HOW THE "WAR" ENDED

6D MONTHLY

Television

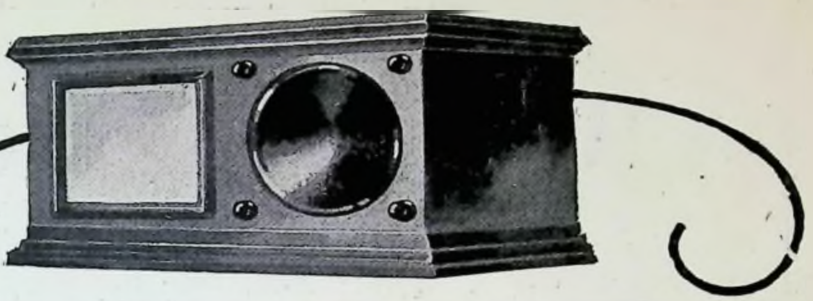
The Official Organ of the Television Society

VOL. 2 MARCH 1929 No. 13

LATEST TELEVISION STUDIO DE LUXE.

The latest Television Broadcasting Studio just completed at the Baird Laboratories is copper lined to eliminate interference from electrical machinery in other parts of the building.

THE WORLDS FIRST TELEVISION JOURNAL



WIRELESS

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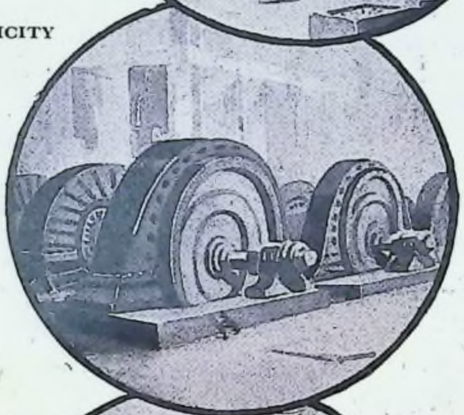

MECHANICS

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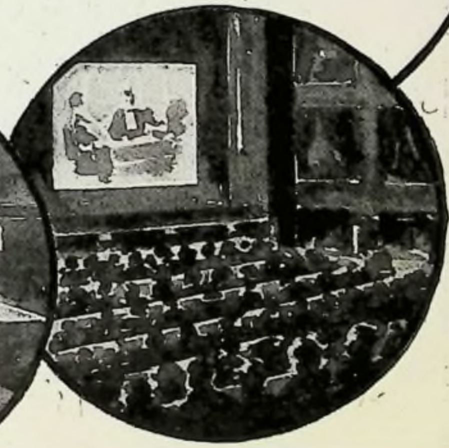

CINEMATOGRAPHY

THE WORLD'S FIRST TELEVISION JOURNAL

The Official Organ of The Television Society

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Vol. 2] MARCH 1929 [No. 13

EDITORIAL

OUR SECOND VOLUME.

THIS magazine has now been in existence one year. With this issue we commence our second volume, and we take this opportunity of thanking our readers for the loyal support which they have given us during the past year. We trust that in the coming year this support will continue and flourish, thus enabling us to extend our sphere of influence and further the cause of the science in which we are all so keenly interested.

* * *

LOOKING back through the pages of Volume I, we find a very complete survey of the elementary principles underlying television and its allied subjects. We find also a very comprehensive record of the progress made in this country and abroad, and many important pronouncements and articles on the subject from the pens of eminent scientists and prominent writers.

* * *

THERE is to be found in those pages a record of our support of, and consistent campaign for, the recognition which is due in this country to the Baird system of television, the only British system. Throughout, we have pleaded for the support of British inventions, lest, as has happened before, they be lost to this country.

* * *

B.B.C. AND TELEVISION.

THROUGHOUT, we have insistently demanded that the broadcasting of television be given a trial through the stations of the British Broadcasting Corporation, under whose auspices such tests must be made in this country, since that body holds a monopoly of broadcast transmission. Our efforts in this direction have met with loyal support from Sydney A. Moseley, whose strenuous activities in this direction appear to have met with success at last.

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A VEIL of secrecy prevents us from obtaining a clear view of the situation as it is at the moment, but judging from reports which have appeared in other sections of the Press, from the speech of the Chairman of the Baird Television Development Co. at the recent annual meeting, and from Mr. Moseley's article in this issue, our efforts would appear to be on the verge of being crowned with success. In another article "A Student of Progress" paints the other side of the picture, and gives us what he believes to have been the B.B.C.'s real attitude towards the question of broadcasting television.

* * *

WHATEVER the exact position may be to-day, and despite what has happened in the past, it is in the public interest that a more amicable spirit should prevail, and the available evidence points to the fact that more friendly relations have been established. We congratulate those concerned on having progressed to that extent.

* * *

BOUND VOLUMES.

BEFORE leaving the subject of our first volume, we would draw attention to the particulars given elsewhere in this issue of our special offer of Volume I, handsomely bound, complete with index. For those who wish to bind up their own copies we are supplying cloth binding cases, with index, which they can take, together with their copies, to a local bookbinder and have bound up for a small sum. We have made these two offers in response to numerous requests from readers who wish to preserve in presentable form the first volume of the World's First Television Journal.

WAVELENGTHS FOR TELEVISION.

IN our last two issues we have referred to the present congestion on the normal broadcast wavebands. There are several solutions to this difficulty. In our February issue we suggested that the way out is the discovery of a new method of modulation. The Chief Engineer of the B.B.C. recently read a paper, sponsored by the B.B.C., before the Institution of Electrical Engineers, in which it was suggested that the solution lay in the direction of special aerials which would confine the radiation of broadcasting stations to the limits of their service areas. Our esteemed contemporary, the *Wireless World*, has pointed out on more than one occasion that probably a more practical solution lies in the direction of the limitation of the number of stations and the granting of permission to increase power.

* * *

TAKING existing conditions as they are, however, it struck us a year ago as being extraordinarily remarkable, and demonstrative of an incredible lack of foresight, that the International Wireless Conference, held at Washington, did not make any provision for television. One of the functions of the conference was to allot on an international basis wavelength bands for every conceivable purpose. Its decisions will hold good indefinitely. The last international conference was held in London in 1912, and the decisions then reached were antiquated and hampering to wireless development for years before the Washington Conference was held. Is television in danger of being held up on account of the lack of provision made for it at the recent conference?

WE are reminded of this matter by Commandant Brenot's pronouncement, reproduced on page 5, which shows clearly that the delegates to the conference did not then appreciate the significance and impending importance of television. Commandant Brenot attended the conference as a delegate of France.

* * *

IMAGINATION versus TELEVISION.

IN its issue for February 2nd the *Christian Science Monitor* prints an article which seeks to prove that the addition to sound broadcasting of television would not be a boon but a disillusionment. The argument put forward is that mankind prefers imagination (or anticipation) to realisation, and the following illustration is given: "An Englishman, who knew Russia well and had interpreted its life to his fellow countrymen, listened on the wireless not so long ago to the music of the ballet played at Moscow. He was happy, because he loved the land into which political considerations denied him the entrance."

* * *

ALL well and good for the listener who has been to the country he is listening in to. He knows the terrain and can visualise what is happening. But what of the millions of others who have not been so fortunate as to be able to travel, and whose interest in foreign countries has been raised by broadcasting to such a pitch that they would dearly love to have a glimpse of those countries? Television will provide this majority with the sight which it wants. And the minority can switch off its televisor and let its imagination run riot to its heart's content.

Prominent Continentals Enthusiastic over British Television

Commandant Brenot, Chief Engineer of "Radio-Paris."

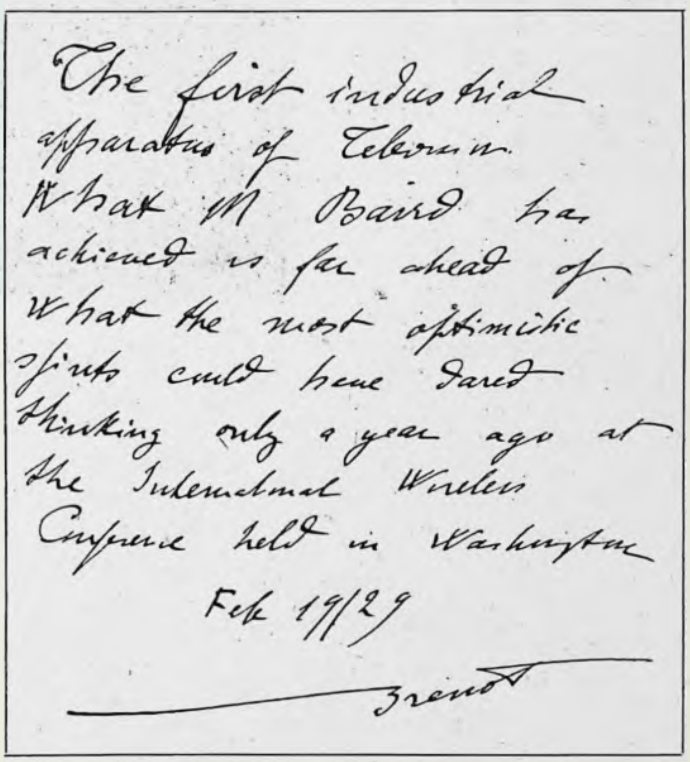
IN our January issue we described how interest in the Baird system of television is rapidly becoming world-wide. We referred in particular to the fact that a company was being formed in France to exploit this British system. Now we are authoritatively informed that, in addition to the other French stations which we mentioned in January, Radio-Paris will also broadcast television.

We are informed that one of the most distinguished visitors to the Baird laboratories recently was Commandant Brenot, Chief Engineer of Radio-Paris, whose photograph appears above. In addition to holding this position, Commandant Brenot is President of the Société of French Radio Dealers and Managing Director of the Société Française Radio Electrique, which owns and supports Radio-Paris.

Originally a pupil (in wireless matters) of General Ferrié, the builder of the Eiffel Tower Station, Commandant Brenot has to his credit the building of Sainte Assise, near Bordeaux, Europe's biggest radiotelegraph station, the Prague and Buenos Ayres stations, and he established the radiotelephonic service between France and America which was recently inaugurated. His achievements during the war earned for him the Legion of Honour.

What this leading French wireless engineer thinks of the Baird system of television is reproduced here in facsimile. As a result of what he has seen in London we are given to understand that he has informed the Baird Company that they may instal "sending apparatus of the Baird television system at the earliest convenience to you for regular broadcasting." This was foreshadowed in our January issue.

Another distinguished Continental visitor, whom



The first industrial
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What M Baird has
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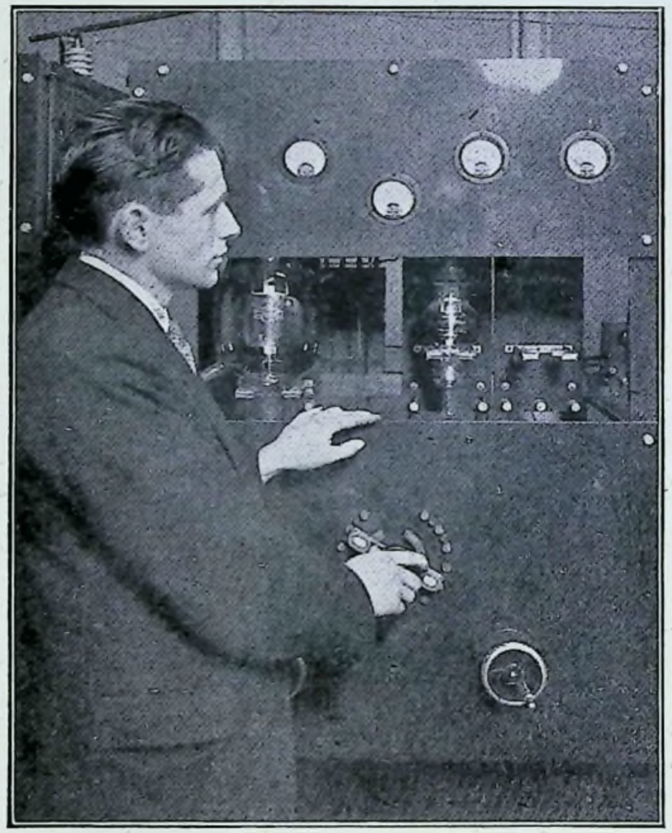
Conference held in Washington
Feb 19/29
Brenot

"The first industrial apparatus of television. What M. Baird has achieved is far ahead of what the most optimistic spirits could have dared thinking only a year ago at the International Wireless Conference held in Washington.
"Feb. 19, 1929. Brenot."

we also had the privilege of interviewing, was Mr. Eduard Svoboda, Technical Manager of the Czechoslovakian broadcasting service. The influence of this service, in which the Czechoslovakian Government retains a 51 per cent. interest, extends into Poland.

Ever since the war Czechoslovakia has been a particularly go-ahead country which has taken the fullest advantage of modern business methods. In the matter of broadcasting stations to-day she is somewhat ahead of her neighbours. She has scrapped inefficient low-powered stations and installed in their place modern high-powered equipments. In Prague there is a 5-kw. (aerial output) Western Electric station; at Brno a 2-kw. Marconi set; a 10-kw. station in Moravia; and plans are afoot for the building close to Prague of a new station which will normally radiate 60 kw. of power, although provision is being made to increase this power at will to 120 kw.



An engineer adjusting the oscillator panel of the Baird Company's new wireless television transmitter on the roof of the Long Acre laboratories.

The purpose of this high-power station will be similar to that of our own 5XX; it will supply alternative programmes, or, according to Mr. Svoboda, the alternative programme may be sacrificed in favour of the broadcasting of television. Mr. Svoboda contends that Czechoslovakia, being in the centre of Europe, must compete with neighbours on all sides, and must emerge supreme in the quality and power of her broadcasting. He declares that by the end of this year Czechoslovakian broadcasting will have reached a very high level indeed.

Questioned on his impressions of what he had seen in the Baird laboratories, Mr. Svoboda was very enthusiastic indeed in his praise of what has been accomplished. "I have no doubt in my mind from what I have just seen here in London that television has definitely reached a commercial stage," he said. "Television to-day is unquestionably much further advanced than radiotelephony was in 1923 when broadcasting was first started. And do not forget that the eye is a much better judge than the ear. The imperfections of broadcasting in 1923, while tolerable then to the ear, would, if we could have seen them, have been quite intolerable.

"All that is necessary now is for television transmitters to be installed, and for television receivers to be made available to the public, and I am convinced that there will immediately be an immense boom similar to that which took place when sound broadcasting commenced. It is inevitable. It must come. With the inauguration of a regular television broadcasting service further improvement is certain to be rapid, as it was in the case of sound broadcasting. But a start must be made."

Questioned regarding television progress in Germany, Mr. Svoboda said that there is no comparison between the German systems and what is being done in this country. He endorses entirely the views expressed by Dr. Alfred Gradenwitz in our issue for December last.

Asked if, before coming to London, he had expected to see such perfect results here, Mr. Svoboda answered in the negative. "I was astonished," he said. "I had heard much about the Baird system. That is why I came; but I never expected to find it so far advanced. People, when they speak of television, have got into a habit of mind such that they say to one another 'Yes, television will be very wonderful when it comes; but it will be another five years or so yet before it comes.' They do not realise that television is *here*, NOW. A start must be made with broadcasting in order to prove to the public that this is so."

Mr. Svoboda gave us to understand that he is very anxious to secure the rights of the Baird system for Czechoslovakia, and such is our admiration for his enterprising country that, on leaving him just as he was departing for home, we were constrained to wish him every success in his efforts.

The Story of Electrical Communications

by

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

Part III.—SUBMARINE TELEGRAPHY

WE have seen how credit for early developments in line telegraphy fell chiefly to Great Britain, America and Germany, but early developments in submarine telegraphy may be credited to Great Britain in the first place with the United States of America as runner-up.

Earliest Pioneers.

The first messages sent by submarine cable were probably those transmitted across a river in India by Brooke, an Englishman, in 1838, though about the same time our old friend Morse, of America, sent messages across the harbour of New York. Morse, as we have seen, was then in the throes of poverty, and it was at this time that he wrote, as has often been quoted, "My stockings all want to see my mother, and my hat is hoary with age."

Cornell, of America, the founder of Cornell University, carried out some successful experiments a few years later, and in 1846 West, of England, had some success with a submarine cable at Portsmouth. West, like Morse, failed for want of money, and in this incident will be seen the reason why, unlike what we found in line telegraphy and what we shall find again in telephony, amateurs have had to yield the palm to professionals in the technical pioneer work of submarine telegraphy.

It is obvious that experiments in submarine working must be very costly compared with line working, and the amateur experimenter is not as a rule a man of great wealth. Neither, for that matter, is the professional, but, other things being equal, wealthy men are more likely to back the professional than the amateur. That is what happened with the first Atlantic cable. To his everlasting credit Cyrus Field, an American millionaire, had the vision to back the scheme.

But we are going too fast. The short submarine cable was a practical proposition before Field stepped in, largely due to the untiring industry and enthusiasm of the brothers Brett, of England, who, entirely at their own expense, laid the first cable across the English Channel from Dover to Calais in 1850. This cable was soon put out of action by a fisherman and his nets, but it had served its purpose; it was replaced, and others followed.

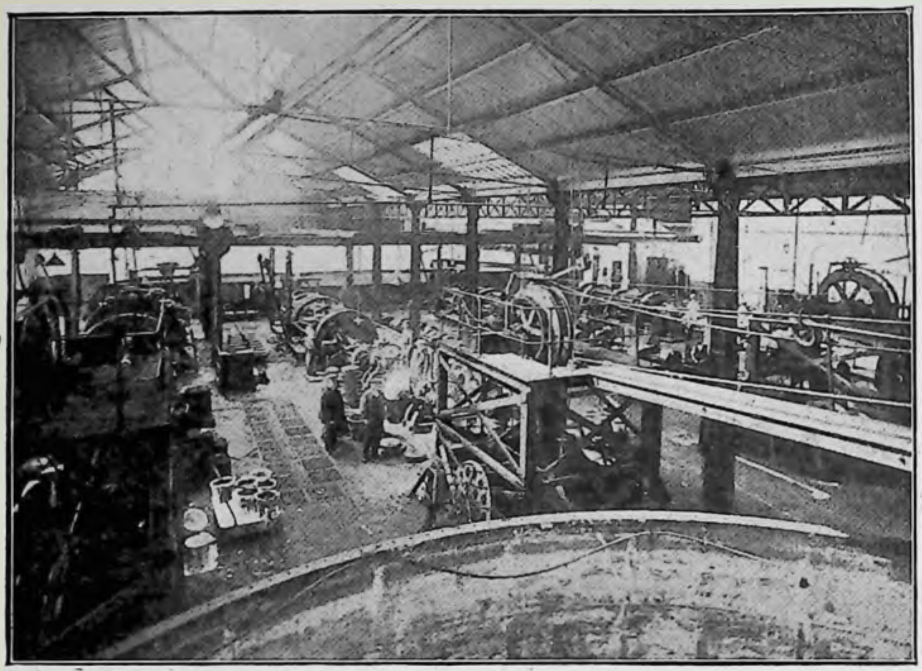
Transatlantic Pioneers.

Cyrus Field came to England and with others over here backed the Bretts financially, and had the good fortune to enlist the help of Charles Bright, an English electrical engineer. Bright was a born pioneer. He had all the attributes—courage, enthusiasm, ability, and, perhaps not least, poverty and youth. Not poverty of the hoary-hat variety, for poverty, like all else, is comparative. Before he was twenty he was well known in what was then the small telegraphic world; before he was forty he was known as "the father of the Atlantic cable."

Field's driving power and Bright's technical ability were fortunately supplemented by the genius of Thomson, but unfortunately clogged by the stubbornness of Whitehouse, who had been appointed engineer-in-chief of the scheme. William Thomson, afterwards Lord Kelvin, was an Irishman of Scotch descent. His father's people had come to Ireland from Scotland some two hundred years before, and his mother was Scotch, but he was born in Belfast and can be justly claimed by Ireland. And William Thomson is well worth claiming. He was one of the greatest scientists and one of the greatest inventors, not only of our country, but of the world. At first Thomson was merely on the board of directors, and it was not till August, 1858, that he was appointed engineer-in-chief in place of Whitehouse, whose attitude, to put it mildly, had become insufferable.

Thomson's advice on all matters, and his practical assistance in carrying out tests on the cable, were invaluable. He applied the principles of his mirror galvanometer not only to testing the cable, but to the reception of signals. With Whitehouse's receiver it took 16 hours to pass the first message of 99 words from our Queen to the President of the United States. At this end, where Thomson's receiver was used, it took 67 minutes for the message to be repeated back.

It must be understood that signals through a submarine cable are not only attenuated, but they are very distorted. The signal, in fact, takes an appreciable time to die away, and if the morse code were used, the dots and dashes would run into one another unless the speed of signalling was extremely low, which is quite out of the question for remunerative working.



Interior of a submarine cable factory.

The Syphon Recorder.

It was Thomson who first devised a suitable method for sending and receiving signals. He invented the impulse method of signalling, in which a dot is represented by an impulse of positive current, a dash by an impulse of negative current of the same length, and a space between letters by a corresponding zero interval, the message being recorded on the receiving tape in the form of a wavy line.

The receiver which Thomson invented, and which is still used on some cables, is the Syphon Recorder. It consists of a small glass tube shaped like a syphon, with one end immersed in an ink-well, the other end being free to move to and fro across the surface of a paper tape. The syphon is connected to an electro-magnet in the line circuit in such a way that currents in the line produce movements, to and fro, of the syphon across the tape. When the syphon is at rest a straight line is drawn on the tape, but when in movement a wavy line, whose characteristics depend on the signals being received.

The First Transatlantic Cable.

