in the properties of the quantum and the electron.

In a given state of excitation, the conductivity produced by light is strictly proportional to the intensity of the light and reaches its maximum

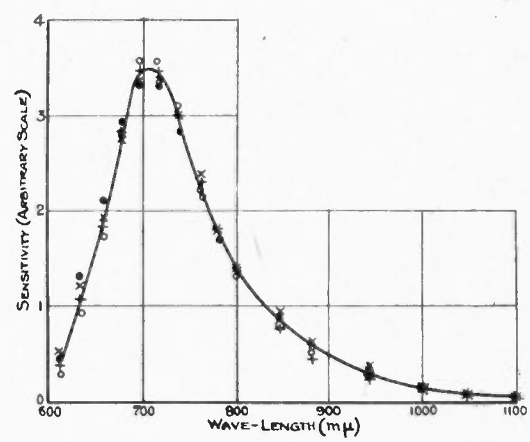

Fig. 4.—Spectro-Photo-Electrical Sensitivity Curve for the Primary Photo-Current (Position A.)

value in less than 10^{-4} second. Here again the primary effect is attended by a slowly progressive secondary effect, which increases the absorption and sensitivity for the red end of the visible spectrum. The primary effect of X-rays is probably the production of "active centres" in the crystal with distortion of the crystal lattice, making easier the liberation of photo-electrons by visible light from the lattice. It may be noted that, as Joffé states, the colouring of the crystals with X-rays is not due to any contamination, as it may be produced in the chemically purest crystals. Rock-salt becomes brown in colour, and potassium chloride violet. The problems involved in these coloured crystals are more difficult than those for the crystals having a high refractive index, and it is questionable whether the quantum equivalent rule is always applicable. Joffé states that the ratio of the absorbed energy to the average energy necessary to liberate one electron is often larger than two, so that it is possible that secondary electrons are liberated by the primary ones.

3.6

Regardless of the refractive index, if a crystal has dispersed throughout its volume certain types of impurities such as metallic colloids, it is photo-electrically active, and the seat of ionisation by the light is in this case the particles of the impurities or irregularities in the crystal structure. Examples of this class of crystals are all the naturally coloured quartzes and alkali halides.

In conclusion, it may be mentioned that there still remains yet another class, namely, photo-active cells with fluorescent electrolytes,[20] upon which, however, little more than qualitative observations have been made.

§ (4) It may perhaps be thought that, "in attempting to simplify the complex, complexities have been detected in what had hitherto been regarded as simple." but it is only by investigating the phenomena which limit the practical utility of photo-conducting cells that we are able to find out their mechanism and so learn to avoid or overcome these limitations.

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APPENDIX.

In contradistinction from the normal selenium cell, in which the incident illumination produces a change of resistance, primary selenium cells have been described, in which the incident illumination actually produces an electro-motive force. For example, in 1888, Uljanin observed that in his cells a strong e.m.f. was produced on illumination (with no externally applied e.m.f.), amounting in sunlight to 0.12 volt.

This photo-electric phenomenon, which has been observed in many other substances, was originally described in 1868 by Becquerel, and has since been termed the "Becquerel effect." Becquerel observed that the potential of a platinum plate, covered with a silver halide, against an electrolyte of acidified water was increased on illumination of the plate.

The "Becquerel effect," together with the general phenomena of photo-conduction, appear to throw some light upon the mechanism of the formation of the latent image in photography. In paragraph 3.4, it was suggested that in selenium cells an actual mechanical flow in the crystalline structure took place on illumination, following the primary ionisation by the light. Recent investigations indicate that the complete building-up of the latent image in photography is determined by secondary photo-currents, which result from a photo-electric liberation of electrons inside the crystal lattice. These secondary processes involve chemical reactions between the grains and the surrounding gelatin in the photographic emulsion.

Wightman, Trivelli, and Shephard, have shown that photo-halide emulsions prepared by different methods gave optically different photographic sensitising. The high absorptive power of the silver bromide crystal for foreign substances is well known. Prominent among the various kinds of impurities in the silver halide crystals of highly-sensitive photographic emulsions, are the silver sulphide specks, the presence of which involves a strain in the lattice structure of these crystals. This necessarily results in a deformation of the ions of the lattice in the immediate neighbourhood of the speck. The physical conditions at the boundary of the speck are such, that a decomposition is extremely probable; for there is a discontinuity in the refractive index at the boundary, and, as Trivelli emphasises, it is well known that, in heterogeneous catalysis, the reaction takes place at the boundary of the two phases. We have an analogous case in Lenard's inhomogeneous crystal phosphorogen, with its molecular complexes of foreign substances, which are called "centres." The photo-electric effect is localised in those "centres" which are active in a phosphorescent sense. It was mentioned in paragraph 3.5, that electrons are pulled out of these "centres" by the light, and that phosphorescence is produced by the electrons falling back into the charged "centres" in the dark.

The primary mechanism of the light upon the photographic emulsion will be a photo-electric liberation of electrons, most probably from the silver sulphide speck. We may assume that a number of elementary electric currents will appear between the silver sulphide speck and the electric charges discontinuously distri-

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Further Reports of Amateur Television Reception

WHILE experts in wireless theory are busy wrangling and trying to convince everyone, including themselves, that the Baird experimental television broadcasts are no use and have proved worthless, the amateurs have been getting busy to some purpose.

The most interesting report of reception during the present month comes from Mr. J. P. Shillingford, who lives within a mile or so of Brookman's Park. His age is fifteen, and he states the only assistance he has had is the TELEVISION magazine. He writes from school—Robert Pearce House, The College, Bishop's Stortford—and announces successful reception from December 23rd to January 15th, the period when he was home on holiday.

Broadcast times are not helpful to him, but during the holidays he lost no opportunities, rigged up a disc in the shortest possible time, and "looked-in." Synchronising gear consisted of his thumb pressed on the motor shaft. After trying leaky grid detection and finding it anything but successful, he went over to anode bend and secured satisfactory results. His report on what he saw is correct, and agrees with the transmission programmes.

The whole of his set is mains operated, A.C., and writing of it he says :—

"I was very satisfied with results considering that *owing to lack of pocket money* I had to construct the mains eliminator from second-hand half-wave valves, condensers, chokes, etc., purchased from an ex-Government dealer," and then explains that his last power stage in the amplifier consists of two valves in parallel which, between them, can handle about 30 m.a. as a maximum.

Mr. Shillingford need not worry about the poorness of his apparatus or the shortage of pocket money. Television was first demonstrated and proved with the most unlikely-looking apparatus purchased from an ex-Government dealer, and at the time Mr. Baird also was *short of pocket money*.

Mr. Shillingford has surely set up a record for age, and further proved that television reception is not the awful, complicated, impossible business the critics have been telling us.

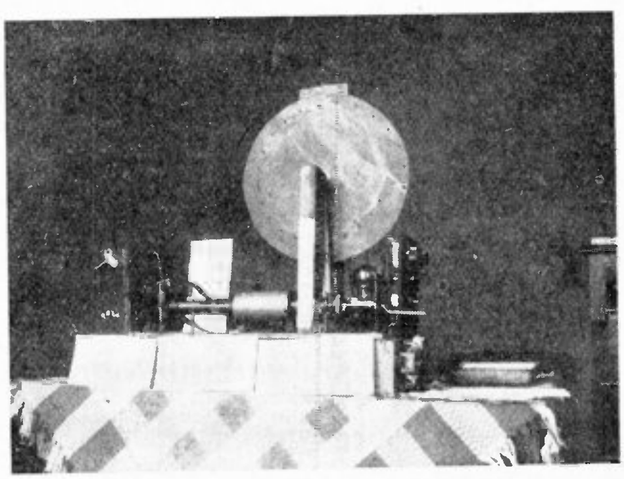
During the month the Baird Studio staff received another recognition shock. Mr. A. E. Kay, of Manchester, whose apparatus and results were mentioned in TELEVISION for February, took the trouble to travel to London and, walking into the Baird Studio, went up to one of the engineers with "How are you ? I have seen you frequently by wireless. By the way, you were wearing a scarf when I saw you on Friday night. I should not do that if I were you, as you are appearing before a large audience, and should look your best."

He was quite right. The engineer in question was wearing a scarf. He had forgotten to remove it, having arrived a little late for the midnight transmission. Mr. Kay, however, had not finished, for turning to one of the lady artistes present he told her when she had appeared and for how long, also what she had done on each occasion.

He uses the same synchronising gear as Baird, but feeds it from his receiver in a different way, which also is his own idea, and is constantly being varied. His receptions of television in Manchester are becoming famous, and amateurs in the area are constantly writing to him for advice. His reception is remarkable for, as he puts it, he has only a "rotten commercial type neon tube with the resistance still in the cap," and expects to get an even better picture with a proper neon.

