# Television in Colours

6D MONTHLY

# Television

The Official Organ of the Television Society

VOL 1. AUG. 1928 No. 6


MR. BAIRD demonstrating to
MAJOR A. CHURCH, D.S.O., M.C.,
his new
COLOUR TELEVISION RECEIVER.
Read MAJOR CHURCH'S powerful article
in this issue.

THE WORLDS FIRST TELEVISION JOURNAL

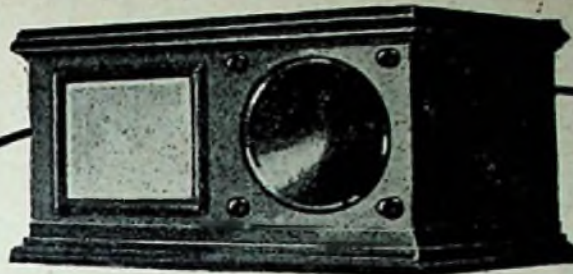

We manufacture Neon and Projector Lamps suitable for television apparatus.

*Obtained from all local electricians.*

USE PHILIPS LAMPS—
AND SEE.

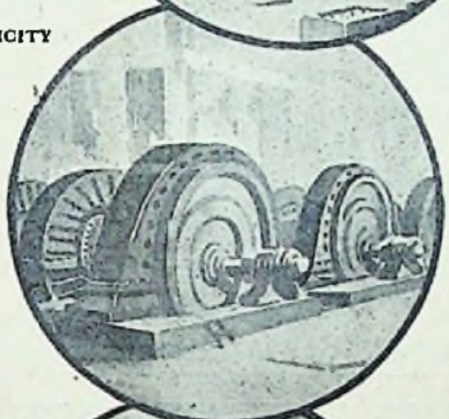
# PHILIPS
## NEON LAMPS

PHILIPS LAMPS LTD., PHILIPS HOUSE,
145, CHARING CROSS ROAD, LONDON, W.C.2



WIRELESS

ELECTRICITY



MECHANICS

# AUGUST 1928



OPTICS

CHEMISTRY

CINEMATOGRAPHY

*Mention of "Television" when replying to advertisements will ensure prompt attention.*

# Television

THE WORLD'S FIRST TELEVISION JOURNAL

*The Official Organ of The Television Society*

*Edited by* A. DINSDALE, A.M.I.R.E.

*Consultants:* Dr. C. TIERNEY, D.Sc., F.R.M.S.; W. J. JARRARD, B.Sc. (1st Hons. Lond.), A.R.C.S., A.I.C.

*Technical Editor:* J. C. RENNIE, B.Sc., A.M.I.E.E.

Vol. 1] AUGUST 1928 [No. 6


# EDITORIAL

IT has frequently been pointed out of late, both by ourselves and by others, that, in this age of rapid scientific progress, the latest scientific achievement, television, is bound to make very speedy progress. It is but a few short months ago since we had the pleasure of announcing to our readers that television had spanned the Atlantic. Up to that time the subject to be televised had to be illuminated by artificial light, or by invisible rays.

LAST month our eminent contributor, Dr. J. A. Fleming, F.R.S., in an article describing his visits to the Baird Laboratories, announced that television in ordinary diffused daylight had been demonstrated to him. This means that television has now been developed so far that its scope can be extended to embrace outdoor scenes.

THIS month we have to record a further development of vital importance. Whereas, up to the present, images seen on the televisor screen have been portrayed in monochrome, Mr. Baird has now succeeded in transmitting and receiving television in colours. Further particulars of this latest advance are given elsewhere in this issue by such men of science and letters as Dr. C. Tierney, D.Sc., F.R.M.S.; Major A. Church, D.S.O., M.C., B.Sc.; and Mr. Shaw Desmond.

* * *

ACCORDING to a recent newspaper announcement we note that a large American corporation claims to have achieved television in sunlight, and claims also that this is the first time that this has been accomplished. As our readers well know, this latter claim is entirely without foundation, for television in daylight was achieved by Mr. Baird in this country a month previously. Further, our readers will note that the American demonstration was carried out in bright sunlight, whereas Mr. Baird demonstrated to Dr. Fleming on a dull day, a fact made plain by Dr. Fleming in his article last month, in the following words: "The object whose image is to be transmitted can be simply placed in *diffused daylight.*" (The italics are ours.)

* * *

IN his capacity as Chief Engineer of the B.B.C., we have the greatest admiration for Capt. Eckersley's technical ability in connection with his own job; but when he makes, or writes, statements for publication we have observed, over a long period, that he seems to have a flair for making observations which can only be described as "unfortunate." In a recent article, in which he dissociates the B.B.C. entirely from television experiments, he repeats a time-worn statement which we have grown tired of reading: "I believe that a radical discovery is necessary before television will be practicable." It would be interesting to know just how much Capt. Eckersley knows about television. We are authoritatively informed that neither he nor any other member of the B.B.C. staff has been inside the Baird laboratories for the past two years.

OTHER hostile criticisms which we have also grown tired of seeing repeated in print, appear once more in a letter written to *The Times*, on July 20th, by Mr. A. A. Campbell Swinton, who concludes by saying: "Thus both scientific theory and skilled experience join in the opinion that satisfactory television that can be broadcast on any reasonable scale still remains to be accomplished, and that this may take a long time."

THE best refutation of unfavourable "scientific theory" is practical accomplishment. Satisfactory television actually *has* been broadcast. We ourselves have witnessed it. As to "skilled experience," where can one find it in this country except in the laboratories of our one and only successful exponent of the art?


*Editorial & Publishing Offices:*

The Television Press, Limited,

26, Charing Cross Road, London, W.C.2.

*Telephone: Regent 6437.*

SUBSCRIPTION RATES, 7/6 PER ANNUM, POST FREE.

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

# SEEN ON THE TELEVISOR SCREEN

THE GENERAL ELECTION, 1929.

*First Flapper*:—"Father's voting Conservative."

*Second Flapper* (pointing):—"I'm voting for *HIM*. By the way: What party does the darling belong to?"

# Do we Encourage Genius?

## By Major ARCHIBALD CHURCH, D.S.O., M.C., B.Sc.

**Major ARCHIBALD CHURCH D.S.O., M.C., B.Sc.**

*the author of this powerful article, has had a wide and varied career as General Secretary of the Association of Scientific Workers; editor of "Scientific Worker"; first Chairman of the Science Advisory Committee of the Labour Party; representative of Science Graduates on Standing Committee of Convocation of University of London; formerly Member of Parliament for Leyton (East); Parliamentary Private Secretary to the Right Hon. Sidney Webb, M.P.; Member of Medical Research Council, 1924; author of "East Africa: A New Dominion"; contributor to General and Scientific Press on Educational Problems, the Organisation and Administration of Scientific Research, etc.*

IN common with many other scientific workers, I had taken more than a casual interest in the transmission and reception of light by means of the selenium and photo-electric cell, but it had not occurred to me until I read of the successful experiments carried out by Mr. Baird in 1926, that the stage had been reached when the commercialisation of television had become inevitable.

However, it was quite obvious at the public demonstrations which were given by Mr. Baird at Leeds during the progress of the British Association meeting in September, 1927, that a British inventor had achieved enough and was sufficiently in earnest to command the attention of any financial corporation or individual financier who possessed the imagination to foresee the possibilities of the application of television in various fields of activity.

I was one of the privileged few to be present when the first semi-public demonstration was made of transmitting images of living persons from the Long Acre laboratories to Hartsdale, a suburb of New York. That was very early in the morning of February 9th. Looking at the pilot images I realised the progress which Mr. Baird had made since the Leeds demonstrations, and that perfect transmission was merely a question of time, and that time to be measured in months rather than years.

On June 18th I was again invited to the Long Acre laboratory to further demonstrations. In the first one the persons were seated on the roof in front of the transmitter, the object being illuminated only by daylight. (Incidentally it was an exceptionally dull day.) **At the receiver I had no difficulty in distinguishing between the features of one person and another, or in detecting their slightest movement; there was, in fact, more detail observable than I had seen at the February demonstration when the object was artificially illuminated.**

A recent photograph of our Contributor.

In the receiver, the disc of which was rotating more slowly than was the case when artificial light illuminated the object, I noticed that the only visible effect of imperfect synchronisation was to cause the image as a whole to shift slightly up or down in the field of vision. There was no observable disintegration of the elements which some experts had prognosticated.

Before I left I was enabled to observe the progress which had been made in the transmission of an artificially illuminated object. **There was no necessity in this demonstration to call upon the imagination in the slightest to identify the objects. Their images came through with what can only be described as a wealth of detail.**

### Colours Reproduced Perfectly.

I paid another visit to Long Acre on July 3rd. On that occasion Dr. Tierney, of the Microscopical Society, and I were given a demonstration of colour television. The dummy, or the person seated in front of the transmitter, was provided with a blue hat and red scarf or vice versa. At the receiving end the colours were reproduced perfectly.

A trained mind, a restless, a tireless undaunted spirit, an enthusiasm born of inspiration, a peculiar genius for the selection of essentials in experimentation—these are the qualities which have enabled Mr. Baird to out-strip in positive achievement the powerful American corporations with their almost unlimited resources.

In bygone days the makers of magic were honoured and powerful, and prophets were stoned. Nowadays we honour our prophets, whether they be jeremiahs like Dean Inge, castigators of our follies like Mr. G. B. Shaw, or hopeful futurists like Mr. H. G. Wells. But the rewards of the modern magic-makers, the men whose lives are devoted to scientific discoveries, to whose achievements the benefits of modern civilisation are due, are not usually "blessing, and honour, and glory, and power."

Sir Richard Gregory, one of the greatest modern exponents of science, has said: "Neither the multitude nor its masters are familiar with the names of the men whose work has provided the comforts of the present day."

We live, indeed, in an age of unexampled educational progress, but even this enlightened community has very little real appreciation of the things that matter. Disproportionality is still a universal affliction. Only a short time ago the newspapers devoted daily headlines to the alleged discovery of a "death-ray," a source of electric power which would kill people at a distance. The press and Members of Parliament urged the Government to buy up the invention lest it should become the property of a foreign power.

There has been as yet no such manifestation of popular interest in the inventions of Mr. Baird. Scant attention was paid to his successful demonstration of television carried out in the presence of eminent scientists in 1926. Even men of science themselves were either comparatively indifferent to the achievement, an achievement the more remarkable inasmuch as Mr. Baird had carried out his experiments without financial or other assistance, or definitely discouraging, expressing strong doubts on the possibilities of Mr. Baird ever surmounting the practical obstacles in his path by the methods he employed.

### Neglected Inventors.

It is distinctly unfortunate that men of science, conscious as they are of the immense changes wrought in their own life-time by the application of science to life in all its aspects, roused again and again to indignant outbursts because of the lack of imagination of governments and peoples, are, nevertheless, conservatively suspicious of those who put scientific theory into practice. Scepticism is a virtue when applied to undemonstrable claims; it is the worst of vices in the face of established fact. Yet this is a vice to which scientists are addicted.

The history of scientific discovery during the last hundred years is only too replete with instances of discoverers and inventors being neglected, not only by the ignorant and uninitiated sections of the population, but, what is more lamentable, by their compeers. Joule's announcement of the mutual convertibility of heat and mechanical power in exact units to the British Association for the Advancement of Science at its meeting in Cork in 1843 was received in silence and incredulity.

The work of the Abbé Mendel on hybridisation of plants, described by him in 1865, was left unnoticed by the scientific world until rediscovered in 1900, and even then the conclusions arrived at were sharply disputed because they did not conform to accepted scientific theories. It is now recognised that Mendel's work is the most fruitful source of inspiration in the field of biological science.

Perkin's discovery of synthetic dyes was ignored in England and exploited by Germany. The scorn with which the news was received in this country of the pioneer aeroplane flights in America of the brothers Wright is probably within the recollection of many readers of this article.

In the realm of wireless transmission a similar scepticism was pronounced. It was not until four years after Hertz had demonstrated experimentally in London in 1888 the possibilities of telegraphy without wires, which had previously been postulated by Clerk Maxwell, that the world of science showed any great interest in his results. It was left to Marconi to exploit the discovery commercially ten years later.

### The Difficulties of Genius.

I have digressed thus to explain, perhaps unnecessarily, the difficulties which confront the man of genius, the prejudices which have to be overcome, the discouragement and disparagement which have to be endured. Yet there is less excuse for the present generation, familiar with wonders and possessing an intimate acquaintance with sound transmission by means of electro-magnetic waves, to display the slightest scepticism regarding the transmission of light-waves. It is acknowledged that the practical difficulties are greater than in the case of sound, but the crudest demonstration of a partial success should have been sufficient to arouse not only the whole of the scientific world, but the whole of the people of the nation to which Mr. Baird belongs, to a real enthusiasm.

The possibilities of television are so immense that it should have been regarded as a question of national honour to have backed substantially any inventor whose discovery in this field was based on the established laws of science, and whose results could be demonstrated.

(*Continued on page* 8.)

Our illustration shows Mr. BAIRD with a member of his laboratory staff sitting in daylight before the electric eye. The writer of this article can be seen in the background.

# My Impressions of Daylight and Colour Television

By Dr. C. TIERNEY, D.Sc., F.R.M.S.

THE variable electrical response of different photo-electric substances is a fundamental factor well known to physicists and workers in television problems, and the sensitivity of such substances to definite wave-lengths of light is now engaging the attention of busy minds. When J. L. Baird first demonstrated the possibility of transmitting and receiving a recognisable image over a distance of a few yards it was looked upon by many as a mere scientific novelty and not likely to get any further; but to-day we are able to witness and record the transmission and reception of recognisable images over many hundreds of miles, and the classic instance of the image received on board the steamship *Berengaria* in mid-Atlantic is now too well known to need repetition.

### Priority of British Demonstration.

The harnessing of these phenomena and their application to the service of man is one of the outstanding accomplishments of the present century, and we have just cause to be proud that it is to British inventive genius that the credit belongs for the remarkable development of television as we know it to-day.

On July 14th we read in a London morning newspaper a report from New York that television by sunlight had just been demonstrated in America for the first time. One would hesitate to deny to our American friends the credit for this accomplishment were it not for the fact that the record is wrong in one important particular, i.e., that of priority. It is already on record that television had previously been demonstrated in this country not only by sunlight but also by dull London daylight, and that the demonstration has been witnessed by several independent and competent observers. The writer, therefore, wrote a letter to the Press the same day, of which the following is the text:—

Dr. CLARENCE TIERNEY, D.Sc., F.R.M.S., the author of this enlightening article, is the Chairman of the Television Society. As one of the Secretaries to the Royal Microscopical Society, Dr. Tierney has long been known to the public for his scientific research and his applications of optical knowledge to industrial progress.

"Having noted in your issue of to-day a report from your New York correspondent to the effect that television by daylight had just been demonstrated for the first time in America, I would like to point out that television by daylight was demonstrated in this country over a month ago. I was myself present on two occasions when the image of a person illuminated only by dull daylight was transmitted from the roof of the Baird Laboratories in Long Acre to a laboratory four floors beneath. On the second of these occasions representatives of the Press were also present. Several demonstrations have since been witnessed by scientific and other public persons and Press representatives, not only of daylight television, but of the still more notable achievement of Baird—the transmission and reception of objects in natural colour."

One of the daylight demonstrations referred to above was described by Professor J. A. Fleming in the July issue of TELEVISION, and the purpose of the present article is to record another development even more remarkable—television in natural colour, demonstrated to the writer on July 3rd.

The subject seated at the transmitter in the Baird laboratories wore around the neck a blue scarf of sapphire colour, and a red scarf on the head. The reception of the coloured image in another laboratory in the same building was remarkable for its faithfulness of reproduction not only of the subject but also of the colours, which were as near the original shades as one could determine. The position of the coloured scarves was constantly changed and interchanged by the sitter for the purposes of the test, and to watch at the receiving end the placing of the neck scarf upon the head and the head scarf around the neck and the faithful reproduction of the received image was most convincing. The principles involved in the transmission and reception of the red and blue apply also to green and every other colour of the visible spectrum.

### As we shall See it.

It requires no great amount of imagination to visualise the ultimate significance of these notable achievements.

The radiation of audible sound has now attained so near a state of perfection as to leave but little to be desired, and has rendered possible

(*Continued overleaf, Col. 2.*)

(*Concluded from page* 6.)

Only last month the Committee of Civil Research, of which the Prime Minister is chairman, published a report in which the following passage occurs: "No nation can advantageously depend only upon the efforts of other nations for the purposive promotion of knowledge. This is not only because such dependence is an ignoble parasitism, but because, in the field of international relations, no less than in national life, the power that comes from knowledge comes from its early and rapid use, and from close association with the men who have actually gained it."

There is obviously no necessity for Great Britain to descend to ignoble parasitism in the matter of television, but it is obvious that it is due to no prevision on the part of our Government or its advisers that we have not lost association with the man who has gained such valuable knowledge. Had Mr. Baird gone to America we should have had only ourselves and our own deficient imagination to blame. That, and some of our own scientists, whose attitude of mind is

Captain O. G. HUTCHINSON, Joint Managing Director of the Baird Television Development Co., Ltd., the man who is largely responsible for the commercial organisation of the Baird inventions.

reflected maybe by Sir Alfred Ewing, Principal of Edinburgh University, who in the course of an address entitled "A Century of Inventions," delivered on June 4th on the occasion of the celebration of the centenary of the incorporation of the Institution of Civil Engineers, said: "Communication may be extended to include vision; that is half done already, and I confess to no enthusiasm for the other half."

### A Powerful Weapon.

Enthusiasm or no enthusiasm, Sir Alfred Ewing and those who share his views, fearful perhaps for the new and powerful weapon which science is putting at the disposal of man without any great confidence that it will not be misused as have been the other weapons science has forged for him, are probably now aware that the other half is already an accomplished fact.

Conscious as I am of various criticisms that have been made of the Baird system of television, I feel that when I made the following statement in the April, 1928, issue of the *Scientific Worker*, I was perfectly justified, particularly in the light of subsequent developments:—

"It now remains to be seen whether the various bodies in this country interested in wireless transmission will provide the Baird Television Development Company with the necessary further financial support and encouragement to enable it to out-strip its rivals in America and Germany. The experiments have now reached a stage which would amply justify Government support being given to the Company."

---

(*Concluded from page* 7.)

almost perfect reception of both speech and music over vast distances. Add to this the prospect not only of hearing but also seeing at a distance the performance of a Russian ballet or a Covent Garden opera in all its glory of light and shade and elaborate coloration; or, again, the riot of colour and design of a Chelsea flower show or an Ascot race meeting; and this is no disordered dream of the night flung out for the understanding to browse upon, for television is a very definite achievement, and we may look hopefully to the future of this latest application of science to the benefit of the community.

### The Nature of Light.

The application involves, however, a close and difficult study of the nature of light itself, for physicists are unable as yet to say with any definiteness what light really is.

Two theories at present hold the field—the wave theory and the corpuscular theory, and although both afford a working hypothesis,

Mr. CHARLES IZENSTARK, the American financier with the powerful personality, who, as described in last month's issue, intends to commercialise the Baird system of television in America.

neither of these accounts for all the phenomena we observe, and both break down in different particulars.