But we anticipate again. Field and his English friends lit the cable torch so well on both sides of the Atlantic that even the Governments succumbed, and on August 6th, 1857, an expedition for laying the first cable set off from Valentia on the south-west coast of Ireland. Each Government had supplied a warship; the American ship was to lay the first half of the cable from Valentia, and the British ship was to continue it from mid-Atlantic to Newfoundland.

Unfortunately, 400 miles out, the cable snapped, and the ships came into Plymouth. More money had to be raised, and again the expedition started off in June, 1858. Terrific weather was encountered, and again there was failure. But once more the money was forthcoming, the attempt was made, and, as in all good fairy tales, the third attempt was crowned with success.

It does not sound much in the telling, but that is only because the difficulties were so great that even a summary of them would require the space of a whole article. All we need say here is that the laying of the first Atlantic cable will rank for ever as one of the epics of scientific achievement.

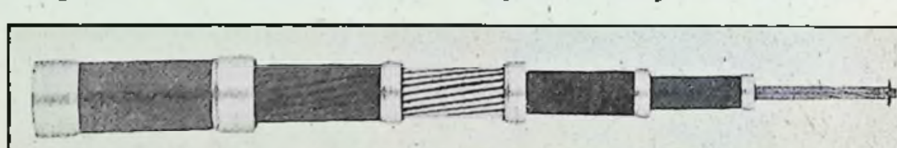
This cable only lasted two months, but over 700 messages had been sent, and the possibility of long-distance submarine telegraphy was proved beyond a doubt; and it was doubt that had been the greatest obstacle of all, as, indeed, was again the case when Marconi was trying to span the Atlantic by wireless telegraphy, 44 years later. It was largely a triumph of youth and enthusiasm. Bright, like Marconi, was only 26 years old when he conquered the Atlantic.

The next attempt was made in 1865, and the largest ship afloat, the "Great Eastern," was used for the purpose. The cable was much stouter than before, and weighed 4,000 tons, but it broke in the laying, and it was not until July 27th, 1866, that at last a satisfactory cable was laid.

Present Transatlantic Cables.

There are now sixteen cables between the British Isles and North America, owned and controlled by one or other of the two great American companies, the Western Union Telegraph Company and the Commercial Cable Company, the two companies which also own the inland telegraph system of the United States, and partly that of Canada. At this end the Western Union cables are landed at Valentia in Ireland, or Sennen Cove near Penzance; the Commercial cables at Waterville in Ireland.

The first of these cables was laid in 1873, and the latest one, a span between the Azores and Newfoundland, last September. This new cable is the world's fastest long-distance cable, capable of transmitting four messages each way simultaneously. It was manufactured and laid by the Telegraph Construction and Maintenance Company, of London, for we still maintain a premier position in constructing and laying cables. The only transatlantic cables controlled by this country are two Government cables, worked at the moment by the Post Office, but shortly to be disposed of to private enterprise under the merger scheme which will be dealt with later.



A section of a submarine cable, showing the various coverings.

Four transatlantic cables between France and North America are controlled by the French Cable Company. The Italian Cable Company controls one from Italy, and the German Atlantic Company have recently laid one from Germany.

How the "War" ended

By A STUDENT OF PROGRESS

We print the following important article by "A Student of Progress" without necessarily endorsing his views. The personality of the writer warrants the publication and consideration of his opinions—particularly since they help to an understanding of the attitude of the B.B.C. The article, as the writer himself suggests, should be read in conjunction with that written by Sydney A. Moseley.

THE fact that I occupy a position of detachment from the controversies which have raged round television in the past two years may have influenced the Editor in inviting me to contribute to his columns. Anyway, my sole interest is to foster the real progress of the application of science to the needs and happiness of humanity.

In the days when it was customary to throw ridicule upon the broadcasting of voice and music, I was glad to find myself on the side of the pioneers of what has now become, in a few short years, a tremendous beneficent force in the community. That the instrument of broadcasting should have been so wisely conceived and conducted in this country is a matter for gratification among all British people. I hold no brief for the B.B.C., but when I notice the intemperance of some of its critics I am moved to suggest a readjustment of perspective. When all is said and done, the B.B.C. is carrying out its policy of providing in nearly 90 per cent. of the homes of Britain the best available entertainment, thought, culture, and general enlightenment. Moreover, the B.B.C. is miles ahead of any other similar organisation in the world both in the efficiency of its entertainment and in the social value of its work. Having said this one is entitled to criticise as much as one likes!

B.B.C. Procedure.

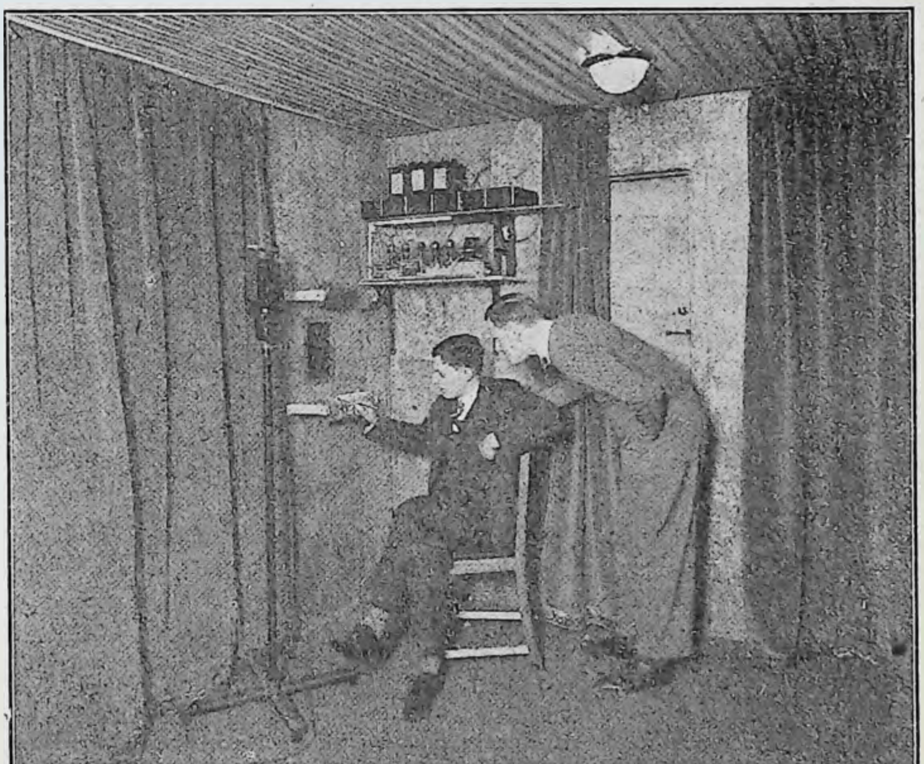
I do not agree with all that the B.B.C has done and failed to do in connection with scientific development. But I understand and appreciate the motives that lie behind its necessarily conservative attitude. Many new inventions and ideas are constantly being brought to Savoy Hill, where they are examined with care and consideration. If they are regarded as being of potential value in a general service sense then they are taken up, developed, and ultimately incorporated.

This general procedure, unfortunately, was not applied early enough in the case of Baird television. Unhappy concatenations of circumstances conspired against the invention. Some of the most zealous and coherent of its earliest advocates happened to have been bitter opponents of the B.B.C., and with their advocacy of television linked a demand for the dissolution of the B.B.C. On the one side irrational claims were made; on the other side was incubated an attitude of intolerance and resentment. The normal channels to coöperation were closed and secured. This was four years ago. The merits of Baird television became obscured in the repeated skirmishes of personalities.

Uninspired and uncontrolled by the Baird companies, the "City" took a fancy to television. There was speculation with all the consequent suspicions. Meanwhile the inventors and research engineers were steadily "plugging away" in the Baird laboratories. But still other considerations stood in the way of coöperation with the B.B.C. Effort on both sides seemed to be much more concerned with increasing the gulf than in building a bridge.

"Spirit of Distrust."

To get the discussion placed on a



THE LAST WORD IN TELEVISION STUDIO DESIGN.
A new television broadcasting studio which has just been completed in the Baird Laboratories is completely lined with copper for the purpose of screening off interference.

*

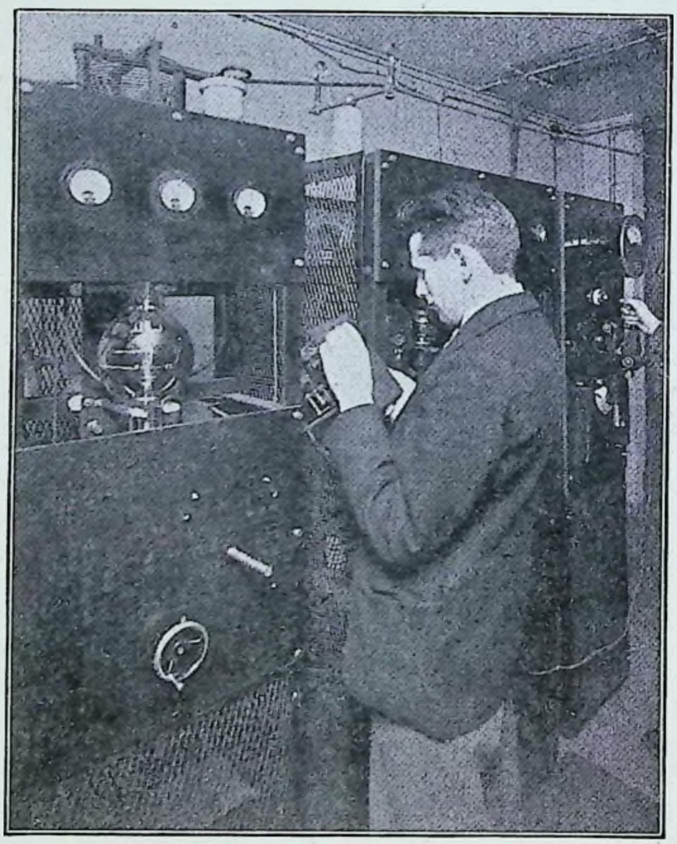
proper technical basis was the task undertaken by well-disposed people last autumn. But it was not possible to exorcise the spirit of distrust at once. The inspection by the B.B.C. in October was a real advance, significant of the first practical contact in four years. The verdict was not liked by the Baird people, who failed to understand that, in view of all that had gone before, it was the only possible one. The B.B.C. said, in effect, that they were distinctly impressed with Baird television, but that it was still in the laboratory stage. If, however, it was improved they would be glad to come and examine it again. Implied in this verdict was the offer of technical assistance, if sought.

Two important mistakes were made on both sides. The Baird engineers declined to allow Captain Eckersley to see the transmitter, thereby losing a golden opportunity of interesting him personally. The Baird interests regarded the verdict as a declaration of war, and acted accordingly, paying no attention to the real possibility of constructive coöperation contained in the B.B.C. verdict, and declining to recognise the *bona fides* of the B.B.C. engineers.

The B.B.C., on the other hand, might have been more cordial, and gone farther towards coöperation; and secondly, should not have published its verdict in advance of communication to the Baird Company. So, on the whole, there was not left very much but the wreckage of good intentions.

War was resumed; as sterile as most wars. And then after a period of this unprofitable exchange of acerbities, some *thinking* was resumed. Common sense slowly asserted itself. Forces of reconciliation and understanding were set in motion. Executive chiefs were brought together in friendly conference for the first time. Various proposals were considered in an entirely new spirit. At the time this is being written considerable progress is being made. It has been possible, for instance, for both the President of the Board of Trade and the Postmaster-General to call attention to the new spirit in the House of Commons. Pledges of secrecy must be observed as to the details and nature of concrete proposals. Nevertheless, the outstanding fact is that the almost traditional war between the Baird companies and the B.B.C. has been brought to an end—it is hoped for good.

What of the future? I would venture to predict with some confidence that even if the Baird system is still regarded as in need of development to fit in with a broadcasting service in conjunction with the broadcasting of sound this will be undertaken with greatly strengthened technical resources, and with the goodwill of the B.B.C. readily available. And one final word.



One of the Baird Company's engineers checking the wavelength of the wireless television transmitter on the roof of the Baird Laboratories.

Many hard things have been said about Captain Eckersley in this connection. I want to impress readers of this journal and friends of television generally that I am sure Captain Eckersley has done nothing that he did not regard as his absolute duty from the beginning. It would be well if some of his traducers would stop to reflect how much easier it would have been for him to have allowed his technical doubts to be overcome in order to share in the limelight and glamour of hastening the advent of a revolutionary invention.

When the full history of these transactions and events emerges from the facile pen of Sydney Moseley—himself a principal protagonist for the cause of recognition—I believe it will be discovered that, taking the long view, Captain Eckersley's honest doubts and opposition have really served the progress of the application of science to the needs and happiness of humanity.

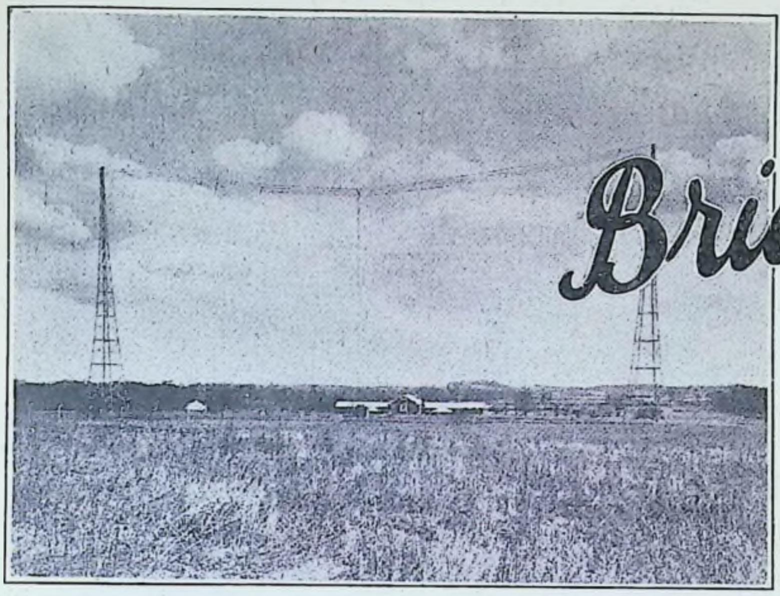
Those whose duty it is to think in terms of service to millions must put the brake on the natural enthusiasm of those whose sole concern is inventions—the more wonderful and compelling the more calculated to invert perspective.

BAIRD TELEVISION DEVELOPMENT COMPANY MEETING.

In the House of Commons recently Mr. Thurtle asked the President of the Board of Trade if he was aware that the Baird Television Development Company, Limited, had not held any annual meeting or submitted any accounts and balance sheet since the company was floated in 1927, a period of more than eighteen months; and if he was proposing to take any action to enforce the law against this company.

Sir P. Cunliffe-Lister: "I understand from the chairman of the company that the meeting was deferred in view of negotiations with the General Post Office and British Broadcasting Corporation, which were in progress in the latter part of the year for the provision of facilities for an experimental broadcast of television, that arrangements have only just reached a stage at which progress can be reported to the shareholders, and that a general meeting is now being convened. In the circumstances, I do not think that any action on my part is required."

The first annual meeting of the Company was held on Feb. 19th, at which the Chairman, Sir Edward Manville, repeated the above explanation of the delay, and foreshadowed "interesting developments" in the near future.



Bridging Space

by

JOHN. WISEMAN

Part IX.—THE RECEIVER

IN our last article we left the modulated carrier wave travelling in all directions from the transmitting aerial, and hinted that the next obvious course was to establish ourselves at a receiving station and see how the broadcast energy could be harnessed, and in effect make it retrace its steps by reproducing at the receiving end all that happened at the transmitting studio.

The first requirement, of course, is a good aerial, such as the one shown in the accompanying photograph, and since we have seen in earlier articles how the transmitting aerial was evolved, we need not go into the matter again, as electrically the receiving aerial is the same as the transmitting aerial. That is to say, it possesses an open or distributed capacity, due to its elevated position, while additional inductance and capacity is invariably provided by locating an inductance or loading coil in the down lead, together with a variable condenser (see Fig. 1). The frequency of any natural aerial oscillations is a function of the total inductance and capacity, and by making one (or both, if required) of these variable—generally the condenser—we can control this factor, and this is extremely important, as we shall see in a moment.

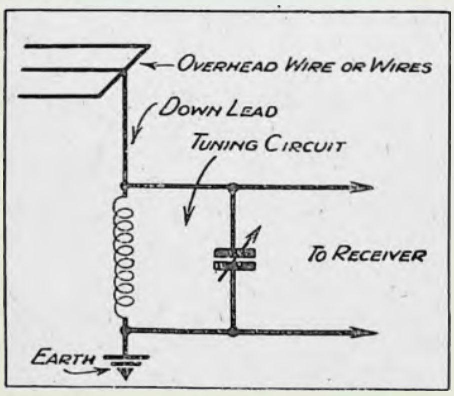


Fig. 1.—Diagrammatic representation of the receiving aerial circuit.

Relative Effects.

Regarding our aerial as a whole it acts as an absorber of some—actually an extremely minute fraction—of the energy from the "wireless" waves. Originally we made an oscillating current in the transmitting aerial produce an electromagnetic field which spread out into space, and this field has the property of inducing a small amount of energy into the receiving aerial as it sweeps across. It is a well-known property of electricity that if a conducting wire is moved across a magnetic field a voltage difference is produced across its extremities, so that if the wire forms part of a closed circuit a current will flow.

Now, although the down lead of our aerial does not actually move through a magnetic field, in a relative sense the effect is the same if the magnetic field moves across it. It is immaterial whether you run up a flight of stairs or keep stationary and allow the stairs to move and take you along, as in the underground escalators; you will reach the top just the same.

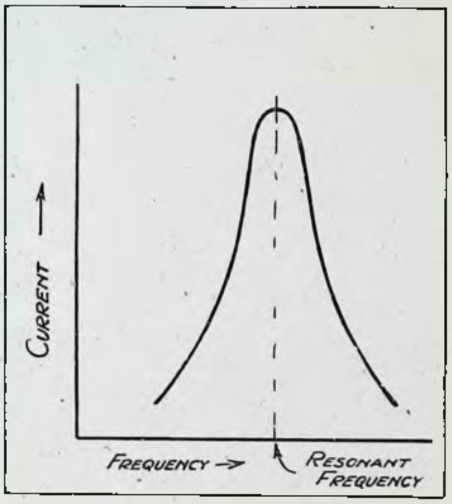
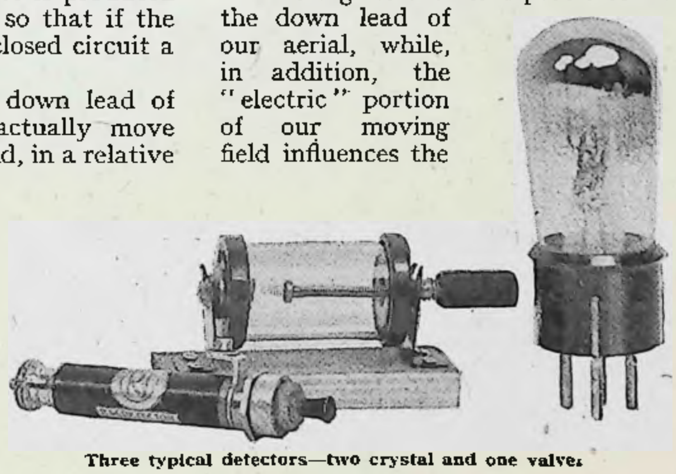


Fig. 2.—A typical resonance curve.

An Exact Replica.

A voltage is therefore produced in the down lead of our aerial, while, in addition, the "electric" portion of our moving field influences the



Three typical detectors—two crystal and one valve.

condenser section of the aerial and the combined effect is to produce a very small voltage between the top of the aerial and earth. But since our incident electromagnetic waves are alternating in character the voltages produced are alternating, and we really have an exact replica of the original oscillations in the transmitting aerial, but, of course, very much feebler in strength.

Selecting the Signal.

It is at this stage that we can see how necessary it is to be able to select just the signal we require in order to pass it on to the receiving set. A number of other transmitting stations, within range, are sure to be sending out signals simultaneously with the station, the signals of which we desire to receive, and consequently the receiving circuit must possess the ability to "tune out" the unwanted signals which are reaching the aerial and "select" that signal sent by the station with which we desire to communicate. Without this means of selecting a desired signal we should be in a very unfortunate position, but happily the problem is easy to solve.

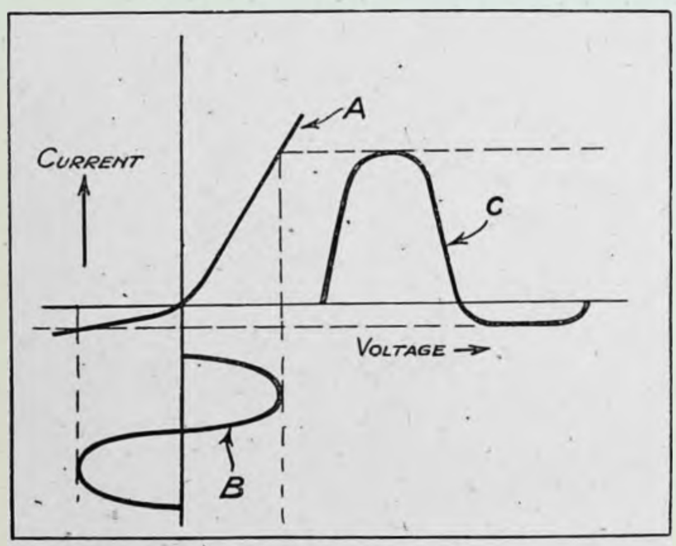
Earlier in this series we saw how the oscillation frequency was a function of the inductance and capacity in the circuit. Consequently, to make this current in the aerial assume its maximum value, we must adjust these electrical quantities so that the aerial's natural frequency coincides with the frequency of the impressed E.M.F. imparted by the electromagnetic wave. This process is called "tuning the aerial," and we actually bring it into resonance with the frequency of the incoming wave.