From Sweden, Adolf Herrlin of Fil Kand, Åhus, writes to ask why he could not get a recognisable picture, using a 24 hole disc, although he was getting a strong signal. He has been put on the right track. Nothing but a 30 hole disc or mirror drum can be used to get recognisable results on a 30 hole transmission.

He is a student, and since writing has had to return to Lund to college, but he mentions that his apparatus is entirely home-made, mains transformer,



The home-made television receiver used by Mr. Adolf Herrlin, a Swedish amateur. The motor is arranged to drive a Fultograph machine when necessary.

electric motor and other necessary parts. During the next holiday further experiments will be carried out, and he promises a report on them.

A London amateur, Mr. V. J. Ross, of 15, Barandon Street, Notting Hill, reports the reception of recognisable images, using a 20 ins. diameter disc, with a picture of 2 by 2 ins. Some distortion with a picture so much out of ratio is inevitable, but he says the images are easily recognisable, although crude and lacking in half-tones. His wireless circuit is straightforward, using leaky grid detector, R.C. coupled to a small power valve, then transformer to a Hyper-power valve. The neon choke is fed with a 1 m.f. condenser in each lead.

The neon tube is of the ordinary commercial type, but placed to one side of the disc, the light being focussed on to the disc by a magnifying shaving mirror. This gets rid of the design of the elements in the neon, and gives a more uniform lighting to the image. His motor is an ordinary fan motor, and synchronising is carried out by varying the speed of the motor by a resistance. As the arrangement of neon and mirror to get over irregular illumination offers distinct possibilities for other amateurs who are faced with a similar difficulty, a diagram is reproduced.

Mr. N. Hoskins, of Braemar Avenue, Ealing Road, Wembley, describes the images he received as being of "excellent quality, and containing more detail than the average newspaper photograph." With regard to the extended scenes which have occasionally been transmitted, he has seen one person walk in front of another, and on one occasion someone produced a handkerchief and buried his face in it. The person concerned had a bad cold, and did produce his handkerchief and use it, forgetting that he was being televised.

Another interesting report is that of Mr. Eric L. C. White, the Hon. Secretary of the Cambridge University Wireless Society, who, writing from Sidney Sussex College, says :—

"I picked up your morning transmissions from 2LO on February 4th, 5th and 6th ; about a dozen members of the above Society being present on each occasion. This was done on very rough apparatus, merely to try and interest members in television. . . . . Not having the necessary tools to construct it, I have not attempted to make a synchroniser, but I find no great difficulty in 'holding' the picture with the aid of a rheostat controlling the motor. Admittedly such a method is useless for entertainment purposes.

"A point of some interest is that I found that an Osram P.625, consuming 24 milliamps at 250 volts, was quite powerful enough to control the neon lamp. I think a vision of 3 L.S.6A's in parallel, or something like that, dissuades many people from making a 'televisor,' and this fallacy is supported by many contributors even to TELEVISION. Further, a very simple receiver was used, consisting of grid detector (with a moderate amount of reaction, the tuned circuit being heavily damped by the aerial), two resistance coupled L.F. stages, the last coupled by a transformer (R. I. Hypermu with parallel feed) to the P.625."

W. C. F.

Television Society

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buted in the surrounding silver bromide lattice, where foreign substances are imbedded. But, owing to the increased positive charge of the silver-sulphide speck, the ionic forces will soon tend to set up a new atomic equilibrium ; electrolytic deposition will necessarily follow. The electrolysis of crystallised silver halides and their mixtures has been studied by Kohlrausch, Lehmann, Lorenz, Czepinski, Tubandt, Benrath and Wainoff, and in all these cases, Faraday's law for electrolysis was found to hold. It is interesting to note that only one ion moves, namely, the Kation.

In television, with our photo-conducting or photo-electric cells, we are attempting to follow the response of a photographic emulsion, so as to produce a continuous picture of light changes.

* * *

Society Notes of the Month

The members will *NOT* hold their usual monthly meeting on the first Tuesday evening in March as the date of the Annual Meeting falls shortly afterwards. This year the Second Annual General Meeting is being held on TUESDAY, MARCH 18TH, at University College, Gower Street, London, W.C.1, at 6.0 p.m., followed at 6.30 p.m. by the Presidential Address, to be delivered by Sir Ambrose Fleming in the Botanical Theatre at the College, on the subject : "The Relation of Governments to Invention." All Fellows, Associates and Students of the Society will have received tickets admitting them to this meeting ; ADMISSION IS BY TICKET ONLY and the few tickets that remain undistributed will be gladly sent to those interested if early application is made to the Head Office of the Society.

The next meeting following the Annual General Meeting is that on Tuesday, April 1st, at the Engineers' Club, when Dr. T. H. Harrison, B.Sc., A.Inst.P., addresses the members on the subject of "Photo-electric Cells and their Applications." This meeting is at 8.0 p.m., and will be preceded at 7.0 p.m. by an Informal Discussion of Mr. G. P. Barnard's very instructive paper on "Selenium," delivered at the February meeting. The date of the Second Annual Exhibition of members' work has not yet (at the time of going to press) been definitely fixed, but it will be HELD EARLY IN APRIL and all members are asked to give their support. In this connection, the Council has pleasure in announcing that Capt. B. S. Tuke has generously presented to the Society a silver challenge cup, which will be awarded annually to the member showing the best exhibit in relation to television at the exhibition.

J. J. DENTON, A.M.I.E.E.,
W. G. W. MITCHELL, B.Sc.,
Joint Secretaries.

"Television will be a boon to the police in the stamping out of crime," asserts a newspaper. Those sensitive photo-electric *cells*.

Television for the Beginner

PART III

By *John W. Woodford*

WE left off our subject last month by gravitating to the receiving end and learning that the light flashes of a neon lamp when coupled to a wireless receiving set tuned in to a television signal represented an electrical equivalent of what was occurring at the transmission studio. Our aim is now to assimilate generally the conditions that must be met in order to transform these signals into an intelligible picture.

The Right Light

I can appreciate that this may seem to you a difficult proposition. Someone said to me the other day: "Although I have not got a technical mind I can understand fairly well how we get wireless speech and music, but to talk of human features coming over the wireless is beyond my comprehension." I sympathised with this friend, and then went on to point out that it was really only a question of relative terms or relative effects. In both cases the material at our disposal at the transmitting end, whether speech or face, is turned into an equivalent electrical current with suitable apparatus and then reconverted back to physical quantities at the receiving end which can be made to influence the ear in one case and the eye in the other.

A "Picture Canvas"

As we saw last month, it is fairly obvious that we require a geometrically similar disc to that used at the transmitting end, and we also added the proviso that it must be revolving in step with the transmitting disc. Mounted behind the revolving disc so that the perforated holes pass across it, or we should say "scan it," from bottom to top is a neon lamp which glows. This particular lamp is really the "canvas" on which we build up our picture, and the reason for choosing such a lamp will be gone into when we analyse the receiving mechanism in greater detail later on.

The light from this glowing lamp reaches the eyes of the observer through the small disc holes. When the first hole of the transmitter disc allows a pencil or beam of light to explore the object so that a certain percentage of this light is reflected on to the photo electric cells, what happens at the receiving end? Why, we allow our disc to move its first hole across the lighted neon plate and we can see it bright in one spot and brighter or darker in another according to the flickering of the lamp.

Persistence of Vision

There must be perfect synchronism between transmitting and receiving discs, then the line or narrow channel viewed across the glowing plate varies in light intensity exactly as does the line explored across the object. But each hole explores a different section of the neon and we see a succession of these lines built up side by side to form an image possessing gradations of light and shade similar to the original object. This effect is brought about by a phenomenon known as persistence of vision.

It is a property which makes the whole image appear simultaneously instead of in a series of strips or even several still pictures. We experience the same effect when paying a visit to the cinema theatre. The actual film is made up from a long series of small photographs each of which portrays a motion just slightly removed from its immediate predecessor. With these run through the projector mechanism at a

The Baird Television Transmitter.

sufficiently rapid rate, that is, ten complete pictures or more in one second, the appearance on the screen is that of continuous motion and not a jerky sequence of still pictures speedily portrayed to the eye, which, of course, is what is actually happening.