Nevertheless, Nature yields the secrets of her phenomena, though slowly, to the patient and persistent observer. The spirit of research, of investigation, of finding and following of new learning, is the monopoly of none and the inspiration of all. So accustomed have we become in this age to the consciousness that human knowledge is being quietly and rapidly advanced day by day in the studies and laboratories of the learned, that the steady progress is taken for granted. The world no longer shudders at the philosopher's demonstration of some new and subvertive truth; it expects it of him, and wonders cheerfully "What will they find out next?"

### Further Revelations.

In the study of applied physics, as in so many others, matters have been pressed so that far we now seem to stand upon the threshold of some immense revelation of cosmic truth, and chance favours only the mind that is prepared.

# Recent Advances in Television

## *Television by Daylight and Television in Colours*

By The Editor

**In this article you will read many things of interest on the recent developments in television, now known as Television by Daylight and Television in Colours. Having been present at both demonstrations the Editor is in the happy position of being able to touch upon these advances in an authoritative way.**

Mr. Baird demonstrating daylight television reception to a group of scientists and press representatives.

THE possibility of transmitting television in colour has been visualised for some considerable time by those intimately connected with television developments, but this advance was only achieved practically on July 3rd, 1928, when, by employing a three-colour process, Mr. Baird was able to demonstrate the transmission of images in their natural colours.

This process is extremely interesting, and is essentially very similar to the process employed in one of the forms of colour cinematography. It consists in presenting to the eye, in rapid succession, first a green image, then a blue, and then a red image.

These three colours form the well-known primary colours, from combinations of which any other colour or tint may be obtained: for example, purple is a mixture of red and blue, yellow is a mixture of green and red, and all other colours excepting the three primaries, red, green and blue, are in a similar way composites of these three colours in varying proportions. When the three colours are combined together they give to the human eye an impression of white.

The actual mechanism used in these first experiments consisted of a disc perforated with three spirals of holes arranged consecutively round the disc. (See Fig. 1.) This disc was used in conjunction with the light spot system which has already been described in the pages of this journal. By using a disc with three sets of perforations it was possible to traverse the image firstly with a blue spot of light, secondly with a red spot, and thirdly with a green spot, the perforations being covered with blue, red and green light filters.

### Points on the Neon Tube.

The operation of this mechanism, therefore, caused the light-sensitive cells to transmit first a picture which showed only the blue parts of the scene, then a picture showing only the red parts of the scene, and lastly a picture showing only the green parts of the image.

At the receiving station a similar disc was used, the three sets of perforations, or spiral apertures, being covered by blue, red and green filters respectively in a fashion similar to those at the transmitter. The difficulty at the receiving station, however, was to find a light source of generating blue, red and green rays.

The neon tube which has hitherto been used for reception, while exceedingly rich in red rays, has practically

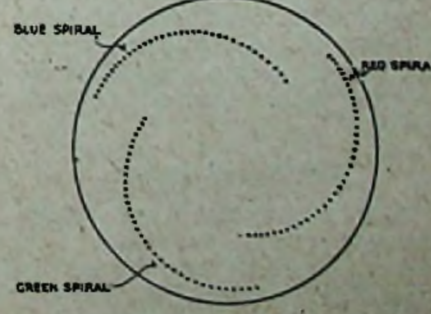
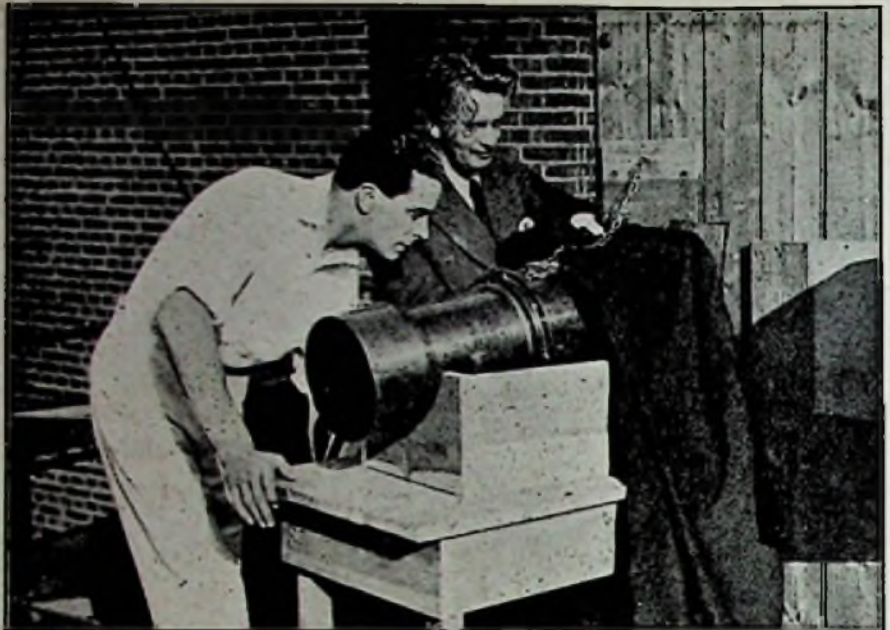



Fig. 1.
The spiral disc used for colour television.



Mr. Baird demonstrating his daylight television transmitter to Mr. Jack Buchanan. Mr. Buchanan is an old school chum of Mr. Baird's, and, by a strange coincidence, they are at present occupied within a stone's throw of each other.

no blue and green components. In order to solve the problem, an attempt was first made to construct a special glow-discharge lamp by mixing neon, helium, and mercury vapour. This experiment proved unsatisfactory, because the blue and red components, and also the green component, varied, their proportions depending upon variable conditions in the lamp.

A solution of the difficulty was ultimately arrived at by making use of two separate lamps, one a glow-discharge lamp containing neon and the other containing helium and mercury vapour, the mercury vapour providing a very intense green component and also part of the blue. The addition of helium in this lamp assisted in the production of the blue component. By means of a commutator it was arranged that while the red viewing holes in the disc were between the eyes of the viewer and the lamps, only the neon lamp was illuminated, and when the blue and green holes had rotated to the correct position the helium and mercury lamp was switched into circuit.

### The Speed Factor.

It will be seen that in this arrangement, although there are three separate images, these images are transmitted in succession, and only one channel of communication is necessary for transmission.

On the other hand, the rate of transmission must theoretically be increased three times, as there are three times as many images being transmitted per second. In practice, however, it is found that it is not necessary to increase the speed so greatly, for the images have many parts in common, and a much lower speed may be used without the flicker being disagreeably noticeable.

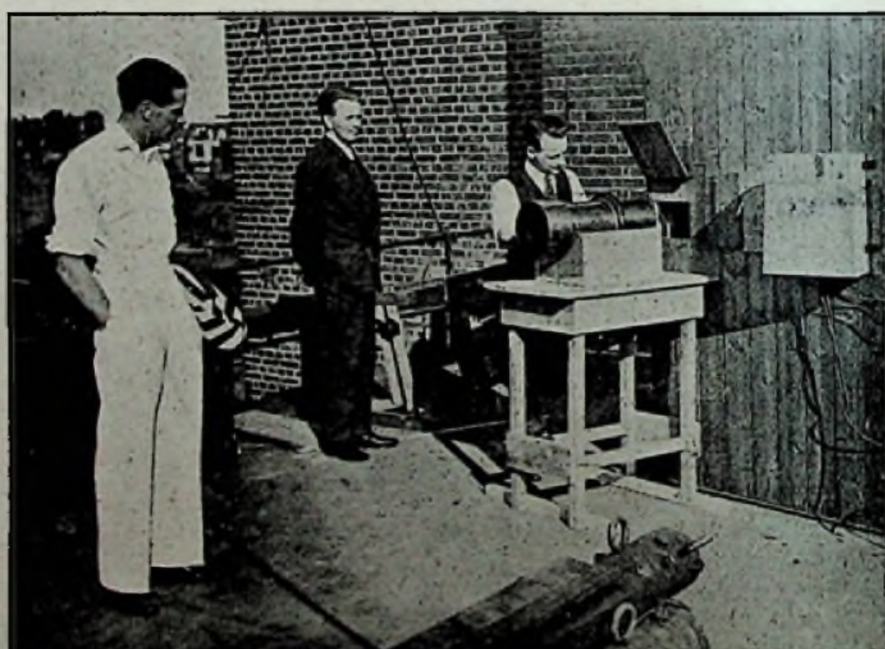
### Vast Possibilities.

By means of this apparatus very successful demonstrations of colour television were given, and such objects as flowers, baskets of fruit, and coloured objects, such as a policeman's helmet, appeared very vividly in their natural colours. Various shades of colour were also transmitted, a human face being portrayed on the receiving screen in a different shade of pink from the tongue.

The addition to television of reproduction in natural colours indicates a greatly-increased field of utility, as obviously there are many objects and scenes which depend for their visual value entirely upon colour; one has only to witness colour cinematography as opposed to the ordinary black-and-white film to appreciate in full the force of these remarks.

The writer had the privilege of being present at demonstrations both of colour and of daylight television transmissions. Television transmission by daylight gives results similar to those obtainable with artificial light, but a more extended field of view can be dealt with. The colour transmission demonstrations were amazingly vivid, the colours standing out most strikingly, particularly in the cases where images of flowers and fruit were being received. The

(*Continued on page* 26.)



Another view of the daylight transmitter, before which Mr. Buchanan is posing for transmission.

# Seeing Round the World*

## *What Television will mean to YOU*

### By SHAW DESMOND

"SEEING at a distance" is going to touch the lives of each one of us; take us out of our ruts; bring us fortune and perhaps, sometimes, fortune's maladroit sister "Misfortune"; and, generally, turn our lives upside down. It is going to change the outer lives of men and women as much as the telegraph or telephone. It is going to do more—it is going to make both those instruments of human advance and human torture (perhaps one and the same thing!) infinitely more potent whether for good or evil.

From the moment that you, John Brown, or you, Mrs. John Brown, get out of bed in the morning until you pass into your beauty sleep at night, television is going to haunt you. Nor, indeed, will either of you, separately or together, be able to escape the multitudinous activities of the televisor even when you have retired to your room! The televisor is the eye that sees everywhere . . . *but*, and it is a very big "but," NOT *unless you wish it*! You need not answer the telephone by your bedside unless you wish. Similarly, you need not be seen by the televisor unless you wish. **But the insistence of the televisor will undoubtedly be as great as that of the telephone.**

**Hard Facts of the Future.**

Here I shall indulge in no airy prognostication. I shall confine myself strictly to facts, or to things about to become facts. When I speak of buying a beefsteak by the televisor. When I speak of buying a Paris "creation" by the televisor. When I speak of addressing thousands of your constituents to be when running for that incredible talking-shop known as the House of Commons—in all these I shall be dealing with hard facts about to mature or already matured.

You are a business-man, Mr. Brown. You telegraph. You telephone. But now you are going to "televise" (patent applied for). You are going to be "televised" (additional patent secured).

You will find that fellow Smith at the other end of your wire—or rather "wireless"—walking and talking as in life. No use for Smith, whom you loathe, to disguise himself behind a mere "voice," as he does now over the telephone. You will be able to mark each flicker of Smith's eyelashes ("confound the fellow! why can't he smile?"), note each gesture, draw your own conclusions. For you are "televising" Smith.

Mr. SHAW DESMOND, the well-known novelist and publicist, tells our readers, in his usual inimitable and amusing style, how he thinks television is going to affect our everyday life.

Smith's usually oily voice on the 'phone, with Smith's plausibility, but minus Smith's expression, may mislead you to-day when you telephone. It can't mislead you to-morrow. Smith's face has got to "come across with the goods." Smith has to speak something like the truth because Smith's face is there to give the voice the lie, if necessary.

The telephone is probably the world's biggest time-waster! That statement I make without fear of effective contradiction. The last time I made it was to a New York banker who in his time steered America through one of her banking crises—and he admitted the essential truth of it, after consideration.

**"Business is Business."**

For to-day you, Mr. John Brown, probably send three times as many messages over the 'phone as you need to send . . . just because the 'phone is at your elbow. If you were an American you would send five times as many. I sat once in a New Jersey house where for some hours I listened to forty-eight messages on the 'phone (a most reprehensible proceeding!), and afterwards put it to my host that of these forty-eight messages, thirty-seven need never have been sent. He denied. Thought. Admitted!

But with the televisor automatically put into action with the lifting of the telephone receiver you will think twice before you send a useless message. It is one thing "to talk to a voice." It is another thing "to talk to a man." That is the difference.

With a voice, you can avoid responsibility. You are under no compunction to "watch out." You are not being observed. But when you talk to a man, not in the spirit but in the concrete flesh, you have to watch your step. You will be apt to think twice before you make connection. That is human nature.

Or a contract has been signed in New York whilst you sit in your London office. It purports to be signed by Jones. It has been "wirelessed" that it contains certain clauses. You want to see that signature. You want to see those clauses. You don't want any "funny busi-

*[Copyright in all Countries.]

ness," because you are not quite sure of Jones.

So you ask the New York end kindly to hold up the contract before the televisor. To "televise" the contract. You see exactly what is being signed. You know where you are.

**But all this drops into nothingness when we come to what I will call "television-advertising." It is going to shake the world to its publicity centres. It is going to revolutionise the sales of everything from chewing-gum, that modern devitamised food, to white elephants and cures for corns.**

As I have already dealt with what I have called "television broadcasting" fairly fully in the columns of various London newspapers, I propose here to leave out the minuter details of the enormous possibilities of wire-less-broadcasting if ever the "B.B.C." pass out of the stodgy official stage to be taken over by private enterprise. Yet I will venture to set out the conclusions to which I have arrived after discussing it with various editors of dailies, publicity specialists, and big business leaders.

### The Programme of To-morrow.

My conclusions, after these conversations, set out in order of importance are:—

1. That television-advertising will probably be a commercial proposition within two to three years and in common use within three to five years.

2. That used with broadcasting and compared with the present use only in advertising of the printed word, in which *sight* alone is used, it will be as much more effective as would be the comparative effects of a play on a man sitting in a theatre with eyes open, and a man sitting in the same theatre blindfolded. When *seeing* is added to the hearing we have a pretty perfect combination.

3. That the day is now fairly close when the great dailies will use "television-broadcasting" as part of their daily work, in a way to be shown later in this article, and that instead of hurting them this new advertising medium will enormously increase their circulations and power. *For nothing can completely replace the printed word.*

4. That the great stores, etc., will be able to reach their millions by the "advertising-televisor" where to-day they reach their thousands.

5. That as television is a British invention, and by virtue of the international strength of the Baird patents, if England be alive to the possibilities of the new medium, it will give her an initial impetus over her competitors similar to the initial impetus which steam gave her a century ago in the industrial world.

Compressed, we shall see (for steps are now being taken indeed to make it effective) our great dailies broadcast to millions of readers and "listeners-in" the front page of their edition of the *morrow* with, printed across it, the words: "This space has been reserved in to-morrow's edition for Messrs. Blank, the great popular emporium, to advertise their motor-cars," or dresses or hats, as the case may be.

> **Mr. Shaw Desmond says on this page:—**
> **"There will be scarcely a house in England to-morrow which will not have its own television screen... entertainment both visible and audible... a pretty perfect combination."**

But you will ask: "How shall I be able to see this?"

As Sherlock Holmes would say to his dear Watson: "That is elementary."

**There will scarcely be a house in England to-morrow which will not have its own television screen. You will sit in your armchair after you come home from "the city," put a pipe on, switch on your wireless and look at the screen which will be hanging like a picture before your eyes. On that screen you will see perhaps a curtain as in a theatre. The curtain will roll up. And behind the curtain you will see the front page of your favourite daily, to-morrow's issue, with to-morrow's date, and underneath the announcement I have mentioned.** *C'est tout!* After a minute or so, when you have properly tuned in your televisor, the entertainment, both visible and audible, will commence.

It is possible that, if the editor of TELEVISION permits, I may return to this "television-advertising" in a later article. I will now content myself with stating, first, that an invention is now maturing which will certainly make this "home-screen" possible; secondly, that it is considered sufficiently "brass-tacks" to have interested leading business men and newspaper men; and, lastly, that as Edison recently said to me in his laboratories in New Jersey, **"there is practically no limit to the possibilities of power-projection," whether that projection takes the form of wireless motors or wireless broadcasting, or television-advertising.**

We are only at the beginning. And it is now, as always, the first step, already taken, which costs.

So much for the business side of television and Mr. John Brown. What about John Brown's wife?

### "Take Politics."

Woman has come out of her shell—commercially, socially, artistically. But the shell has not yet quite dropped from her. Bits of it are clinging to her still!

She is finding all sorts of difficulties in her new freedom. She finds that "the brutal male" has still to be reckoned with; that sex-war is fact, not fiction; and that she must fight for what she wants, and that she can only hold what she wants so long as she fights!

Television may be described as the midwife of the new society—of that society in which woman will play her part equally with man.

Take politics!

Do you realise that there is actually in existence a televisor which can stand on your table and which takes up little more room than a typewriter? Do you realise that this handy little instrument is about to be used by Mrs. Phillipson, Lady Astor and Mr. Lloyd George, also by Messrs. Winston Churchill and Ramsay MacDonald? They may not know it yet—but they will either have to use it or lose their seats! This is not hyperbole, it is stern fact. **The vote is to be "televised."**

No more meetings in little stuffy halls when the candidate, his halo newly polished, seeks the suffrages of the intelligent electorate! No more tortuous train journeys! No more travelling a hundred miles by outraged constituents to the lobby of the House to call the sitting member over the coals!

Not on your life ! (I regret this American slang, but would plead that everybody is doing it, from peers to postmen !)

Think of the awful advantage of a beautiful woman would-be M.P. over a plain common or garden male when she takes out her powder puff, does something diabolic with a lipstick and pencil, and puts on a devastating hat !—to appeal over the televisor to her constituents to be ! Think of Jix or Winston in the same position. Where does the mere male come in ?

He doesn't !

### "An Awful Prospect !"

Nor is this any joke. It is going soon to be hard brute fact for the wretched male politician. For the televisor will be used in every election from Land's End to John o' Groats.

It might even mean a female majority in the House. Awful prospect !

A female Prime Minister. A female War Minister. A female Minister of Morals ! The mind baulks. For all these things the televisor may make possible.

But coming from suffrage to sausages.

Has any woman reading these lines known what it is to go out under a broiling sun to see Mr. Diehard's legs of mutton or steaks ? Has any unhappy housewife (and we men simply don't know what women go through in the house !), following me thus far, ever had to trust to luck and Mr. Greenheart's honesty for plums or apples or oranges or Brussels sprouts ? Why, every daughter of Eve of them all has been through it.

Enter the televisor !

You "televise" Mr. Diehard, the butcher. You tell Mr. Diehard that you don't want any aged meat, nor are you primarily concerned with Mr. Diehard's bank balance—but rather with your own digestion and that of your husband. Has Mr. Diehard any *really tender* beefsteak ?

No use Diehard saying he *has* ! You want to see what you are buying. Won't he please hold up the piece of meat for your inspection through the televisor ?