A WELL-INSTALLED AERIAL.

This resonance effect is encountered in a similar manner in many mechanical ways. It is the reason why soldiers are made to break step when crossing a none too safe bridge, for if the slight shocks given to the bridge by their tramping feet are in the natural period of the bridge they may set up such violent oscillations as to break the bridge.

Resonance.

To revert to our aerial, then, by tuning it to the frequency of the signals it is desired to receive, the current due to these signals is made a maximum, while the currents flowing in the aerial due to signals sent out from other stations which have a frequency differing from that of the signal being received are relatively much weaker. If we had a sensitive meter in the aerial circuit and plotted a curve between current and frequency it would resemble that of Fig. 2.



Typical Detector Curves.

It will be noticed that the current falls off rapidly on either side of the resonant condition. Of course, in actual practice there are other factors which have a distinct bearing on this problem of selectivity—efficiency and resistance of aerial, type of coupling between aerial and receiver, number of tuned circuits employed, etc.—but since these are side issues as far as we are concerned, and do not affect the principles under discussion, we must pass them over and examine the next important detail of our receiving equipment.

Making the Signal Perceptible.

How can we make these very feeble oscillations in the aerial perceptible to the ear for speech broadcast, or visible to the eye for television broadcasts? Taking the speech case, our first thoughts would lie in the direction of the employment of a telephone receiver similar to that shown in one of last month's diagrams. However, if these rapidly oscillating currents were passed direct through such an instrument it would fail to respond. The currents moving first in one direction and then in another at frequencies reckoned in hundreds of thousands pass too rapidly to produce any effect on the diaphragm, owing to mechanical inertia.

We must provide a piece of apparatus which will reduce these effects to audibility, and yet retain the true character of the signal.

(*Continued on page* 15.)

How to Make a Microammeter

By H. WOLFSON

In the following article our contributor describes, in a simple manner, the construction of a microammeter suitable for the use of the experimenter. Such an instrument has a multitude of uses in the laboratory, and will well repay the amateur for the trouble taken to make it.

AN instrument capable of detecting and measuring extremely minute currents has a wide sphere of useful application both in radio and in television. Unfortunately commercially made instruments are usually too expensive for most of us, and I determined to try and design one which could be made quite easily at the cost of a few shillings. The result has been really surprising, and I have made a really sensitive instrument for the small sum of 5s. 6d.

Let us first consider briefly the theory of the instrument, which is of the suspended coil type. In this instrument we have a coil of wire suspended in a powerful magnetic field. This is shown diagrammatically in Fig. 1, where *N* and *S* are the poles of the magnet, and *CC* represents a section through the coil. The dotted lines and arrows indicate the direction of the magnetic field and the field due to the coil. The forces which are brought into play as a result of the two fields result in a couple being

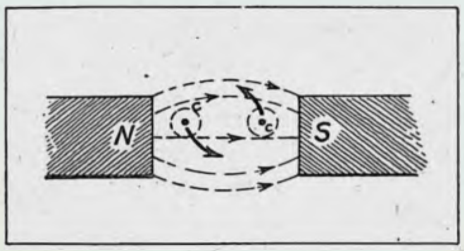


Fig. 1.
Theoretical diagram, showing lines of force due to magnet, and direction of motion of coil CC.

applied to the coil, thus causing it to move in the direction shown by the large arrows.

In order that the deflection of the coil shall be proportional to the current flowing through it for all values of the current, it is essential that the magnetic field shall be uniform for all positions of the coil; this is known as a *radial* field. We shall see how this is achieved when we discuss the actual constructional details.

Since the coil is suspended it will act as a pendulum system, and will thus oscillate about the point to which it has been deflected for a few seconds before it finally comes to rest. This is, of course, inconvenient from the point of view of being able to take readings quickly, and it is usual either to wind the coil on a copper frame, or alternatively to surround the coil with a copper case, constructed of very thin foil, since it is necessary to keep the weight of the coil system as low as is possible.

The Magnetic Field.

The magnetic field required by the instrument is provided by two ex-Government magnets, of the type used for magneto ringers in field telephone sets. These can be obtained from a number of firms who deal in ex-Government stock, for a shilling or so each. As previously stated, the magnetic field must be uniformly distributed. This is quite easily achieved by the use of soft iron-pole pieces. For the construction of these you will require a piece of soft iron of dimensions 1¾ in. long by ¾ in. wide, and 1½ in. deep. This has now to be drilled with a ⅝ in. hole through its centre as shown in Fig. 2. Since many of us are not prepared to drill this hole ourselves, it is best to get the hole drilled at the same time as you purchase the iron. Many firms who deal in iron girders, etc., will supply you. I obtained my piece ready drilled for the small sum of sixpence!

Having obtained the drilled piece of iron, the next operation is to file it true, and make it so as to fit tightly between the poles of the magnet. Having done this, the iron must be sawn into halves.

This requires some care to make quite sure that the cut is made exactly across the centre of the hole, and that it emerges centrally at the other side. You will need a really good hacksaw blade to do this easily and satisfactorily, and any trouble expended will be amply repaid when the instrument is put into commission. The inside of the hole can

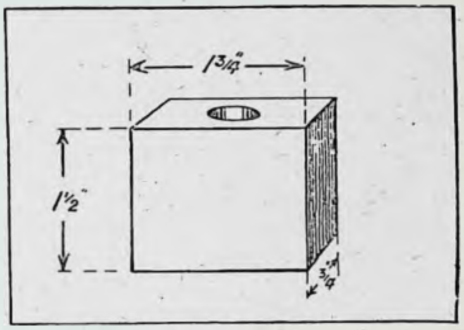


Fig. 2.
Showing block of iron with ⅝ inch hole drilled through.

now be trued up with emery paper and any burrs and inequalities remaining from the sawing can be carefully removed with the file. The object in view is to secure these pole pieces to the magnets so that there is a narrow gap between the pieces, this gap not exceeding ⅛ in. (Fig. 3).

You will be wondering how the pole pieces are to be secured to the magnets, for it is well-nigh impossible to drill the hardened cobalt steel of which they are made. Fortunately there is no need for this, as the use of two magnets in place of one gives us an alternative.

If we drill the ends of the pole pieces centrally, as shown in Fig. 4a, and tap the holes with any convenient thread, say 2BA, we can pass the securing bolts *between* the magnets, as illustrated in Fig. 4b. A large washer should, of course, be placed on the bolt before screwing it tight. It is unnecessary to drill holes right through the pole pieces, so that they cut through the cylindrical part, the depth of the hole need be no more than $\frac{3}{8}$ in.

At this stage it is best to make the case for the instrument. This can be left largely to the personal fancies of the constructor, so that a brief outline will suffice. I myself was fortunate in having an old mahogany box of suitable dimensions—namely, $4\frac{1}{2}$ in. by $5\frac{1}{2}$ in. by $2\frac{1}{4}$ in. deep. To this is fitted a cover of ebonite, and in this respect I would advise constructors to adhere to this, as the appearance of the instrument is thereby much enhanced. This piece of ebonite completely covers the top of the box, and must be cut out as is illustrated in Fig. 5, so as to form a window through which the movement of the pointer is followed.

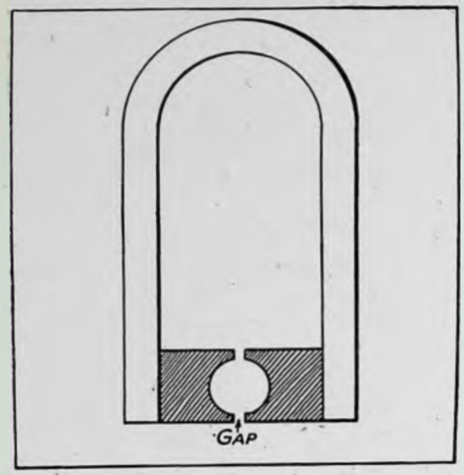


Fig. 3.
Pole pieces shown shaded.

Preparing the Case.

The method of cutting out this window is as follows. Having decided where the centre of the pole piece system will come under this cover when the apparatus is assembled, a slight mark should be made in this position, which will be about one inch from the edge of the ebonite (*C* in Fig. 5). With this as centre, an arc of a circle of radius four inches should be described; this is shown at *AA* in Fig. 5.

A straight line is also drawn under this arc, at a distance of $2\frac{3}{4}$ in. from the centre mark (*C*, Fig. 5). The constructor should then decide the width of the window and mark off some convenient distance from the edge of the ebonite along the arc. In the instrument which I constructed this distance was $\frac{1}{4}$ in. From these two marks straight lines should be drawn to the centre of the arc, *C*. These will, of course, cut the straight line, and thus there will be the outline of the window, *AALL*. This should now be cut out of the ebonite, and though various methods of procedure may be adopted, perhaps the most convenient is as follows.

First drill four small holes at the corners of the window and then a number of larger holes near to the edge of the outline, care being taken not to cut into this outline. It is then an easy matter to insert either a hacksaw blade or a fretsaw, and remove the portion marked out. It is advisable not to work too near to the line, as it is easy to run outside the line, which would, of course, spoil the neatness of the job. The final trimming is best accomplished by the use of a flat ward file.

A piece of glass is next cut to fit the ebonite, or, if the reader prefers, any glazier will cut the piece to order. This can be fitted by carefully "springing" it into the ebonite, and if of the correct size will hold without any other means of support.

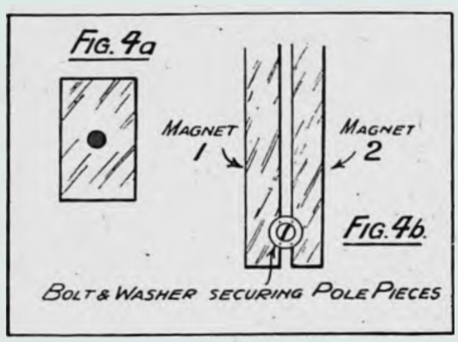


Fig. 4.
(a) End view of pole piece showing tapped hole for securing to magnet. (b) End view of magnet system.

The final piece of drilling is to make a $1\frac{1}{2}$-in. hole in the ebonite to accommodate a piece of ebonite tubing, of internal diameter 1 in. and length 3 in., which should be procured before the drilling is commenced. The hole should be of such a size as to take the tube very tightly, so that there will be no need to fasten the tube by any other means.

This hole should be drilled at the point *C*, which was the centre from which the other lines were marked out.

The external part of the instrument is completed by fitting to the top of the ebonite tube, which projects from the panel, a knob of the type employed for condensers, etc., and about $1\frac{1}{2}$ in. in diameter. This may have to be filed down somewhat to make it fit tightly and a hole should be drilled through its centre so as to register with the threaded hole in its centre, for it is through this hole that the supporting screw will project into the tube.

Coil and Suspension System.

Having completed the foregoing parts of the construction we are now at liberty to tackle the most delicate and important part of the work. I refer to the coil and its suspensions system. This need present no difficulty if the instructions are adhered to, and can be completed in less than an hour. First choose a well-seasoned, straight-grained, piece of wood, such as canary wood, and trim out a piece $1\frac{1}{4}$ in. long and $\frac{1}{2}$ in. wide. The wood employed should be $\frac{1}{4}$ in. thick. Reference to Fig. 6 will make matters clearer. The coil former is made from this piece of wood by filing a groove $\frac{1}{8}$ in. deep and $\frac{3}{16}$ in. wide all round the wood, as shown in Fig. 6. Two brass pins should be firmly driven into the two top flanges of the former, as illustrated, to be used for the suspensions and connections.

The wire used in winding the coil should be 47-gauge enamelled copper wire. This can be conveniently obtained from old Ford coil secondaries, or purchased from scientific suppliers. Half to one ounce will suffice for several coils.

Having removed the enamel from a few inches of the wire by gentle friction with a piece of glass paper, several turns are wound round the pin and secured by soldering. Care must be taken both at this stage and while

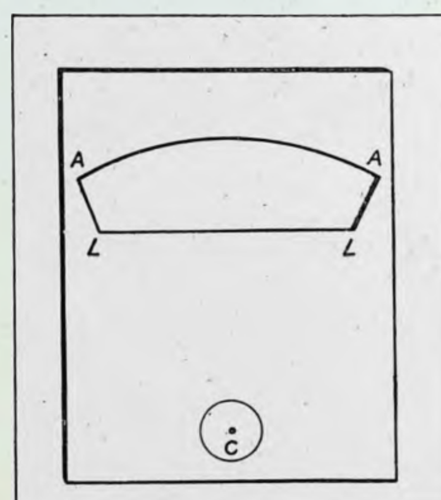


Fig. 5.
Showing ebonite panel with window and hole for ebonite tube.

winding that the wire does not break; do not put too great a tension on it, for it is hopeless to have to join it. As an alternative a thicker piece of wire about two inches long can be soldered to the end of the fine wire and this can be secured to the pin. Two hundred turns of wire are wound on the former, as evenly as possible, and the outer end of the wire cleaned and soldered to the other pin. With care, quite a neat coil can be made without difficulty, but if the wire breaks it is both quicker and safer to start afresh.

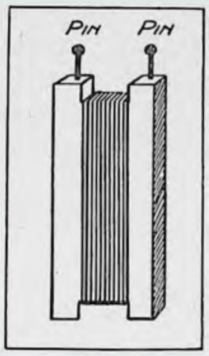


Fig. 6.
Shows coil former, wound, with brass pins for suspension.

Our instrument is now nearing completion. All that remains to be done is to suspend the coil. Consider first Fig. 7, which gives a view of the knob which fits in the top of the ebonite tube, and shows also the $1\frac{1}{2}$ in. brass bolt which passes through the knob. The thread of this bolt which projects through the knob should be filed away, so that a piece of insulating sleeving, "Systoflex," can be forced on so as to cover the brass completely.

Two pieces of 24DCC wire are next tightly bound with thread, as shown, to the insulated bolt, and these two wires form the supports from which the coil and suspension hang, and serve also as conductors by which the instrument is connected to the circuit. The suspension consists of either 47-gauge copper wire or the special phosphor-bronze suspension which can be bought from scientific suppliers.

The suspension, of whatever type, should be first soldered to the pins in the coil former, and having determined the length which will be required the free ends should be soldered to the connecting wires at *WW*, Fig. 7. It is very important that both suspension wires should be of the same length, otherwise the sensitivity of the instrument will be considerably diminished.

Having completed the foregoing operation, the coil is carefully lowered through the ebonite tube, and the connecting wires brought outside the tube for subsequent connection to terminals. The knob is fixed securely into the top of the tube.

A pointer and scale are all that is required to complete the instrument. The scale should be drawn on cardboard, and graduated in any way desired, since the instrument has not yet been calibrated. The pointer is made from thin aluminium foil, or preferably one can employ glass pointers. These are made by drawing out a piece of glass tubing in the Bunsen flame to capillaries. These are extremely light in weight and are about a quarter of a millimetre in diameter. The end should be dipped in ink to render it visible. The best way of attaching the pointer is to make use of a little red wax, sealing wax, shellac or similar material, and the only point to be noted in this connection is that the pointer swings clear of both the cover and the scale.

Note that the instrument is only adapted for direct current measurements, and that it has therefore a positive and negative terminal. This is found by trial. The current from a flash-lamp battery in series with a high resistance should be used for testing; if the pointer swings across the scale, the battery is connected correctly, and the terminals should be marked for future reference. If the pointer tries to go the wrong way the battery connections should be reversed.

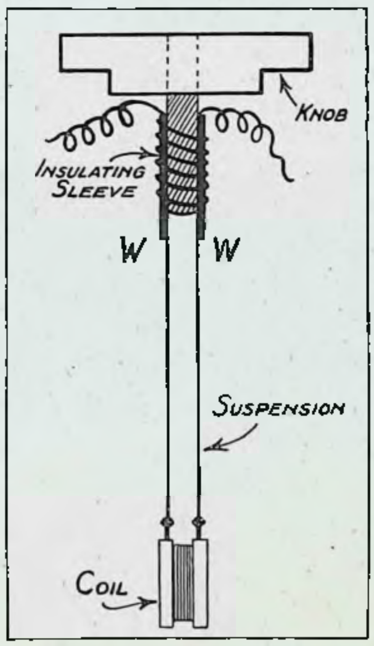


Fig. 7.
Moving coil suspension.

Calibration of the instrument and the method of adapting it as a "Universal" meter for measuring current and voltage in all ranges will be dealt with in a later article.

Bridging Space.

(*Concluded from page 12.*)

Some form of electrical "valve" or "rectifier" is needed and, as users of broadcast receivers are no doubt aware, this is provided generally in one of two main forms, namely, a combination of two crystals or a crystal and a fine-pointed wire, or, alternatively, through the medium of a thermionic valve connected up in a circuit in a specific manner. One of the accompanying photographs gives three commercial examples of these rectifiers.

The device included must enable the current to pass through in one direction and not in the other, that is to say, its main characteristic must be unilateral conductivity. This feature can best be appreciated by referring to Fig. 3, which gives the characteristic curve of a "Perikon" rectifier, utilising the contact between zincite and chalcopyrite, curve *A*. It will be noted that for positive voltages the curve rises steeply in a positive current direction, but for negative voltages the current rises very slowly in a negative direction and is extremely small when compared with the positive component.

Supposing, then, we apply an alternating voltage to this crystal junction as indicated by curve *B*. When the voltage rises from zero to its maximum positive voltage and back to zero again the current passed through the crystal will resemble somewhat the positive portion of curve *C*. For the same voltage change in the negative direction, however, the negative current will be quite small, as seen in the bottom half of curve *C*.

Rectification.

This process is said to be rectifying the alternating current (it being, of course, remembered that an alternating voltage produces in its own circuit an alternating current), for although there is a small negative current, if we were to take a number of complete voltage cycles instead of the one shown in Fig. 3, the *average* effect (and itis this that influences our telephone receiver, owing to its inherent mechanical inertia) would be a positive current impulse.

As we shall see in our next article, it is the application of this principle that enables the operator to hear signals of a nature identical to those imparted to the microphone at the transmitting studio.

Television is the Latest of the "Impossibilities"

As WILLIAM J. BRITTAIN'S Facts Show

THAT Baird's disc method can now achieve television of a scene, including full figures of people, is news that the "impossible" has been achieved.

In the early days of the present boom in television many experts said that mechanical means, and especially a disc, never could achieve television.

I went on a tour through the Continent to see what prospect there was of investigators in other countries being first to bring "seeing" to the home.

Dénes von Mihály, who was using oscillating mirrors, told me emphatically that Baird's disc would explode before it achieved a speed fast enough to allow passable transmission of scenes.

Disc apparatus, he said, served only to demonstrate the principle of television, and was satisfactory only so long as one was content with a transmission of 60 to 100 spots of light.

Now he has turned to the disc, and I am informed that it is producing results pleasing to him and to the company formed around his system.

Professor Hans Thirring, of Vienna University, the famous experimenter with selenium cells, was cautious, but inclined to express the same opinion about discs.

He gave me the reprint in German of a long address given by Professor F. Aigner, of the Technical High School, Vienna, which set out to prove that electrical television was impossible.

Professor Max Dieckmann, of Munich, of whom I formed a high opinion as a sincere and able research engineer, told me that he had scrapped his mirror apparatus because he had come to the conclusion that mechanism never could achieve television. Success has not yet met his efforts to harness cathode rays for television transmission.

Pronouncements on the impossibility of mechanical television by such physicists as Sir Oliver Lodge have been frequent. Mr. A. A. Campbell Swinton has expressed to me the opinion :

"It seems very doubtful whether it is possible, by mechanical means, to obtain any much better results than those shown in America at vast expense with very elaborate and complicated high-speed running apparatus, and it has therefore now for a long time been thought and suggested that something better than mechanical methods should be employed."

I have expressed similar opinions myself. I could not see how a holed disc could achieve television of a scene. The thing seemed impossible.

Of course, the disc has not yet vindicated itself completely. It has televised a small scene, but it has yet to show to the public what the public has long expected—a horse race or a boat race scene at home.

There is no reason why the disc should not do this, now that it has travelled so far and so swiftly along the road of impossibility.

If we accept relativity we must believe that one velocity added to another gives the original velocity as total. We must not talk about impossibilities ; it may be that our senses are not acute enough to see why a thing can happen.

There have been many occasions when science has declared impossible what has later come to pass. Werner Siemens, the inventor and scientific discoverer, and founder of the great electrical firms bearing his name, said that it was impossible to fly by machines heavier than air. And Helmholtz proved it mathematically !

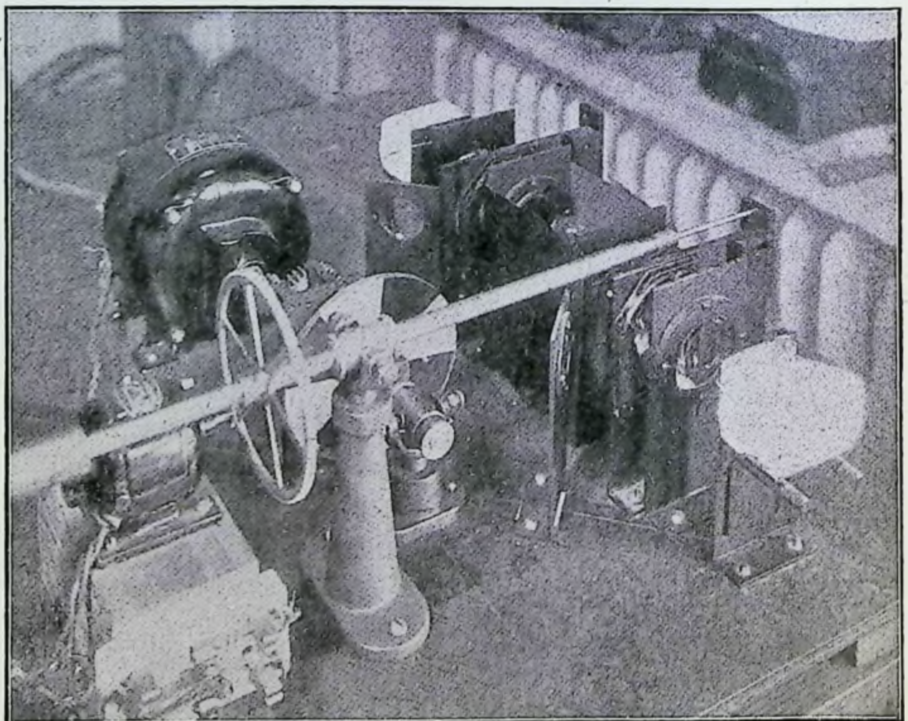
Scientific experts here laughed, and accused the Wright brothers of trying a hoax when they reported that they had flown.