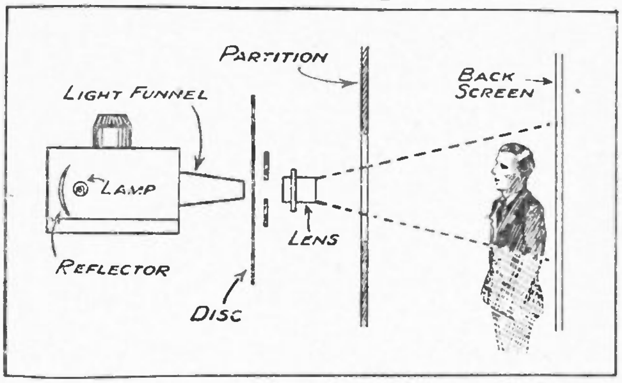


Fig. 1.—Sketch showing the arrangement of a Television Transmitter.

The Speed of the Disc

Therefore in our receiving apparatus we must revolve the disc at a rate fast enough to prevent the eye from dwelling on the mechanics of the process, and the speed generally used by the Baird Company is 750 revolutions per minute, corresponding to 12½ pictures in one second. The persistence of vision in the observer's eye then enables him to see the light flashes in their correct place rather than as a sequence.

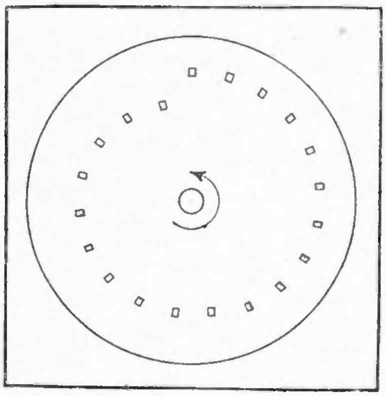


Fig. 2.—The Scanning Disc.

In just the same manner as a loud-speaker attached to a wireless set serves the ear, so we can look upon our revolving perforated disc and its associated neon lamp, which together recreate the image as serving the eye in a similar way.

This in general terms describes the whole television process by the Baird method and has, I hope, given the reader a mental picture enabling him to understand roughly the stages involved. It now becomes necessary to elaborate the scheme for it is in the more detailed explanation that we shall get a complete idea of how each piece of the apparatus is dovetailed in place and performs a part necessary to the whole.

The Need for the Amateur

Improvements are being effected veritably week by week, and this is where the resources of amateur co-operation will prove so useful. Our daily broadcasting of speech and music could never have reached such a stage of perfection in a comparatively brief space of time if it had not been for the unstinting help accorded by amateurs in both transmission and reception. A similar band of enthusiasts can perform the same thing with television once they understand its inner working.

It is advisable now to supplement the general working arrangement which has been described with a more intimate analysis of the parts of the apparatus, so we shall revert to the transmitting end once more.

The Transmitter Again

Since the holes in the transmitting disc are very minute, it follows that if we desire to force intense rays of light through them, then the source of illumination must be very brilliant. This is provided by a special type of metal filament projector lamp or, alternatively, an arc lamp. Behind this lamp is positioned a reflector which can be adjusted to concentrate the light down the funnel of the metal container which houses both lamp and reflector.

An examination of one of the accompanying photographs will give an excellent impression of one standardised form of Baird transmitting table, the case and funnel being clearly visible on the large flat metal top. The switches and meters are for the purpose of controlling the electrical supply to the lamp and transmitter motor.

As the rectangular beam of light emerges from the funnel it plays upon the flat metal disc, which is made heavy so that it acts as a flywheel and thus tends to run at a constant speed. The diagram Fig. 1 shows a section of the arrangement we are describing, and this, together with the photograph, should make the explanation quite clear. The scanning disc has 30 square holes pierced in it near the periphery, and these are arranged in the form of a spiral somewhat as indicated in Fig. 2. They have equal angular displacements around the disc, the outer edge of one hole being on the same circumferential arc as the inner edge of the next hole, and so on all round.

The beam of light from the funnel is correctly positioned with reference to the disc, so that each hole passes through the light and a ray is thrown on to a large white back screen by each hole in turn. With the aid of a focussing lens the person or object seated or placed in front of the screen has the light rays accurately focussed on him.

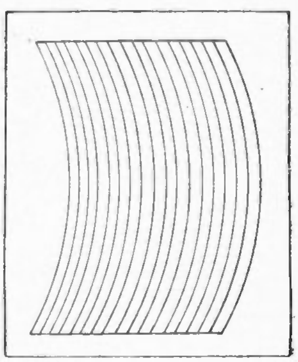


Fig. 3.—How the image is scanned.

Thus if the disc was stopped, a small clean-cut square area of light would illuminate a tiny section of his features, although it is appreciated that this adjustment must perforce be a "mean" one, owing to the presence of "depth" in nearly every surface of a televised object. A partition is placed between the disc and the televised object (see Fig. 1), and the photo-electric cells are shown mounted above an aperture in this partition, as was illustrated in the photograph accompanying last month's article. No direct light must influence the delicate cells, but only that reflected from the surface purposely illuminated by the travelling light spot.

Why Use Square Holes?

Some readers may query why the shape of the hole is square. Would not a round hole be equally effective, or even one which possesses any shape, provided it allows light to pass through it? Looked at from the point of view of the passage of the greatest amount of light for a given area, then obviously a square hole is best suited, and this is the one generally employed.

As the disc revolves it will cause the light strips passing through the holes to cover a definite shaped light area somewhat as indicated in Fig. 3. If we turn back to Fig. 1 it will be clear that the actual size of the light area on the back screen is dependent not only upon the distance between the lens and the screen but also upon the difference of the radii between the first and last holes and the circumferential distance between each hole. See accompanying photograph for an impression of how a subject is illuminated by the travelling light spot.

Photograph of an announcer at the Baird Company's studio being televised. The microphone is seen on the right.

It is arranged that the direction of rotation of the disc and the position of the fixed light source with reference to the disc is such that the scanning operation starts in the bottom right-hand corner of the area of Fig. 3. Each spot then moves from the bottom to the top of the picture as a strip, and each strip is marked out on the left of its predecessor until one revolution is completed. Always bear in mind, then, that the scanning or exploration is effected in two directions, from bottom to top and right to left. This is an important point, as we shall see later on in this series.

Good News

(*Concluded from page 15*)

models, and came to the unanimous conclusion that this was the neatest of them all.

Readers who have followed my articles will acquit me of any tendency to exaggerate; on the contrary I prefer to err on the side of caution, and would point out to my friends and readers that a wireless receiver is necessary, in conjunction with this "Televisor," in order to obtain reception. Obviously, a good many readers will be in possession of wireless receiving sets powerful enough to be used in conjunction with the "Televisor," but this I warn you necessitates certain changes which may not be within the competence of every amateur to accomplish. However, I have made arrangements with the Baird Company to supply readers of this magazine who desire to try their hand at accommodating their receivers to the needs of the "Televisor," with a blue print. If they will send a stamped addressed envelope this blue print will be forwarded to them in strict rotation.

The past month or two has resulted in activity further afield. General Russell comes back from Berlin with a very interesting report—a report that interested me particularly, since I had something to do with the inception of Baird television in Germany. Then Lord Angus Kennedy tells me of the extraordinary enthusiasm which his demonstration in Glasgow aroused among the thousands who attended the exhibition purposely to see television; while I myself can add personal testimony, after a visit to Paris, of the immense amount of interest which is taken in the Baird process in France.

Now all that one needs is for friends and critics alike to band together and help to put this thing over beyond all possible doubt.

Now if those critics who were in the forefront of the fight in the past will divert their critical faculties towards offering constructive and helpful criticism I shall be immensely gratified, and I am sure no one will be more pleased than Mr. Baird himself.

Scotland sees Television!

By *Lord Angus Kennedy*

Vice-President of the Television Society.

THE first public demonstration of television in Scotland was given at the Kelvin Hall, Glasgow, where the first Wireless and Electrical Engineering Exhibition was being held. It started on January 29th and closed on February 8th. Lady Inverclyde opened the Exhibition, Sir David Mason (late Lord Provost) taking the chair. All the speakers alluded to television as the principal attraction. Captain Turner, a consulting radio engineer, in moving a vote of thanks to Mr. Mungo, the promoter of the Exhibition, paid a high tribute to the work of Mr. J. L. Baird.

There was a great rush to obtain tickets for a television demonstration as soon as the Exhibition was declared open. These were sold at 6d. each. The first to attend the demonstrations were Lord and Lady Inverclyde, Sir David and Lady Mason, and a party of friends. Lady Inverclyde was televised, and her friends expressed the greatest surprise at seeing her face and hearing her voice at the televisors. She had a very good television face!

On the opening day it was found impossible to cope with all the people who were anxious to have a demonstration, which took the form of a brief announcement describing what was taking place, a song from a lady artist, concluded by a short demonstration of telelogography, and portrait of the inventor.

In order to deal with the large number of people who were anxious to see television, the demonstrations in the afternoon and evening had to be of shorter duration. An average of over 1,000 people per day saw demonstrations.