Mr. Diehard sighs and does so. No chance now to send round a bit of tender and a bit of tough to help each other out. He's got to deliver the goods—the identical goods you have inspected through the televisor. Result : happiness, digestively and maritally. More human happiness turns upon human digestion than most of us are ready to concede !

Or you, Mrs. John Brown, are living in the wilds. Down there in the heart of Devonshire or up in the north-west Highlands from which I have just come after listening to the complaints of all sorts and conditions of women who "won't buy a London dress because they can't first see what they are getting."

### The Mannequin Parade.

You want a London, a Paris, or a Viennese dress. You don't order in the dark or "in the blind" as the idiom goes on the continent. You wireless Selfridge or Peter Robinson's or Wörth, tell them what you want, and ask them kindly to place the dress before the "exhibition screen." You have the morning of your life enjoying the latest creations a thousand miles away (perhaps tomorrow three thousand miles away when you see and speak with New York as easily as with Balham or Blackfriars) without having to stir a foot from your own home, without exertion, and without that irritation which I gather from my women friends is inseparable from "buying a dress," which is worse than buying a horse or buying a gun.

"Oh ! but," you say, "what about the colour ?"

Well, what about it ?

Did you not know that we are now well on the high road to solving colour transmission by television, as it has already been solved on the films ? That is but a detail—an important and even difficult detail—but a detail now on the point of solution.

You will be able to see the delicate jade in a Paquin dress as clearly as though you were in their Paris showrooms. The costly exquisiteness of the "absolutely simple" dress of the really great designer will be as plain to your eyes as though the mannequin were strutting before you in your own room—*as she will.* For **I do not doubt that ultimately either a genius like Baird, or another, will bring in the stereoscopic effect into the televisor** which will let those to whom you speak walk, as they certainly will talk, *right out of the screen.*

### A Word to the Wise.

You, Mrs. Brown, will be able to indulge your *penchant* for fashionable "At Homes" without going out. Your friends will be able to come into your room without *their* going out. You can have a "Televisor—At Home" hour fixed beforehand when all your friends will touch the switch, let the screen roll up, and find themselves speaking together in that screen, as though in the flesh.

And, of course, I have only touched the fringe of the commercial and social and political potentialities of television. And, of course, as certainly, all sorts of clever—clever people will say : "But that's all in the future. It's not going to be in our lifetime."

For the comfort or dismay of those critics (and no intelligent man objects to intelligent criticism) may the writer, who does not own a television share, and as novelist and publicist has in this no axe to grind, state the following unchallengeable facts :—

First, that **a man has sat in a chair in London and his image has been "televised" to New York, his features and personality being recognised there.** Secondly, that cases like that of the wireless operator of the Cunarder *Berengaria* in which, when one thousand miles out at sea, he recognised his *fiancée* in a televisor screen, will become each day more common and soon will no more call for comment than a long distance telephone conversation. Lastly, that television in the United States at least is already recognised as one of the most formidable business propositions on that live-wire continent, with already a formidable organisation and revenue of its own, and

**The author on this page has a few remarks to say about the many applications of television to the ordinary events of everyday life—politics, buying that new frock, interviewing the butcher, and the "at home," new style.**

that what America is doing to-day England will be doing to-morrow (would that it were the other way about !).

If the doubting Thomas or Thomasine (for the feminine doubter does exist) want further hard unassailable facts then let them digest these :—

The fact brought to my notice when I was engaged recently in completing the scenario of one of my novels for a leading producer, that **no film of a certain type is being written to-day without consideration of its future television possibilities.** The fact that, as Mr. M. A. Wetherell, the internationally known producer of the "Robinson Crusoe," the "Victory," "Somme," and other films recently stated to me: "Television is going one day to revolutionise the world of pictures from roof-tree to foundation." And that final, hard-headed fact, for "money talks," that Hollywood, which I visited not very long ago, as also the world of the legitimate theatre, are being deeply exercised in their minds by the possible effects of television upon their entirely separate worlds.

If this consensus of evidence will not convince you, Mr. John Brown, and your charming partner, Mrs. John, that television is not something "in the air" but something already with its tentacles set deep into solid earth, then I am afraid nothing will convince you. And if the England for which you both stand will not be convinced—so much the worse for England! But the men who run England are, many of them, already half-way on the road to conviction—to that strange compelling conviction—that we are about "*to see round the world!*"

**The recording turntable of the phonovision apparatus in the Baird Laboratories.**

# The Pitfalls of Research

## By "Alpha"

THERE are essentially two types of research worker. The first, who must be possessed of an independent income, indulges in research purely and solely for its own sake. He is not concerned with the utility or commercial value of his inventions or discoveries. His work is undertaken entirely out of scientific interest.

The other type of research worker has continually in view the production of a commerical article. He must, in fact, make money from his discoveries; and their success or failure is measured by their money-making capacity.

### The Average Worker.

Between those two extremes lies the vast bulk of workers. They are actuated by both motives. Few of us are blessed with independent incomes, and no matter how pure our research for truth may be, the products must bring in bread and butter; and it is to the man who seeks in the field of invention to provide for himself a living that these lines are chiefly directed.

In the bad old days the starving inventor was a commonplace, and history is filled with pathetic and grossly exaggerated tales of inventors who were robbed of the fruits of their efforts by unscrupulous and flinty-hearted financiers and manufacturers. These days are fortunately passing, and already inventions and inventors are receiving more of the credit and more of the support to which they are entitled.

The path, however, is still dangerous and difficult, and anyone who fails to realise this has only to visit the Patent Office and look through the thousands of patents which have been filed, and which now lie dead and useless in the musty volumes of that graveyard of lost hopes. Those who have succeeded are distinguished as a rule from those whose labours have faded away without fructifying, by the fact that their names appear again and again and invariably in connection with the one subject. It is a striking evidence of the saying "a man with one idea is always dangerous."

If you would succeed, then, it would seem advisable to keep persistently on the one subject. Choose your subject carefully and make yourself an expert and a specialist. The field of science is so vast that no one man may expect to cover it, and only by specialising is success to be achieved. This advice is easy to give but difficult to follow. The research worker of experience knows only too well the temptations held forth by new paths. The attraction of novelty and the unknown is sometimes overpowering, but nothing is easier than to fritter away the whole of one's energies and activities in pursuit of side issues.

### Do not be Side-Tracked.

Beware of red herrings drawn across the track, and turn a blind eye to all but the one object in view. This is the true key-note to successful research work, and it is interesting to observe how well Hertz, the great experimenter, kept to this rule. In the course of his research on wireless waves he discovered the phenomenon which led Hallwachs to produce the photo-electric cell. Hertz, having satisfied himself that the phenomenon had nothing to do with the wireless waves upon which he was concentrating, merely noted the effects observed and then did nothing further in that direction, but resumed his research upon wireless waves.

# Natural Vision and Television

## Part IV.

By J. DARBYSHIRE MONTEATH

**In this, the final article of his interesting series, our contributor goes into the question of colour sensations, and how they are produced. It is explained how, from the three primary colours, all other colours can be produced. Mr. Monteath concludes his article by giving his readers some insight into the how and wherefore of the latest and most marvellous television development—colour television.**

TELEVISION in colour is a crowning achievement, and it may truly be said that only details now remain for the research worker and the engineer to perfect, in order to secure by electrical means the reception of images of distant scenes that will be comparable with natural vision.

A basket of strawberries starred in the recent colour television demonstrations. The shapes and colours of the luscious fruit were clearly seen, and contrasted well with the handle and sides of the straw-coloured basket.

The colours of fabrics and flowers, the blue eyes of a dummy, and the pink tongue displayed by a human sitter marked these demonstrations, which were witnessed by scientific and technical specialists as a finale to the brilliant series of demonstrations in this branch of applied physics so steadily and successfully pursued by Mr. Baird.

Colour vision has a physical basis in the frequencies of the luminous rays, and the subject can scarcely be treated without reference to Newton and his experimental research which culminated in our present knowledge of the spectrum.

Already in these articles some attempt has been made to suggest elementary ideas and experiments that lead to the notion of light frequency and colour phenomena as investigated by the spectroscope.

### Newton's Disc and Colour Vision.

Newton led the way to the scientific appreciation of colours, but it has been left to this generation, through the work of Mr. Baird, to apply to its full value the principles of Newton's disc, by both bicolour and tricolour methods for the reception of naturally coloured images by television.

Newton's disc may be made of cardboard and painted as suggested by Fig. 1. Colours representing the spectrum colours may be selected as follows :—

Red.—Ordinary vermilion plus a small amount of permanent violet.

Orange.—Orange cadmium.

Yellow.—Chrome yellow.

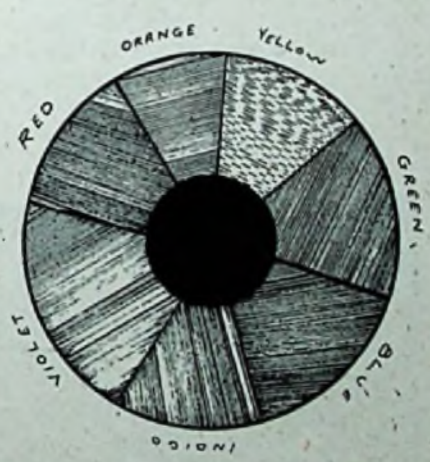



**Fig. 1.**

**Newton's Disc, by means of which colours can be superimposed to produce white.**

Green.—Prussian blue and auerelin.

Blue green.—Veridian plus a small amount of cobalt blue.

Blue.—Ultramarine.

Violet.—Permanent violet plus a little blue.

Having made the disc, mount it on a small motor and rapidly rotate it. The colours will then be superimposed on the eye, and the resulting appearance will be white.

The eye is less analytical than the ear, for in the case of sound the ear can select frequencies from harmonies ; but the eye cannot discover the colours contained in this white light, although a rotating mirror easily renders them visible.

### Producing various Colour Sensations.

The subject may further be investigated by painting the sectors variously, starting with two or more colours. On rotation every colour is viewed in rapid succession, and persistence of vision may result in a simple sensation of colour, although a colourless sensation may be produced.

Three properly-chosen colours can be made to produce almost any colour sensation, and the same effect can be obtained if successive images of colour are made to pass in front of the eye so that the colours are placed rapidly on each other.

Instead of using pigments, cut sections in the cardboard disc, and paste on stained gelatine films, and view the transmitted coloured light.

The effect of two colours falling momentarily and intermittently on the eye is the same as if the interruptions were absent and the coloured lights were mixed.

The impression of red light does not fade from the retina before, say, a blue light is impressed, so that the resulting sensation is purple. Many experiments may be made on the effect of superimposing coloured transparencies, light filters, or coloured lights.

### Lord Rayleigh's Experiment.

A beautiful colour experiment, suggested by Lord Rayleigh, can be made by making a mixture of alkaline litmus and chromate of potash. Then by the aid of a prism view through the vessel containing the mixture a window backed by brightly-lighted clouds; red and green images will be separated, and where they overlap the colour will be yellow.

### Lambert's Experiment.

Place a red gelatine film (about one inch square) on black paper, and about three inches behind it place a blue film. Hold a piece of plate-glass midway behind them, and so incline the glass that while looking through it and the red gelatine a reflected image of the blue one will be projected into the eye in the same direction as that of the red image. The sensation of purple will be realised.

NEWTONS RINGS

Fig. 2.

### Clerk Maxwell's Experiment.

The yellow spot in the eye may be made to take part in the investigations on the superimposing of colours. Clerk Maxwell found on looking into a solution of chrome alum contained in a vessel with parallel sides that an oval rosy, purplish spot could be seen in the greenish colour of the alum, and he noted that this spot was due to the yellow spot of the eye interposing its own pigment.

### Newton's Rings.

The experimental side of colour research cannot be passed over without again referring to Newton and his work on the effect of interfering reflections and retardations of light, in thin films of transparent materials, especially as it has a bearing on the

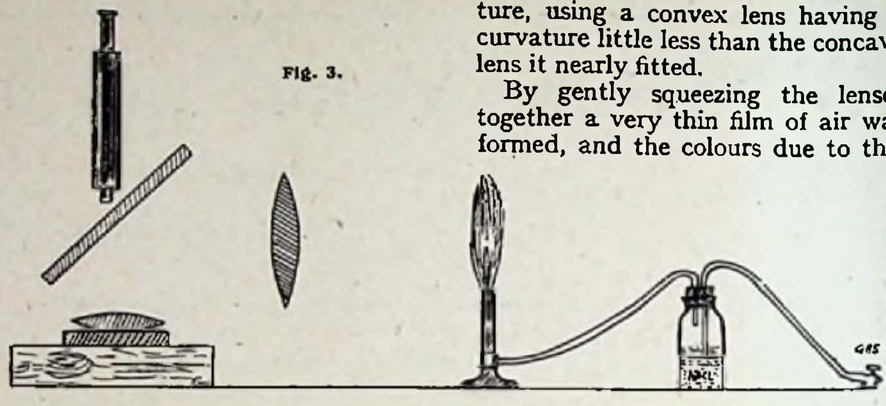



Fig. 3.

NEWTON'S METHOD OF OBSERVING RINGS.

reproduction of naturally-coloured images.

The beautiful colours of the soap bubble, oil films, and the surface films of shells and minerals are to be interpreted in terms of the explanation of Newton's rings.

Dr. Robert Hooke (1638–1703) laid before the Royal Society his observations on very thin slips of mica and other exceedingly thin transparent films, and called attention to the fact that a blue film superimposed on a coloured mica produced a deep purple colour.

He found it impossible to measure the thickness of the films. Newton took up the matter and finally found a method of measuring extremely small spaces.

He formed a film of air between two lenses of large but known curvature, using a convex lens having a curvature little less than the concave lens it nearly fitted.

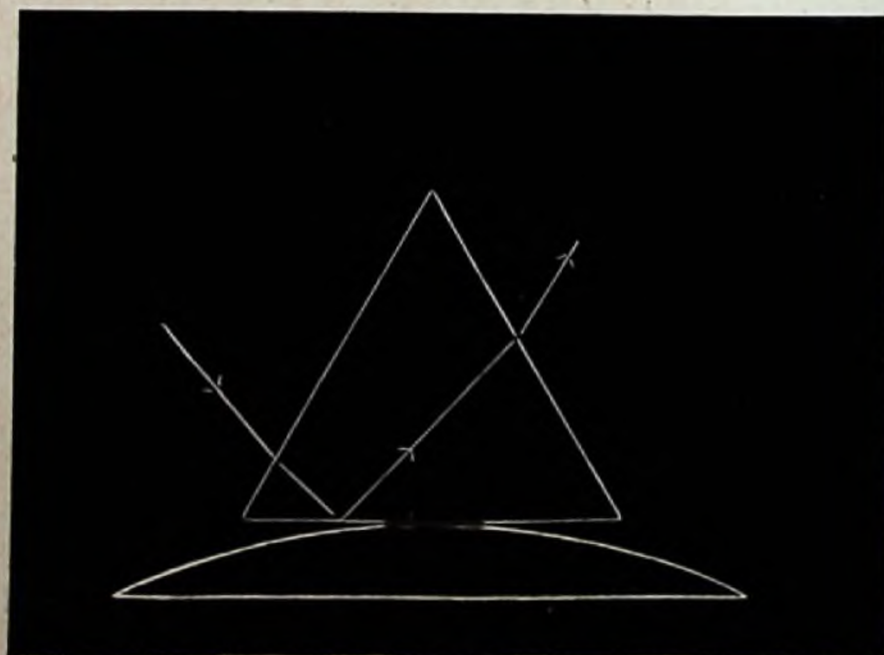
By gently squeezing the lenses together a very thin film of air was formed, and the colours due to this film have since been called Newton's rings.

The experiment may be repeated by the reader by pressing a spectacle lens or eyepiece against a piece of plate or flat glass, when beautiful coloured rings will appear (Fig. 2).

### Measuring the Wavelength of Coloured Light.

Using monochromatic light, as suggested in the illustration Fig. 3, a central black spot will be seen by reflected light, and this will be surrounded by concentric rings and dark intervals.

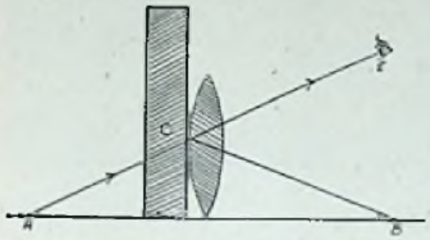
By viewing the rings with the aid of a travelling microscope, and in this way measuring their diameters, the wavelength of the yellow sodium light can be obtained, and the frequencies of the vibrations causing



Newton's method for viewing a greater number of coloured rings.
Fig. 4.

the colour sensation can easily be calculated.

Figs. 4 and 5 show later methods suggested for observing the beauty of



VIEWING COLOURS OF GREATER BRILLIANCY AT ARAGO'S EXPERIMENT

Fig. 5.

the rings, and Fig. 6 shows the rays of reflections internally reflected from a film.

Using Dn for the diameter of the $n^{th}$ ring and R for the radius of curvature of the lens, the wavelength of sodium light =

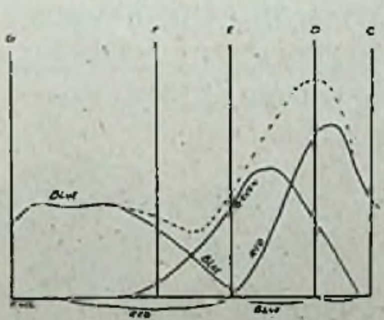
$$\frac{Dn^2}{2\,R\,(2n+1)}$$

Although the frequency of the light vibrations undoubtedly gives rise to colour sensations experimentalists have yet to assure us that every spectral ray is individually capable of giving rise to its own peculiar colour sensation.

And we know that complementary pairs of colours cannot form all the natural colours.

### Theories of Colour Sensations.

Thomas Young suggested that the primary colours were the basis of our realisation of colour, and Helmholtz followed with the idea that the eye was capable of registering three sensations, due to three sets of



DIAGRAMMATIC RESULTS OF MAXWELL'S COLOUR CALCULATIONS

Fig. 8.

nerves. When more than one nerve is actuated then mixed sensations express themselves, the exact sensation being dependent on the extent to which each nerve is actuated.

Fig. 7 shows the results of experimental research in this direction by Koenig, working in Helmholtz's laboratory.

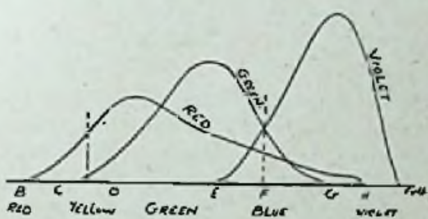
Clerk Maxwell calculated from experimental data the composition of the colours observed in the spectrum, in terms of the three primary colours. His curves are shown in Fig. 8, and Helmholtz's curves (Fig. 9) show the three simple sensations which we are primarily capable of registering—red, green, and blue.

His curves analyse the values of the separate recognition of colours, and by superimposing the curves all our colour sensations can be expressed (Fig. 1).

### Primary Colours.

The three primary colours are violet, 250, near G; Fraunhoper green, 213, between E and F; and red, 100, between B and C.