Many a learned man said that the locomotive was impossible, and both Stephenson and Riggenbach were accused of craziness.

Babinet, the physicist, showed by mathematics that it was foolish to dream of a telegraphic cable between Europe and America.

Experiments of Philipp Reis, which might have led to the telephone, were nipped in the bud by the pronouncement of the famous physicist Poggendoff that the project was impossible. The "Impossible !" continued even when Graham Bell had produced his telephone.

While I know that Baird does not need these precedents to give him courage, they may bring a little meekness to those stalwarts who are still holding their hands over their eyes and crying "Impossible !"



[*Photo by courtesy of* G.E.C., *U.S.A.*

A close-up view of the recording spectro-photometer referred to on page 27.

The Story of Chemistry

Part VI

More Relationships

By W. F. F. SHEARCROFT, B.Sc., A.I.C.

HAVING introduced ourselves to the element family, the acid family, and the oxide family, we can now pass to the family of bases, which, briefly, may be considered as the opposites of the acids.

There is considerable confusion over this group, for the word *base* and the adjective *basic* are used with more than one meaning. This does not lead to misunderstanding to the chemist familiar with the substances concerned, but it certainly does do so with those less familiar.

For our purposes in these articles we will restrict the use of the word *base* to those substances which are properly called *hydroxides* of the metals. A simple example will help —sodium hydroxide is a typical base. It has the formula $NaOH$, in which we see the single atom of sodium connected up to a group of two atoms, which are frequently associated together and are called the *hydroxyl group* (OH).

Oxygen we recall has two valencies, and hydrogen one, and so we get a picture of the hydroxyl group thus: $-O-H$.

Here we see that there is one *free* valency, and therefore it is impossible for the hydroxyl group to have a separate existence. It is always found associated with something else, and when this something else is a metal then the molecule formed is a molecule of a base. In the formation of the molecule there will be one hydroxyl group for every valency possessed by the metallic atom.

Examples of other bases are given below:—

Copper hydroxide	$Cu\begin{cases}OH\\OH\end{cases}$ or $Cu(OH)_2$.
Calcium Hydroxide	$Ca\begin{cases}OH\\OH\end{cases}$ or $Ca(OH)_2$.
Potassium hydroxide	KOH
Zinc hydroxide	$Zn(OH)_2$.
Iron hydroxide	$Fe(OH)_3$.

Examining these examples we can construct a general formula thus: $M.OH$, where M stands for a metal atom. (There are some people who always write the formulæ of bases thus: $M.HO$). There is a group of atoms called the *ammonium group*, which have the formula NH_4, but have no separate existence. They are capable of acting as if they were a metal. This group joins up with an hydroxyl group to form the molecule $NH_4.OH$, called *ammonium hydroxide*, which behaves in all respects as a metallic hydroxide—that is, as a base.

THIS is the sixth of our contributor's articles on the story of chemistry, written in simple language, with the introduction only of those chemical formulæ as are essential to an understanding of the subject. Last month he dealt with chemical families. This month he continues by giving us details of further chemical relationships, and explains the mysteries of salts and how they are formed.

Having stated what bases are, we can now see how they behave. Most of them are powders which are insoluble in water, or only very slightly soluble. Slaked lime is an example, familiar to everybody. It is calcium hydroxide ($Ca(OH)_2$). When strongly heated they usually lose water and leave the oxide behind; thus, for example, when slaked lime is heated we get quick lime, which is calcium oxide.

$$Ca(OH)_2 \longrightarrow CaO + H_2O.$$

Those which are soluble in water give a solution which is *alkaline*. Such a solution has a soapy feel and turns red litmus blue, and has a caustic action on animal or vegetable tissue.

The most important property of the bases is that when mixed with an acid the process we call *neutralisation* takes place. In this action both the acid and the base lose their characteristics. This is the most important action with which we shall have to deal, and so we will try to make it very clear by a concrete example.

Let us take as our example of an acid the solution which is called hydrochloric acid. It is a colourless liquid which fumes in the air, has a very sour taste, and will corrode our skin or our clothes. It produces very bad sores on the hands, and if we drank it we should very soon die in awful agony. This substance has the formula HCl.

As our base we will select caustic soda, or, to give it its proper chemical name, sodium hydroxide ($NaOH$). This is a white solid, which deliquesces—that is, absorbs water from the atmosphere, and so must be kept in tightly stoppered bottles. It is easily soluble in water, giving a solution which has a caustic taste, is very corrosive, and turns red litmus blue. Again, if we drank the solution, we should quench for ever the best thirst imaginable.

Into some convenient vessel we will put a little of the acid solution, and add a few drops of litmus, which will colour the solution red. Now slowly, and a little at a time, we will add the solution of caustic soda, and stir the mixture well after each addition. Nothing visible occurs at first, but after a time we note that the red colour seems a little less red, and a stage will come where the colour is neither red nor blue, but a kind of in-between, port wine colour.

Now we know that the acid would

**

turn the litmus red, and the base solution would turn it blue, but in this mixture of both acid and base neither colour changes are occurring. Whatever there is present, neither acid nor base can be there. Actually if you carry out this experiment—and be careful that you have arrived at this neutral state—you can now pick up the vessel and drink the contents with safety! You will immediately recognise that you are tasting salty water.

If we go a step further and boil this final mixture, then the water will boil away and we shall get a residue which is a white crystalline powder, and can be recognised as the ordinary common salt which we use to season our food. Here is a most wonderful change, and something similar occurs when we mix any acid with any base in the quantities required for neutralisation. We may write in general that: *base+acid*⟶*salt+water*.

We must not make the mistake of supposing that any acid and base will give us common table salt. The word *salt* in chemistry is given to a class of substances, which are, in general, crystalline substances, and they can be made by this process of neutralisation of the appropriate acid with the appropriate base. Let us put this reaction into general symbols:

$M.OH + H.R \longrightarrow salt + H.OH$,

and an examination of this will indicate that the general formula for a salt is $M.R$. A salt is formed by taking the metal from a base and combining it with the acid radicle from an acid, and this gives us,

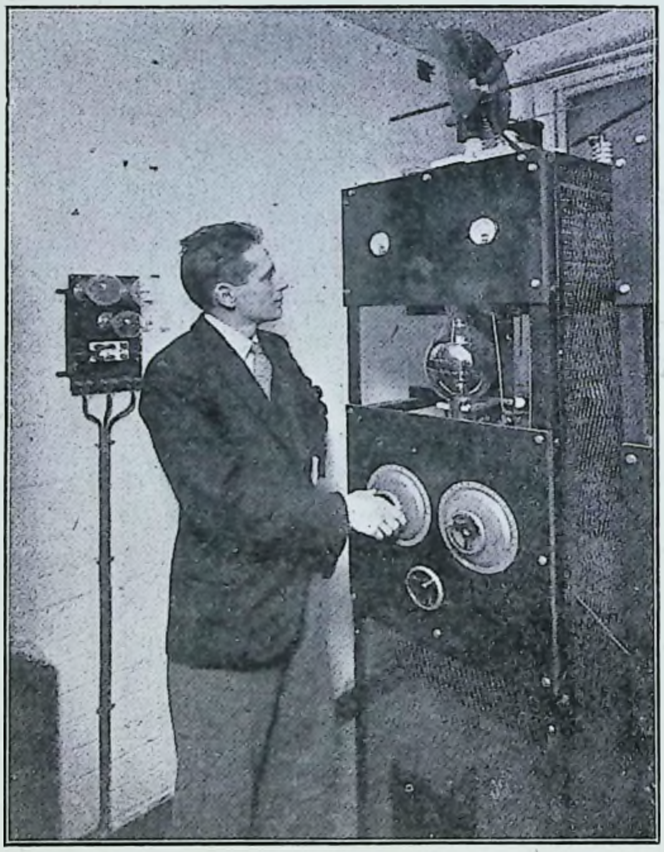
$$M.OH + H.R \longrightarrow M.R + H.OH.$$

Converting this into the particular case with which we dealt we get:

$$Na.OH + H.Cl \longrightarrow NaCl + H.OH.$$

The formula for table salt is $NaCl$, and the formal name is *sodium chloride*. All salts are named in this way. The name of the metal comes first, and the name of the acid radicle comes next. Thus *sodium sulphate* is the salt made from the metal out of sodium hydroxide, the base, and the radicle out of sulphuric acid, which is called the *sulphate radicle* (SO_4).

(Dating back almost a century there still remains the echoes of another method of naming salts in which the name of the acid radicle comes first, thus: chloride of sodium, sulphate of sodium. There is little chance of making a mistake here, but there is also a still more objectionable method used in everyday life and in commerce, such as the well-known substance which you buy from the druggist's shop as *carbonate of soda*. Now, actually, this is a salt, and its proper name is *sodium carbonate*, which tells you what it is. Fortunately these archaic expressions are dying out, and the only way to deal with them is to refer in all doubtful cases to a list of common names and their chemical equivalents.)



A hitherto unpublished photograph of the new wireless television transmitter, which is situated on the roof of the Baird Laboratories in Long Acre.

In the table below is given a list of the common acids, and the formulæ and name of their radicles. This should enable us to give a name to the formulæ of any salt which we come across.

Acid.	Formula.	Radicle.*	Salts are
Hydrochloric .	HCl	$(Cl)^-$	Chlorides.
Sulphuric . .	H_2SO_4	$(SO_4)^=$	Sulphates.
Sulphurous .	H_2SO_3	$(SO_3)^=$	Sulphites.
Nitric . . .	HNO_3	$(NO_3)^-$	Nitrates.
Nitrous . .	HNO_2	$(NO_2)^-$	Nitrites.
Carbonic . .	H_2CO_3	$(CO_3)^=$	Carbonates.
Hydrosulphuric	H_2S	$(S)^=$	Sulphides.
Phosphoric .	H_3PO_4	$(PO_4)^{\equiv}$	Phosphates.
Phosphorous .	H_3PO_3	$(PO_3)^{\equiv}$	Phosphites.
Hypochlorous .	$HClO$	$(ClO)^-$	Hypochlorites.
Acetic . . .	$H(C_2H_3O$	$(C_2H_3O)^-$	Acetates.

* The radicles are written in parentheses to suggest that they have no separate existence.

For example, what are we to make of this: $Pb(NO_3)_2$? First, we must recognise it as a salt. The formula starts off with Pb, which we find is the symbol of the metal lead. Whatever the substance is, it will be lead "something." In the rest of the formula we spot the group (NO_3). It does not matter that the formula gives two of these groups. (NO_3) we recognise as the radicle of nitric acid, the nitrate radicle, and hence the substance is the salt, lead nitrate.

Now we may ask, why are there two nitrate groups in the formula for lead nitrate? In nitric acid the nitrate radicle is attached to one hydrogen atom, thus: $H-(NO_3)$. Therefore, when the molecule is torn apart, the nitrate radicle will have one free valency with which to hook on to metal atoms. The lead atom has two valencies, and so it will require two nitrate radicles to satisfy it, which can be represented thus:

$$Pb \begin{matrix} < \end{matrix} \begin{matrix} (NO_3) \\ (NO_3) \end{matrix}$$

or in the more usual manner, $Pb(NO_3)_2$. In the table above it will be noticed that to each radicle little dashes have been added, and these represent the valency of the radicle. Knowing the valency of any metal atom, we can write correctly the formula of any salt. It must once more be stressed that these tricks, as it were, are only possible as the result of the research work that has been done in the past on the substances concerned.

You will come across salts in the pages of TELEVISION which are not included in the tables given here. This is not a text-book, but a series of semi-popular articles, and it is only possible to deal with simple things.

Light: The Essential of Television
Part VII.

By CYRIL SYLVESTER, A.M.I.E.E., A.M.I.Mech. E.

Light is one of the most important factors in connection with television, and one which must be carefully studied by all serious students of television. The principles and nature of light are by no means so widely known and understood as one would anticipate, and in this series of articles our contributor is elaborating them month by month.

IN a scene which contains objects with high reflection factors, considerable care must be taken when choosing positions for, and the intensity of, artificial lighting units.

Let us consider the case of a lighting unit of the semi-dispersive type which, by calculation, is considered suitable to illuminate an object, with the correct amount of light and shade to a certain intensity. If other bodies round this object have high reflection factors light is reflected from them on to the object at different angles to that of the unit with which it is intended to illuminate the object. The effect of this is that the shadows are not so dense, or emphasised, so that the object appears to lose shape.

An example of this can be seen in any school room where wooden objects, painted white, are used for model drawing. The light upon these objects must be directional. The objects are placed upon a blackboard laid on the floor in such a position that light from the windows is projected upon them in a definite direction. The blackboard absorbs the whole of the light incident upon it, so that no light is reflected in an upward direction. If the walls of the room are light, then a certain amount of light will be reflected from them on to the models. This light is much lower in intensity than the daylight, according to the reflection factor of the walls, but it is not sufficiently intense to destroy the shadows completely. Where two models are almost touching, at a point between them, where they are not obtaining direct light, the shape of the objects will appear to be different. I have seen an hexagon appear as a cylinder, the sides of the former appearing to be perfectly flat.

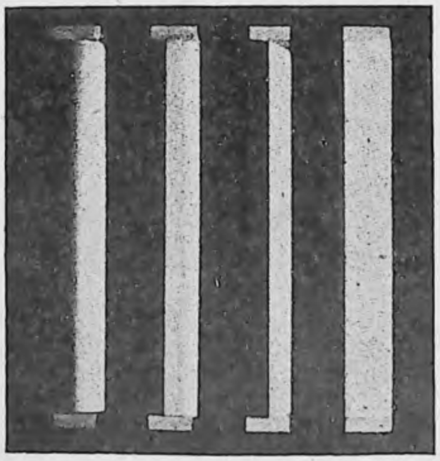


Fig. 1.

Effect on Shape.

But light, especially of an artificial character, must not be too directional, or here again the objects will appear to lose their shape. This is illustrated in Figs. 1 and 2. The photographs from which these illustrations were reproduced were taken some time ago when I was investigating the effect of various kinds of light upon objects as seen by the eye or the camera. Four objects of wood of different shapes were placed in a box which was equipped with lighting units in such a manner that light could be projected upon them from certain directions.

In Fig. 1 light of high intensity was projected upon them from a unit located at the right-bottom side of the box. The inside of the box was painted dead black. The effect is that the first object, a cylinder, is half obscured in shadow; its shape can just be seen by consideration of the top and bottom. The second object is an hexagon; it cannot be seen whether the portion on the left follows the same contour as that on the right. That is, it may be just half a hexagon from what can be seen of it.

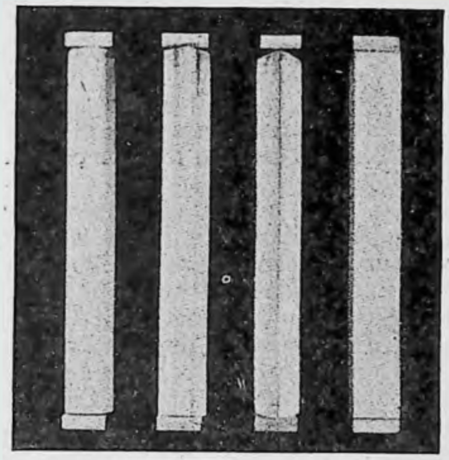


Fig. 2.

The third object is square with the corner pointer to the observer; here, again, the shape of half of it is entirely lost. The fourth object is also square, with one face towards the observer. This is, as is to be expected, flat. If the interior of the box had been painted, say, dark grey, a certain amount of light would have been reflected back on to the objects so that they would appear to have definite shape, from which it will be seen that, although direct light in this case conceals the shape of the objects diffused light assists in revealing them in their true perspective.

In Fig. 2, which illustrates the same objects, but under different conditions of illumination, the shape of the objects can readily be seen. The transference of the shadow on the cylinder from one side to the other should be noted; this was inevitable,

Fig. 3.

because a lighting unit was fitted in the box at a point opposite to that of the first one. The intensity of this unit was higher than that of the first one; if it had been lower, the intensity on the square piece of wood would have been too low for correct illumination.

Figs. 3, 4, and 5 are interesting since they illustrate the effect of various kinds and degrees of illumination upon a plaster figure. In Fig. 3 (left) the illumination is of a dispersive character; it is obtained from a number of units located round the object. One can just see that the object is a bust of a man with a beard. Faint lines indicate the positions of the nose and mouth, but on the face, in general, is expressionless. In this same illustration (right) the light is diffused, but of a directional character; it is projected from below the object, but slightly from the front. The units had a narrow angle of cut-off, this resulting in cutting the base of the bust off completely. It can be seen, however, that the face has assumed some expression; the mouth is more clear and the nose has taken shape. It is a better effort of illumination than the first one, but it is not good by any means.

Lighting from Above.

The method adopted to illuminate the object in Fig. 4 (left) has certainly had the effect of making some of the features more prominent. When this photograph was taken a number of lamps in clear bulbs were accommodated in mirror glass reflectors; they were located above, but just in front of, the object. The effect is a dense shadow below the head and hard shadows round the mouth and nose. Let us consider for a moment the effect of fitting lighting units of the same kind below the object, in an effort to eliminate the shadows.

The shadows would be less dense by fitting units of the same intensity, with light in the same direction; they would not, however, be entirely eliminated. The effect would be to reduce the density of the shadow on the chest of the bust, but slight shadows would appear on the lower part of the mouth and the upper portion of the nose. The general effect would be something like that illustrated in Fig. 3 (right) with the lines emphasised.

In Fig. 4 (right) the same lighting units were used as for the left illustration; they were located slightly above and to the left of the object. The result is a dense shadow on the right of the object which completely obliterates some of the features. The face appears altered in expression. So much so that it may be said that,

Fig. 4.

if the two illustrations were not closely compared, it may be considered that the objects are not the same. In Fig. 5 (left) the lamps were accommodated in dispersive type reflectors and their location was altered slightly; they were placed a little more to the front. The expression on the features is destroyed which, at first thought, may be considered as a step in the wrong direction. This is not so, as will be seen from the following considerations.

The shadow has been moved round the object so that more of the latter can be seen. The features on the left are not too clear; the lines need to be more emphasised. The illumination at the base of the head appears to be correct, so that it is merely a question of reducing the remaining shadow and increasing the shadow which will give tone to the lines on the face.

This effect is shown in Fig. 5 (right). The eyes can be clearly seen, the nose has shape, the features of the face are symmetrical, and there is just sufficient shadow at the bottom of the head to make the latter "stand out" from the chest of the bust. The illumination was produced by dispersive type units placed at the bottom and top of the object. The intensity of light in the downward direction was higher than that in the upward direction; hence the soft shadow on the chest. The lamps were clear ones and they were accommodated in reflectors of the concentrating type. The latter produces illumination of a directional character, although it is dispersive.

Purpose of a Reflector.

I have previously pointed out that the object of a reflector is to collect the whole of the light rays from an electric lamp and direct them in any desired direction. The effect of light projected from a reflector depends in no small measure upon its distribution. By the term distribution it is meant that a reflector fitted at a certain height above an object will illuminate objects within a certain area. If the lamp in the reflector is decreased in candle power the area illuminated will be the same (providing the lamp filament centres are the same) although the intensity will be less.

All dispersive type reflectors of the circular type produce an illuminated area in the form of a circle or disc; this is only true when the plane to be illuminated is at right angles to the direction of the beam. Let us assume, for instance, that a dispersive type unit is located above the centre of a stage. The illumination on the floor will be in the form of a circle. If, however, light is projected upon

Fig. 5.

the stage from a "front of the house" spotlight the beam will be elliptical.

This factor has to be considered in the illumination of settings. Let us assume that a number of dispersive

(*Continued on page* 22.)

Sydney A. Moseley

ON

"AT LAST!"

IT doesn't seem so long ago since I began my campaign in this journal for the broadcasting of television in this country. All I asked for—and asked repeatedly!—was a fair trial for television.

That was all.

Lately readers may have noticed the note of optimism that has crept in my articles. I had reason for it. Although I was unable to make public everything I knew, I gave as many broad hints as were possible, without breaking a pledge of secrecy to which we were all held.

Well—at last! I was not permitted to say a word about it. And now both the Postmaster-General and the President of the Board of Trade have let the cat out of the bag!

Both the B.B.C. and Bairds kept strictly to their arrangement to say nothing about the tests; but obviously questions in Parliament have to be answered straightforwardly, and the P.M.G. had no other recourse but to tell the ever-increasing number of members interested in the subject that at long last television was to be properly tested by broadcasting.

A red-letter day for all those who had faith in this big thing.

How did it all happen? For the benefit of future historians let me set down the facts.

After the Post Office engineers had witnessed a demonstration at the Baird studios in Long Acre the Postmaster-General wrote saying that he now had no objection to the use of a broadcasting station for experimental purposes, subject to suitable conditions, etc. What it all amounted to was that the Post Office engineers had O.K.'d television and that, so far as they were concerned, experimental broadcasting of television might begin right away.