The enthusiasm expressed by many of the visitors would be hard to describe. Mr. Baird has certainly many warm supporters on the banks of the Clyde, and the new science caused great interest among all classes. Among some of the visitors were: Lord and Lady Inverclyde, Hon. Cameron and Mrs. Corbett, Sir David and Lady Mason, Lady Lorimer, Wallace Fairweather, Esq., D.L., Sir Thomas and Lady Dunlop, Sir John Reid, Sir Hugh Reid, Prof. Magnus Maclean, Prof. Gray, and a number of prominent wireless engineers. Several well-known singers were also present, including Mr. Alexander McGregor, and many actors and actresses, among whom was Miss Emma Haig, and Mr. Tommy Lorne.

At the close of the Exhibition Mr. Mungo (the promoter) awarded a medal to Mr. Baird who was, unfortunately, unable to be present through illness. The Scottish Press were unanimous in their praise of the demonstrations and the Rev. Mr. McLellan preached a sermon at Trinity Church on Sunday evening, February 2nd, in which he took for his subject the work of Mr. J. L. Baird, Mr. Mungo, having briefly described from the pulpit what television was, and given a short account of the demonstrations that were taking place. There was a congregation of approximately 1,000 people, who seemed deeply interested.

Many of the more technically minded visitors took advantage of the fact that the studio and the control room had a glass window which enabled them to see not only the studio, but the transmitter as well, and many took a keen interest in the method of transmission which was done by land line. It appeared to me that there is a very strong feeling in Scotland that Mr. Baird's invention should be broadcast from a Scottish station. Now that the B.B.C. are about to grant a two-wave length broadcast in England, and the commercial machines are coming on the market, it will undoubtedly seem an injustice if Scotsmen are to be denied the privilege of benefiting from their fellow-countryman's invention.

Glasgow and the surrounding district has produced many great men who have left their mark on the World of Science. Did not Sir John Reith himself come from there? I understand that the feeling so often expressed, that Scotland is not fairly treated in the matter of broadcasting, will be remedied when the new regional station near Falkirk is opened, but undoubtedly some enthusiasts will think this is too long to wait for television.

A group in the Television Studio in Glasgow. (Left to right) Lord Angus Kennedy, Alex McGregor (well-known baritone), Miss Ian McLelan, Miss Lilian Hamer.

Platinum

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

Fellow of the Television Society

THE pursuit of any hobby, however remotely connected with electricity, comes at some time in contact with the metal platinum. It is in more than one of its properties almost unique in the aid which it gives to the electrician.

Platinum is an element which occurs in the eighth group of the periodic table. The elements in this group exhibit a peculiar arrangement, being grouped in three sets of three elements each. One such group is formed by iron, cobalt, and nickel, another consists of rhuthenium, rhodium, and palladium, while the last triad contains osmium, iridium, and platinum.

These triads are distinguished from other such groups of elements by the fact that their atomic weights are almost the same, as is instanced for the platinum group thus :—

Element.	Symbol.	Atomic Weight.
Osmium	Os	190·9
Iridium	Ir	193·1
Platinum	Pt	195·2

As usual, all members of the group have many physical and chemical properties very closely related.

The platinum group of metals seems to have been known rather vaguely in classical times, but it is usual to date its discovery much later, as the use of the metal is first known of in South America. It was there considered to be worthless, and, owing to its specific gravity being very close to that of gold, was used for adulterating this noble metal. The Spaniards even suppressed its export, and presumably used it themselves at a cost of about eight shillings per ounce !

Native platinum made its first appearance in Europe in 1735, and was described as a new metal by the English physicist Watson in 1750. It attracted considerable attention at the time, but it was not until considerably later that its many valuable properties were appreciated. It takes its name from the diminutive of the Spanish word *plata*, meaning silver, owing to its whitish colour, which also gives it its miner's name of " white gold."

It is found in the so-called platinum ores, usually alloyed with other members of the group, as small grains or scales, and sometimes as nuggets. The biggest nugget of which there is any record weighed about 20 lbs. Although it has been found associated with definite rock deposits, the main sources are among deposits of debris which give evidence of having been transported some distance from their source. Two forms of native platinum are recognised, one being magnetic, and may even display polarity, while the other is non-magnetic, and has a higher density. The magnetic properties seem in some way to be connected with the iron content of the native product, but it is not a direct relationship.

Sources of Platinum

Platinum is found in Brazil, and was discovered in the Ural regions in 1819, from which the main supplies are derived at present. Lapland, Borneo, New Zealand, New South Wales, British Columbia, the Yukon sands and those of the Rhine, Spain, and County Wicklow, Ireland, can also claim supplies of platinum ores.

The native platinum as found in its ores has a variable composition. Typical analyses vary from a content of platinum ranging from 86 per cent. in a Ural deposit to 46 per cent. in a Spanish one. A typical analysis of the British Columbia product is given below :—

	Per cent.
Platinum	76·82
Iron	7·20
Palladium	0·50
Rhuthenium	1·22
Iridium	0·85
Copper	0·60
Osmiridium	0·95
Gold	1·00
Sand or gangue	0·95

The native platinum is washed out of the sand and gravel in which it is found, much in the same way as gold is " panned " from an auriferous sand. In the Urals the gold mixed with it, which appears in the platinum concentrates, is removed by repeated amalgamation with mercury. The product obtained in this way is usually exported in its crude condition, and for many purposes is quite pure enough for use.

Refining to obtain a purified process consists of the dissolving of the native product in aqua regia by prolonged digestion. The solution is diluted and filtered and then evaporated to a syrup. Hydro-

(*Continued on page* 46)

Feminine Reflections

Television Fashion Lessons

The Super-Modern Miss Finds her Heaven

By *Nancy Debenham*

LIFE'S 'ard! We order frocks that touch the ground at the back and sides and within a few days we find that smart Paris is wearing trailing, clinging creations that sweep our toes, and that our silver slippers should dart like finny fishes from a froth of lace and frills.

We gloomily murder our dressmakers and in a state of despair turn to these latest modes. Nobody can make them! We look hideous. Like unruly ghosts. Like children dressed up. Like sacks tied in the middle. In fact, like anything but modish young women.

Fickle Fashion

Shaped "bodices," waists, flowing skirts and trailing draperies are not made for the stay-at-homes; a visit to Paris, and an extensive course of lessons on "how to dress" are needed in every home during the year 1930.

We sigh in vain for the little-boy fashions of a year ago—but it's no use.

But wait!

A blinding ray of sunshine lightens our gloom.

Why *should* we have to journey to Paris for our new frocks; why indeed? When Paris can come to us on the screen of the televisor!

Fashions are the most suitable subjects on this earth for television; I have always felt I would like to run my own private mannequin show. I want to be able to sit by my fireside and study at my leisure the intricacies of the latest godets, flares and hip-yokes.

In a very short time I am sure it will be possible to see a complete pageant of to-morrow's fashions on the televisor, broadcast direct from designer to wearer, and we shall all take out our little scissors and snip and snip as the secrets are revealed on the screen.

A soothing, masculine voice with a delicious Parisian accent will explain to us exactly what suits our particular type, and no longer will short fat women wear frills, or long thin women wear "fishtail" draperies. At least, we hope not!

Intimate Broadcasting

I spent half an hour in Mr. Baird's experimental studio recently and was struck by the unhurried smoothness of the pictures on the screen; there is something so intimate, so human about television, that I am sure fashion lessons, hairdressing demonstrations and lessons in massage and manicure would be exceedingly popular.

The young man who demonstrated for us was so real I almost started asking him questions as he talked to us from the screen. He had a mobile face, and every change of expression was faithfully recorded; the whites of the eyes and the details of the features were perfectly clear.

A pretty fair-haired girl took his place afterwards, and it was her nicely waved, not-too-short thatch that made me wish I could have a weekly lesson in hairdressing when I buy my nice new television set.

I hope the people who are spending many long hours in experiments for the good of television "fans" will remember all these poor, lonely, badly dressed women when compiling their programmes.

As one of the aforesaid poor lonely, etc., etcetras, I beg them to be intimate; we can put up with subjects of general interest, such as the making of salmon-flies or the life of a caterpillar, provided they also give us our own subjects; after all, if our husbands don't like them they can always go and clean their golf clubs until they are over, and such subjects *would* keep us good-tempered.

Besides, think of the money we should save through our television lessons (perhaps!).

They Wouldn't Like It

Mind you—I can think of plenty of people who would be most upset at the idea of revealing the secrets of their little world to thousands of television "See-ers-in" (I *can't* make that look right!), but it will be "up to" the broadcast people to bribe dressmakers, hairdressers, beauty specialists and others into their way of thinking.