Colour blindness is usually due to defects in one set of nerves, seldom two. A red colour-blind person sees by two sets of nerves, and possess violet and green sensations, so that




THREE SETS OF PRIMARY NERVES ARE STIMULATED BY LUMINOUS RAYS OF DIFFERENT WAVE LENGTH

Fig. 7.—Koenig's Curves.

such a person sees poorly at the red end of the spectrum. In the case of a green-colour-blind person, violet and green sensations are weak or totally absent, but equal violet and red stimulation gives the sensation of white.

Instead of blue light a green colour-blind person sees white, for the spectrum he sees is red, then white, and then violet.

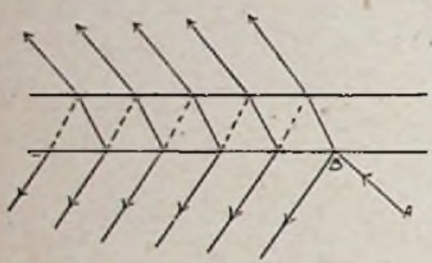
### Photo-Colour Images.

Accidentally Becquerel (in 1850) obtained natural coloured photographs, and in 1891 Lipmann disclosed a process for producing coloured images by means of plates or films.

A plate of glass is coated with a granuleless panchromatic light-sensitive emulsion, and exposure is made by the photographic camera, so that it is made through the glass, with the sensitised side in contact with mercury.

As in the case of Newton's rings, reflected rays interfere with the incident rays and produce in the thin film very fine laminæ of silver separated by half a wavelength of the light that produced them. On looking through the plate the transmitted light appears brown, but by reflected light the silver particles affected by the light give the effect of a reproduction of the natural colours of the object to which the plate was exposed.

Zenker in 1868 explained the colours



COLOURS REFLECTIONS OF THIN PLATES OR FILMS.

Fig. 6.

of the Lipmann film as being due to stationary waves formed by reflections.

### Lipmann's Film.

Fig. 10 illustrates a section of the film. The upper surface was in contact with the mercury. The dark bands represent antinodal planes where the silver salt has been decomposed by light. The clear spaces show the nodal planes. And it is interesting to note that the spaces between the antinodal planes are only about 0·0035 millimetres apart.

Three-colour photography depends on the selection of the three primary


DIAGRAMMATIC RESULTS OF HELMHOLT'S THEORY OF COLOUR SENSATIONS

Fig 9.

colours, red, green (or yellow) and blue, from the natural colours to be photographed, so that three monochromes are produced which can be superimposed to reproduce the object photographed in a representation of its natural colours.

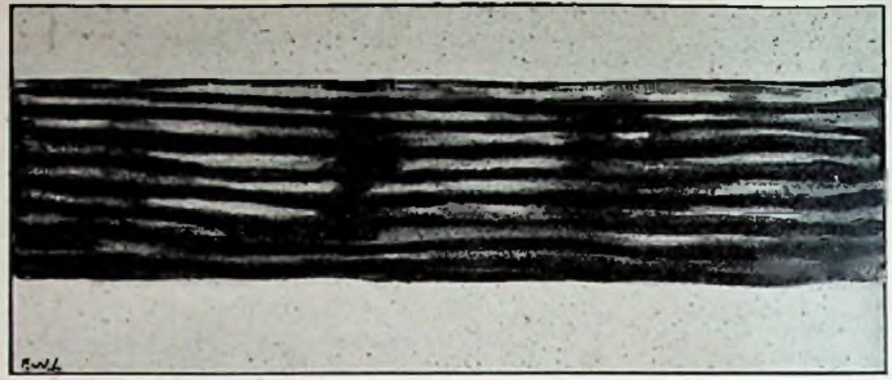


Fig. 10.
The Lippmon's Film (showing transverse section magnified 1500 dia.)

To secure these monochromes light filters (or colour screens) are used which select each primary colour of the image.

### Colour Television.

And so we find that success has been reached by Mr. Baird in the superimposing of colours, and tricolour films, both in the transmitting and receiving televisors, for the reproduction of distant scenes in natural colour.

In the Baird process selected coloured rays of the primary order are in turn allowed to fall on the object, and their reflections operate on light-sensitive cells. The varying voltages of the cells are amplified and caused to produce somewhat similar rays at the receiver by the aid of electrical glow lamps of the vacuum tube order. At present high voltage variations are essential, and the result is that luminous bands of the spectrum illuminate the screen. By strict yet automatic synchronisation each area lighted appears on the receiver at the same time and of the same colour as the original area at the transmitter. Retentivity of vision now operates and enables the effects of successive visual spectra bands from each glowing vacuum tube to be superimposed, with the result that the received image is seen in its natural colours.

The process is therefore one of optical synthesis where results are obtained by the mixture of coloured lights; facts relating to which have already been dealt with in these articles.

We close this series of articles with hearty congratulations to the British pioneer worker who has persistently developed and practically applied this branch of physical research to so popular an end as colour television.

Newton, speaking of the spectrum, said it was "a very pleasing divertisement to view the vivid and intense colours produced thereby," and we must say to-day, having been privileged to witness Mr. Baird's demonstration, that a more fascinating subject than the reception of naturally-coloured television images accompanied with speech or music will indeed be very hard to rival.

# LOUIS BYRNE

***gives rein to a facile pen concerned with a few tremendous thoughts on the invention of daylight television***

REGULAR readers of this journal must have learned with some excitement that television in broad daylight is now an accomplished fact. In the July issue Dr. J. A. Fleming recorded his impressions, while the national press has since printed accounts of the demonstration to which its representatives were also invited.

It is not in the least surprising that the more imaginative among us have given full rein to our creative brain cells, and justifiably have taken a few peeps into a future which we may speak of as being near rather than distant.

Whatever one may have thought of television before the daylight achievement, there is now food for thought for us all . . . enthusiasts and sceptics alike. In speaking of the former we can safely leave them to their own inventive fancies—for the moment at any rate, and address ourselves more directly to the latter people, who have reserved judgment on the question of whether or no television is a *fait accompli*.

### Historic Notes of Dr. Fleming.

From the point of view of the man in the street who is at the mercy of the things he hears and the things he reads, there is something historic in the brief notes which Dr. Fleming has written for the information of the readers of this magazine. He has seen. . . . There are millions who have yet to see.

Unlike many other inventions of world-wide influence which emerge from the laboratory only after years of improvement, modification and refinement, the present generation is seeing television advance step by step.

In years gone by scientists were wont to pursue their studies "far from the madding crowd" and the busy-bodies who cry that nothing good ever comes out of the present. They were perhaps the better for their seclusion, compulsory though it was. In the days of the carbon filament and the black deposit on the glass bulb great strides were made unknown to the outside world.

To-day, the lot of the inventor is different.

He invents to-day; to-morrow the world knows. Thus we are at this moment made familiar with great inventions, we know what they mean and the effect they will have on commercial and domestic life in but a very short space of time. Our great national newspapers convey to the remotest part of the country in a few hours news of inventions which in the good old days would only have reached it by circuitous ways many months after the first release of information.

Not being an inventor, it is rather difficult for me to say what the inventor thinks about it all. Whether to proceed along the narrow furrow alone without praise or blame, or to be at the call of newspaper headlines whenever the occasion arises. This is something which must be left, however, for the inventor himself to decide as circumstances suggest, or, perhaps, dictate.

As citizens, we hear about inventions while they are yet undergoing research. We are, as it were, almost spectators constantly present in the inner room. Although we may not follow the inventor's genius along its specific line of scientific thought, we observe the result he attains, and after all that is the thing which really matters.

> **OUR CONTRIBUTOR'S OPINION.**
>
> **The author of this article, who is well known in the "Street of Ink," says of Mr. Baird :—**
>
> **"Let it be said, therefore, at this point, that in giving us reproduced light rays with their varying frequency and intensity in the form of readily recognisable images Mr. Baird must go down in the history book of science as an inventor of the greatest calibre, to whom future generations will not stint either praise or credit for the invention of, and the making practicable of the modern development which we speak of to-day as television, or the ability to see over distance or through space electrically."**

### Television is here.

This system may or may not be good for us. . . . If experience is able to tell us anything it is that a consistent "close-up," or rather the watching of the process from alpha to omega, is perhaps conducive to peculiar reactions. If, on the other hand, one sees the final perfected object . . . Oh! but that is another story. The rapid pace of modern life calls for invention and commercialism to run in harness, a state of affairs which fills the wood with trees as well as undergrowth.

We have heard it on all sides for years, we hear it to-day—"it's bound to come." That is, that television is bound to come. Dr. J. A. Fleming tells us that it is here with amazing practicability.

### Electric Light for All.

The technical stages which have preceded the accomplishment of television in broad daylight are too well known to reiterate in detail here. Elsewhere in the pages of this magazine—in this and in earlier numbers—eminent scientific authorities have shown us the technical progression from the original to the reproduced image on the screen.

This is something extremely fascinating for the scientist and the technician, opening up continents of ground for investigation, analysis, and imagination. To the man in the street who knows little of science and cares still less, *cause* finds him rather unsympathetic. . . . It is *effect* with which he is concerned, or "results," to express it colloquially. Show him something and his soul is filled.

By his invention of daylight television Mr. Baird has brought electric sight to the man in the street. This is really tremendous in its possibilities for every phase of life. In fact it is so tremendous that to the ordinary citizen it is almost approaching the magical. Just by way of comparison let us take a thought or two on those days—very far distant in terms of actual advance—before the commercialisation of radio. Does it not appear an age ago? So long ago that it is really difficult to form an accurate idea of what the world was without radio a score of years ago.

### Greater Things to Follow.

There would be only a few who at that time were able to "gaze into the crystal" and see the remarkable transformation for which radio has been responsible. To-day we take the wonders of radio for granted . . . we are almost at the point of taking television for granted.

The scientists who have actually seen for themselves the latest apparatus which was used at the daylight television demonstrations acclaim the fact that television is here. They have seen the process from beginning to end. They know every little reason for this and that and understand the purpose of every piece of apparatus and why it is used here and not there. Great strides have been made, and if we read the signs of the times rightly there are a number of greater strides now being made about which we shall hear when we are least expecting to do so.

### A Bold Thought.

In the minds of those who have seen the wonder of the electric eye television is taken for granted. As an accomplished thing it is here. That the transmission and the reception of an image has been accomplished electrically is now scientific history; it has been for years. In the days of Mr. Baird's original experiments in Frith Street, television was of immense interest to science. Scientific men saw in it infinite effects destined to add to the advancement of commerce and, logically, domestic life. **What radio has done for commerce and for the private life of the citizen, television will do in far greater measure.** That is a bold thought. In August, 1928 A.D. it might also appear to be a tremendous thought. What radio has done for hearing television will do more for seeing. *To hear is human by comparison with seeing, which is—and who but the blind could really understand?—almost divine.*

Think for a moment or two about hearing and seeing. So far as we are able to read our thoughts on the subject, to hear inspires the wish to see. A happy thought to carry in one's mind upon the very next occasion when a ten-deep crowd deprives one of sight, whether this be at Lords or at the Oval. "Soccer" and "rugger" enthusiasts may possibly have the same thoughts when in a similar predicament. Pass now to the fact that the records of science now include the achievement of television in ordinary daylight as we know it during our waking hours at the office and at play.

### Space Annihilated.

To give play to one's imaginative powers to the limit then television brings the mind to many remarkable observations which to-morrow our every-day existence will accept as commonplace. It depends upon individual and personal characteristics what line is adopted for these observations. **The business man will see many of his particular problems overcome by the aid of television. The family man will visualise into his home life the illimitable pleasures which television will bring to him and his family.** Space, by which we understand ocean and continent, will be overcome. Radio brought distant speech and music into the home. Any night one is able to hear in one's own study the characteristic intonation of the American's English, the gutteral German or the *langue à la Français.* It is so commonplace that nothing is thought about it. Yet it really means that space has been annihilated—reduced to nothing. To the ears of men space does not exist; it has been conquered by radio.

### A Practicable Invention.

This dimension presented a far greater problem so far as the eyes of men were concerned. One's ears are so easily deceived; not so with the eyes, which perhaps are the most highly developed of our five senses. Let it be said, therefore, at this point, that in giving us reproduced light rays with their varying frequency and intensity in the form of readily recognisable images Mr. Baird must go down in the history book of science as an inventor of the greatest calibre, to whom future generations will not stint either praise or credit for the invention of, and the making practicable of the modern development which we speak of to-day as television, or the ability to see over distance or through space electrically.

**By his system of electric sight we in this generation have witnessed the dimension of space overcome for the eyes of men to such a degree of success that it is now possible to operate the electric eye apparatus in the same daylight that we use for our vest pocket camera.** This conception of, or rather comparison between, the art of the electric eye and the art of the camera is wonderfully descriptive, and it is due to Dr. Fleming. It conveys to the mind exactly what we may expect from television in many, many ways. It outlines to us its innumerable applications in the business world and in the private lives of the men in the street . . . a lens some hundreds of miles away with a screen in the office or at home. . . .

### What Television Really Means.

We know only what Mr. Baird has done. He has shown us television by electric light—the first landmark. Then he took us into total darkness and we saw television reach the next stage. Last month we went outdoors into the open air in a very ordinary light for Mr. Baird to reveal to us that the greatest step of all had been made—television in broad daylight. This comprises a remarkable programme of scientific endeavour which speaks for itself. A few lines of type tell us all. **Remember in the days shortly to come what television really means to modern civilisation—a lens some hundreds of miles away with a screen in the office or at home.**

# Optical Reflectors

PART II

By Professor CHESHIRE, C.B.E., A.R.C.S., F.I.P.

**[This is the second of a new series of articles by Professor Cheshire on optical subjects likely to be of special interest to those of our readers interested in the working of known types of television apparatus and the designing of new ones. These articles will also deal with the construction and application of optical elements made available by optical science in recent years.—EDITOR.]**

**Optical Pointers.**—Every schoolboy who has temporarily blinded his class-mates by surreptitiously flashing a beam of sunlight into their eyes, with a bit of broken looking-glass, knows what an optical pointer is: it is a narrow beam of light of any desired length which can be turned in any desired direction.

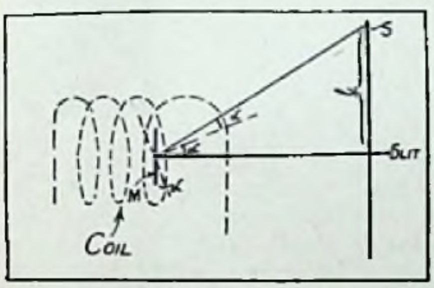



**Fig. 1.**
**Optical pointer fitted to a galvanometer.**

Fig. 1 shows in plan an optical pointer as applied to Thompson's (later Lord Kelvin) mirror galvanometer—the instrument which played such an important part in the successful introduction of submarine telegraphy more than half a century ago.

A small mirror, M, about the size of a threepenny piece, and weighing a few grains, has stuck upon its back two or three tiny magnets. This mirror is suspended by a silk fibre and adjusted so that it lies across the axis of a wire coil through which passes the electrical current to be measured.

Light from an illuminated slit falls nearly normally upon this mirror and is reflected back again in the same vertical plane, on to a scale S, the zero of which is immediately above the illuminated slit. The mirror is slightly lenticular in shape, so that a sharp image of the slit is thrown on to the scale.

When a weak current passes, the magnets and the mirror are twisted through a small angle $\alpha$. The angle of incidence, originally zero, is now $\alpha$, and since the angle of reflection is equal to the angle of incidence, it follows that the reflected beam has been deflected through an angle equal to $2\alpha$, and this angle is represented on the scale S by a length $l$, which depends upon the distance of the scale S from the mirror M.

## Multiple Images by Reflection.

When a candle, placed at a distance of, say, 15 to 20 feet, is seen by glancing reflection in an ordinary looking-glass, lying flat upon a table, a number of images of the candle are usually seen, tailing off in one direction or the other with diminishing intensities, and if the looking-glass is rotated in its own plane—i.e., about a vertical axis—the tail of images will be seen to waggle slowly and change in length. If now we substitute for the looking-glass a plate of glass which has been worked accurately to plane-parallelism—a first-class sextant horizon glass silvered at the back will do—it will be found that only one image of the source of light (which in this case should be a distant hole in a piece of cardboard with a candle behind it) will be seen; and rotating the glass in its own plane produces no effect.

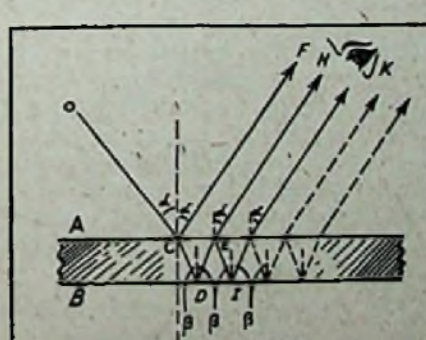



**Fig. 2.**
**Optical action of plane-parallel plate.**

This experiment, giving "one image all round," is an old workman's test for plane-parallelism. In more modern shops the more delicate test afforded by interference phenomena is used. The light in the last experiment should be not less than 15 to 20 feet away. If only a few feet away multiple images will be seen, *but they will be unaffected by the rotation of the plate.*

Anent the experiment with the ordinary looking-glass referred to above a story is told which is too good to be lost.

Many years ago someone wrote to the *Daily Graphic* and explained that although it was generally believed that the satellites of Jupiter could not be seen without the help, at least, of a pair of opera-glasses, he possessed a remarkable looking-glass—a treasured heirloom—in which the satellites could be seen by simple reflection.

The next day, however, a wag wrote to say that he possessed a still more wonderful glass, for not only did it show the satellites by reflection, but, when the glass was rotated in its own plane, *it showed the satellites rotating around Jupiter!*

The correspondence then ceased.

### How Multiple Images are Produced.

When light falls upon a plane surface of a transparent body it is split into three parts. One of these is scattered or reflected in all directions, one is regularly reflected in accordance with the law of reflection, whilst the third part enters the medium and is transmitted in accordance with the law of refraction.

In the case of polished glass the scattering is negligible. Suppose, then, that light falls upon such a glass, plate AB, Fig. 2. At every point of the surface A, such as C, the light falling in the direction OC is divided into two—one CF, reflected, and the other CD, transmitted. Similarly when the ray CD falls upon the second surface B it is divided again into two, a reflected ray DE, and a transmitted one DG (not shown).

Again, at E, EH escapes into the air and is refracted, whilst EI is reflected. If the surface B, which may be silvered, is accurately parallel to the first surface A, then the angles $\alpha$ are equal, as are also the angles $\beta$, from which it follows that the rays CF and EH, together with an

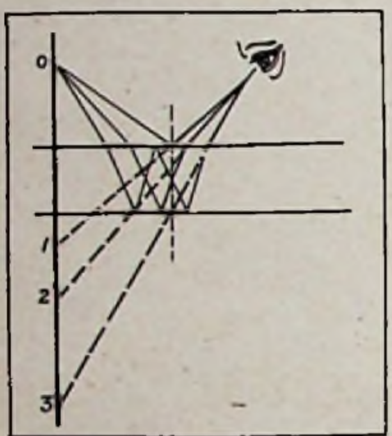



Fig. 3.
Multiple images in plane-parallel plate.

indefinite number indicated in dotted lines, emerge parallel to one another.