Now came the snag. The existing broadcasting stations were in the hands of our friends the B.B.C., and we were referred to them for the purpose of making the necessary arrangements and terms.

IN the course of an answer to a question in the House of Commons recently, the Postmaster-General said: " . . . so far as my Department is concerned, I should be prepared to agree to the use, subject to suitable conditions, of one of the B.B.C. stations for experiments with television apparatus. . . . A further demonstration is being arranged, after which the question of using a broadcasting station for television will be reconsidered."

What happened afterwards readers well know. The technical people of Savoy Hill did not see eye to eye with the Post Office engineers. And we were left to stew! Recollect, however, that the B.B.C. added a paragraph to their communiqué (in which they stated their inability to grant the Baird Company the use of a B.B.C. station) that *they would be prepared to reconsider the matter as soon as television improved!* Apparently news soon reached Savoy Hill from many quarters that it had. There came to the Baird studios, as I told readers, many distinguished public men and women. They beheld, and saw it was good. And one and all told Sir William Mitchell Thomson about it.

I may now reveal one more little secret since it rebounds to the credit of the Postmaster-General. According to the *People, he came himself with Viscount Wolmer, his assistant, to find out the truth about television.* A friend of mine who was present at the demonstration told me that both the chief and his first lieutenant were vastly interested. Next came Mr. Ammon, M.P., for many years associated with the Post Office. He made no secret of the fact that he was agreeably surprised to find that television had advanced far more rapidly than he had imagined. He was particularly concerned lest Germany broadcast television before we did. My friend, Bob Williams, the great Trade Unionist, wrote "Marvellous" in the visitors' book after he had seen it. He did more; he wrote to Ramsay MacDonald about it, just as another eminent publicist wrote to Mr. Baldwin.

To do the B.B.C. justice, when these reports reached them, they sat up and took notice. Either television had suddenly improved or—well, it had been judged by its representatives rather within the too narrow "technical" limits.

"If the present state of television interests so many people, the fair thing to do" (they must have said) "is for us to give experimental transmissions from 2LO or from 5XX. Then if a jury of disinterested members of Parliament find it as interesting at Savoy Hill as everybody seems to have found it at the Baird studios, we can give it a trial run—and then we can tackle the technical problem, if any."

So it is that for the first time in history the *heads* of the B.B.C. and the Baird Company have come together in the friendliest possible manner.

Now that is all I have demanded. I am certain that, providing normal transmissions are assured, it will be shown that television in England has reached a commercial state. And the prospects are that after all *England will be the first country to give a regular transmission of the British system of television.* It will be a near thing, however. Both France and Germany were neck to neck in the race to be the first country to broadcast the Baird system.

Engineers have left the studio in Long Acre for Berlin as I pen these lines. They have gone to Germany at the invitation of the wireless authorities to take measurements for the installation of the first Baird television transmitters.

At the same time the French group of wireless experts were so delighted at what they saw in London that an enticing offer was made to the Baird Company for the control of television on the Continent.

Altogether, then, things are beginning to hum in earnest. Admittedly we are not entirely out of the wood yet, and I do not wish to shout prematurely. But it has been a wonderful fight to obtain and maintain the recognition and the right of the only British system of television.

It is but a few months since I approached mutual friends at Savoy Hill to try to establish unofficial liaison between the B.B.C. and Baird television. Through many vicissitudes I have at least succeeded. For an outside interpretation of what has happened I will ask you to turn to the article by "A Student of Progress," a pen name which hides the identity of an eminent independent patron of scientific development.

Memories of recent strife are still too bitter within me to permit me to go the full distance with this writer in his explanation of B.B.C. policy and attitude. Moreover, I think he should have had something to say about the determination, fortitude, and patience of my friends Baird and Hutchinson. But with these reservations I am with him all the way, and hope he will continue to help forward the task of ushering in the era of television.

Light: The Essential of Television

(*Concluded from page* 20.)

type units are fitted to illuminate a setting. The illumination may be fairly even, but it is not completely so. This is because, assuming the edges of the beams to be touching, there will be a space upon which no light is projected. This space is illuminated only by virtue of the fact that objects in the vicinity have greater or less reflection factors. With even illumination of a dispersive character the true effect of light and shade is impossible. From this it will be seen that, in addition to what may be termed general illumination, the light projected upon a setting must also be directional.

By this I am not suggesting that objects should be flooded with directional light as illustrated in Figs. 4 and 5; the necessary effect may be produced by projecting light of high intensity upon a white sheet from which it is re-directed on to the objects which it is desired to illuminate. If it is necessary to project direct light upon a setting care should be taken to ensure that none of it is reflected back on to the opposite side of the object. The way to provide against this is to fit screens, just off the stage, which have a zero reflection factor; in this way the light incident upon them is absorbed.

A SIMPLE SHADOWGRAPH TRANSMITTER

By E. V. R. MARTIN

Since we described how to make a simple televisor in our first three issues a large number of experimenters have written to us describing the results which they have obtained, and enclosing photographs of their apparatus. One of the best descriptions is that given in the following article by Mr. Martin, who very successfully demonstrated his apparatus on January 15th in the course of a lecture on television at the Midland Institute, Derby, before the Derby L.M.S. Railway Wireless Club.

THE principles involved in the construction of a machine to transmit the shadow of an object are fundamentally the same as those required for television, but there is the advantage that the method is much more easy to demonstrate, and the cost need not be so great.

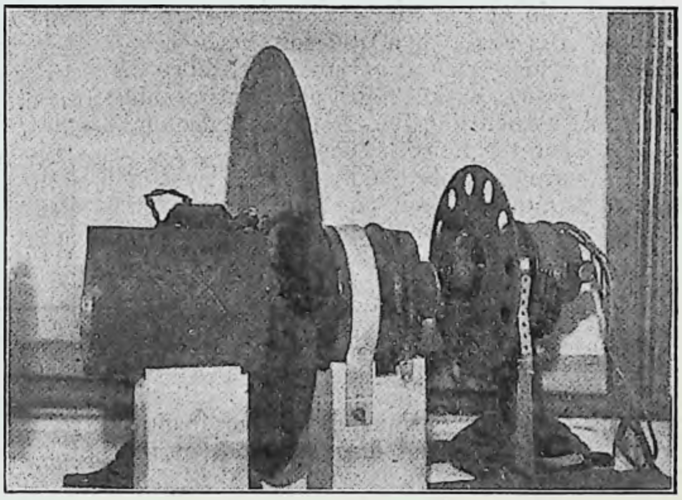
Although the available literature on the subject is only small in amount it is possible by reading the patents columns in electrical journals to get a variety of ideas for experimental work.

The apparatus described has been very successful and has well repaid the time expended upon it, although it has now been scrapped to make room for a more ambitious projector. In order to keep the details together the instrument is divided into three sections — the transmitter, the receiver, and the amplifier; these will be described in that order.

The Transmitter.

The first part of the machine to be constructed was the optical bench, and is a system of lenses and light source mounted on a long, narrow board. A narrow base is used so that the driving motors for the discs can be easily adjusted to the correct distances relative to the lenses and the selenium cell. The source of light is a 200-watt gas-filled electric lamp which is mounted in a sheet-metal shield at the extreme end of the base board in order to give ample room for focussing. There are three lenses in the system which were found to be necessary to get a good image of the lamp filament on the face of the selenium.

A $5\frac{1}{2}$-inch condenser was purchased and experiments were tried with it complete in its housing, but it was soon apparent that to get the image to stay on the cell the scanning disc must rotate between the lenses of the condenser. It was therefore cut in half and each lens mounted separately on a hollow wooden block so that they could move to and fro on the base until proper focussing was achieved.



A view of the transmitter.

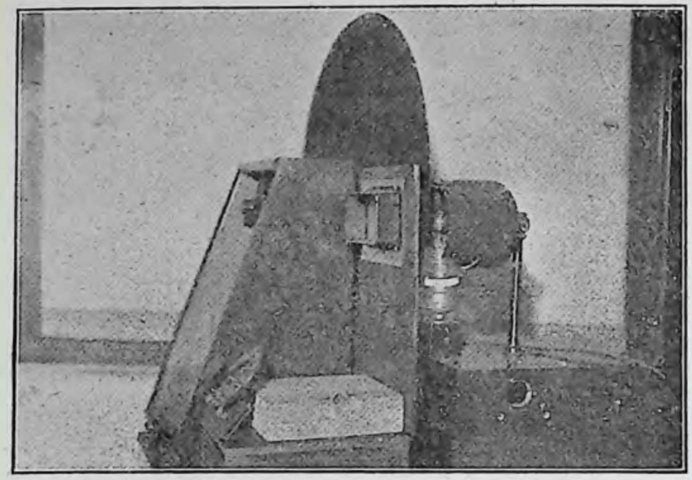
An uncoated selenium cell was fixed at the other end of the board and the lamp filament image focussed upon it. An extra lens was then mounted just in front of the selenium to further reduce the amount of picture which was outside the active area on the face of the cell. The selenium cell itself was mounted on a bracket which ran in grooves in order to get final adjustments with the scanning discs in place. The cell was also readily detachable as a duplicate had to be interchanged when one failed.

The selenium cell is probably better purchased from a reliable source. The two cells the writer had both broke down with a potential of only twenty volts. They were recoated with powdered selenium, which was stirred about the face of the cell when hot enough to melt. A lot of time was spent on coating the cells as more often than not a cell which was good one day had gone wrong the next.

Cells are best kept in the dark and in such a position that damp cannot condense on the back of the condenser plate edges. The most successful coatings were obtained by cutting off the heat when the powder melted and stirring the mass with a pointed glass rod until an even covering was obtained, the surplus was removed with the side of the rod and stirring continued till crystallisation set in. When the first crystals appear do not touch the cell again and a good crystalline film gradually covers the surface.

The Scanning Discs.

The diameter of these was decided by the motors available at the time, and was fixed at 20 inches. The size of picture was intended to be around 3 inches by 2 inches, and the holes were drilled accordingly. These are



The receiver, showing speed control rheostat in foreground.

twenty-four in number and were marked out on the sheet tin discs with a sharp point. First 24 radii are marked out at equal distances. Then ½ inch from the edge of one of these a mark is lightly made with a centre-punch. This point represents the first of the spiral of holes. On the next radius a point is marked which is ⅛ inch nearer the centre than the previous one, and so on with the remainder of the radii until all are marked.

All the points are drilled with an ⅛ inch drill and the burrs carefully removed from the holes. No attempt has been made to make the holes square or segmented. The centre hole is enlarged to take the motor spindle bushing and the whole disc is painted dead black.

The driving motor for the scanning disc is a 200-volt 50-cycle induction motor with squirrel cage rotor. Single wound field, that is; no starting winding. This motor at the zenith of its career drove a fan, but the blades having been removed the scanning disc was easily fitted to the spider which remained. A simple series resistance controlled the speed from about 100 to 2,000 revs.

At the higher speeds the whole thing vibrated badly owing to the disc being out of balance. Small balance weights were therefore bolted at a suitable position on the rim.

The Interrupter Disc.

Various experiments were tried with cardboard discs and the final arrangement was 10 inches diameter, with twelve holes each of sufficient size to expose the full face of the selenium cell. This disc was mounted on the shaft of another fan motor, a D.C. machine being used on this occasion. A series resistance controlled the speed and the motor was operated on the A.C. mains.

The whole transmitter can be assembled very simply by sliding the scanning disc in between the two condenser lenses until the rotation of the disc produces an image on the cell face which does not wander off at the commencement and finish of the scanning operation.

In order that no two holes were in action at one time a cardboard cover was made for the lens nearest the light source, which only allowed an area 3 inches by 2 inches to be illuminated.

After carefully adjusting the position of the cell the interrupter disc is placed just in front of it, so that the holes will allow proper illumination to take place.

The Receiver.

This is really a very simple piece of apparatus. It consists of a scanning disc, exactly the same as the one at the transmitter, mounted on the shaft of a 200-volt D.C. motor which has a variable resistance in series with it for accelerating and decelerating the disc when "fishing" for the image. The motor and disc are suitably mounted on a wooden framework on one side of which is fixed a support for the reproducing light source, a reflector and the receiving screen.

A G.E.C. Osglim lamp is used, mounted inside an ex-W.D. signalling lamp in such a position that a beam of light approximately parallel is produced on causing the bulb to glow. The receiving disc is placed in this beam as near as possible to the light source. At the other side of the disc the receiving screen 3 inches by 2 inches is fixed at the proper height and distance from the centre to be correctly scanned by the spiral of holes in the disc. This screen is placed as near to the disc as possible without contact on rotation. As both discs were found to be slightly buckled after the drilling operations it is not possible to get much nearer than ⅛ inch.

The Amplifier.

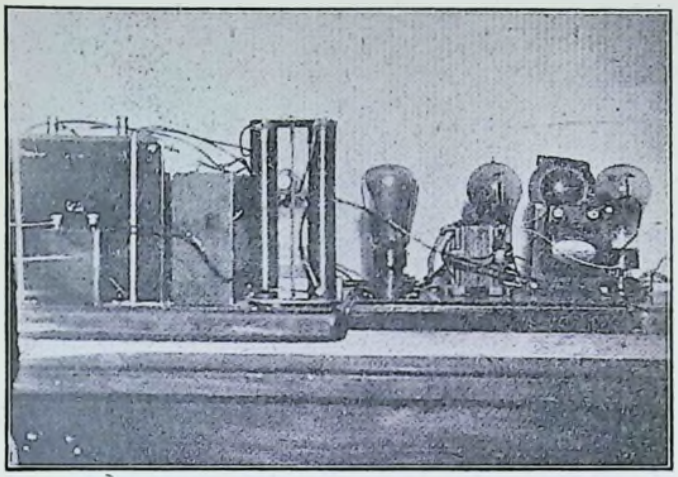
If any success is to be achieved in serious experimental work on television a really good amplifier is essential. In the writer's opinion the output stage of the amplifier should be capable of dissipating a minimum of 25 watts in order to get proper response on the weaker portions of the transmitted signal.

The equipment used is complete in itself and only requires connection to the 200-volt A.C. lighting mains.

The power-supply unit consists of a B.T.H. mains transformer delivering 1,200 volts, 150 m.a. on a centre-tapped winding, also 7½ volts centre-tapped for heating the filaments of the R.H.1 rectifying valves. Another 7½-volt winding serves to heat the filaments of the B.12 power valves. There are two previous stages both transformer coupled, the valves being two Metro-Vick A.C.G. with 4-volt separately heated filaments or cathodes. These heaters are connected in series across the B.12's.

The high pressure winding is fed to the R.H.1 valves and full wave rectified into 600 volts D.C. This is smoothed by a 6 mfd. condenser tested to 1,500 volts, together with a smaller 6 mfd. condenser and several of 2 mfds. The smoothing choke is the 100-volt magnet pot of a Rice Kellogg loud speaker, which, in addition to smoothing the supply and exciting the speaker is made to provide the necessary 100 volts or so to grid bias the B.12 valves. The connections are clearly indicated in

One of the scanning discs and driving motor.



A view of the amplifier.

the diagram, and are protected under B.T.H. Patent 294250, July 22nd, 1927 (U.S.A.).

The full circuit of the amplifier is also given. There are several methods possible of getting the energy in the last valves to light the neon lamps. The usual system of the lamp in series with the H.T. supply was not considered practicable. For one thing, the B.12's are run with 475 volts on their anodes at a current density of 30 milliamps per valve, and the biasing arrangements to persuade the lamp to go out when no signals were being received would be troublesome; again, the operator might easily receive a severe, if not fatal, shock supposing he came into contact accidentally with the neon lamp. To avoid unpopularity on this score it was decided to try a choke and condenser feed to the lamp, but the response was not sharp enough.

A special output transformer was then made up with an air gap of ⅛ inch and a ratio of one to one. This gave very much brighter signals and better response when no object was being transmitted, but was not quite good enough when the light rays reaching the selenium were further cut down by the presence of the object. This difficulty was finally disposed of by making use of the known ionising potential of the neon lamp.

If a dry H.T. battery is connected in series with the lamp and the voltage gradually increased from 70 to 150 or so a point will be found at which the lamp just commences to glow. This is in the neighbourhood of 140 volts, and further increments of voltage cause the brilliancy of the lamp to increase step by step. Care should be taken when carrying out tests of this nature as the current rapidly increases as the voltage rises and the lamp eventually flashes over. This applies only to the special lamps sold for television which have had their series ballast resistances omitted.

Good response and brilliancy were secured finally by biasing the Osglim lamp with a 99-volt dry battery in series with the secondary of the output transformer.

Instability of the Amplifier.

Most experimenters have met this difficulty which usually manifests itself as a continuous glow in the neon lamp, usually accompanied by a very high pitched whistle from the output choke or transformer.

This is easily overcome by the judicious use of lead-covered cable in places where reactions are likely to occur. The writer has persistently urged the use of lead-covered wire for amplifier connections, both internal and external. The advantages of doing so are many and various, but the work is by no means simple.

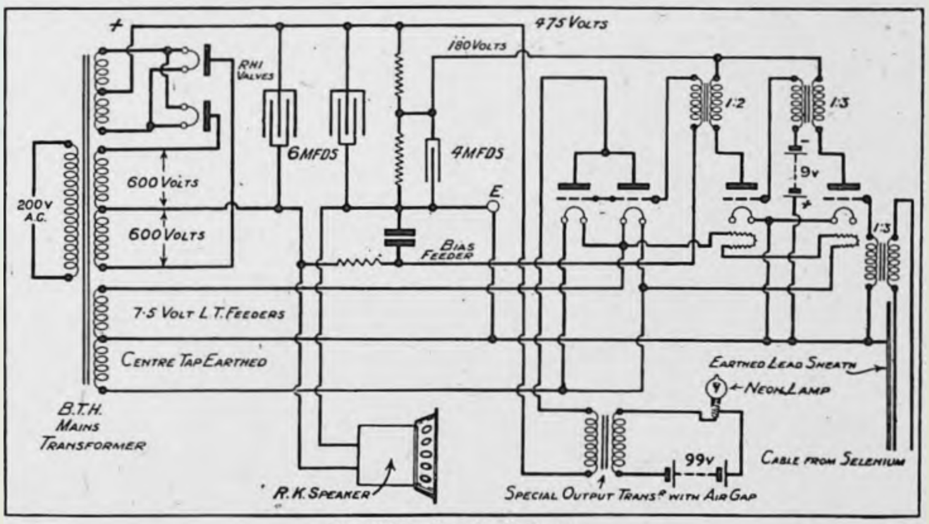
Operating the Apparatus.

The transmitter is set up with all discs properly placed and the selenium cell exposed. The scanning disc motor is started up to some 150 revs. per minute and the interrupter set going at about 800.

A pair of telephones and a 20-volt accumulator are connected in series with the selenium and the light source switched on. If all is correct a characteristic note produced by the holes in the scanning disc is heard, superimposed on which is a higher pitched note from the interrupter. The presence of these notes separately can be tested by stopping one or the other of the motors, leaving the cell aperture open. The signals heard will not be loud, and if accompanied by a fizzing or hissing noise operations should be stopped and the cell tested for silence. If the cell is silent the noise is sparking at the motor brushes, and steps should be taken to remedy it forthwith. It may be necessary to go round all the motor carcases with an earth wire, and of course see that the connections to the selenium cell are lead-covered and that the covering is properly earthed.

A twin lead covered cable is substituted for the phones if the selenium is responding properly, and the distant end is connected to the input of the amplifier.

The 200-volt supply is switched on to the amplifier and the neon lamp should begin to glow. It is probable there will be a slight flickering of fairly rapid frequency observed. If the hand or a pencil or a cardboard letter is placed in the beam of light coming through the 3 inches by 2 inches opening cut in the cardboard cover of the lens, the neon lamp will be observed to flicker in a different manner characteristic of the separate objects. If the beam of light is entirely obscured the lamp should cease to glow.



Complete circuit diagram.

Having got thus far the real entertainment begins. Assuming the receiving apparatus is correctly assembled and the neon lamp in place in its reflector, the motor driving the scanning disc may be started. The transmitter should be working without any object being placed in the frame. As the speed of the disc increases at the receiving end the single spot of orange-coloured light which is visible on the screen forms into lines and irregular patterns strongly reminiscent of the stroboscopic experiments of one's early youth! As the speed approaches synchronism with the transmitter the whole screen becomes evenly illuminated with a somewhat coarse grain. When this condition is reached an attempt may be made to send a shadow of an object or a stencil cut from card.

The stencil is placed in the 3 inches by 2 inches aperture at the transmitter and the operator at the receiver endeavours to get the receiving disc absolutely in step with that of the transmitter. At first the process is somewhat difficult, but by accelerating the disc and allowing the speed to come down slowly it is possible to use the stud switch on the resistance to keep fairly good synchronism.

By noticing the doubling up of the images and their apparent direction of motion (either progression or retrogression with respect to the direction of the disc's rotation) it soon becomes an easy matter to drop on the right speed.

Alteration of the speed of both discs to a higher rate of revolutions improves the images considerably, and if the screen is crossed by slowly moving black patches or lines an acceleration of the interrupter disc is indicated.

Without the aid of special synchronising devices extremely good shadows have been transmitted via a length of twin L.C. cable, but some simple form of synchronising motor is a great help, although this means an extra conductor for the impulse.

A projecting stud was mounted on the back of the transmitter disc which made contact once per revolution with a brass spring. At the receiving disc a horizontal armature was attached at the centre lying equally along a diameter. Facing this was mounted a laminated electro-magnet excited from a 60-volt dry battery so connected to be magnetised when the contact was made at the transmitter.

The position as regards phase between the stud on the transmitter and the armature on the receiver was carefully chosen to hold the disc in step with the picture reasonably central on the screen. This remarkably crude device was a huge success, but had to be scrapped because the mortality amongst the H.T. batteries was somewhat high, and also the impulse on breaking the field of the magnet insisted on operating the amplifier and smudged the picture in spite of several microfarads across the contact.