It will, eventually, create new careers for them; but that is really the subject of another article, so we will leave it at that.

Book Review

"Experimental Radio" and "Fundamentals of Radio"

By R. R. Ramsey, *Ph.D.*

When historians come to consider the present age probably one of the things which will stand out before all others will be the tremendous appeal, as a hobby, which wireless has made to all classes. The striking thing about it is that the alternating currents which play so large a part in wireless represent the most complicated and tricky part of all electrical engineering.

The breakaway from the age when sticking stamps or pieces of broken pottery on drain pipes or plates, or the production of fretwork and wool mats was considered a suitable hobby for a man, is complete. Capacities, inductance, resistance, H.F., and a host of other terms are now commonplaces of everyday conversation, but very few of the persons who use such terms could define them or tell how they are measured.

The fault in most cases does not lie with the amateurs, but with the technical writers, for most books produced on electricity are either so elementary that they tell the average amateur nothing, or else they are so severely technical that no one but university professors can make anything of them. Under the circumstance any book that attempts to fill the gap and supply a long-felt need is welcome.

In this connection two useful books have recently been published from the pen of R. R. Ramsey, Ph.D., of America, by the Ramsey Publishing Company, Bloomington, Indiana, U.S.A.

"Experimental Radio" (price $2.75, post free), now in its third edition, is purely a laboratory manual of radio experiments, and gives instructions for 128 experiments illustrated by 168 figures and diagrams. It is bound in cloth, has 255 pages, and is a convenient size for the pocket or work bench.

"Fundamentals of Radio" (price $3.50, post free) is a more pretentious book of 372 pages with 402 illustrations and diagrams, and is described as an elementary text-book for college students. In his preface the author explains that he has endeavoured to give the basic theory of radio as it is exemplified in modern practice.

Both books cover practically the same ground, but whereas "Experimental Radio" merely describes the experiment, and then says "measure so and so and compare," or words to that effect, "Fundamentals of Radio" enters into a little more explanation of the terms used.

If anything, both books fail to a certain extent fully to meet either the requirements of the amateur who wants to know or the more experienced worker who wants to delve to the bottom of and fully understand the phenomena with which he is working. No one, without some knowledge of algebra, can understand or work out the mathematics given in either book—that knowledge the author assumes—but if such a reader is prepared to dodge the figures, signs and symbols, a reasonable idea of the why and wherefore of wireless procedure can be gained. Each book starts with the simple process of testing cells, and by easy stages deals with every class of wireless measurement up to the tricky business of measuring the field strength of a station. Every step is explained and the circuit arrangements illustrated with diagrams. In many cases instructions for the building of suitable apparatus for the experiment or test is given.

In one particular only might one find serious fault with both books. To calculate the internal resistance of a battery, either accumulator or dry cell, small or large, it is stated that a low resistance ammeter of about 01 ·ohm resistance should be connected directly across the terminals of the battery. At the end of the paragraph in each case it is mentioned that the connection should be made for as brief a time as possible as short-circuiting a cell tends to ruin it. As the connection has to be made for at least an appreciable period of time to get anything like a true reading, it would have been better if the author had given the warning first and pointed out that the test should not be applied to cells that were to be used for any other purpose.

It may, as he points out in the case of "Fundamentals of Radio," be "the general practice in America to test dry cells by short-circuiting them through an ammeter," but no person who has to buy his own cells and knows anything about the use of them, or who wants to use his ammeter again for another purpose, would dream of applying such a drastic test.

This example unhappily comes early in each book, and tends to give one a false impression of what can otherwise be fairly described as useful additions to the wireless amateur's library.

"PHOTO-ELECTRIC CELLS." By Dr. Norman R. Campbell and Dorothy Ritchie. Sir Isaac Pitman & Sons, Ltd. 1929. Price 15s. Pp. 209.

The authors of this book are both members of the research staff of the General Electric Co., and are thus in an unique position to give their readers a wealth of information at first hand on the practical side of the subject of photo-electricity.

The book is divided into three sections, which we will consider in turn. The first hundred pages are devoted to an outline of photo-electric theory, to which the non-technical reader is introduced by "A General Survey." It is unfortunate that the discovery of the photo-electric effect is wrongly attributed to Hallwachs, for though he was a pioneer, Hertz's fundamental work is always recognised as the discovery of the effect.

In the following chapters the theoretical side of the subject is covered fairly completely, though the treatment is acknowledged by the authors in the preface to be somewhat scanty. To my mind, it would have been better if certain points had been enlarged upon; for instance, in discussing the "threshhold," the derivation of equation (1) from the more usual quantum expression $E = h\nu$, together with a fuller account of quantum theory would have been of advantage.

A large number of the very excellent graphs have been prepared from the authors' own data, and can certainly be taken as representative of the very latest ideas on the subject. So much work has been done in this field during the last few years that theories of five or ten years ago are now shown to be unsound. The present volume is certainly most up to date. Complicated mathematics finds no place in this book, which is designed to interest all from the wireless amateur to the professional physicist.

The use of photo cells is admirably dealt with in the second part of the work. Never before has so complete an account been available in one volume. At the same time, no words are wasted, and a knowledge of radio principles is assumed. A rather serious error has been overlooked on page 145. A few lines from the bottom $E_0 r_+$ and $E_0 r_-$ are given for the anode and cell voltages of a particularly interesting and useful circuit. These should read $E_0 r_+/(r_+ + r_-)$ and $E_0 r_-/(r_+ + r_-)$.

Lastly, the applications of these cells to the measurement of luminous flux, illumination, colour and absorption are dealt with. I feel that here again, perhaps more than in the first part, a fuller treatment would have been of advantage. Several methods of colour matching, automatic titration, etc., have been published, and I should have liked to have seen them included here, along with some circuit diagrams of the proposed apparatus.

Lest it seem that I have been unduly critical, let me say that I consider the book, on the whole, as excellent, and despite the shortcomings indicated above, one which every television experimenter should have to hand at all times. The diagrams are uniformly excellent, and the printing clear and particularly free from errors.

Platinum

(Concluded from page 43.)

chloric acid is added, and the mixture evaporated to dryness and heated to 150° C. The residue is dissolved, and the platinum precipitated as ammonium chloroplatinate $(NH_4)_2 PtC_{16}$. This is separated, washed, and heated to redness, when a spongy mass of platinum is obtained. This may be made into a paste with water, compressed into moulds, and forged by hammering and heating into massive blocks, or it may be fused in a oxyhydrogen furnace.

Such an outline of the purification is much modified in practice by numerous processes strictly preserved as trade secrets. The commercial product still contains about 2 per cent. of iridium, which is not a disadvantage for the general uses to which platinum is put. To obtain a completely pure product is a complicated business, because the properties of platinum and iridium and their compounds are so much alike.

Characteristics of Platinum

Platinum is a silver-white metal which will take a high polish. It is a little harder than silver, but does not tarnish in the air. It is malleable and ductile, being able to be drawn out into thin wires and hammered into thin foil. When alloyed with a little iridium its hardness is increased, but its ductility is reduced. If the iridium content is over 20 per cent. the alloy becomes very difficult to work.

The density of native platinum varies from 14 to 19 gm. per c.cm., and that of pure platinum varies with its physical condition—being in the region of 20 to 21 gm. per c.cm. Its coefficient of expansion is 0·0000089 between 0° C. and 100° C. This figure is almost identical with that of the coefficient of expansion of glass. This makes it possible to seal platinum wires with glass, and when such a seal is cooled an air-tight joint, without internal strain, is obtained.

The melting point of platinum is given as 1753° C., and it is this high melting point coupled with its high resistance to chemical attack by the atmosphere which fits the metal for such uses as sparking- and contact-points in electrical apparatus.

The metal also resists the attack of all acids except aqua regia, and so finds many uses for the construction of vessels designed for use with corrosive liquids. Its resistance varies fairly regularly with temperature, and hence it is used for the widenings on electrical thermometers. It finds many uses as a catalytic agent in chemical processes, notably in the contact process for the manufacture of sulphuric acid. Possibly its greatest use is in dentistry and the making of jewellery.

Platinum is very expensive, mainly owing to monopolies in its production, and so various substitutes are in use, the best known of which are alloys of platinum and gold. Gold in a pure state is the only solder for platinum.

Television

(The following article is reprinted from the January 25th issue of " The New Statesman " by kind permission.)