If the source of light be at such a distance that the angle of incidence $\alpha$ does not change appreciably from point to point of the surface A, then all the rays will form a parallel bundle, which, filling the eye anywhere as at K, will come to a single-point focus on the retina producing the single image seen.*

When a near source of light, some two or three feet away, is used with a true plane-parallel plate, the angle of incidence $\alpha$ changes from point to point of the surface A, and multiple images result, as shown by the diagram, Fig. 3.

The first image seen in the direction EI is due to reflection at the first surface A only. The second image, 2, is due to light reflected once from the surface B, whilst light reflected twice at this surface produces the third image, 3. It is important to remember that the crucial test for plane-parallelism is to rotate the mirror in its own plane. If the image or images do not move the plate is plane-parallel to a fairly high order of accuracy; if the images do move the glass is wedge-shaped.

**Curvature**—Newton has given us for the expression of the curvature of a line at any point the equation—

$$C = \frac{1}{r} \quad \ldots \quad (1)$$

where C is the curvature, and $r$ the radius of the circle which fits the curved line at the point considered—the so-called osculating or kissing circle. Newton in thus defining curvature as the reciprocal of the radius of curvature was simply giving mathematical expression to the popular conception of curvature. The smaller a circle the greater its curvature.

The curvature of the line L at the point A is equal to $1/r_1$, the reciprocal of the radius $r_1$ of the kissing circle shown; similarly the curvature at B is equal to $1/r_2$.

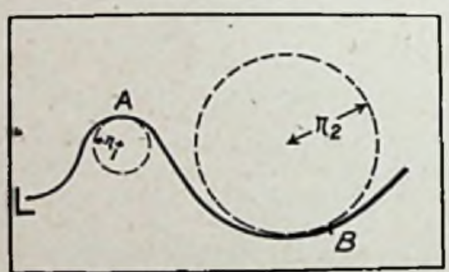



Fig. 4.
Line with varying curvature.

## Radii of Curvature.

Let us consider for a moment the varying curves which occur on a railway line, taking conveniently a mile as our unit of length. A section of the line, described with a radius of one mile, would have a curvature of $1/1$=unity. A sharper curve with a radius, say, of a quarter of a mile, would have a curvature of $1/\frac{1}{4}$, equal to F, and so on. For a straight line, which may be looked upon as part of a circle with a radius infinitely great, the curvature is $1/\infty$, equal to 0 or zero, the symbol $\infty$ indicating that $r$ is taken as very great—strictly speaking, infinitely great.

Fig. 5 shows a circle with a radius $r$ and a curvature therefore of $1/r$. Let a diameter be intersected rectangularly by a chord cutting off the arc AA, and a segment $s$ † of the diameter. By the geometry of similar triangles—

$$s : h :: h : (2r - s) \quad \ldots \quad (2)$$

If the arc AA is but a small part of the complete circle, as it is in most mirror and lens problems, then $2r$ can be taken as equal, very nearly, to $(2r - s)$, so that we can write—

$$s = \frac{h^2}{2} \cdot \frac{1}{r} \quad \ldots \quad (3)$$

i.e., so long as $h$ is constant in length, the length of the segment $s$ varies directly with the curvature $1/r$.

## Measurement by Spherometer.

In the case of large lenses, such as the object-glasses of astronomical telescopes, it is not practical to measure the radii of curvature directly, but with the aid of the spherometer shown by Fig. 6 the operation is a simple one. The spherometer in one form consists of a short length of tube P, the radius $h$ of which is accurately known, fitted with an axial micrometer screw Q. The tube P is placed upon the spherical surface O to be measured and the screw Q adjusted to touch that surface.

The distance $s$—the sagitta—between the lower end of the screw Q and the plane defined by the lower edge of the tube P is then read off on a circular scale T, carried by the screw Q. Let the radius of the sphere O be $r$; then, from equation (2) above, it follows that:

$$r = \frac{h^2}{2s} + \frac{s}{2}$$

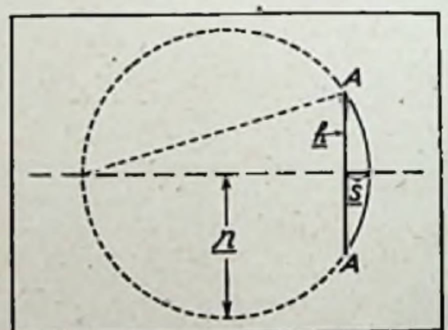



Fig. 5.
Relationship of radius and sagitta.

* In many text-books the diagram Fig. 2 has been given erroneously to explain multiple images. So long as all the imaging rays are parallel to one another one image only can be seen.

† This segment $s$, from the similarity of the figure to a bow and arrow, was called by Kepler the "sagitta" of the arc; hence the modern method of dealing with mirror and lens problems by the consideration of waves and their curvatures, originally introduced by Porro, is often referred to as the sagitta method.

so that if $h=6$ inches and $s=0{\cdot}1$ inch, then

$$r=\frac{6\times 6}{0{\cdot}2}+0{\cdot}05=180{\cdot}05 \text{ inches.}$$

The approximate formula (3) above, gives 180 inches.

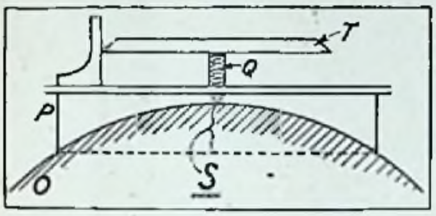



Fig. 6.
Spherometer in use.

The result arrived at in equation (3) is a very important one, because one of the most delightfully simple and natural methods of solving mirror and lens problems is based upon it—the method in which waves are considered rather than rays. Obviously, by using a standard aperture in which $h$ is made equal to $\sqrt{2}$, $h^2/2$ is made equal to unity, so that the sagitta $s$ of an arc becomes numerically equal to $1/r$.‡

Thus, using this standard aperture on a sphere with a radius of 10 inches, it would be found that the corresponding sagitta had a length of 1/10 inch.||

## Reflection by a Curved Surface.

When a light-wave falls upon a plane surface it is reflected, as we have seen, without change of curvature; but if the reflecting surface be curved it then impresses a curvature upon the incident wave during the act of reflection, with the result that the curvature of the reflected wave differs from that of the incident wave. Indeed, a curved mirror might be defined as an optical contrivance for changing the curvature of light-waves.

In Fig. 7 a plane wave is shown falling symmetrically upon a convex mirror M, which may be looked upon as a circular disc, with a linear aperture ABA, cut out of a hollow sphere with its centre at O, and having a radius $r$. The wave, at the instant shown, has reached the vertex V of the mirror, but it has still a distance $s$, equal to VB, to go before it strikes the rim of the mirror at A.

Whilst it is moving through this distance near A from right to left, the part of the wave at V will move from left to right to the point $V_1$, also through a distance $s$, so that, when the reflection is completed, the wave will have the shape shown by the dotted line, passing through the three points $AV_1A$.

Assuming that the angular aperture $\alpha$ of the mirror is small, the new wave $AV_1A$ may be treated as part of a circle with a curvature equal to the length of the sagitta $BV_1$, which is equal to $2s$, and which again is equal to $2/r$. But the curvature of the mirror is $s$, equal to $1/r$, so that we have arrived at the conclusion that a plane wave—i.e., one with zero curvature, falling upon a convex mirror, has impressed upon it during reflection a curvature equal to twice that of the mirror itself—i.e., the reflected wave appears to diverge from a point F, called the principal focus, situated halfway between the vertex V, of the mirror and its centre, O. The distance FV, usually written $f$, is defined as the principal focal length of the mirror. Its reciprocal $1/f$, equal to $2/r$, is a measure of the curvature impressed upon plane incident waves.

## A Summing-up.

We might go on to consider combinations of convex and concave-fronted waves with convex and concave reflecting surfaces, when we should find that all our results could be generalised by the statement: *When a wave is reflected by a mirror its curvature is increased (algebraically) by an amount equal to twice that of the mirror itself.*

But the reader will ask, What does all this mean arithmetically? Let us see. We will start by agreeing to treat as positive the curvature of a wave *converging* to a focus, and as *negative* that of a wave *diverging* from a focus. Similarly, the curvatures of concave and convex mirrors will be treated as positive and negative respectively, because by the first type a plane wave is made to converge to a focus, whilst by the second type it is made to diverge as from a focus.

The general statement italicised above may now be put more concisely into the equational form:—

Final Curvature=Initial Curvature+Impressed Curvature.

If the distance from the mirror of the final image be denoted by $v$, that of the object by $u$, and that of the principal focus by $f$, the curvatures in order will be $1/v$, $1/u$, and $1/f$, where $1/f$ is equal to $2/r$, twice the

(*Continued on page* 26.)

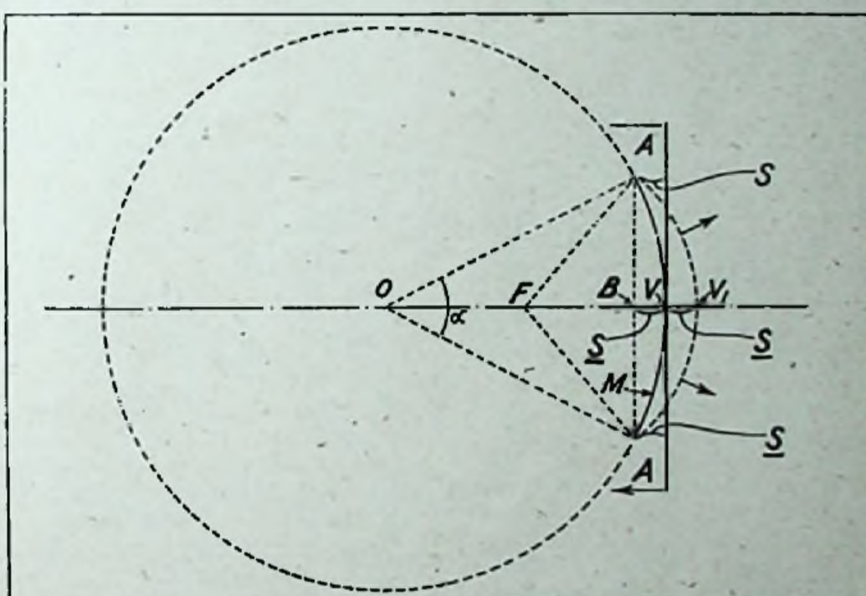



Fig. 7.—Reflection by a convex mirror.

‡ This really arises from the fact that in all the problems with which we shall be concerned we shall have to deal with linear equations only, in which $h^2/2$ is a multiplier of both sides, so that it cancels out.

|| The reader is strongly advised to draw a number of circles on paper with different radii, then draw a chord of 2·83 inches in each one. Measure the sagitta and check it against the reciprocal of the radius.

# Bridging Space
## (*Part II*)

By JOHN WISEMAN

*This is the second of a series of articles in which the fundamental principles of electricity and wireless will be explained in the simplest possible language.*

READERS will no doubt remember that last month I dealt at fair length on the fundamental nature of things, and it was suggested at the end of the article that any body charged with electricity has electric "lines of force" radiating from it *in all directions*. Dr. Fleming, in the June issue of TELEVISION, also dealt with the problem in his typical able manner, but since this section of our subject is of such importance it is advisable to reiterate the outstanding details. Mentally picturing our electric lines of force as "strings" stretched out into space, we find that when these strings fall on another electric body the two bodies attract one another.

This does not mean that the bodies necessarily move towards one another until they collide, any more than ordinary stationary objects move towards the earth, although we know there is a gravitational attraction between them. When the lines of force actually link two bodies we find that they are charged with opposite kinds of electricity—i.e., positive and negative; but should two bodies charged with the same kind of electricity be brought near to one another there is a state of repulsion between them.


**SUMMARY OF POINTS IN THIS ARTICLE.**

**The writer of this article commences with a brief recapitulation of the theory of electric "lines of force," so ably expounded by Dr. J. A. Fleming, F.R.S., in our June number.**

**Following on this point, it is explained how wireless waves are generated and detected at a distance, details being given in simple language to describe some of the apparatus used, and the characteristics of different wireless waves.**

**In his next article the writer will deal, in equally simple language, with the wireless aerial and its functions.**


### The Formation of Waves.

We can think of our single electron, with its lines of electric force radiating out in all directions in straight paths, in much the same way as, say, the light from a star; then when the electron is at rest we have a condition such as that illustrated in Fig. 1 R. There is an electric field round the body, but it is only quite close to the body that the field has any appreciable strength.

Now what happens when this electron has a sudden movement impressed upon it? As Dr. Fleming showed, the lines of force will move, of course, but it is impossible for the movement to be imparted simultaneously along the whole length of the lines, as would be the case if the movement was a very slow one. A certain fraction of time is required for the lines to adjust themselves to this new condition, just as we have in the analogous case of a piece of string kept rigid at one end and moved quickly by the hand at the other end. We know that the string does not move in a rigid manner, but the movement of the hand at one end evidences itself as a kink, hump, or wave travelling along the length of the string.

For each up-and-down movement there is a complete wave travelling along the string, and in the case of our electron a similar condition exists. The kink moves along the lines of force in the manner shown diagrammatically in Fig. 1 M, constituting an electric wave.

### A Double System.

But we saw also that the kink produces a magnetic force, and it is this *double* system of lines of magnetic and electric force moving outward in all directions as a result of the electron motions that gives us the popularly termed wireless waves. They are also referred to frequently as ether waves, but the existence of an ether (a universally diffused medium pervading everywhere) is a hypothesis concerning which there is considerable controversy amongst

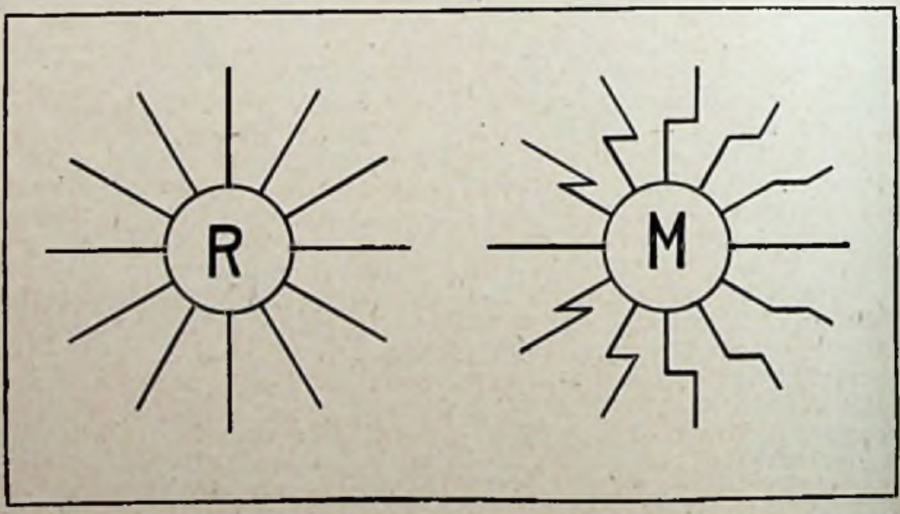



**Fig. 1.**
**Illustrating the lines of electric force which radiate from (left) an electron at rest, and (right) an electron in motion.**

scientists, so under these circumstances it is perhaps advisable to adhere to the terms electro-magnetic or wireless waves.

Now, it will be obvious that the amount of energy propagated into space each time an electron changes its motion is infinitesimally small, but if it is possible to cause an enormous number of electrons to move or change their motion in the same way and at the same time, then we shall be able to generate quite a powerful wave by the uniting of each small effect. This could be detected at one or more receiving points and thereby establish a wireless communication system. We reach, therefore, another important stage in our investigations into the bridging of space—namely, the means adopted to initiate a large electron movement and how a control over the wavelength is effected.

The two pieces of apparatus which have a marked bearing on this are called a condenser (capacity) and a tuning coil (inductance), and we must investigate their peculiar properties to ascertain how, together, they can produce a controllable oscillation.

### Condenser Properties.

In its simplest form a condenser consists of two sheets of thin metal separated by an insulating material, such as glass, mica, air, &c., the separating medium in whatever form it takes being designated the dielectric. In spite of its name this simple piece of apparatus does not condense anything in the true sense

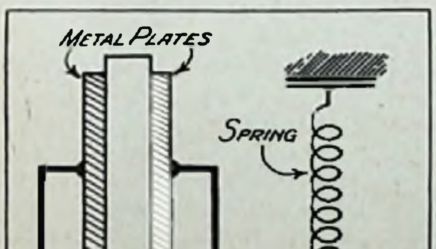



Fig. 2.
A simple diagram of a condenser, the operation of which, by the aid of the spring shown at the right, is explained in the text.

of the word, but acts as a store of electrical energy.

If we connect a battery across the condenser plates an ordinary continuous direct current flow catnno take place owing to the presence of the insulating dielectric, and hence an absence of a complete metallic circuit. What actually occurs is an accumulation of electrons at the positive end and a dearth at the negative end, as illustrated diagrammatically in Fig. 2 A, the dots serving to represent electrons. We have actually upset the normal electron distribution or equilibrium of the condenser owing to this change in electron orientation, the charging effect of the battery on the two plates bringing about a state of strain in the dielectric—the strain, in effect, being a storing of energy. We can compare this with an open spiral steel spring stretched by a weight suspended at one end (see Fig. 2 B).

### An Impetuous Rush.

Assuming that there is no trace of leakage between our condenser plates, we shall find that this state of strain will persist even when the charging battery is removed. A removing suddenly the weight from the end of the extended spring, when, of course, the spring contracts, and in so doing actually becomes shorter than its true length, and has to expand and contract two or three times before a steady state is reached.

### Spark Discharge.

Reverting to our condenser, it is not actually necessary that the two plates should be metallically connected in order to effect the discharge. If a wire is joined to each plate and the free ends of the wires are brought close together, the state of electric strain is so great that a spark will leap across the intervening space. The insulating properties of the air are really broken down, but the actual spark does not consist simply of one leap of electrons across the gap. It consists really of a to-and-fro electron movement which persists until equilibrium is restored.

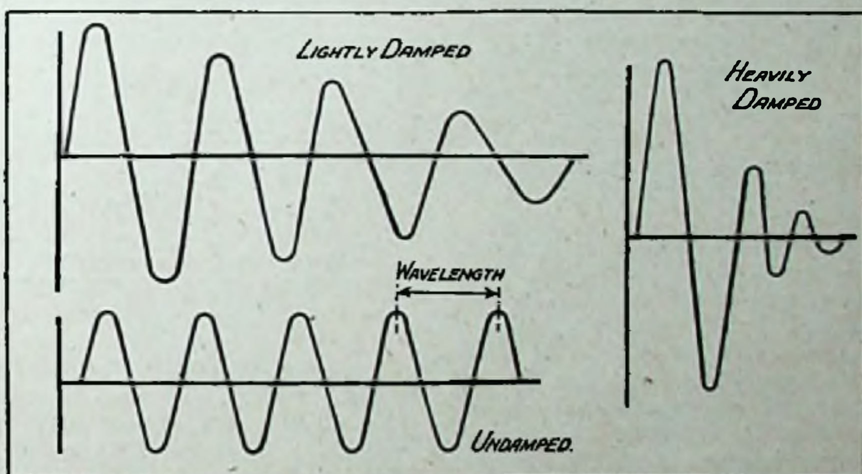



Fig. 3.
These diagrams clearly illustrate the various forms of wireless waves.

return to the normal state can only be brought about by externally connecting the two plates together by, say, a wire, and if this is done then there is a very rapid rush of electricity between the plates. There is a natural tendency to restore the condenser to its previous discharged condition, but the rush of electrons is so impetuous that they overshoot the neutral mark and the plates become charged in the opposite direction.