The photographs show the transmitter, receiver, amplifier, and the transmitter scanning disc by itself.

In the photograph of the transmitter can be seen the 6-inch diameter copper tube containing the first condenser lens, the scanning disc, and then the second lens mounted in its original housing. It should be mentioned that the two flat faces of these lenses are together.

On the same mounting is the small extra lens which further concentrates the beam from the light source on to the selenium cell. The Meccano strip bracket supports the selenium cell which is not shown. This bracket slides along grooves in a steel plate for final focusing. In front of this can be seen the edge of the interrupter disc with its circular holes. All connecting wires and motor speed controls have been omitted for the sake of clearness.

The receiver photograph shows the motor framework, gelatine screen, neon lamps, and reflector. The synchronising control resistance can be seen in the foreground.

The amplifier output stage has two valves in parallel, but only one can be seen in the photograph as they are arranged behind each other.

Death of a Broadcasting Pioneer

ONE of the most colourful careers in the world of radio was brought to an abrupt close on Thursday, January 10th, when Charles Broadwell Popenoe, Treasurer of the National Broadcasting Company, U.S.A., died in the Miami Valley Hospital, Dayton, Ohio, after a brief siege of pleurisy and lobar pneumonia.

A pioneer in broadcasting, Mr. Popenoe was the manager of WJZ, the second broadcasting station in the United States, established at Newark, N.J., in 1921, by the Westinghouse Electric and Manufacturing Company. He piloted it through the early experimental stages, and in 1923 he was appointed manager of the Broadcast Division of the Radio Corporation of America, when that organisation took over WJZ, and moved its studios into Aeolian Hall, New York. When the National Broadcasting Company was formed in 1926 he became treasurer of the company.

According to an anecdote that his friends remember, Mr. Popenoe considered it a "raw deal" when he was appointed manager of the first broadcasting station. Broadcasting was considered something of a joke when, up in a little stucco house on the roof of the Westinghouse Company's building, he started his experimental station going. But with his transmitter installed he next found that he had nothing to broadcast; phonograph records were all that he could count upon. Artists did not know what he was talking about and were openly sceptical about the whole business, especially when they discovered that there was no financial compensation for their work.

At last Mr. Popenoe induced a few singers to take a chance. But his troubles had only begun. At any moment his set was apt to break down. And always on the floor below could be heard the whirr of the motor generator. The studio was just a corner of the ladies' rest room. The piano was frankly rented. The rest of the furniture was of mysterious origin. And the audience was altogether problematical. Yet WJZ was born and Mr. Popenoe was father of the second broadcasting station in the world.

American Instrument Developments in 1928

A brief review of new apparatus, of interest to television experimenters, which has been produced in America during the past year

A TRANSMITTING valve operating on a wavelength of six metres and fifty times as powerful as preceding short-wave valves; added experiments with the cathode-ray tube, and a new recording spectrophotometer or colour analyser are among the research developments of the General Electric Company of U.S.A. during the past year.

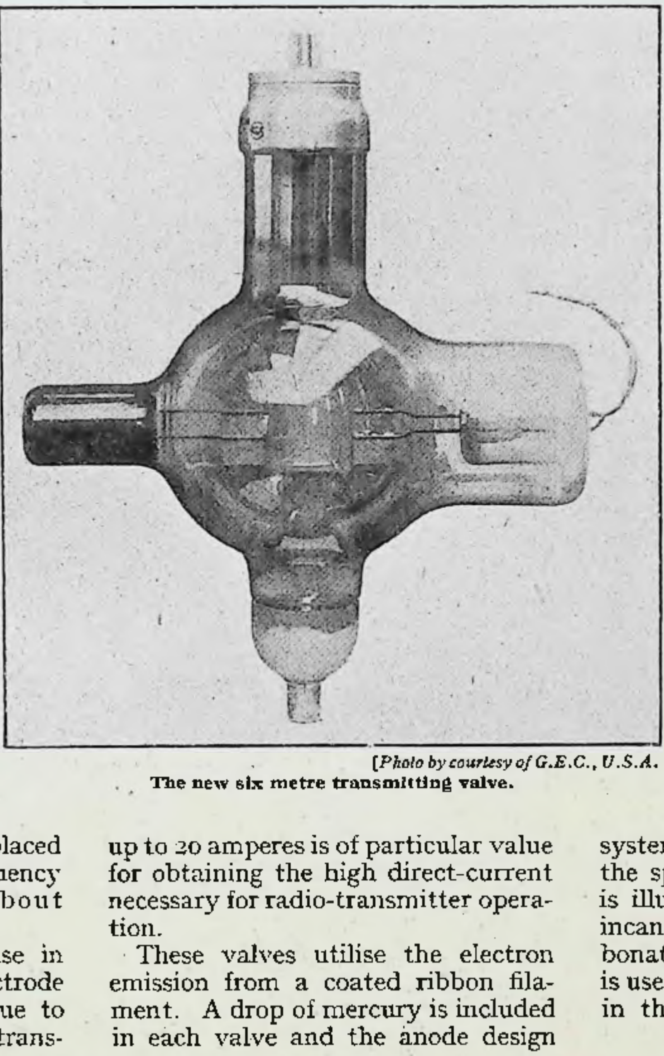
Valves.

A thermionic valve, five inches in diameter and about two feet long, was operated as a self-excited oscillator on a wavelength of six metres. It is capable of radiating from ten to fifteen kilowatts of high-frequency power — probably fifty times as much as any short-wave valve has heretofore been able to radiate. It is connected through a coupling system to a three-metre copper bar, which constitutes the tuned aerial circuit.

Several interesting physiological effects have already been noted in connexion with the new valve. Medical observations were made of several men placed near enough to the radiating antennæ to make possible measurements of changes in body temperature. It was found that the blood temperature rose to nearly 100° Fahrenheit in about 15 minutes, after which period the experiment was stopped. It was also found that a salt solution corresponding in strength to blood serum is heated most when placed very close to the high-frequency generator operating at about 50,000,000 cycles.

There was a decided increase in the use of screen-grid four-electrode valves in radio transmitters due to the fact that a large number of transmitters recently manufactured have been for short-wave operation and require certain wavelength control. Circuit stability and ease of adjustment have always been problems with short-wave transmitters in the past, and the use of the screen-grid valve prevents undesired coupling between the different parts of the circuits and thus greatly simplifies the design and operation of these transmitters.

A new form of rectifier valve for relatively high voltages and currents up to 20 amperes is of particular value for obtaining the high direct-current necessary for radio-transmitter operation.



[*Photo by courtesy of G.E.C., U.S.A.*

The new six metre transmitting valve.

These valves utilise the electron emission from a coated ribbon filament. A drop of mercury is included in each valve and the anode design is similar to that of the conventional mercury-arc rectifier. In comparison with the high-vacuum type of rectifier valve, this new mercury-vapour valve has the advantages of better regulation, better efficiency, and consequently higher output for a given size of valve.

Cathode Rays.

The cathode ray was utilised for the first time for the commercial inspection of the materials used in the production of meter jewels.

The cathode-ray oscillograph was provided with auxiliaries so that lightning itself caused the oscillograph to operate and record the magnitude, time, and frequency of the stroke. This opens up a new field in lightning investigation on power systems and makes possible the duplication of system effects in the testing of lightning arresters and other apparatus.

Colorimeter.

The exact duplication of any colour at any time and at any place has been made possible by a new colorimeter or spectro-photometer which eliminates human judgment and automatically, rapidly, and precisely measures the wavelengths of colours of any substance. Not only does it measure a colour accurately but it makes a record by which it is possible to reproduce it.

The instrument utilises a combination of an optical system and electrical devices whereby the specimen colour to be analysed is illuminated by a ribbon-filament incandescent lamp. Magnesium carbonate, the whitest substance known, is used as the standard of comparison in the laboratory instrument. The

(*Continued on page* 30.)

The Theory and Action of the Simple Magnifier

Descartes' Work on the same—Telescopes

Part VIII

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

IN a number of the preceding articles in this series, we have derived simply and fundamentally a few of the more important algebraic equations, a knowledge of which is necessary for the understanding, even in the most elementary way, of the optical action of such simple instruments as the microscope and telescope, or simpler still a pair of spectacles.

Given the position and size of an object, we are now able to find the corresponding position and size of its image as projected by typical optical systems, and we can go further and find the power and position of a single lens equivalent to a number of lenses in train. In the light of this knowledge we will consider more fully the action of such instruments as those referred to above.

Optical Aids to Vision.

Spectacles have already been dealt with. The optician in correcting the eye seeks to give it, when in the at-rest condition, a clear and well-defined picture of distant objects, and to supplement, if necessary, the accommodating power of the eye when satisfactory vision of near objects is required.

So-called normal vision for one age is not normal vision for another. A child of ten years of age can for the purpose of looking at near objects increase the converging power of its eye by as much as 14 diopters; in other words, it has a near point of 1/14 metres or 40/14, equal to 3 inches. With age the accommodating power falls off until at middle age—say, 45 years—it is not more than 4 diopters—i.e., the near point is now 40/4=10 inches away, and this is the case of normality that we will take as our standard. At 70 to 75 years of age all accommodating power has been lost.

Model Eye.

For many experiments in connection with vision, carried out on the optical bench, it is convenient to employ a model eye in the form of a tiny camera which may take the form of a short length of brass tube fitted at one end with a simple lens about one-third to half an inch in diameter, and with a focal length of two-thirds of an inch, which is the equivalent* focal length of the normal eye in air. The other end of the tube should be fitted with a small disc of ground-glass in the focal plane of the lens.

If such a model eye be directed towards a distant landscape there will be found upon the ground-glass screen images of distant objects identical in size with those projected upon the retina of the human eye when viewing the landscape in question. A more striking model can be made from a thin glass bulb (Fig. 1A) with a flat ground on one side to a depth sufficient to expose a hole abut one-third of an inch in diameter, over which the lens of two-third of an inch focus is cemented. The opposite side of the bulb is roughened to form a focussing screen. A model made up in this way will be employed in our experiments and shown in future diagrams marked "M.E.," the letters of course being a contraction for "model eye."

* The equivalent focal length of the normal human eye is more accurately 17·1 mm.

The Optical Action of a Simple Lens Magnifier.

When a page of small print is held sufficiently far away from the eye it cannot be read because the retinal image is too small. As the print is brought nearer, the retinal image increases in size until the print can be read. Brought nearer still, so long as the distance away is greater than 10 inches, the retinal image becomes still larger and still more easily read, because the eye calling upon its accommodating power maintains the retinal image in focus.

If the print be brought within

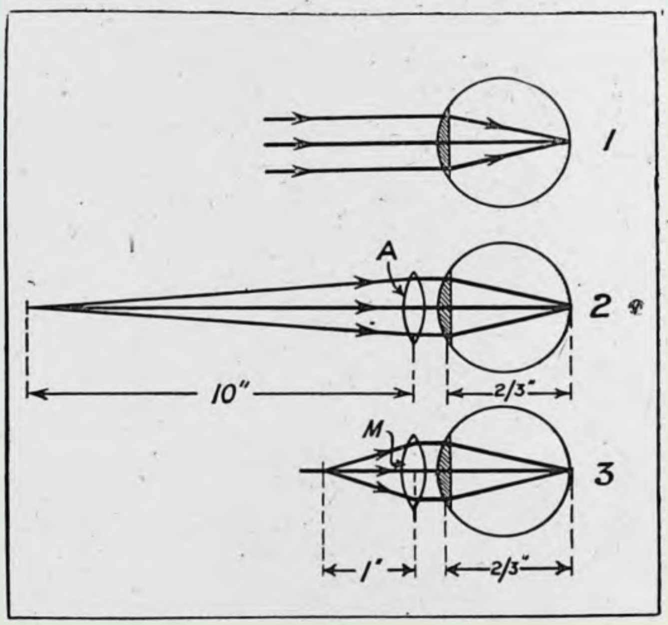


Fig. 1.
A model-eye for optical bench experiments.

10 inches—the least distance of distinct vision—the eye cannot accommodate further, so that the rays from an object-point fall upon the retina *before* being brought to a focus; confusion of the image results, and the print cannot be read, not, be it noted, because the retinal image is not large enough, but because it is not in focus.

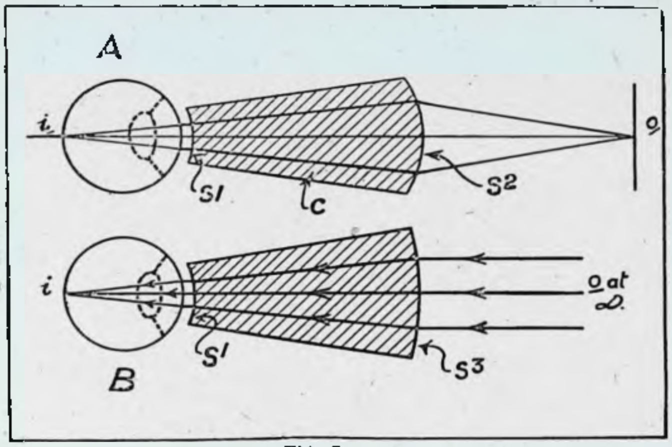


Fig. 2.
Optical Action of a Cartesian Cone.

Experiments with the Model Eye.

1. Mount the M.E. on the optical bench and observe that distant objects only, are in sharp focus on its screen or retina. Take a +4D lens (10 in. focus) and place it immediately in front of the lens of the M.E. This will now represent our normal eye fully accommodated.* Objects 10 inches away are in sharp focus, and, since the object is in the focal plane of the accommodation lens, the image must be in the focal plane of the lens representing the unaccommodated eye, so that we have in effect two lenses projecting an image of an object in the focal plane of one into the focal plane of the other.

Under these circumstances (see Fig. 3, p. 41, of the January issue of TELEVISION) the size of the retinal image is equal to that of the object multiplied by the focal length of the eye—two-thirds of an inch—and divided by that of the accommodation lens—10 inches—the retinal image is then 1/15 of the size of the object, so that it is minified.

If we now take the accommodation lens A away and replace it by a short focus lens M, we have, suitable for our optical bench experiments, a model eye unaccommodated, but fitted with a magnifier. If the lens M has a focal length of one inch, say, then the retinal image will be two-thirds of the size of the object, i.e., *ten times greater than when the object is seen at a distance of* 10 *inches with the unaided eye.* For this reason a one-inch magnifier is said to give a linear magnification of ten times.

In practice, therefore, it is not necessary to take account of the sizes of retinal images. An object is said to be seen under *unit* magnification when it is at the conventional distance of 10 inches from the eye. When, as in the use of a magnifying lens, this distance is lessened to the focal length (f) of that lens the magnification (M) is obtained by dividing 10 inches (λ) by the focal length (f)

$$M=\frac{\lambda}{f} \quad . \ . \ . \ (1)$$

A two-inch focus lens, when used as a magnifier, gives a magnification of five, whilst a powerful pocket lens of one-third of an inch focus gives one of $10/\frac{1}{3}=30$ times.

The simple magnifier, or its compound equivalent, derives its importance from the fact that it is used, not only for the direct observation of accessible objects, but also for the observation of the aerial images of inaccessible objects, as in the telescope, for example. Here an aerial image of the moon, say, is projected in air by a comparatively long-focus lens, the object-glass—and this image is observed by a short-focus magnifying lens or lenses.

We will now digress to consider for a short time a fascinating chapter in the history of our subject.

The Eye of a Giant-Cartesian Telescope.

The famous philosopher, Descartes, published his great work entitled "*Discours de la Méthode*" in the year 1637, some thirty years only after the invention of the telescope. One of the most interesting and valuable of the parts of this book bears the sub-title "*La Dioptrique.*" In this, amongst other optical matters, Descartes deals at considerable length with the eye as an optical instrument. He knew that the size of the retinal image, and, therefore, the apparent size of an object depended upon the ratio of the diameter of the eye, to the distance away of the object itself—the bigger the eye the bigger the image, and the bigger the apparent size under which an object was seen.

Starting from this fact he proceeded to invent a simple type of magnifying instrument, which is still referred to as a Cartesian telescope, and which depends for its action upon the changing of a normal eye, for the time of an observation, into the eye of a giant. Descartes then, with the object of increasing that diameter of the eye effective for optical purposes, took a hollow truncated cone of sheet metal, the outer and bigger end of which was glazed with a disc of glass shaped like a common watch-glass, with its bulge outwards.

In use the cone was completely filled with water and then the smaller end was applied to the eye in the manner of an eye-cup. In this way, as Descartes pointed out, the refraction

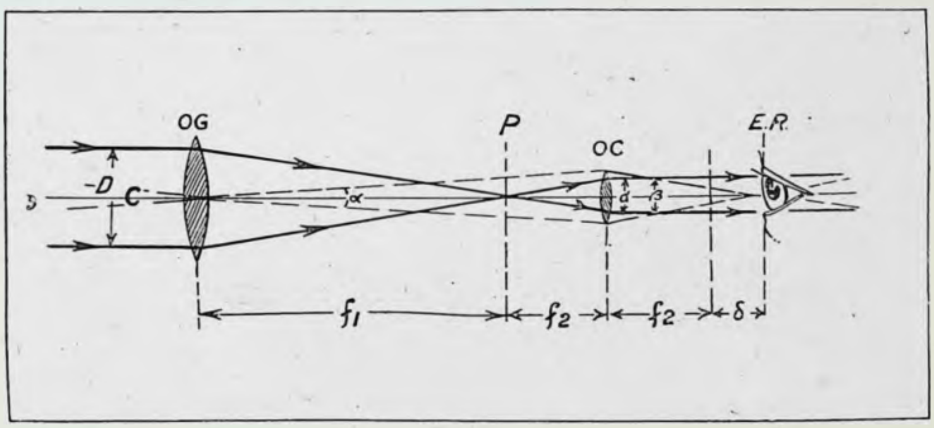


Fig. 3.
A diagram of an astronomical telescope.

* It is convenient to represent the accommodation by a separate lens in optical bench experiments. In the eye of course accommodation is effected by an increase in the curvature and therefore in the power of the crystalline lens.

which occurs when a ray passes from air into the eye is done away with and transferred to the curved window at the outer end of the tube. The diameter of the eye, effective for imaging purposes, was thus increased by the length of the cone of water. By a suitable choice of the curvature of the outer end of the cone Descartes showed that the water could be replaced by glass. This is always done in the modern form of the instrument. Similar lenses known as Steinheil *loupes* have been made for the correction of high degrees of myopia.

Fig. 2A shows a diagrammatic copy, so far as is necessary for our purpose, of a figure which occurs in "*La Dioptrique*." The smaller end of the glass cone S^1, is ground to the curvature of the cornea, but it is shown slightly separated therefrom to permit of simplification of the description of the optical action.

The curvature of the front surface is so calculated that light rays from an object point o are so refracted by it that, upon reaching the surface S^1, they are refracted out into air as a parallel bundle, in which condition they enter the eye and are brought to a focus in the image point i on the retina. In the case of a water cone, the surface S^1 is in contact with the cornea so that rays pass across the junction without refraction.

Fig. 2B shows a Cartesian cone with its front surface of such a curvature that parallel rays from a distant point are refracted at the ends of the cone in such a way that they emerge parallel to one another. In this case, therefore, the cone is a one-piece Galilean telescope or opera-glass.

Magnifying Power of a Telescope.

The magnifying power of a telescope can be derived quite easily from first principles. Suppose that we have a photographic camera with a lens of 12 inches focus throwing an image of a distant landscape on to the ground-glass screen. If we could look into the lens without obstructing the light rays, we should see the image of the landscape of the same apparent size as the landscape itself when viewed in free vision from the same spot.

Getting behind the camera and looking at it from a distance of 6 inches (we are supposing that the accommodation power of the observer is adequate) the image would be seen of twice its apparent size as seen through the objective or in free vision. Generally, the magnification would be obtained by dividing the focal-length of the photo lens by the distance at which the observer's eye is placed. If now the latter takes a 1-inch focus magnifier to look at the picture the rule still holds, and the magnification will be $12/1=12$ times.

By taking the screen away the aerial image will be seen and, without altering the magnification, we have converted our camera into a telescope. If f_1 be the focal length of a telescope object-glass and f_2 that of its eyepiece then the magnifying power is got from—

$$M=\frac{f_1}{f_2} \quad . \; . \; . \quad (2)$$

Example: The focal length of the O.G. of a prismatic binocular is 120 mm. and that of its ocular 20 mm. Its magnifying power is $120/20=6$ times.

In Fig. 3 we have a diagram of an astronomical telescope which gives, of course, an inverted image of a distant object. A pair of incident rays are drawn through the upper and lower edges of the O.G. which come to a focus in the plane P, which is also the focal plane of the ocular. After passing through the latter the two rays emerge parallel to one another and enter the eye as shown. Another pair of rays, shown in dotted lines, pass through the centre of the O.G. on to the ocular, by which they are brought to a focus in the so-called eye-ring, or Ramsden circle E.R.

From this diagram we can deduce important facts. First as to magnification. It is obvious that a small object seen under the angle α, in free-vision will be seen under the angle β, through the telescope. These angles being small,

$$\frac{\beta}{\alpha}=\frac{f_1+f_2}{f_2+\delta}$$

but from equation 4, on page 37 of the November issue of TELEVISION, $\delta f_1=f_2^2$, so that the magnifying (M) power of the telescope is—

$$M=\frac{\beta}{\alpha}=\frac{f_1}{f_2} \quad . \; . \; .$$

agreeing with the result obtained from first principles.

Again the diameter D of the incident beam is reduced to a diameter d in the emergent beam. But $D/d=f_1/f_2=M$. Thus, finally, the magnifying power of a telescope is obtained by dividing the diameter of an incident beam by the diameter of the corresponding emergent beam—an important fact made much use of by the opticians.