APPLIED science has accomplished such miracles in the last half century that we are no longer disposed to recognise any arbitrary limits to its possibilities. Broadcasting, in particular, has made vast additions to the amenities of life. The B.B.C. programmes do not loom very large in the life of a Londoner who possesses a fair income and is in the prime of life; for he can usually contrive to attend in person any events which arouse his interest, from a concert to a coronation. But the vast majority of the population formerly suffered from various forms of isolation which broadcasting has modified to an enormous degree, and upon these " isolated " persons the B.B.C. has conferred incalculable benefits. Blind and sick people probably receive the maximum benefit from the programmes; many a prisoner in a lonely room has found life fundamentally transformed by the small mahogany case which houses a portable wireless receiver. Others, whose incomes are small, or who compulsorily reside in districts where a penny reading at the village hall is the sole public amenity, regard the B.B.C. with an almost adoring affection.

It is true, on the one hand, that the B.B.C. has displayed real genius in utilising the single factor of sound. There are, indeed, many competent and distinguished people whose personality and magnetism evaporate almost completely when one is set to hear them, but cannot see them. It is equally true that many occasions and many spectacles lose most of their value when they are merely " overheard " by an enthusiast who is to all intents and purposes temporarily blind, because he is listening out of visual range. But the B.B.C. have accomplished a very great deal with this one sense of hearing. If they can ever wed sight to hearing in their programmes, they will multiply the benefits most enormously. Consequently, their more grateful and appreciative licensees experienced no mean thrill when they heard that the Baird television interests had been allotted restricted facilities for broadcasting sight. There has latterly been something of a reaction. At present no television receivers are purchaseable, although it is announced that a thousand sets will be offered at perhaps £25 apiece during February next. Listeners recall the history of the Fultograph picture transmissions. For some months the B.B.C. broadcasted still pictures for half an hour after the luncheon interval. Four small and rather smeary pictures—fashion plates, portraits, newspaper cartoons and the like—could be received on damp paper in half an hour by a tolerably adept enthusiast equipped with a moderately expensive apparatus. The system possessed obvious commercial applications, and was never without value to the newspaper editor and to the police. But from the standpoint of the general public, it was not more than a scientific toy. And the public is now wondering whether the Baird televisor is just another scientific toy: or whether, perhaps, it is ultimately going to add to the true amenities of life for everybody who suffers from any marked degree of what I have called " isolation." In other words, whether in a not too distant future a silvered screen may supersede a mirror overmantel in our homes, and on that screen we may hope to see kings being crowned, treaties being signed, test matches won or lost, and the notables of the world engaged in the major transactions of history. Everybody knows that no such revolution is within human grasp at the moment. But a decade ago popular wireless amounted to no more than delicate experiments with a fine wire against a small crystal, which on occasion created an infinitely faint tippety-tap in a pair of headphones, reminiscent of a mouse squeaking under the floor; if the listener could read the Morse code, and perhaps further possessed the key to a shorthand cipher, he might laboriously decipher some press or shipping message. To-day the science of wireless has progressed so far that he can make his dwelling quiver with the mighty chords of a famous orchestra; and the product will be musically satisfactory. Is television destined to equal this lightning development?

No dogmatic answer is possible at the moment, any more than the pioneers of the crystal and the coherer ventured to dogmatise prophetically about the swift results of their particular researches. It is only possible to state what has already been achieved, and to draw tentative parallels with the history of other sciences applied to popular entertainment. A few years ago we suffered from aching eyeballs after watching the first crude cinema films, which mercifully ran for no more than a beggarly ten minutes. To-day we sit in a hall with 3,000 spell-bound people, and listen to the " talkie " " Trial of Mary Dugan." A few years ago we picked up the evening press bulletin from the Eiffel Tower if the cat's-whisker could find a congenial " spot " on our fragment of felspar. To-day we do not particularly care whether we listen to a Queen's Hall concert in our own houses or in Langham Place. A similar evolution may occur in television; or it may not. Half a dozen brilliant improvisations, five years of meticulous spade work, and that silvered overmantel may figure in every house; or conceivably the televisor may take permanent rank with the Fultograph as a laboratory toy, or as an instrument with restricted technical applications. No man really knows. But capital, science and even officialdom seem to be on the side of the angels, and perhaps the hope of the " isolated " Britons that vision may yet supplement hearing in lonely homes will not be wholly frustrated.

With this preface let me describe what is already in being. In the Baird studios at Long Acre a draped and darkened room contains a chair. In this chair every morning from 11 to 11.30 members of the staff take their seat. They adjust their position so that head and neck are reflected in a small mirror, mounted above and before them at a suitable angle. The whirr of a small electric motor is heard and a spot of light plays rapidly over their features. What it records is transferred by land line to Brookman's Park and thence radiated. Conditions being favourable, any person equipped with suitable apparatus and operating the apparatus within some such range as the distance between Berlin and London, will receive the transmission. A typical television receiver will consist of a cabinet approximately 3 ft. wide, 2 ft. high and 1 ft. thick. In the panel is mounted a lens resembling a ship's porthole. Gazing into this porthole in a partially darkened room, the observer will see the person who is being televised. Every detail of the bust will be absolutely recognisable. The actual size of the portrait may not be much larger than a cigarette card, but as it is viewed through a lens an observer who stands well back will naturally see a larger picture, and it is obviously possible to project the image on to a screen, as is already done with the tiny films which are the matrix of a cinema show—experiments in this direction are well in hand. Technically, the image does not yet compare at all favourably with film reproduction. The details are there and are as exact as one could wish: it would be a simple matter, viewing the same person from day to day, to detect a new pimple. But substantial defects are discernible. The image is viewed as if through a screen of black gauze travelling at speed from left to right past the image, and the "gauze" is interspersed with dark vertical streaks. This gauze effect may be largely due to electrical interference—arcs, lifts, motors and the like; but such interference may be as difficult to eliminate as the interference of "atmospherics" with broadcast programmes. The image is suffused with a reddish light, originating from the neon tube of the installation. The image itself "wanders" slowly up and down a few inches in an oscillating fashion, a defect admittedly due to a certain crudity in the synchronisation of the revolving discs, which are electrically pulled into step at each revolution. There are no defects here but such as are instantly comparable to the original defects of the cinema and the wireless receiver—defects which have been swiftly eliminated for the most part by painstaking research and brilliant invention. Television has far to go before we can watch the Wimbledon tennis finals on an overmantel screen with any pleasure; but within our lifetimes the cinema and wireless were equally inchoate. A few years ago scientific opinion was guarded and capital was shy in respect of both these latter methods of applying science to the entertainment and instruction of the public. It would be foolish to cherish any violent optimism about television at the present moment. It would probably be more foolish to depreciate its possibilities. The scientific toy of to-day is often the valuable commonplace of to-morrow. All over the world, especially in Berlin and America and France, competent brains are busy with the problems which remain unsolved. In none of the centres of development is capital displaying its normal and intrinsic timidity. In none of these centres is officialdom callous and contemptuous, as has too often been its wont. The Baird system is perhaps the only system which can claim any really important public achievement. But it is not the only system. Other inventors consider, rightly or wrongly, that television has not yet emerged from the laboratory stage, and that it is a blunder to seek publicity when at any moment some revolutionary discovery may render all past achievement nugatory. But it is at least true to say that the Baird system is already an entrancing scientific toy, pregnant with thrilling possibilities.

It may serve to cast readers into the proper mental attitude if I conclude by describing a side line of the Baird people which is far more uncanny, and which they call by the uncouth name of Noctovision. A man sits in an absolutely dark room before a special instrument. An observer, furnished with the appropriate receiver, watches at a distance of 500 miles, if you wish. He can recognise the sitter in the dark room, and observe his every gesture, facial expression and action. Infra-red rays are harnessed for the purposes of this remarkable transmission. It only remains to add that audible transmission can be coupled with the visual transmission. If the transmitter is given the use of an adequate band of wavelengths, it is a simple matter for one and the same receiver to display a moving picture of a vocalist, coupled with perfect reproduction of the song.

GEOFFREY WEALD.

Television and the Empire.

(*Concluded from page 27.*)

foreseeing television as the greatest *unifying* force the Empire has yet had at its disposal.

There are those, I know, who will think that the picture, as I have tried to draw it, is altogether too optimistic; that the technical obstacles in the way of television development will render progress very slow and painful. There are difficulties, but they are there to overcome, and already we have a hint which encourages our highest hopes.

The writer believes that before long it will be necessary for us to change very considerably our views as to the nature of wireless waves. Interlocked with this change he foresees an *amazing* opportunity for the development of television as an instrument for Empire consolidation. It is only a hint, but the passing of time will make its significance clear.

Is it too much to ask that those in authority shall seek an early opportunity for making themselves *au fait* with the situation and become identified at the earliest possible moment with the progress of a scientific invention which is fraught with such possibilities for the future welfare of the Empire? If they will do this, there is no reason why the leading maritime nation should not take the lead in the wider Empire of the Ether.