This to-and-fro movement may take place a few times before equilibrium is restored; that is to say, the electrons are normally distributed and the condenser is discharged. Referring to our analogy of the stretched spring, the effect is equivalent to

This condition of oscillation which we have just examined forms the basis of our rapid electron movement, provided we can harness the energy in some way and make it conform to our imposed conditions. Each set of oscillations produced by the charge and discharge of the condenser decreases in amplitude, or intensity, and under these circumstances the oscillations are said to be damped, the magnitude of the damping being the determining factor as to the number of complete oscillations. It is possible to produce oscillations which do not die away, and these are known as undamped oscillations or continuous waves, and both forms are represented diagrammatically in Fig. 3.

### A Closed Oscillatory Circuit.

Now it can be shown that a complete circuit consisting of a condenser and an inductance (Fig. 4) has a certain definite resonant frequency at which oscillations will take place in the circuit, the particular value of the frequency depending upon the electrical constants. The inductance for our purposes generally takes the form of a coil of wire, the shape of the coil and style of winding being governed by the specific purpose for which the oscillating circuit is to be used, that is, transmitting or receiving.

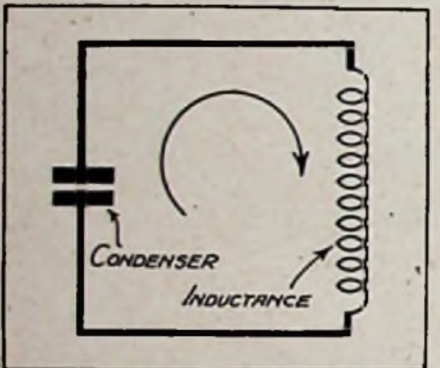



Fig. 4.
A combination of capacity and inductance for producing wireless waves.

The closed circuit of a condenser and a coil will meet our needs, therefore, since by making either the condenser or the inductance variable we can control the number of oscillations per second, and thereby the wavelength propagated into space, for there is a definite relationship existing between the length of our wave and its frequency, the length being the distance between two similar points in a complete cycle (as illustrated in Fig. 3).

### Extending the Field.

Provided we can continuously charge our condenser by some suitable apparatus, and allow it to discharge through the circuit of Fig. 4, then damped or undamped oscillations will persist according to the manner in which the charging is effected. The range over which such oscillations can be detected will be very limited, however, for we are operating in what is called a closed electrical circuit and the lines of force, or we should say the influence of the lines of force, is kept within very narrow limits. How can we cause these lines to spread out into space instead of being confined within a small compass? Logical reasoning will suggest that either the inductance or the condenser must be made larger, and it is here that we meet the aerial.

---

(*Concluded from page* 23.)

curvature of the mirror. Thus finally we get—

$$\left(\pm\frac{1}{v}\right)=\left(\pm\frac{1}{u}\right)+\left(\pm\frac{1}{f}\right)\ldots(4)$$

This equation, which is the key to the numerical positioning of object and image points on the axes of the mirrors (and lenses), put into words reads: The curvature, either positive or negative, with which reflected waves start from the mirror is equal to the curvature, either positive or negative, with which the incident waves strike the mirror, added to the curvature, either positive or negative, which the mirror itself impresses. To show how simple this all is in practice we will solve two or three problems:

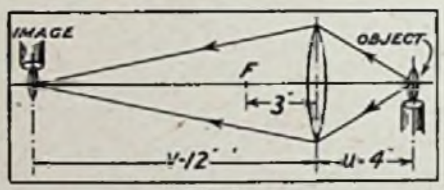



Fig. 8.
Action of lens.

**Experiment 1.**—A candle is placed 30 inches away from a concave mirror with a radius of curvature of 10 inches. Find the direction and distance of the image. The waves in this case, falling upon the mirror, are diverging from a focus, and have therefore a negative curvature. Since the mirror converges, it impresses a positive curvature, so that we have in equation (4) above:

$$\frac{1}{v}=-\frac{1}{30}+\frac{1}{5}$$
or $v=+6$.

Thus the reflected waves converge to a focus, or image, 6 inches away in front of the mirror.

**Experiment 2.**—A candle is placed a foot away from a convex mirror with a radius of curvature of 6 inches. Will the image be real or virtual, and where will it be found?

In this case the incident waves are of negative curvature and the impressed curvature is also negative, thus—

$$\frac{1}{v}=-\frac{1}{12}-\frac{1}{3}$$

Whence $v=-2{\cdot}4$ inches.

The reflected waves diverge as from a point 2·4 inches away behind the mirror, so that the image is virtual.

The equation (4) above is not only true for mirrors; it is also true for lenses—a subject which we have not yet dealt with, but which we will anticipate by the solution of a problem.

**Experiment 3.**—A thin lens (Fig. 8) which gives an image of the sun 3 inches away, is required to give a real image of a candle a foot away. Where must the candle be placed to obtain this image?

The transmitted or refracted waves in this case are by supposition converging to a focus, so that their curvatures are positive. The lens is also a converging one, thus—

$$\frac{1}{12}=\frac{1}{u}+\frac{1}{3}$$

Whence $u=-4$.

The candle, therefore, must be placed 4 inches away from the lens. The negative sign means that the incident waves are diverging as they strike the lens.

---

(*Concluded from page* 10.)

natural effect of the images, as seen on the televisor screen, were very greatly improved by the addition of colour, and colour television unquestionably marks a very great advance and opens up an entirely new field in television research.

The other important development, and one which opens out at once a path towards the transmission of the Derby and similar outdoor scenes, was achieved when, in July of this year, Mr. Baird succeeded in transmitting scenes illuminated only by daylight, and it is noteworthy that his transmissions were made, not in direct brilliant sunshine, but by diffuse light during weather in which the sun was not visible.

### A New Development.

Another advance has also been made in obtaining synchronism without the use of a separate channel of communication, or of elaborate oscillating circuits, but details of this latest development are not to hand at the time of going to press.

# Photo-Electric Currents of 100 Ampères !

*Photo-electric currents which have been produced up to the present are so minute that they have had to be measured in microampères, and before they can be used for television purposes they must be amplified very considerably. In the following article Mr. Wolfson describes some highly-interesting investigations which have been made in Germany in connection with high-power metal-cased mercury arc rectifiers. The investigators tend to the belief that they have been successful in detecting and measuring photo-electric currents as high as 100 ampères. If their deductions are correct, they may well lead to revolutionary developments in television.*

By H. WOLFSON

IN this paper I am proposing to put before the readers of TELEVISION an account of the work of two German scientists, Herren Schenkel and Schottky, who claim to have measured photo-electric currents of 100 ampères, together with a résumé of the paper of Dallenbach and Jahn, who hold an opposite view of the question.

Before commencing a discussion of the work which has actually been done, let us consider for a moment precisely the effect such a discovery would have on the future of television, if it could be successfully applied to television transmission.

Bearing in mind that the ordinary photo-electric cell gives a current of, at the most, about ten microampères, we can see that here we should have a current at our disposal approximately ten million times as great. This would immediately enable a substantial reduction tobe made in the number of amplifying valves necessary to amplify the minute fluctuating currents which are fed into the transmitter from the "electric eye," with a consequent reduction of distortion due to amplification.

Then, too, small changes in the intensity of the light received by the cell would produce larger variations in the resultant current, with improvement in the detail of the televised image, and this great sensitiveness would enable the intensity of illumination to be very considerably reduced. It must be remembered that up to the present time no cell designed on the principles discussed below has yet been made, but the author hopes that this paper, which is the first account of the subject in English, may be the means of encouraging research along the lines indicated.

While carrying out work with metal-cased mercury arc rectifiers at the works of Siemens-Schuckert, in Germany, Schenkel and Schottky discovered that there were certain things about the graphs and results which they obtained which were not in accordance with those previously obtained when working with the small type of rectifier.

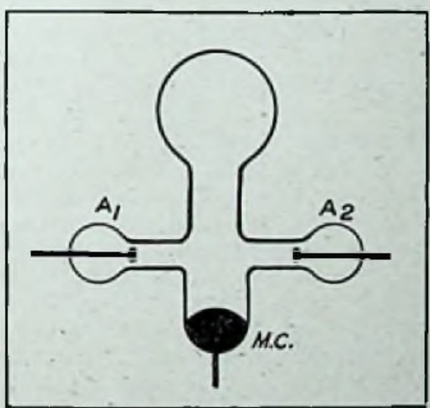



Fig. 1.
An "all glass" mercury vapour rectifier. $A_1A_2$=Anodes. M.C.=Mercury Cathode.

It will perhaps be convenient to deal first with the nature and action of mercury arc rectifiers, before discussing the actual results obtained.

The all-glass type, shown in Fig. 1, consists of an evacuated glass bulb through the walls of which are sealed platinum leads to make contact with the mercury which is contained within the bulb. The apparatus is connected to the supply of alternating current through a transformer, as shown in Fig. 2, and an arc struck by the usual method of tilting the bulb till the mercury joins the anode to the cathode for a fraction of a second. This produces a heating effect, resulting in the vaporisation of the mercury, and a consequent sparking across the low-resistance path created by the vapour between the anode and the cathode, this sparking being maintained to form the arc. Under these conditions it has been found that the alternating current supplied to the arc is rectified, and if we place a load at the points LM (Fig. 2) we have a continuous current produced at those points. The inductance shown is placed there to stabilise the arc, and for the purpose of the present article, need not be taken into account.

The metal-cased rectifier, though little used in England at present, is extensively employed on the Continent. In principle it is identical with the ordinary glass-bulb mercury rectifier, but the metal casing necessarily introduces several differences.

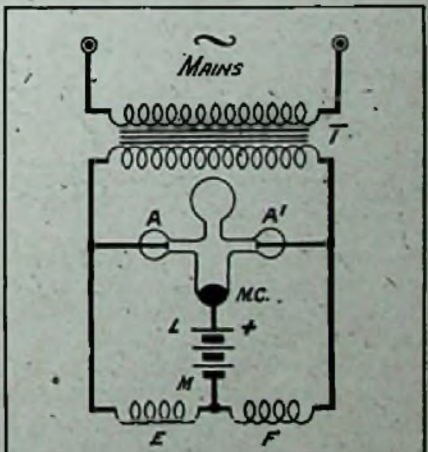



Fig. 2.
How the rectifier is connected. T=Transformer. AA¹=Anodes. MC=Cathode. LM=D.C. load. E and F=Reactances.

The electrodes have to pass through insulating bushes in the metal case, and the sealing of these joints, so as to be airtight, though difficult, has been overcome in a very ingenious manner by carefully plugging the annular space between the electrode and the bush with asbestos washers, over which is placed a layer of mercury. On evacuating, the mercury is drawn into the pores of the asbestos and thus makes an airtight joint. To ensure a well-maintained vacuum, however, the rectifier is connected to a small pump, which is always kept running. Beyond the starting devices, which are of a special pattern, the large rectifier does not differ from the glass-bulb type already described. It is shown diagrammatically in Fig. 3.

The iron vessel of a large mercury rectifier takes a potential difference of ten volts higher than the working value to drive a discharge to the isolated cathode opposite. If we put in circuit (as shown in Fig. 4, between the cathode and the vessel) a potential difference continuously variable between positive and negative, then the vessel will become

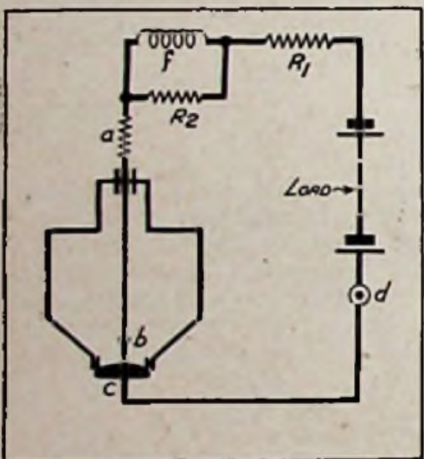



Fig. 3.
Diagrammatic circuit of metal-cased mercury rectifier. a=Starting Solenoid. b=Starting Anode. c=Cathode. d=push button to start. f=inductance. $R_1R_2$=starting resistances.

the anode or cathode of a discharge according as E is larger or smaller than the potential of about ten volts, which is indicated as "vessel free."

The electric potential characteristic of this discharge depends on the rectifier current being a constant quantity in the equation; this quantity being represented by the symbol $J_g$. Fig. 5 shows a few of the curves obtained by Schenkel and Schottky, taken from their paper in the original German. These curves show, above all, that by their arrangement, the potential which is represented as "vessel free" (therefore $J=0$) increases with the rectifier current $J_g$.

If one increases E in this manner then J rapidly rises, and the vessel then becomes the normal anode of the rectifier, i.e., the anode of a discharge whose cathode is the mercury bath (Fig. 4, M). Let us, on the contrary, decrease the value of E to $J=0$, and then change to negative values; a negative stream is produced already after a decrease

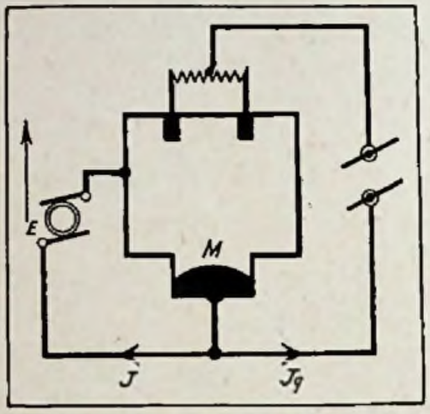



Fig. 4.
Another simplified diagram of the metal-cased rectifier.

of potential of several volts, which has the characteristic of a saturation current which retains its value fully unchanged by further decreases of potential. Schenkel and Schottky have been able to carry this on only to a potential value of $-30$ or $-40$ volts, for at these potentials the discharge in an arc ceases, and observation has shown that the cessation forms a cathode spot on the vessel.

This saturation current grows with $J_g$ more than proportionally. Their curves in Fig. 5 show that they are approximately quadratic. Fig. 6, obtained by Dallenbach and Jahn, is a confirmation of Fig. 5.

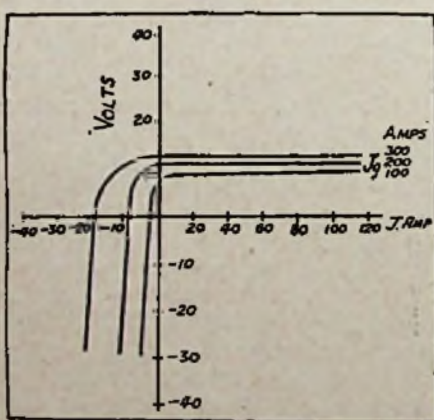



Fig. 5.
The curves obtained by Schenkel and Schottky.

The description which one can make concerning the changes in an electric arc are unfortunately still doubtful, but the work of Frank and Hertz, and that resulting from it, indicates new aspects and intelligence for the happenings in the arc, and more especially in mercury vapour rectifiers. We know, however, no results of this work on the elementary changes of ionisation and recombination at higher temperatures and higher current densities, and in so complicated gaseous mixtures as are present in the cylinder of a mercury vapour rectifier. At least, it appears problematical to calculate the ionisation potential of pure mercury vapour, as was done by Schenkel and Schottky, but if one looks at the qualitative aspect of the curves in Fig. 5, the arc consists of a dissociation equilibrium of electrons and positive ions, in which the process of ionisation, recombination and diffusion to the walls hold the balance.

Thus it is nearer to assume that when the vessel current J becomes positive it will attract more electrons than positive ions, but the negative

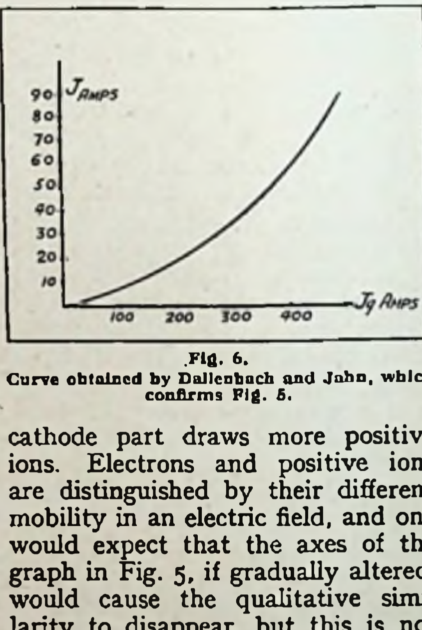



Fig. 6.
Curve obtained by Dallenbach and Jahn, which confirms Fig. 5.

cathode part draws more positive ions. Electrons and positive ions are distinguished by their different mobility in an electric field, and one would expect that the axes of the graph in Fig. 5, if gradually altered, would cause the qualitative similarity to disappear, but this is not the case, as a glance at Fig. 5 will show. From the positive anode part of the curves one can think that it is indicative that the vessel of the arc attracts most strongly a mass of electrons, and least strongly a mass of positive ions; but the negative cathode axis where the current strength becomes independent of the potential at the sharp bend is explained by Schottky in the words: "the negative saturation currents are therefore photo-electric currents."

They have observed, when working

with rectifier currents of 400 amps., that they have measured photo currents of about 100 amps.

They appreciate that the almost quadratic rise of the photo-electric current with the rectifier current is not easily understood, for on account of the constancy of the descent of arc the cylinder loss, and presumably also the developed light energy, is proportional to the current strength. Further, they find the supposed photo-electric change unusually high, without having resort to absolute measurements of the photo effect, for Dallenbach and Jahn contend that if 400 amps. rectifier current and 10 volts fall of potential were changed into light energy then this would give, according to their measurements, a photo effect of 100 amps. per 4,000 watts, or 4·19/40=1/10 coulombs per calorie of absorbed light energy. (N.B.—4·19 is a figure called Joule's Mechanical Equivalent of Heat.)

But Pohl and Pringsheim have measured for potassium amalgam a maximum of 11/10,000 coulombs per calorie for absorbed light energy, and for the selective effect on sensitive sodium cells for light of a wavelength 365μμ, 15/1,000 coulombs per calorie. Dallenbach thinks, on this ground, that an explanation other than "photo-electric effect" must be

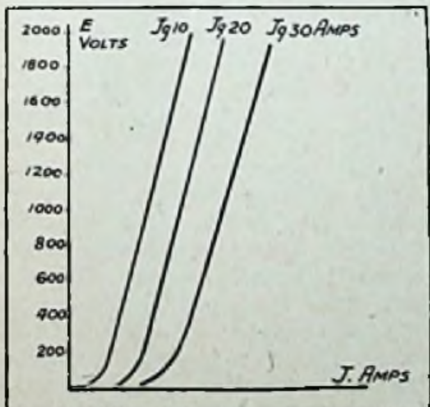



Fig. 7.
Curves obtained on a large mercury rectifier by Dallenbach and Jahn.

advanced for the unexplained behaviour of large mercury rectifiers at this so-called "saturation current."