American Instrument, etc.

(*Concluded from page* 27.)

light from the incandescent lamp falls perpendicularly on both the specimen and the magnesium carbonate standard and, after reflection from them, enters the slit of an ordinary spectrograph system.

Immediately in front of the slit is a rotating glass disc having alternate silvered and transparent segments. The disc is so located that light from the standard enters the slip when a transparent segment is in the beam, and light from the specimen when a silvered segment is in the beam. The spectrograph system disperses the light and a second slit selects the proper wavelength band. Light passing through the second slit falls on a photo-electric cell which receives monochromatic, or single wavelength light, of pulsating intensity when the standard and specimen reflect different amounts of light in the spectral region.

This pulsating light intensity is changed to a pulsating current by the photo-electric cell, is amplified, and is then employed to run a small motor. This motor actuates a shutter in the beam between the light source and the standard, and automatically finds a position where the pulsations of the light cease. This position is independent of the characteristics of the photo-electric cell. A pen, attached to the mechanism controlling the shutter, records the reflecting power of the specimen on the rotating drum. A second motor rotates the drum and at the same time drives the slit across the spectrum, thus giving a complete colour analysis in less than a minute.

WGY, the Schenectady station of the General Electric Company, and the first station anywhere to offer television on a regular schedule, discontinued television transmissions on January 1st. However, experimenters interested in receiving television signals will continue to find them on WGY's two short-wave transmitters, W2XAF and W2XAD, operating on 31.48 metres and 19.56 metres, respectively. The present schedule calls for afternoon transmissions, Tuesday, Wednesday, and Friday, 1.30 to 2, and Sunday evening, 11.15 to 11.45, by W2XAD, and Tuesday evening, 11.30 to midnight, by W2XAF.

The Television Society

Report of the February Meeting

ONE of the best attended meetings of the Television Society was held at the Engineers' Club, Coventry Street, London, on Tuesday, February 5th, to hear Mr. Ronald R. Poole, B.Sc., lecture on "Methods of Light Modulation in Television Receivers."

In the absence of Dr. Clarence Tierney, the Chairman, who was laid up with influenza, the chair was taken by Mr. W. G. W. MITCHELL, B.Sc., Joint Hon. Secretary, who, introducing the lecturer, referred to the number of members present and mentioned that extra chairs had had to be sent for.

He had received a letter, he said, from Dr. Tierney saying how sorry he was not to be with them. He was sure they would join with him in sending Dr. Tierney their sympathy coupled with a sincere hope that he would soon be quite fit again.

The meeting was a notable one because Mr. Poole was originally assistant to Dr. Fleming and was now assistant to Professor Clinton, who had only recently taken over the Chair of Electrical Engineering, which at one time was held by their President, Professor Fleming, at University College. They would be interested to hear that Prof. Fleming, who had been abroad for health reasons, had recently returned looking very cheerful and fit, in spite of his advanced age.

It had originally been decided that the meeting should be an informal one and an exhibition of work, but when Mr. Poole had been secured to lecture the Committee had postponed the informal meeting to next month, feeling that a lecture on such a subject would be of general interest.

Personally, he was glad, for the extra month would enable them to put on a really good show. The Council felt, too, that the informal meeting would be a real opportunity for members to meet and get to know one another a little better than they had had a chance of doing at the rather formal lecture gatherings.

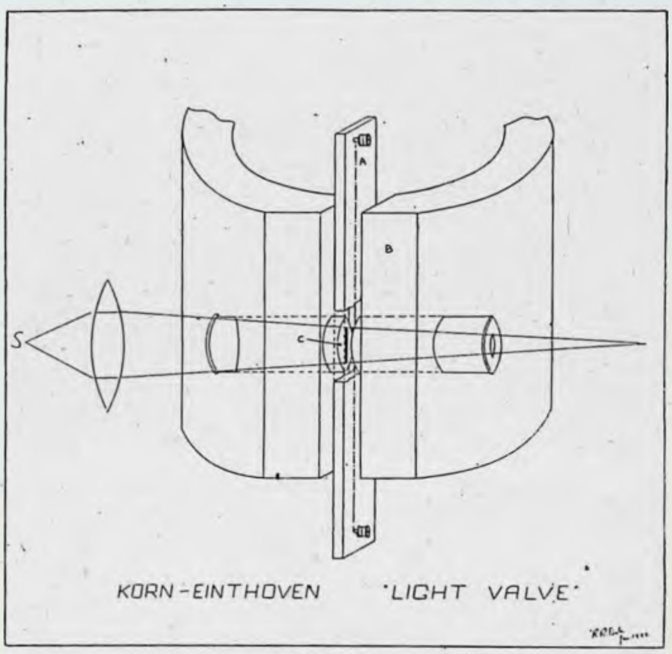


Fig. 1.

Korn Einthoven Light Valve.

This consists of a fine metal strip A, about ·05 mm. by :003 mm., stretched between the poles of a powerful electromagnet B, and connected to the receiver. Currents cause it to deflect, uncovering more or less of the strongly illuminated slit in the diaphragm C, and allowing light to pass in proportion to the received signal.

The subject of light modulation was almost the essence of television. There were few better qualified to speak on the matter than Mr. Poole, who had been experimenting for some time in that direction, and, if he might say so, had unique opportunities at his disposal for experimental work of that kind.

It gave him very much pleasure to call on him to give his lecture.

Mr. POOLE said the Chairman had referred to the subject of light modulation as being the essence of television, and he thought in many respects that was so. One might contend that the initial proceeding of converting the light into electric energy—the photo-electric cell one might say was more important because it naturally came first—but methods of doing that were known for many years before any satisfactory way was found of reconverting the electric impulses into light.

The discovery of selenium and its strange property of being sensitive to light was made about the middle of last century, and it led to a considerable revival of the long investigated and long pondered over subject of television.

One of the earliest means by which this was carried out in any practical form was to have a vast array of selenium cells arranged on a screen upon which an image of the subject was projected by means of a large lens. Each cell then responded to a small portion of the subject and the electric current produced by the amount of light falling on it was transmitted along a wire to a kind of galvanometer acting on a small shutter allowing light to pass from a lamp. The method was, of course, extremely cumbersome, but it was used recently by Rignoux and Fournier to demonstrate a principle of television—a *principle* rather than a method.

They arranged sixty-four cells in eight rows of eight each, and each was connected by wire to a small galvanometer whose needle operated a shutter. It was evident also that that system could only have a very limited application. For one thing, a separate channel had to be provided for each cell, which, of course, made it impossible to extend it to anything like the extent found in nature, where the light-sensitive cells in the eye, corresponding to the selenium cells, are connected with the brain by an enormous number of channels.

It was found then that more satisfactory results could be obtained, although the method was not available, if the image could be divided up into a number of small sections, each section transmitted one after the other with such rapidity that the whole image could be transmitted at least sixteen times a second.

This at once ruled out the prospect of using any kind of mechanical shutter, already referred to, on account of the great speed with which it would have to operate. Its inertia would preclude all possibility of its moving at the required speed.

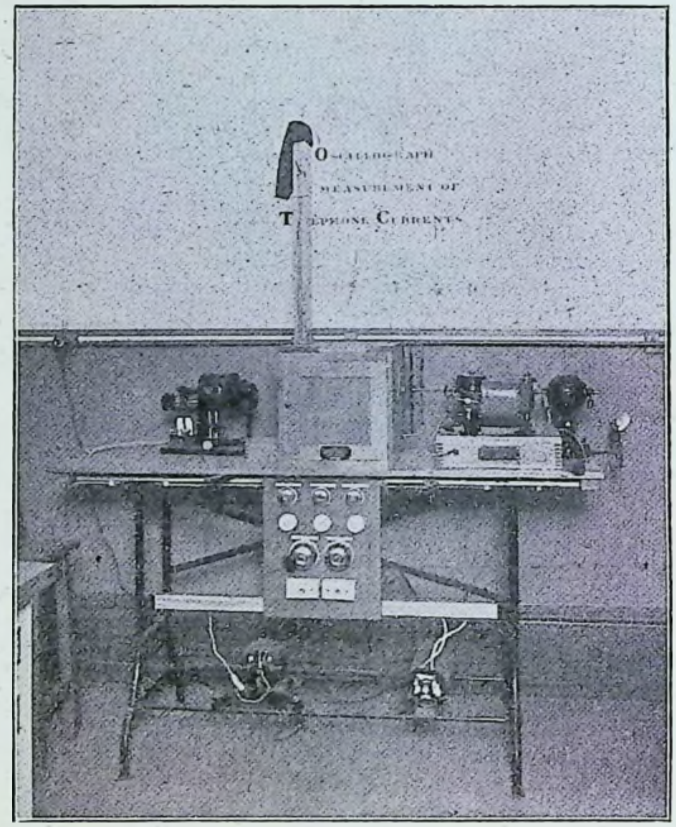
The Korn Light Valve.

About 1908 Professor Korn invented what he termed a "Light valve," employing the principles of the Einthoven galvanometer (see Fig. 1). It consisted of a fine wire suspended in a magnetic field produced by an electro-magnet of considerable depth. Through one hole of the magnet was a tunnel and in a corresponding tunnel in the other limb of the magnet was placed a kind of telescope. In it was a disc with a narrow slit cutting down the light passed. The slit was normally covered by the wire between the holes of the magnet. In this case the wire took the form of a narrow strip of material about one mil thick and four mils wide. The strip was so placed that normally all light was cut off from the slit.

On receiving a small current through the wire it was reacted on and deflected sideways, and of course uncovered more or less of the slit, and allowed light to pass through. The light was collected by a lens and brought to a focus, from which it could be reconverted into an image in the usual way by some kind of oscillating mirror or by a rotating wheel, as in the Baird system.

At the time it was used only for telephotographic purposes and found very satisfactory because the drum carrying the film was rotated slowly with a spiral motion and the concentrated point of light, of course, printed on a sensitive film permitting more or less light to pass according to the signal received. This also had been tried more recently for television purposes, but it had certain disadvantages, one of them being that the amount of light obtainable through the slit was very small.

It must also be remembered that in any form of television the average intensity of illumination on the screen is equal to the amount which can be got by distributing the point of light which traverses the screen over the whole screen. This was one of the objections to building up an image by the light-spot method. In telephotography the objection did not hold because the reproducing mechanism was worked very much more slowly, and of course the slower it ran the greater the effect of the light on the sensitive film. The average time taken to print off a picture measuring about 6 inches square with the method was about 15 to 20 minutes. As all that in television had to be done within one-sixteenth of a second such a method was ruled out.



A Duddell oscillograph, as installed in the new department, now known as the Communications Department, University College, London.

Szczepanik and Mihaly.

Light valves seemed for some time to be the only possible way to get at the problem of reconverting the electricity into light. Various methods were tried. In 1908 Szczepanik used the system in a modified form and later Mihaly in Austria also made use of it (see Fig. 2).

In his system the image of a slit in a screen situated in a beam of light was directed on to a small mirror in a Duddell oscillograph. Two fine wires situated in an intense electric field had a small mirror cemented to their centres. Current was led up one wire and down the other, and their combined movement caused the mirror to oscillate.

If the image of the slit was projected on to a triangular slit any movement of the mirror caused more or less light to pass through the triangle. The lecturer showed a rough demonstration model of this apparatus, the light point reflected from the mirror, which was mounted on strings, being thrown through the triangular slit on to a ground glass screen.

Continuing, Mr. Poole pointed out that if in place of the ground glass screen there was a lens to further concentrate the beam of light on to a mirror or revolving disc or other reconstructing mechanism, it would be possible to reproduce the original picture.

This scheme suffered from the same defect as Korn's apparatus, i.e., if the mirror was to be small enough to vibrate fast enough it was going to be too small to reflect much light.

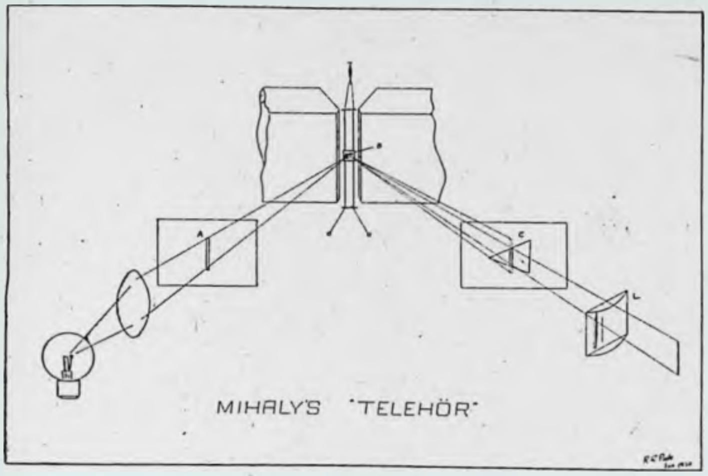


Fig. 2.
Mihaly's Telehör.
The image of a strongly illuminated slit A is focussed on the vibrator mirror B of an oscillograph of the Duddell type. The reflected beam traverses a triangular opening in a screen C and is conveyed to a line of varying length at D by a cylindrical lens L. The amount of light passing the screen will be proportional to the deflection of the beam and hence to the current.

The system was, however, useful in telephotographic work, where speed of operation was not of first importance.

This objection, too, was fundamental in all mechanical reproducers of that kind, for the mirror could not be made to go fast enough if it was of any useful size.

The defect led to much investigation on other lines, but at that time the thermionic valve had not been invented—it did not make its appearance until about ten years after these inventions were tried, being invented about 1912, and it was not until about 1915 that it had developed sufficiently to be of use in television work.

Cathode Ray Oscillograph.

Other lines of research led to the cathode ray oscillograph, which had attained a certain degree of perfection.

The illustration thrown on the screen (see Fig. 3) was of a hot cathode type of tube. At one end was a screen of glass covered with some active material such as calcium tungstate or platinum sulphocyanide, each of which emitted a glow when impinged upon by the rapidly-moving stream of electrons.

The filament of the tube was platinum, usually coated with lime, which emitted a generous stream of electrons. The tubular plate had about 500 volts applied to it and imparted to the stream of electrons a high velocity, so much so that they were carried past it and impinged on a small glass diaphragm placed in the middle of the tube. In the centre of the diaphragm was a small hole roughly of the same area as the stream of electrons. Those which passed through travelled along the core of a solenoid which was used to concentrate the beam of electrons and imparted a rotary motion to it. Normally they tended to spread by reason of their mutual repulsion. The solenoid, by concentrating the beam, gave a cleaner, sharper spot of light on the screen.

A form of modulation of the beam

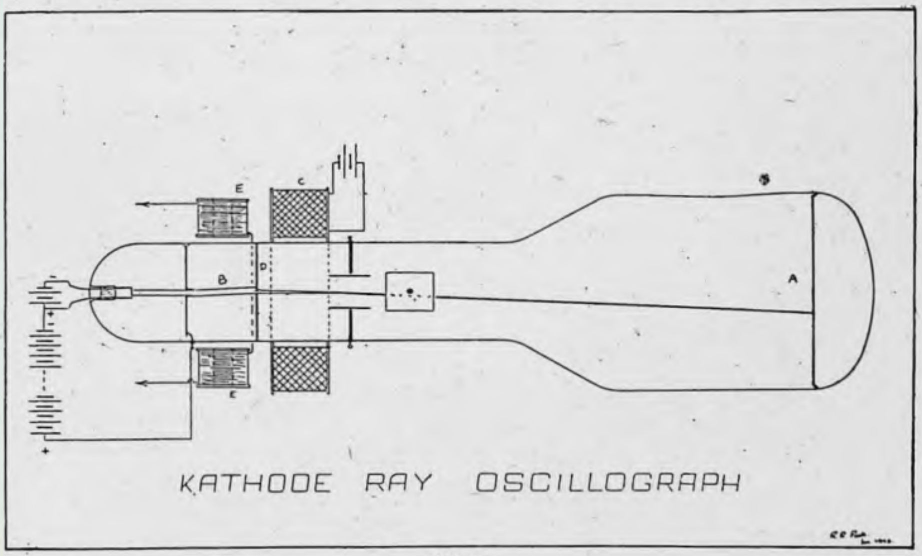


Fig. 3.
The Kathode Ray Oscillograph.
In this the electron beam B is deflected by a field from small electromagnets E connected to the receiver. The beam has to pass through a hole in the glass diaphragm D and the amount passing varies inversely with the deflection and hence with the received signal. The beam is focussed on the fluorescent screen A by means of a solenoid, C, and may be made to traverse this screen by means of deflector plates or electro-magnets, so as to reconstruct the picture.

could be got by electrical means. The simplest way to do it was by a magnet so arranged as to give a field across the tube.

This diverted it so that only a portion passed through the hole in the diaphragm.

The tube possessed certain great advantages which were first pointed out by Campbell-Swinton about 1908. If one could give the beam two motions at right angles to each other a suitable way of reconstructing a television image would be available.

Small Field Required.

The simplest way to do this was to pass the stream between a parallel pair of aluminium plates. A potential applied to them drew the beam towards the positive plate while the negative plate repelled it. Two pairs of plates placed at right angles to one another provided the necessary means to give the beam a dual motion. The field required to divert the stream was very small, in fact so small that it could almost be provided from the first stage of amplification of a wireless receiving set. That was a further advantage because one of the great disadvantages in television was the enormous amplification of the signal which was necessary.

However, the whole arrangement was not very satisfactory. For one thing, the tubes were extremely expensive and had a short life. One tube on the market had a life of about 100 hours running and cost £30.

A cathode-ray tube was demonstrated by Mr. Poole, who explained that it was of a type known as the "cold cathode." It had a nickel reflector from which electrons were torn off by very high voltages, the present tube requiring about 2,000 volts for that purpose.

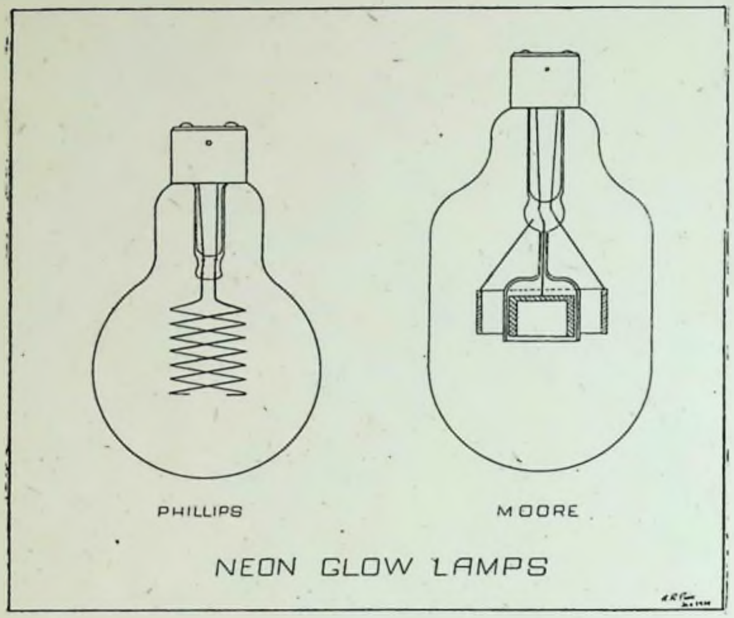


Fig. 4.
Moore's lamp and Phillips's 100-volt neon lamp.

The cold cathode tubes had been known for many years and were very useful in work where the ordinary Duddell oscillograph was unsuitable. One of their great advantages was that the electron beam had no inertia and could be quite easily deflected by an electrostatic field or a magnetic field.

The deflection of the electron stream was demonstrated by the use of an ordinary permanent bar magnet which, even when held a considerable distance from the tube, deflected the beam.

Neon Tubes.

After the oscillograph method came more modern developments which involved the use of neon or other gas-discharge tubes. These tubes owed their development to Mr. Baird, who had done more towards their improvement than most people.

One of the earliest types of neon lamp used was a long tube bent backwards and forwards on itself and supplied about every inch along its length with separate pairs of electrodes. These corresponded to the large number of shutters which were employed in earlier attempts at television, but, unlike them, only one channel of communication was required, each pair of electrodes being fed separately through a commutator running synchronously with the scanning mechanism, so that the various parts of the neon tube were switched in one after another, the whole traversal of the screen being made about sixteen times a second.

A lantern slide of such a neon tube was shown, the lecturer explaining that the tube made up a screen about four feet square. One of the electrodes was in the form of a continuous spiral throughout the length of the tube, while the other took the form of small bands arranged at intervals of an inch along the tube, or small electrodes sealed in the glass wall about an inch apart. A slide showing the detail construction of the tube was shown, together with an illustration of the commutator arrangement, and Mr. Poole then explained that this was the only way to secure a large television image because the light obtainable from a single neon tube was quite small and not sufficient to illuminate a large screen. They would notice that on many of the Baird receivers the screen was quite small, but was viewed through a lens to give a larger picture.

With a screen measuring 4 feet by 4 feet about 500 watts was the least that could be used if one was to have any definition.