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.*

AMATEUR'S RESULTS.

To the Editor of Television.

Dear Sir,—I noticed in the December issue of your magazine that you invited reports from your readers on their success with the television broadcasts, and the following may be of interest.

I have endeavoured to pick up such transmissions as were going since last February on a 30-hole disc with a $1 : 1\frac{3}{4}$ ratio, but without results worth recording until the London station started transmitting.

I then made up a disc from 24 s.w.g. aluminium to the dimensions given by Mr. A. A. Waters.

On attending a lecture at the meeting of the Institute of Wireless Technology, one of the Baird Co.'s engineers stated in answer to a question from me that the picture ratio employed is 3 : 7 and that the ratio is width of the picture to the length of the longer side.

He also stated that the present disc used with the new system of synchronising was 20 in. diameter and ran at $12\frac{1}{2}$ r. per sec. He further made it clear on further questioning that the length of the picture was taken as 70 units and was the strip length of the longer side and not the chordal pitch or distance from centre to centre of points spaced on a circle.

I accordingly modified the 20 in. disc already made to the 3 : 7 ratio.

The holes, starting on an $8\frac{1}{2}$ in. circle and finishing on a $9\frac{1}{2}$, were filled up and fresh ones made.

Given a 10 in. radius disc, at least $\frac{1}{4}$ in. is necessary before the first hole, and this fixes this outside dimension at $9\frac{3}{4}$ in. radius. The chordal pitch given, 12° or 30 divisions, = 2·038 in., and the measurement round the longest strip $2\frac{1}{24}$ in., which fixes the width at $\frac{7}{8}$ in.

The disc was, therefore, marked out $8\frac{7}{8}$ in. inside circle and $9\frac{3}{4}$ in. outside circle, and a square drift made for squaring the apertures after drilling.

The disc was also considerably lightened by cutting five holes 5 in. diameter.

This was then given a trial, and the results were such as to show that the correct proportions were arrived at, but the illumination and detail of the image was not good. I consequently paid a visit to the Baird Co. laboratory and enquired if a proper plate type neon tube was procurable and explained what results I had obtained up to then. They received me with great courtesy and supplied me with a tube to test. (These cost 25s.)

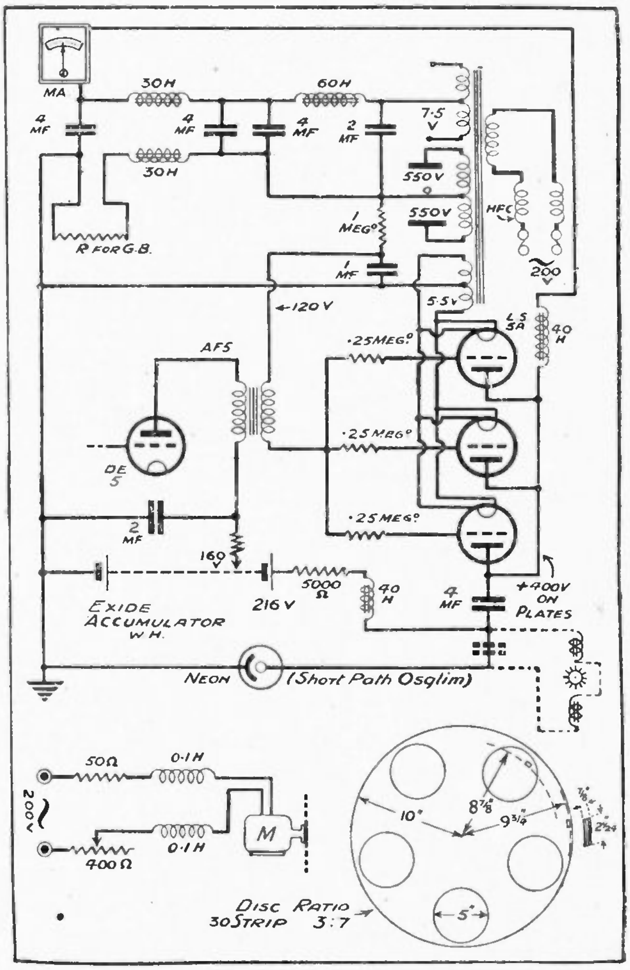
They also staged a special demonstration on one of their televisors to show me what the image should look like. Although I have been a reader of your paper from its inception, and expected recognisable results, I was really astonished at what I saw.

I have since then picked up very good images on my own televisor, and had I not seen how good it could be I should be extremely pleased with my results.

On my receiver the image is viewed through two 6 in. condensing lenses taken from an old projector and give an apparent size of about $3\frac{1}{2}$ in., but being plano-convex instead of concave there is distortion, due to the lenses if magnified up more than this.

It is possible to see such details as a man's fingers, and, of course, any movement, such as smoking, opening the mouth, etc., can be followed.

When there are two faces on view together, the details are bad; also I cannot read letters held up,



The circuit diagram of Mr. Townson's Amplifier.

whereas at the Baird studio they were perfectly clear, as was also such detail as the light and shade on a man's hair.

I would warn all experimenters that it is wise to incorporate a fuse in the neon tube circuit, as a fit of absent-mindedness late at night was responsible for leaving out the series resistance when making a slight alteration to the nickel, with consequent serious damage to the neon tube. I have not yet fixed up a synchronising arrangement, as the Baird Co. have promised to let me have one very soon and also a Vidal motor such as they use themselves.

The circuit I am using is that used in the ordinary way for driving a moving coil speaker.

The H.T. is 550 volts 95 M.A. from two R.H.I. valves, and the output is from three LS5A's in parallel.

There is normally a S.G. H.F. valve, bottom band detector, with R.C. coupling 60,000 at ·05 μF. to a D.E.S. with a Ferranti A.F.5 coupling to the LS5A output valves.

The detail could possibly be improved by having an all R.C. amplifier with a diode detector, and this will be the next move. I give herewith a diagram of the actual connections, which may be of interest.

You will notice that H.T. accumulators are used for the first stages of the set, and also to supply ·008 amps, which is the current required to just give complete illumination of the plate before modulation by the television signal.

The choke seems to give freedom from back coupling due to the output affecting the H.T. voltage of the valves, but stopper resistances are inserted in all leads to make quite safe.

I have found it essential to insert a similar stopper resistance and condenser to the grid-bias lead from the inter-valve transformer to the 120-volt point of the eliminator circuit, as otherwise a hum manifests itself by a background of dull black lines.

My only grouse now with television is the uncomfortable hours of transmissions; also when one has patiently waited for 12 o'clock, a single half-hour is not long enough for any serious work.

Another small complaint, which will be the new grumble very soon, is what there is to see. Last Friday, a photo of the Prince of Wales was left there for 10 minutes or so, and, being without movement, was, after the first glance, without interest.

Wishing your paper every success.

L. T. TOWNSON.
(Townson & Mercer, Ltd., Scientific Apparatus Manufacturers.)

P.S.—*Re* new cover, I personally should prefer TELEVISION to drop the popular magazine cover and in for something similar to, say, *Experimental Wireless*, that is, without a cover that attracts attention if read in public.

Your paper in its new form is very good and a simple cover would give it dignity.

To the Editor of TELEVISION.

DEAR SIR,—Since reading the article on "How Amateurs are receiving the Television Broadcasts," in TELEVISION for February, I thought you might like to know how these broadcasts are received in this part of the country. I have been a keen reader of TELEVISION since its issue in March, 1927, and early in 1928 I determined to build some sort of receiving apparatus. I set to work and at much labour cut and drilled a 30-holed disc from heavy gauge aluminium. The cutting and drilling of this disc took me weeks to complete, for I could only do a little bit at nights, after school if home-work permitted, but considering the tools I used (a fine Swiss file with the butt-end as a drift) it has stood searching tests for accuracy exceedingly well. However, I have been unable to test it by the actual reception of television because I cannot obtain a suitable driving medium.

I have had no experience with electric motors, and knowing the necessity for an absolutely reputable machine I have been unable to get one as the only available electric power I have is from 6-volt accumulators, and though I have enquired, manufacturers do not seem to be interested in the lower voltage models for really serious work. I would be very glad to have any suggestions from you on this point.

When the morning broadcasts began I was able to tune-in the characteristic note very strongly with a very ordinary three-valve set (the 1927 Cossor Melody Maker), and by replacing the loud-speaker with the neon tube I got it to flicker beautifully and checked it by recoupling the loud-speaker up at the same time. I am sure that if I could only get my disc running properly in front of it I should be able to get good reception.

Wishing TELEVISION every success and hoping to further developments in this interesting science,

I am, yours truly,
R. RANDALL.