The paper of Dallenbach and Jahn contains a very full account of their work on the subject, together with the conclusions at which they have arrived. The curves which they obtained are reproduced in Fig. 7, and an enlarged copy is given in Fig. 8, which shows the behaviour of the curve in the neighbourhood of the current axis. It will be noted that the only essential difference between Fig. 5 and Figs. 7 and 8, is that the axes of the latter two are turned round, as only the cathode discharge interests us.

Fig. 7 was obtained on a large mercury rectifier. Between an iron anode and a mercury cathode burns a rectifier arc, the so-called main arc, of current strength $J_g$. It acts in the neighbourhood of a stimulating electrode. Fig. 4 shows the current/potential graph of the inter-cathode discharge of this stimulating electrode, at current strength of the main arc of 0, 10, 20, and 30 amps.

In a very lengthy discussion they bring forward a large amount of conflicting evidence which space does not allow me to discuss, but they conclude by saying: "The speculation concerning the positive column of the arc and the transport of electricity in a mercury vapour rectifier, as far as Schenkel and Schottky build it up from their hypothesis of photo-electric saturation, is one which must be taken with caution."

Herr Schenkel, however, gives us further insight into the question, in a reply to his critics, which was published a short while after their paper appeared.

He thinks that it is possible that the energy which is stirred up by the main discharge of the rectifier mercury atoms, which serves for the release of the observed strong currents, is not only in the form of rays, but also arrives at the upper surface of the vessel in some other way. As has been shown by other workers, the velocity of vapour rays in an ordinary mercury vapour discharge is about 10 metres per second. On the other hand, it is known that the resonance rays of mercury, if once stimulated, are maintained in the pure unrarified mercury vapour, on account of the continuous re-absorption being proportionally big in a definite volume element of the vapour, and to some extent only arrives at the walls by diffusion. It is therefore to be thought that by sufficiently great ray velocity each ray quantum, let it have originated where it will, reaches by being carried along, those parts of the apparatus where the mercury condenses. But that place is the vessel in which the large currents are observed.

By this energy balance the change would be considerably improved in the sense of an Einstein equivalence law, for now, not only the energy of the free-burning part of the arc would come into question, but also that in the cathode chamber. Let us assume on account of the agreement with the critics that for the stimulus of the operated rays the definite fall of potential of 10 volts is required; then we obtain with a driving current of 500 amps. an available impulse of 10 (500–100)=4,000 watts.

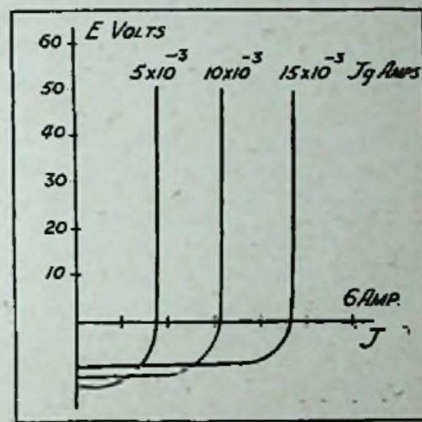



Fig. 8.
Curves showing behaviour near current axis of Fig. 7 curves.

If this impulse is fully replaced in the operative rays of wavelength, 2,537 Angström units, and if for the quantum of energy hν an electron is seized, there results at this frequency a vessel current of 800 amps. The observed current of 93 amps. is then not beyond the bounds of possibility. At the same time, by this research a very plausible reason for the slope of the relative photo-electric value of the driving current is found, for with the increasing driving current the rays' velocity always becomes greater, and thereby the actual loss of the operative rays always becomes less, which results from absorption at the cathode beaker, etc.

Now as to the agreement of Dallenbach and Jahn with direct measurements of the share of the photo effect with absorbed rays. The highest recorded up to now was by Pohl and Pringsheim, 0·0015 coulombs per calorie of the considered rays at wavelength 3,650 A units. By this the value 93/4,000 amp. per watt=0·023 amp. per watt, which is equal to 0·0055 coulomb/calorie, which is certainly only four times the

(*Continued on page* 36.)

# ESSENTIAL FACTORS IN HIGH POWER L.F. AMPLIFICATION

*In the following article the writer explains clearly the essential factors which must be taken into consideration by anybody building or operating a high-power L.F. amplifier such as is necessary in television experiments. Information is given which will enable experimenters to lay out their amplifiers in such a way as to avoid future troubles, due to interaction, etc.; and valuable hints are given which will enable them, while using such an amplifier not only to get the best results out of it, but also to avoid doing accidental damage to valves.*

By OWEN GROSVENOR

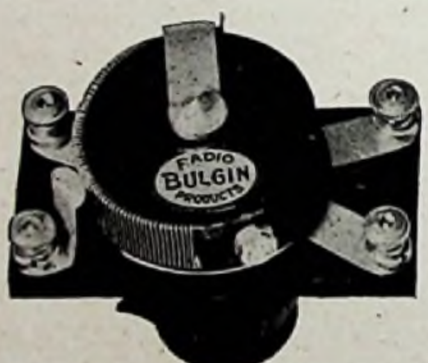
IN the previous issues of TELEVISION readers found that in order to make visible the converted light impulses it was essential to use some form of low-frequency amplifier. The beam of light at the transmitting side of the televisor was focussed on a selenium cell so that these rays could be converted into electrical vibrations. Now these electrical impulses are of low frequency, that is to say, low in the radio sense; the actual frequency being 600 per second. They must pass through the amplifier so that at the output end they have reached sufficient magnitude efficiently to operate the neon tube and enable the object being televised to be clearly and distinctly portrayed.

While, on the surface, this is a relatively simple process, the extent of the amplification required may be gauged from the fact that the input is of the order of average crystal strength, while in the output stage we deal with currents of between 20 and 30 milliamperes at a comparatively high voltage. That being the case, a multi-stage L.F. amplifier, working at high powers such as this, needs to be very carefully designed in order to avoid unpleasant pitfalls, while there are certain points in operation that call for especial care if harm is not to be caused to the apparatus.

### On Broad Lines.

It is not proposed here to take any one amplifier and deal with it step by step, but rather to treat the subject on broad lines and indicate where it is advisable to adopt certain precautions. Naturally, the novitiate in this fascinating and all-absorbing subject of television would rather direct the bulk of his energies to the actual television side, hence it is desirable to be sure of the performance of the amplifier, so that it may be introduced without any doubt as to its proper working.

Owing to the high powers dealt with it is essential to exercise care in making adjustments. Many who use ordinary wireless sets will have got into the habit of altering the high tension, grid bias, etc., without switching off the filament current, and while with the comparatively low H.T. values used in ordinary wireless receivers this may cause no apparent harm, with the high voltages used in a television low-frequency amplifier harm will be done to the valves if the grid bias is removed and the H.T. left on the plate.




The new type of control rheostat referred to by the writer of this informative article.

Furthermore, there is another aspect of this side of the problem which probably has seldom occurred to readers, even if they are old "wireless fans." In any device where two or more sources of electrical power supply are employed it is of great importance to arrange that these various sources are introduced, cut out, or controlled in the correct order and manner. The safety of a piece of apparatus frequently depends upon having one voltage source partially or fully established before another is introduced, as by this procedure we are able to prevent very large surges of electrical potential.

### Electrical Surges.

If we take any piece of apparatus using thermionic valves, when the filaments are at their normal working temperature alternating potentials are produced owing to the fluctuating input energy, and these may reach considerable amplitude, especially when high plate voltages are used as in a television L.F. amplifier. Now if, when the plate voltage is still applied, the filament current is broken suddenly, the various inductances in circuit provided by the transformer and choke windings have transient electrical potentials produced across them which may reach high values and in consequence be detrimental to various parts of the apparatus, causing in some cases a breakdown in the windings.

Similar effects can also be produced when the anode voltage is applied suddenly with the valve filaments at their normal working temperature. Furthermore, with high-power amplifiers especially, it is often dangerous to apply the full anode potential to any apparatus when the filament is inoperative, for in this case the distribution of electrical potentials, either direct or alternating, may be such as to apply excessive strain to certain parts of the components.

### A Novel Protective Device.

Appreciating these points, it would appear that some form of protective device is called for in the case of apparatus of this class, it being arranged that before the H.T. voltage is switched on the filament current is introduced but kept at a relatively low value. Then the anode voltage may be introduced, after which the control device can gradually (or suddenly, when such a policy is merited) increase the filament current to its normal working value. Naturally, the reverse process will apply when switching off, and a further refinement would be the gradual introduction and release of the plate voltage. It is gratifying to note, therefore, that one manufacturer at least (Messrs. A. F. Bulgin and Co., Cursitor Street, E.C. 4) has recently placed on the market a device which enables this form of control to be undertaken in quite an ingenious manner.

In effect it is really a form of rheostat switch, and the accompanying photograph shows the compact form which it takes, it being suitable

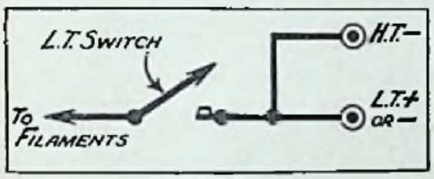



Fig. 1.
The circuit diagram of the ordinary simple "on and off" amplifier switch.

for panel mounting to replace the simple on-and-off switch with which we are so familiar, and which is shown diagrammatically in Fig. 1. The change brought about by the inclusion of the new switch is shown in Fig. 2.

### The Rheostat Switch.

Arranged round half the circumference of a thick ebonite disc there is a resistance strip, a 180° movement of the control knob serving to bring the valve filaments to their normal working current. On the underside of the disc is secured a metal strip so positioned that when about one-third of the filament resistance is cut out of circuit the strip bridges two contacts connected to the pair of terminals shown, and this makes the H.T. circuit. Further movement of the knob to its normal "on" position brings up the filament current, the establishment of the H.T. voltage being maintained. Of course, the movement to the "off" position reverses the order of events.

Fig. 2 shows how to connect up this device when the H.T. switching is in the high tension negative lead, but, if preferred, the high tension switch can be placed in the positive feed when only one H.T.+ tapping is employed, the control device being provided with the double terminals to allow this independence of switching.

It is a sound and safe practice, therefore, to switch off your television amplifier (or any wireless receiving set for that matter) by the operation

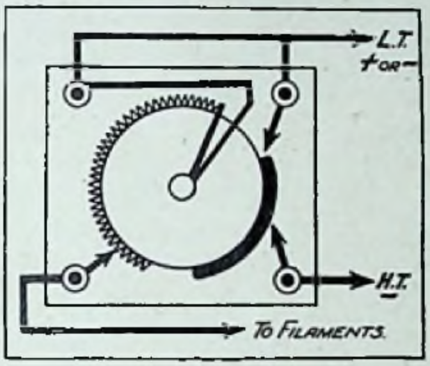



Fig. 2.
The circuit diagram of the new control switch produced recently by Messrs. Bulgin.

of this switch before any H.T. or G.B. battery adjustments are effected, for by this means a greater measure of protection is afforded to the valves and components.

### Best Quality Components.

Pursuing our subject of high-power low-frequency amplifiers, it seems almost unnecessary to mention that only components and accessories of high grade should be used. Employing shoddy materials is only looking for trouble, so while it may mean an increase in initial expenditure, this will be more than repaid by the reliability of performance and superior characteristics of good quality apparatus. For example, in many high-power amplifiers it is necessary to include some large by-pass condensers, say, of 2 mfd. capacity. Under these circumstances it is essential to use only those high-grade condensers which have low internal electrical losses, and whose rated maximum working voltage is in excess of the voltages likely to be used in the amplifier. This will ensure immunity from dielectric breakdowns and the consequent short-circuits which follow in their train.

Any suggestion of resonant peaks in the particular amplifying stages chosen, whether transformer, choke capacity, auto-choke, resistance capacity, double impedance, etc., will bring about distortion. While the ear might not detect this distortion if the amplifier was connected to a receiving set, the eye would certainly not be deceived by the distortion of the resultant image.

### Stability—The Prime Factor.

Another important detail is that the arrangement and connections, both internal and external, for the amplifier must be such that there is no trace or suspicion of low-frequency oscillation. Whether this is caused by interaction between the stages owing to unsatisfactory layout or inefficient wiring, or the outcome of battery coupling, the presence of L.F. oscillation in the case of our televisor will evidence itself by the neon tube at the output end glowing steadily and brilliantly.

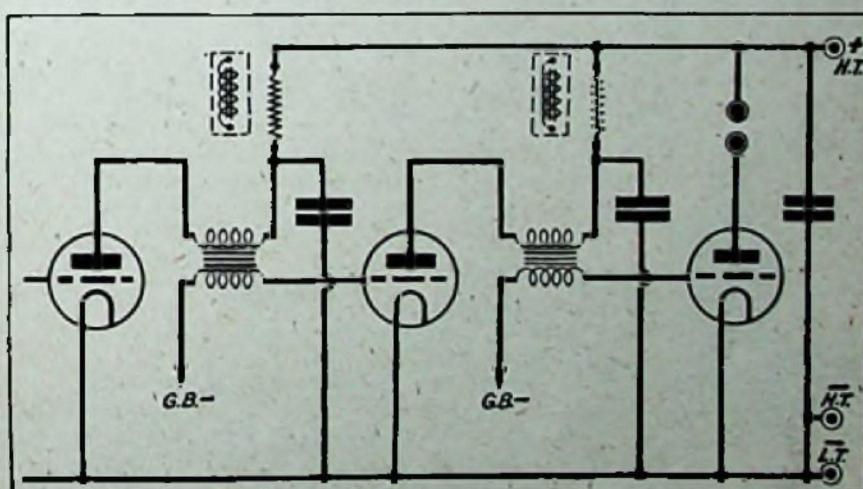



Fig. 3.
Circuit diagram of a three-valve L.F. amplifier exemplifying the use of wire-wound anode resistances and large by-pass condensers as a means of obtaining stability.

Stability in operation is thus of prior, or at least of equal, importance to the measure of amplification required; but in achieving the former we shall find that the latter will come as a matter of course, bearing in mind that a proper balance must be held between the number of valves and the interstage coupling devices.

### Puzzled ?

In the April issue of this journal there was described a three-stage L.F. amplifier, using transformers only, and some readers may have been puzzled at the special relative orientation of these transformers. This was done to avoid any low-frequency oscillation as a result of stray field interaction; hence the designer's insistence that the layout should be followed carefully and rigidly. The leads connecting grids and plates as far as possible should be remote from one another, and while it is not essential to solder lead junctions to the components be careful to avoid any high-resistance joints.

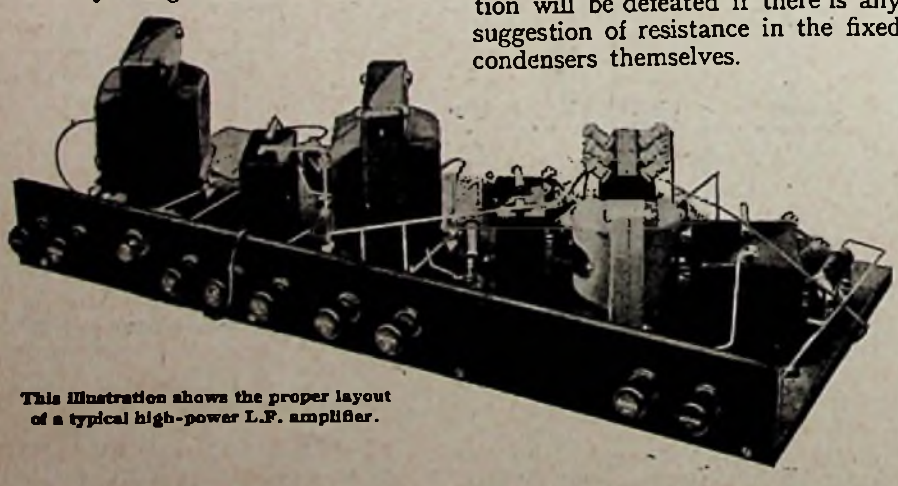
When screwing down the wires to the terminals it is best to loop the wire and file flats on it so that there is an ample contact surface, and also less likelihood of any of the nuts loosening. On the outside of the amplifier use terminals with some form of Bakelite or insulated covering, so that no bare metal is exposed, as this will prevent any possibility of shock should the terminals be touched accidentally. It is an added precaution, in view of the high voltages, to have the connecting wire insulated either by using Glazite or bare wire with lengths of Systoflex sleeving slipped over.

From these little hints readers will begin to realise that with high-power amplifiers it is very essential to pay attention to details, and in so doing they will be paving a way to a performance that leaves nothing to be desired. As far as the choice of valves is concerned it must be borne in mind that, since large powers are to be handled without a trace of distortion or overloading, power valves must be the obvious selection wherever possible, unless, of course, a resistance capacity stage is included, when one of the typical high impedance high amplification factor valves will be substituted.

### A Back Coupling.

Owing to the high plate voltages employed in television L.F. amplifiers (high, that is, in comparison with the voltages we are accustomed to using in our broadcast amplifiers), there is one detail which calls for especial mention, and that is the possibility of low-frequency oscillation being produced from any back-coupling brought about by the source of high tension having a high internal resistance which is common to the anodes of all the valves.

This L.F. oscillation may evidence itself as a series of " pops " at one-second intervals, or, on the other hand, there may be an oscillation above what is termed the audibility range, which will cause general distortion in the neon lamp output. The provision of large by-pass condensers (2 mfd.) across the H.T. will minimise, and in many cases overcome, this defect, but the amelioration will be defeated if there is any suggestion of resistance in the fixed condensers themselves.



This illustration shows the proper layout of a typical high-power L.F. amplifier.

Another way is to arrange for a reverse reaction by reversing either the primary or secondary connections to one of the transformers, or by mixing the couplings so that no two consecutive stages are alike. This will ensure that any oscillations fed back are out of phase with the normal oscillations and produce the reverse reaction effects just mentioned.