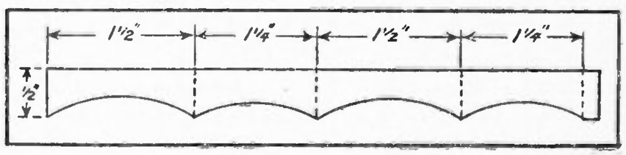
"St. Olafs," Park Road,
Spalding, Lincs.
February 6th, 1930.

To the Editor of TELEVISION.

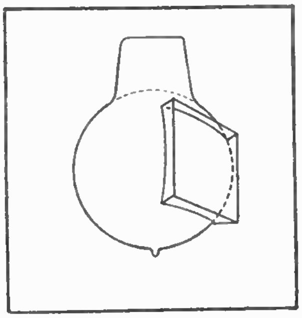
DEAR SIR,—The neon tube is an essential part of the present system of reception of television and there are various types that may be employed. The well-known type that has a large rectangular plate is, of course, the most satisfactory, but has the disadvantages of greater expense, short life, and necessary adjustment of current passing through it.

An efficient substitute that is cheap and robust and that gives good results can be made from an Osglim type lamp. A uniformly bright field can be obtained by a system of internal reflection within the glass bulb.

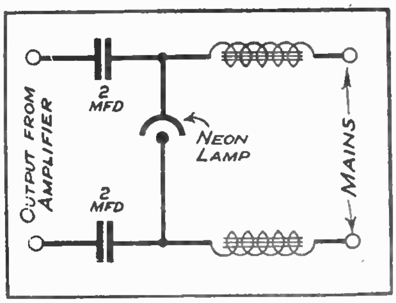
A "window frame" of cardboard is cut to the shape and size indicated in the diagram.



The cardboard is cut half through and bent at the dotted lines to form a frame. This is fixed to the glass bulb with seccotine. The rest of the glass, except the window, is covered with thin foil such as is found in cigarette packets. The foil should be put on in overlapping strips with the brighter side inside and also affixed with seccotine. The inside of the frame is then covered and a piece of ground glass is cut to fit the window and stuck into the frame. The reflecting surface next to the glass destroys the image of the elements and gives a uniformly illuminated surface to the ground glass window. There is the added advantage in use of having this close to the receiving disc.



The resistance in the base of the lamp should be removed. This can be done as follows: Heat the brass cap of the lamp until the solder runs, shake it to remove the solder and the connecting wires will then be loose. File round the brass cap until it can be pulled off, twist off the resistance bobbin, and solder short pieces of thin wire to the element leads. Obtain another lamp base, and remove the solder as before. Put insulating sleeving or pieces of glass tube on the element wires, insert them through the two holes in the cap and solder them outside, after cutting off to required length. The cap should then be fixed to the glass with Chatterton compound.



In use the full mains voltage must never be put on the lamp now that the resistance has been removed, but if a fairly high resistance low-frequency choke, for example, the secondary of a low frequency transformer, is put in series with each lead the lamp is illuminated sufficiently for use. It should then be connected to the amplifier as shown, and will give good results with the minimum of expense.

Yours faithfully,

W. F. NEAL.

Lancing, Newark Road,
Luton, Beds.

February 28th, 1930.

A SERIOUS DIFFICULTY IN TELEVISION, IN THE FUTURE.

To the Editor of TELEVISION.

DEAR SIR,—I recently saw a film in which television was foreshadowed. The film was "High Treason." In one of the scenes the hero, sitting before a screen, "calls up" the heroine and, *looking straight into each other's eyes*, they talk.

A little thought makes me believe that this will never be possible.

We must assume, of course, that the man sits in front of the screen while, from some convenient position, the televisor scans him. Now, as he must be looking at the screen, the lady would, of course, see him from the same angle as his televisor. If this were placed under his screen, on her screen he would appear looking over her head.

The same would apply, of course, to her transmitter, so that the pair would literally be talking "over each other's heads."

If the man looked at the eye of the transmitter to the girl he would "come over" looking directly into her eyes, and into the eyes of anyone else looking at her screen. That would be all right, but, of course, he would not see her at all then. They would have to take it in turns to look at the televisor scanning disc and at the screen, or else be content to see each other looking away overhead.

It would be like talking to a person too dishonest to look you in the face. But perhaps you can suggest a way out of the difficulty, I cannot.

Yours in anticipation,

G. F. LA PRESTI.

30, Hamilton Road,
Golders Green, N.W.11.

February 10th, 1930.

INVENTION

and

DEVELOPMENT

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, W.C.2. Price 1s. each.

Patent No. 322025, granted to GRAHAM AMPLION and RICKETS, W. J. In a copying-telegraph or television system, a single master station transmits synchronising signals which are common to a

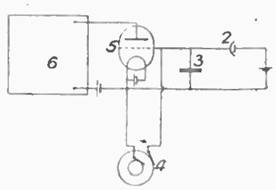


Fig. 1.

number of sub-stations, each of which transmits to satellite receivers picture signals alone, or accompanied only by signals due to a sound accompaniment.

Patent No. 322225, granted to G. M. WRIGHT and S. B. SMITH. The output from a photo-electric cell (2). Fig. 1, is rendered intermittent by means of a commutator (4) which short circuits it at the required frequency so as to facilitate amplification by the valve (5) and amplifier (6). The commutator (4) may be a rotary commutator geared to or driven synchronously with the scanning disc of a television transmitter, so that the

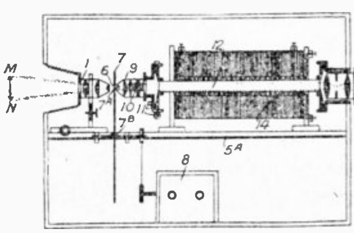


Fig. 2.

frequency of intermittence is definitely related to the scanning frequency. Where light-intensities are weak, the commutator may be a thermionic or other noise-free, short-circuiting device. The frequency of intermittence may be such as to give a grain of 100 dots per inch, and the duration of the short-circuit periods may be adjustable for the purpose of ensuring maximum output from the valve (5).

Patent No. 322481, granted to J. L. BAIRD and TELEVISION, LTD. The holes in a scanning disc, instead of being circular or square, are either longer or shorter in the direction of motion than in the direction at right angles thereto. [Drawings are given in the Specification.]

Patent No. 322504, granted to F. H. ROGERS (Skala Research Laboratories). Light from an object *NM* is passed

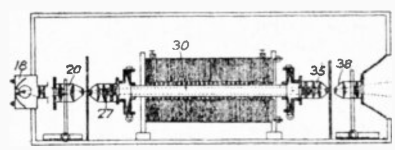


Fig. 3.

through a lens system (1), (9), in Fig. 2; (10) is a polarising Nicol prism. The parallel beam of polarised light is sent through a long glass tube (12), forming the core of an induction coil and containing an optically inactive substance (*e.g.*, carbon bisulphide). A microscopic image is formed at the focus (6), and this image is interrupted by a perforated disc (7) driven by a motor (8). This disc has a number of holes (7*a*) arranged in a circle concentric with the axis (7*b*) of the disc. The prism (10), objective (9) and tube (12) may all be rotated by the hand-operated worm gear (11*b*), and an eyepiece (17) is provided for centreing the image. The iron plate (5*a*) serves to screen the transmitting apparatus from the motor.

Current is supplied to the primary winding (14) of the coil, and it is stated that in consequence of the rotation of the plane of polarisation by the magnetic field, modulations are induced in the secondary windings of the coil and thence transmitted.

The receiver, shown in Fig. 3, is similar in construction to the transmitter, but has no interrupter disc. Light from a lantern (18) is sent through the polarising system (20), (27) and tube (30), and projected by the lens system (35), (38).

Patent No. 321935, granted to D. N. SHARMA. The pictures to be transmitted are recorded on a film which is both light-sensitive and fluorescent. Details are given in the Specification of the method of preparing the emulsions and sensitive coatings. The film (*F*) in Fig. 4 after being inscribed with sound record and picture record, then passes between a cathode-ray tube (*I*) and a light-sensitive cell (7). A pencil of cathode rays is caused to oscillate in a direction transverse to the direction of motion of the film.

Fluorescence is excited at the point of incidence of the cathode-rays and affects the light sensitive cell (7) in accordance with the density of the photographic record at that particular

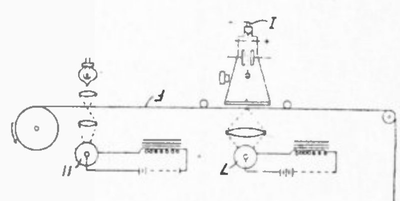


Fig. 4.

point of the film. Simultaneously the sound record influences another light sensitive cell (11), and the output of the cells modulates two different carrier frequencies.

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