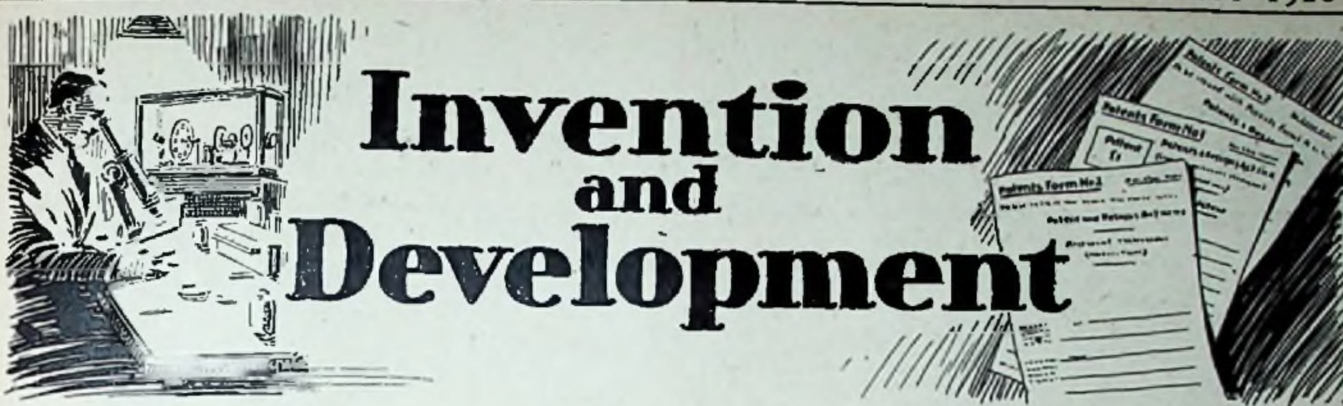
### An Effective Palliative.

The most effective palliative, however, would appear to lie in the provision of wire-wound resistances or high impedance L.F. chokes in the plate leads of each valve, together with large by-pass condensers as indicated in the diagram of Fig. 3. If wire-wound resistances are used there is a further distinct advantage that the resistance values (generally of the order of 20,000 to 30,000 ohms) can be so adjusted that individual plate tappings on the H.T. battery can be avoided.

It is seldom that the full battery voltage has to be applied to any but the last valve, and in consequence the tappings cause an uneven exhaustion of the battery power. By arranging these resistances so that the drop of voltage across them is just sufficient to apply the correct voltage value to the intermediate valve plates, then only one H.T.+terminal has to be provided, and the battery is in effect working at a higher efficiency as a result of the steady current drain throughout the whole of the cells.

One way of calculating these resistances is to subtract the plate voltage desired from the full battery voltage, and divide this quantity by the plate current normally flowing for that anode voltage and the particular grid bias chosen, facts which can be gleaned from the published valve characteristics. From this resistance must be subtracted the value of any plate circuit resistances already existing (e.g., primary winding of transformer, etc.), and the result is the resistance desired. Of course, the values are not absolutely critical, and a commercial product of the nearest value will adequately serve for the purpose.

The foregoing dissertation will enable readers to be in a better position to make up their high-power amplifiers so that they function at maximum over-all efficiency, while any of the suggestions given can be introduced quite easily into existing low-frequency amplifiers, if instability or insufficient total amplification is being experienced.

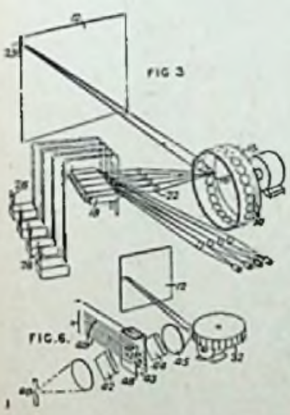


# Invention and Development

THE British Thomson-Houston Co., Ltd., are seeking patent protection for an invention of E. F. W. Alexanderson, of New York, U.S.A., which is of interest to those studying television.

According to the invention, it is proposed to construct television apparatus so that four or more adjacent elements of a picture simultaneously affect an equal number of light-sensitive cells in the transmitter, and a corresponding arrangement is adopted at the receiver.

In the receiving apparatus, shown in Fig. 3, signals corresponding to four adjacent elements of the transmitted picture are received by four aerials 26, which control four "oscillographs" 18, so as to vary the intensity of four light pencils which pass to the screen 12 by way of lenses 22, mutually inclined mirrors 16, and a common lens in the spiral series of lenses 14, which is carried by a rotating cylinder 13. The pencils therefore trace out four adjacent vertical lines of illumination 23, and as successive lenses 14 come into action, successive bands, each comprising four component lines of the picture, are traced out.




The arrangement at the transmitter station is similar; four optical images of the picture are projected by lenses and by four mutually inclined mirrors upon four light-sensitive cells, so that each cell coincides with one of four adjacent picture elements. The pencils forming the four optical images all pass through a lens 14 and are traversed thereby. In modifications described, the spiral series of lenses 14 may be replaced by a series of plane mirrors inclined to the axis of the cylinder at slightly different angles.

In the modified receiver, shown in Fig. 6, seven adjacent light pencils, proceeding from a constant source of illumination 40, pass through a polariser 42 and between seven pairs of plates 48 in a Kerr cell 43, so that the planes of polarisation of the pencils are rotarily displaced under the control of received signals applied through the leads 49. The pencils then pass through an analyser 44, and are projected by a lens 45, and mutually inclined rotating mirrors 32, on to the screen 12.

The advantages of the system are that strong illumination is obtained, since several pencils are used simultaneously and large lenses can be used since the lenses can be rotated at a slower speed than usual. The invention is applicable to vibrating-mirror or other systems, as well as to those employing rotating spirals; it is also applicable to copying telegraphs, and the invisible parts of the spectrum may be utilised in the transmitter or in a photographic receiver. Wireless or line signals may be used.

---

An exploring device for a television system is described in a recent Patent Specification in the name of R. Hall, of London. The device comprises two coaxial-slotted discs rotated at different speeds and characterised by (1) straight slots in one disc and curved slots in the other disc, all extending inwards from the peripheries of the discs, or (2) straight slots at different angles in the two discs extending inwards from the peripheries, or (3) the slots in the two discs being such that when their inner ends are superposed, the outer ends meet at, or near the peripheries without the slots crossing each other.

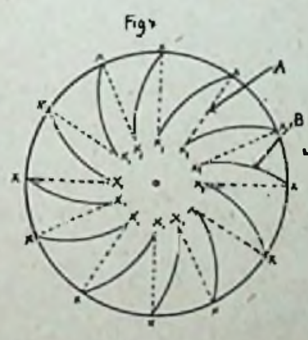
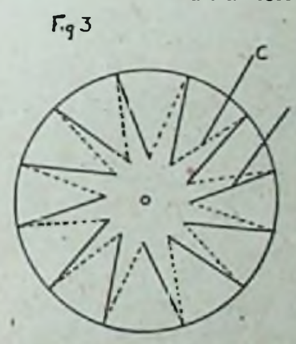



Fig. 1 shows an arrangement corresponding to conditions (1) and (3). The rapidly rotated disc is provided with curved slots B, and the other disc, rotated slowly in the same or the opposite direction, is provided with straight radial slots A.

Fig. 3 shows similarly an arrangement corresponding to conditions (2) and (3). The light-sensitive device at the transmitting station may be in the form of strips of light-sensitive material covering the slots A in the slowly-rotated disc. The strips covering the different slots are interconnected at their inner ends $X_1$, and each is provided at its outer end X with a contact co-operating with a segmental collecting contact.

If the image to be transmitted covers more than one sector between the straight slots, a corresponding number of collecting contacts, each in a separate transmitting channel, is provided. The discs may be formed of thin opaque material fixed to thin sheet celluloid or other transparent material.

Transmission may be effected by the use of infra-red and ultra-violet rays instead of light. An intermediate record of the image may be obtained by converting the fluctuating current into sound impulses and recording these phonographically. A purely local reproduction of the image may be obtained by using different areas of the same pair of discs for the transmitting and reconstituting explorations.




---

L. Thurm, of Paris, France, is seeking patent protection for an invention which may be used in connection with television apparatus. The Patent Specification describes a copying telegraph apparatus in which the object is explored by a plurality of photo-electric cells 1, each producing a record on a steel band 4, and the bands are subsequently connected in sequence to a transmitter.

At the receiving station the processes take place in the reverse order. Each cell explores only a portion of the image, which is explored completely by the set of cells, and photo-electric currents, after amplification at 2, pass to an electro-magnet 3, which makes the record on the band. The bands or wires are in the shape of a spiral, and are so held by a disc 4ª. The bands may be so mounted that a record can be made on both sides of the disc.

The records then travel successively, in a given order, between the poles of an electro-magnet which occupies the usual place of a microphone in a transmitting station, thus modulating the emitted waves.

At the receiving end metallic bands travel synchronously with those at the

(Continued on page 36.)

# THE BEST LETTERS OF THE MONTH

*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.*

RIANT-MONT,
LA ROSIAZ,
LAUSANNE,
SWITZERLAND.
*July 7th,* 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

I was delighted to see two criticisms of my letter in your July issue just received.

I am indebted to "Angström" for his considerations, and, so far, must admit that I have not had time to examine it from his point of view, and am glad to see his theoretical objections. I agree with him entirely that with the present apparatus the scheme is impracticable, but I wish to find a path which would lead to the development of suitable apparatus, and, thanks to "Angström," I shall examine the heterodyning more fully, and would suggest to him that he consider the use of a stroboscopic effect, though I fear that the same difficulty arises, namely, that of a suitable frequency.

I feel that I ought to mention a word in conjunction with Mr. Goldstein's letter; may I suggest that he has unwittingly pulled his own leg, and I would refer him to "Angström's" letter, which states plainly the real fundamental objections. Though Mr. Goldstein's letter is not in essence founded on false conceptions, it is a misinterpretation of mine. I would ask him to stop, think, and look again, as perhaps, not being precise enough, I may have misled him.

My letter consisted of a few theoretical considerations, and was not meant to be based on anything actually practical, and I will now make as plain as possible the correction and adaption of his statements to my personal ideas. I grant that light falling on conductors anywhere must produce some electrical effect, and the fact that the effects have not been utilised will not prevent the possibility of their being so, and it is only a conservative view to imply that because they have not been utilised they must necessarily not be used for television. On the reality of his third paragraph depends the possibility of the whole system, but it is not unnatural to suppose—in fact, it would be illogical *not* to suppose—that lights of different wavelengths and intensities would produce currents of different frequencies and intensities, and even if these did circulate round in a low-resistance conductor, the combination of their effects could be induced into a similar conductor included in a neighbouring circuit. And he will undoubtedly agree with me that it is reasonable to presume that these currents can be amplified proportionately.

I must, however, thank Mr. Goldstein for his interesting letter, as I am sure that there can be nothing better for the progress of a new science or a new branch of science than a complete discussion and experimenting. The pulling to pieces of theories is excellent, and especially the rebuilding of them again. This is practically the only way to discovery.

In conclusion, I may say that I intend carrying out a few experiments, and even if they are entirely negative it would be interesting to let readers know, as it is sometimes the negative results that offer the most valuable help; and we all know that Einstein's theory of relativity explained all the negative results of previous experiments carried out most laboriously, and it was largely these negative facts that led him to his considerations.

Yours faithfully,
E. P. ADCOCK.

---

CHANTERAINE,
LA ROSIAZ,
LAUSANNE.
*July 13th,* 1928.

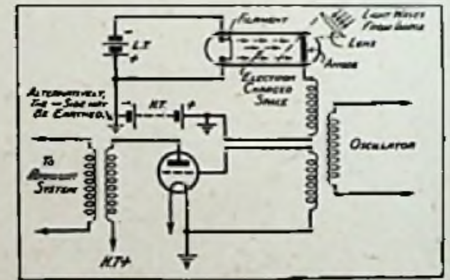
THE EDITOR,
"TELEVISION."

DEAR SIR,

As a wireless experimenter of some years standing I am naturally interested in television, and so your journal has been very interesting reading to me. I specially noted Mr. E. P. Adcock's television scheme which he outlined so clearly in his letter of March 10th. Of course, I quite understand that his idea is purely theoretical, but it seems to me that there are two big questions to be raised as regards the copper plate which he uses for collecting the light waves.

First, can the copper plate reply fast enough to the excessively delicate and minute variations of current imposed upon it? Secondly, admitting that it can, would it be possible to produce a plate of absolute uniformity, because, if not, the differences between the sending and the receiving plate would result in an imperfect image. The first of these two objections seems to me to be the most important. But the receiving "mesh" is a weak point.

To obviate these two objections I have imagined the scheme which I will now expound. It consists theoretically in making use of the electron stream of a two-electrode tube, possibly containing a rare gas such as argon. The light waves from the image to be televised impinge on the space between the two electrodes, thus producing a variation in the electron stream. The resultant variations of current may be imposed or heterodyned on to a wave of lower frequency, as suggested by Mr. E. P. Adcock. At the receiving station the process would be reversed.




**Mr. Roscoe suggests the above diagrammatic arrangement as an alternative to Mr. Adcock's original suggestion.**

Naturally this is but the bare theoretical outline of an idea, but I thought that it might perhaps interest some of your readers. Perhaps a stroboscopic effect could be happily used somewhere in my little scheme.

Personally, I have neither time nor apparatus with which to carry out experiments, but some readers might do this instead. If anyone does, I should be pleased to hear of results, even if negative. I authorise you to publish this rather incoherent letter if it is of any use to you.

Yours faithfully,
EDWIN ROSCOE.

31, Coldfall Avenue,
Muswell Hill,
London, N. 10.
*July 11th*, 1928.

The Editor,
"Television."

Dear Sir,

I have studied with great interest your journal, particularly the letters you have published from Mr. E. P. Adcock and Mr. S. Goldstein. Although only a novice at the science of physics, I think Mr. Adcock is serious and not pulling our legs.

Our laws of physics state that what he proposes doing is impossible; but what of that! Physics said that for an aeroplane to rise above the earth or for an iron vessel to float on water was impossible.

To-day we see the fallacy of saying that because a vessel is heavier than water it cannot float on that medium. In that generation, as man knew things, *it was* impossible.

Again, the metal copper was of little use to the world from a scientific point of view, till along came a great thinker who conceived the idea of rotating a coil of wire in a magnetic field, and thus produced the first dynamo.

The transmission of messages by wireless telegraph or telephone was a costly and nerve-racking experience till the thermionic valve was perfected.

What led to the discovery of the thermionic valve? Simply a patch of carbon deposit in the globe of a carbon filament lamp. (I believe this statement is correct.)

It took Mr. T. Edison to notice that the black patch was unevenly distributed. Man had ignored it. Superman sits down and asks, "How, why, when, and where?"

Similarly with television, figuratively speaking, we have reached the spark or Poulson-arc stage and are looking for our thermionic valve. But are we searching in the right direction?

Are we not looking too far from home for the door-key which is hidden under the step?

Remember, a piece of copper wire was not of any use till a man probed its secret. Neither was a heated filament in an evacuated globe anything except a source of light till a man reasoned things out.

What is it that we are using every day of our lives, which, though of little scientific value, if only we knew it, holds the key to the new science?

When we find *x*, man will take another step up the ladder of science, only to find that instead of having to attain the moon he has to reach the pole star, a step at a time, and instead of knowing more, finds that he knows less than ever he did.

What the world wants is a "madman," if I may use the term. All the great inventors have been declared insane by their fellows because they desired to accomplish and succeeded in doing the impossible.

Wishing the Television Society and its Journal every success.

Yours faithfully,
R. Lloyd Grigg.

# The Television Society.

As announced in the last issue of this Journal, meetings of the Society have been suspended until the autumn, in accordance with the usual plan followed by most scientific societies during the summer season. There is no reason, however, why the absence of the Society meetings should deter enthusiastic television experimenters from pursuing their activities right through the summer if they can withstand the counter-attractions of outdoor sports and hobbies.

In any case, even if active experiments are suspended, members would be well advised to keep in close touch with developments, for in the case of a science which is developing and expanding so rapidly as television, close study of current progress is necessary if one is to keep up to date and be in a position to actively participate in the Society's winter programme.

In this connection the chairman of the Society, Dr. Tierney, writes as follows :—

"In view of experiments recently conducted with daylight and colour television the prospects of the forthcoming session are very promising indeed, especially in view of the facts that receiving sets will definitely be available to the public by the end of September, and that regular television transmissions will be taking place from the Baird Laboratories.

"Nothing, perhaps, will stimulate the growth and development of this new and fascinating art so much as the possibility of having a set in one's own home, and being able to test its performance personally. We may reasonably expect to receive not only the recognisable image, with which many of us are familiar, but also to get it in its natural colours as our knowledge and technique progresses.

"It is now possible both to transmit and receive natural colour television, as was recently demonstrated in the presence of myself and other scientists. It is hoped that members will avail themselves of every opportunity to attend the meetings of the society during the forthcoming session; and it is hoped also that it may be possible to arrange to repeat the recent demonstrations at these meetings."

* * *

The Secretary reports that there is an extremely keen and world-wide interest in this new branch of applied physics. Letters have been received from all parts of the world expressing a desire on the part of the writers to be affiliated to the parent Society.

Group centres are forming, and their local programmes are awaited with interest. The Secretary will be glad to have plans and particulars relating to centres, and the programmes which they propose to follow out, in time for publication in the September issue of this Journal.

It is suggested that organisers of local centres should arrange a course of lectures and some experimental work to cover at least the October–December term. If any difficulty is experienced in obtaining lectures or suggestions for experimental work, the secretary will be glad to assist to the best of his ability, if local organisers will kindly write to him.

Many interesting experiments have already been suggested in this Journal, and most of these are worth repeating at the informal or conversational meetings which should be held at intervals between lecture nights.

Suggestions from all quarters, for the benefit not only of the London branch but all other branches of the Society, are invited regarding the coming session, both as to subjects for lectures and lecturers. The programme for the London centre for the October-December term will be announced in the September issue of Television.

All communications should be addressed to the Hon. Secretary, Television Society, 200, High Holborn, W.C. 2.

(*Concluded from page* 29.)

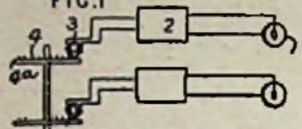
previous highest value. As there are no means of ascertaining the wavelengths which come into the question (but they are very short), we cannot exclude with certainty an effect only four times greater than the previously-known values.

Later work has convinced Schottky that there is an effect which he names the "Konvektiven" photo-electric effect, though there is no evidence to show this to be any other than the ordinary effect. The resonance rays are responsible for certain emissions of atoms, and in a very complete discussion of these views Schottky certainly has good grounds for his belief in the existence of these photo-electric currents; for the conclusion one arrives at after reading his paper, is that there appears to be a fundamental convective transfer of the ray quantum to the rectifier walls, and therefore the process for the release of electrons at the vessel wall would appear to be nothing more than the usual photo-electric effect.

The readers of TELEVISION can be assured that they will be informed of any future develpopments.

(*Continued from page* 33.)

FIG. I



transmitting end, between the poles of an electro-magnet, which occupies the usual place of a telephone or loud-speaker in an ordinary receiving set. The records so produced travel simultaneously in an arrangement similar to that shown between the poles of electro-magnets in circuits, the currents of which, after amplification, act on optical devices which reproduce the image—for example, on a screen.


Printed by HAZELL, WATSON & VINEY, LD., 52, Long Acre, London, W.C.2, and published for the Proprietors, TELEVISION PRESS, LTD., 26, Charing Cross Road, London, W.C.2. by THE ALDINE PUBLISHING CO., LTD., Crown Court, Chancery Lane, London, W.C. Address for advertisements, "TELEVISION" ADVERTISEMENT DEPT., 109, Kingsway, London, W.C.2. Sole Agent for U.S.A., INTERNATIONAL NEWS. Registered for transmission by Canadian Magazine Post.