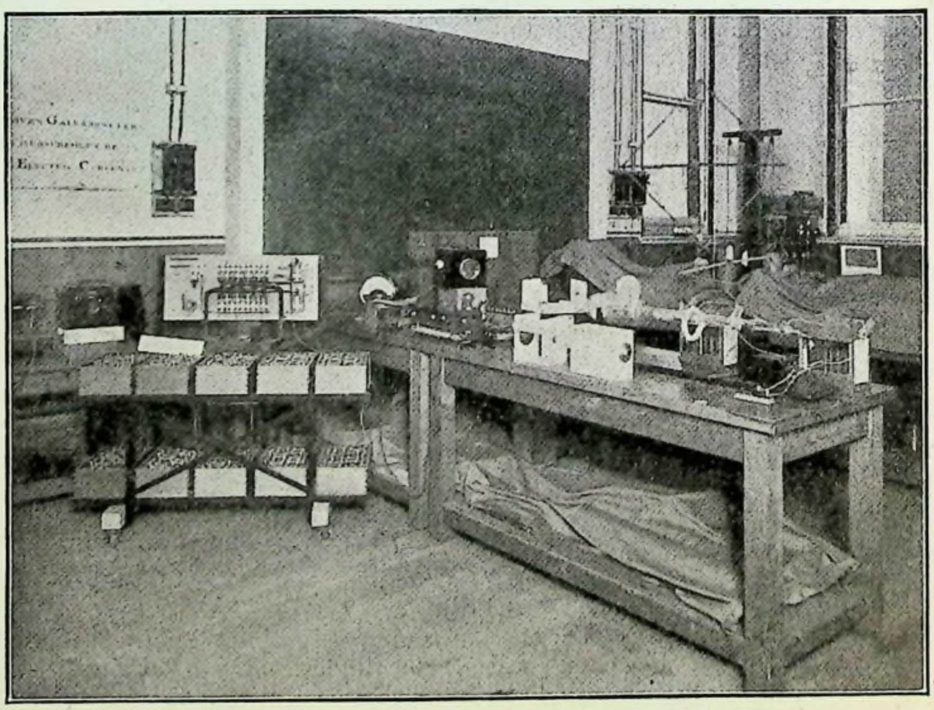
A single neon tube used about three or four watts, which was, of course, quite insufficient for a large screen.

Limit of Illumination.

With the large tube illustrated the illumination could be pushed up to a considerable extent, but it did not seem likely that such a method would be very generally used on account of its complication, although it had its uses in large-scale work.

A somewhat similar device was suggested many years before Mr. Baird started, only using electric light globes instead of the continuous neon, very much on the lines of the present-day electric signs. The time-lag of the electric light globe rendered it quite impracticable for any purpose of that nature.

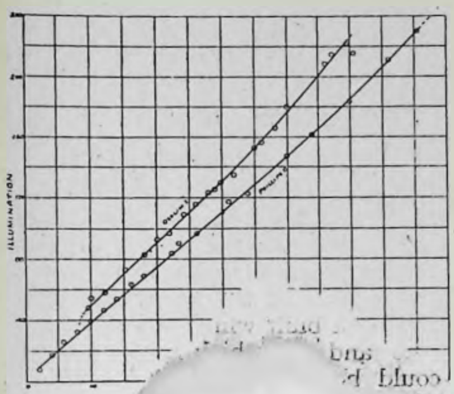
On the other hand, gas-discharge lamps of the neon type had an absolutely negligible time factor, a



A view of the apparatus used by Mr. Poole for demonstration purposes (on table in foreground).

characteristic which made them very suitable for television work.

Mr. Poole then illustrated the



Graph o...
Lum...
lamp...

a fairly good reproduction of white light. Alternately three separate channels could be used. Mr. Baird had already produced an instrument working on the three-colour system, which reproduced the image in its natural colours.

That was a matter very far in advance of the foreign inventors and showed signs of being a very important development.

The Moore Tube.

Another lamp developed by Moore in America (Fig. 4) worked on the principle of the cathode discharge, and consisted of a cathode in the centre, having a hollow in it. It was ...rounded by a glass bell which ... the outside of the cathode, ... the hollow exposed. ... placed a ring- ... his type of

was measured by an Osglim lamp placed at a standard distance from the photometer.

A disadvantage of neon was that the light slowly altered with the current passed through and at the higher voltages tended to become somewhat pinky. It would be seen that the lines on the graph were nearly straight, showing that the illumination varied almost directly with the current.

A number of lamps were tried and nearly all gave the same light for current curve, although the results varied considerably. Possibly this was due to the fact that the production of reasonably fine neon was an expensive process. Consequently, commercial lamps were filled with very impure gas and different batches of lamps showed slightly different characteristics.

Neon Characteristics.

Any given lamp, however, showed ...y little variation in the results it ... over a fair period.

... xt graph showr ... against ...

plate circuit of a valve, say of the L.S.5 type, this effect was accentuated and the lamp often remained alight when extreme values of grid bias were applied.

Such a characteristic was not desirable if the neon was required to follow faithfully in light the voltages applied to it, for it meant that if one was using it to reconstruct a television picture one would have too much light during the transmission of the shadows in the original.

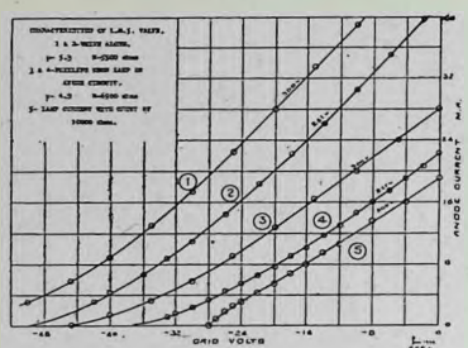


Fig. 8.
Characteristics of valve with lamp in anode circu

experiments were
ound that

of the prisms. If, however, when the prisms were in the extinction position a powerful magnetic field was applied in the direction of the beam of light it had the same effect as rotating, more or less, one of the prisms. In air this field had to be very intense, but in carbon disulphide quite a weak field had the same effect.

A model of this apparatus was shown by Mr. Poole, who explained that as he could find no suitable tank to contain the carbon disulphide, and as that chemical had a most unpleasant smell he had decided to omit that part of the apparatus.

Instead he rotated one of the prisms by hand and showed how the light passed, varied from absolute darkness to its full value over 90 degrees of rotation.

Little work had been d
system of modulati
it offered a
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M

inspiration to those of them who had not taken up that branch of television. He had touched on such a number of points that were of particular interest that he was sure they were anxious to ask questions, which he was equally sure Mr. Poole would do his best to answer.

Many Questions.

Replying to many questions, Mr. Poole said the failure of the cathode ray tube after 100 hours or so of running was due entirely to the loss of emission of the filament. Tubes had been built which were demountable and new filaments could meant that
ube had to
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after the discharge had passed. That was sufficient to maintain the temperature of the gas and keep its impedance low enough to allow the current to pass.

With regard to the cathode-ray tube there was no secondary emission from the rays striking the screen. If there were the rays would be moving quite slowly, and it must be remembered that the screen itself was not charged at all and was non-conducting —therefore there was no particular reason why the screen should glow.

As to getting the cathode ray outside the tube they must not forget that glass was opaque to it, and when the rays struck the diaphragm inside the tube they were lost to the eye. At the same time he believed tubes had been manufactured with a screen which was transparent to the rays and they had been projected beyond the tube.

This concluded the questions, and then Mr. MITCHELL (who had not caught his train) announced that he had been stopped by a member, and as a result of the talk they had had, he thought he could promise them that there would be a cathode-ray tube on view at their exhibition next month.

Cathode Ray Tube to be Exhibited.

This member had done some work with the tube, and it was claimed that not only could results be obtained with it, but colour screens could be interposed and colour work done. There was a need for a good deal of work to be done on the actual screens themselves.

The cathode ray was a most fascinating way of getting light modulation, for there was no inertia to consider when dealing with a beam of electrons.

With regard to their exhibition, now postponed to next month, many members had promised to bring apparatus along " if it worked." But that was not what was wanted. They wanted them to bring apparatus along even if it did not work. Other members might perhaps be able to suggest methods of making it work, and in any case they could discuss it and perhaps find out why it failed to operate.

Also the secretaries were anxious to know what space members required and whether they wanted a current supply of 5,000 volts or 200, which was the standard there.

Historic Exhibits.

They would also be interested to know that Mr. Lloyd Atkinson, a past-President of the Institute of Electrical Engineers, had promised to bring his earlier historic apparatus, which dated back 200 years, along to the Exhibition.

Mr. POOLE, briefly replying to the vote of thanks accorded to him for his lecture, said he would be glad at any time to undertake investigation and measurement work for members in connection with any difficulties they might meet.

Society Notes.

When the history of the Television Society comes to be written, as no doubt one day it will (for surely most societies allow themselves a little licence in such matters on the occasion, at least, of the centenary of their coming into existence !), we hope to find the February meeting marked down with honourable mention. For, in the first place, the lecturer was right; young, and full of enthusiasm for his subject, speaking carefully (and we would add in parenthesis, *audibly*), critically weighing and analysing each of the methods of re-forming the image at the receiving end. This lecture was just the kind we like to have. So crammed full was it of sound reasoning and impartial judgment on the various methods which the lecturer discussed, that it was in itself sufficient to start a veritable volley of questions. And this is just how the lecture was rounded off.

The audience was right, too; numerically in excess of any previous meeting since the opening meeting of the 1928 session, when Mr. Baird occupied the platform, and a tribute to the excellent " staff work " which we happen to know has been going on at Headquarters recently.

But when the proceedings opened the genial presence of our chairman was missed. Dr. Tierney had a few days previously been lecturing in Glasgow and had managed to contract a nasty chill, from which we are happy to add he has now almost recovered, but which was sufficiently severe to keep him away from the meeting on February 5th. The chair was occupied by one of our secretaries, whose name now appears at the foot of those lecture notices which summon us each month to the Engineers' Club.

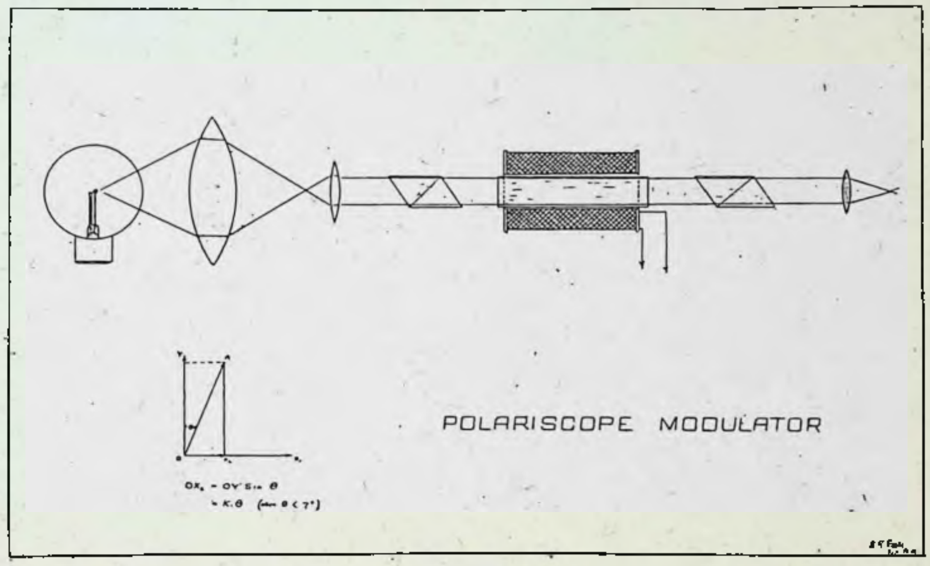


Fig. 10.

Polariscope Modulator.

Intense beam of parallel light is polarised by first Nicol prism in the direction OY on vector diagram. The second Nicol is set with its principal plane in the direction OX, so no light passes until the plane of polarisation is rotated by passing through the magnetic field in the tube of CS_2.

The Annual Meeting and Exhibition.

So much for the past; we now turn to the future. The annual meeting and exhibition takes place on Tuesday, March 5th, and promises to be a much more important occasion than we had anticipated. We are told at Headquarters that offers of apparatus are coming in well, and that members are responding to the invitation to help themselves by returning the " Buff Form." Over

(*Continued overleaf, col.* 3.)

The First Television Subject

By W. TAYNTON

W. TAYNTON.
The first face ever seen by Television.

In the following article Mr. Taynton, who was the first man in the history of the world to be televised, describes in his own words this epoch-making event.

I REMEMBER very clearly how one afternoon while I was working in Mr. Cross's office in Frith Street, Mr. Baird, who had his laboratory above us, came running downstairs in a very excited condition, and almost pushed me in front of him into the laboratory and got me to sit in front of his projection lamps. These were enormous electric bulbs, and gave out a tremendous amount of heat. Behind the lamps there was a whirling disc, and behind that again a quantity of wireless apparatus.

After I had sat down Mr. Baird went into the next room where the receiving machine was, and left me in front of the lights. Without realising that I was spoiling the experiment, I moved back a little way to avoid the glare and heat. After about five minutes Mr. Baird returned, and the moment he saw me he said: "Ah! Why did you go back?—that explains it—you must keep exactly where I put you."

Knowing what was required, I did not move this time, and held on as long as I could. I was just beginning to feel I could not keep still any longer, when I heard a shout from the next room, "Open your mouth." I did this, and was then told to turn sideways, and this was followed by Mr. Baird's sudden return to the transmitter, saying: "William, I saw you; would you like to see what television looks like?"

Mr. Baird seemed very excited, and took me through into the other room, where I looked through a little square opening at the face of a revolving plate. The square seemed covered with a reddish light.

A minute or two later Mr. Baird went into the other room, and on a little screen his face immediately appeared. It was not very clear, but by looking closely I could see his eyes and I could see his mouth open and close, and recognise that it was Mr. Baird himself.

Although I did not realise it at the time, I was the first man in the world whose face had been transmitted by television, and the second man to have seen a televised human face.

I must say I did not then realise the marvel I was witnessing, but thought it had a very long way to go before it could compete with the cinematograph.

It was while I was with Messrs. Will Day, Ltd., of Lisle Street, Leicester Square, that I was kindly invited by Lord Angus Kennedy to see a demonstration at the Olympia Radio Exhibition in September last. On my arrival I was shown to the compartment where the demonstration was being held, and I can only say that I was not prepared for the wonderful improvement.

Things have moved rapidly since that memorable autumn day in 1925, and now television is talked about wherever one goes. But in those days nobody had heard of it, and Mr. Baird, whose name is now so well known, then worked alone in complete obscurity in a little two-roomed laboratory in the back streets of Soho.

The Television Society.

(*Concluded from page 37.*)

eighty of these questionnaires have already got back to Belgrave Road.

Apart from what our members are doing in connection with the Exhibition, two or three firms have promised to show pieces of apparatus of special interest, and other friends of the Society are helping in various ways. We might mention among the latter that Mr. Lloyd B. Atkinson, past-President of the Institute of Electrical Engineers, is showing some early historical "relics" with which he experimented on television over twenty years ago. Mr. Atkinson is explaining the working of the different parts, which will afford added interest to this exhibit.

The Exhibition, which opens at 7.30 p.m. on the evening of March 5th, will be preceded at 6 p.m. by a business meeting, to which only those who are fully elected members of the Society are entitled to be present and to vote.

It is hoped that members will always wear their badges at meetings of the Society; these may be obtained from Headquarters, price 1s. each.

We have just learned that our President, Dr. Fleming, has now returned from a ten weeks' tour in Egypt, looking very fit and well.

Official Notices.

The next meeting of the Society will take place at the Engineers Club, Coventry Street, London, W.1, on Tuesday, March 5th.

The Annual General Meeting will be held at 6 p.m. It is hoped that all members of the Society who are entitled to vote will be present at this business meeting, which is convened to receive the report of the Council and to proceed with the election of officers.

An exhibition of apparatus will take place in the same building and will be opened to members and their friends (on invitations to be obtained from the Secretaries at 95, Belgrave Road, Westminster, S.W.1) at 7.30 p.m. The meeting will be of an informal character, but it is important that the Secretaries should be informed of the members attending the Exhibition. Coffee and light refreshments will be served.

J. J. DENTON,
W. G. W. MITCHELL,
Joint Hon. Secretaries.

LUMINESCENCE

By H. WOLFSON

In the following article our contributor deals in detail with the various forms of radiation which manifest themselves visibly in the form of light which is not associated with heat.

MANY of the facts which we have learned from a study of photo-electric phenomena have a close bearing on the ideas connected with the subject of luminescence.

Under the general heading of luminescence, which was suggested in the first instance by Wiedemann, we include all those cases where light is emitted in the absence of heat. It is convenient to subdivide the subject into five groups, viz. :—

1. *Tribo-luminescence*, by which we mean the emission of light due to friction or crushing, such as is observed by rubbing together crystals of sugar, quartz, etc.

2. *Cryo-luminescence.* Here the light is emitted during the crystallisation of certain salts from solution.

3. *Chemi-luminescence.* This refers to light generated by chemical action.

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

5. *Photo-luminescence.* This group which includes fluorescence and phosphorescence, deals with the emission of light under the action of light, and will be considered in detail in this article.

Displacement of Electrons.

It is important that we should realise at the outset that the removal or displacement of electrons from the luminescent substance must be a very large factor in the process which takes place when light is emitted. In all the five groups we can see clear evidence on this point; thus Group 1 would seem to point to the existence of frictional electricity in a system such as described, while the displacement of one or more valency electrons, such as would occur in chemical changes which involved the breaking of a "bond," leads us to similar conclusions. Further strong support is given by a consideration of the phenomena in Group 4, where it becomes evident at once that the fluorescence of the glass of cathode ray tubes, and the apparent incandescence of certain crystals when subjected to cathode rays* can only be explained on the assumption that electrons are displaced from the atoms of the glass or crystals.

Confining our attention more closely to the last group, it will be convenient to mention now the difference between the two types of photo-luminescence. By fluorescence we imply the emission of light which commences and ceases with the stimulus, whereas luminescence which continues after the stimulus (light) has ceased, is termed phosphorescence. This latter type of luminescence is shown only by luminescent *solids*, while liquids and vapours which fluoresce never continue to emit light after the stimulus has been withdrawn.

As early as 1845 Herschel noticed the blue colour which is shown by solutions of quinine sulphate, and in the following year Brewster recorded his observation of the blood-red colour which he noticed when a beam of light was passed through a solution of green chlorophyll in alcohol.

The general name of fluorescence was first applied by Stokes, who seems to have been the first to realise the importance and interest of a detailed and careful experimental study of the subject.

The method employed by Stokes consisted of examining the substance in different parts of the spectrum. With quinine sulphate and other similar solutions, he found evidence of the activity of ultra-violet rays in producing fluorescence. By a series of investigations on the degree of refraction of the emitted light as compared with that which was incident upon the solution, he suggested a law, which has since been modified so as to be perfectly general. Nichols and Merritt, whose work deserves special mention, state Stokes' law in the following words: "Luminescence is due to an absorption band. The absorption band and the luminescence spectrum overlap, and all waves included in the absorption band can produce excitation. In luminescent bodies the maximum intensity for a given substance is fixed as to wave-length, and is independent of the intensity and of the character of the stimulus."

Phosphorescence.

This form of the law is more exact than Stokes' original law, which held that the wave-length of the rays emitted by a fluorescent solution was always greater than the wave-length of the exciting light.

Phosphorescence is supposed to exist only in what are termed solid solutions, that is, a solid with which is crystallised some other substance, with which it is isomorphous. This other substance may be, and usually is, present as an impurity, and an amazingly small proportion is sufficient to produce phosphorescence. Well-known examples of this are given by the sulphides of metals of the calcium, strontium, and barium group. While pure calcium and barium sulphides show no luminescence, the commercial samples, which contain but minute traces of other elements, such as zinc, bismuth, manganese, etc., have been known for several centuries, under the names "Canton's Phosphorus" and "Bolognian Phosphorus," respectively.

A number of workers have examined the fluorescence of sodium vapour, and have observed spectra of a complicated character. There seem to be groups of spectral lines in the fluorescent light which are associated with one definite frequency of the radiation which excites the luminescence.

*TELEVISION, January 1929, p. 20.

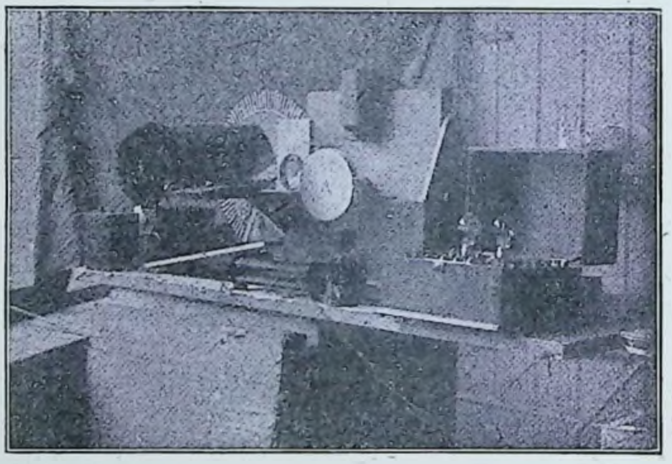
Onnes and the Becquerels have examined the spectrum of phosphorescent light at extremely low temperatures, which have been obtained by the use of liquid hydrogen and liquid helium, thanks to the brilliant researches of Onnes, the Dutch expert on low temperature research. At these temperatures it was found that the luminescence spectra of salts of uranium, which at ordinary temperatures consisted of broad bands, consisted of very fine lines. On plotting curves of intensity to wave-length of light they found that the graphs corresponded with the energy distribution curves for ordinary luminescence.

Lenard and Saeland observed a phenomenon, which they termed the "actino-dielectric" effect, while working with luminescent sulphides. This effect consists of a type of photo-electric conductivity, for when the substance was illuminated with light containing a red component, and was maintained at a positive potential, the galvanometer gave a deflection, which increased to a maximum and remained constant. With the specimen maintained at a negative potential the deflection continued to increase as long as the specimen remained illuminated. When the specimen was exposed for long to the red light it exhibited a form of fatigue, and would not show the effect for several hours. If the substance was made alternately positive and negative there was no tendency to fatigue.

Gudden and Pohl have found an increase in the dielectric constant of zinc sulphide (natural Sidot blende) when exposed to light, and they have also shown that certain phosphorescent materials increase their conductivity when illuminated, though electric fields of the order of 3,000 volts per cm. are necessary to bring about the conductivity change. They plotted graphs in which the effect was shown as a function of the wave-length; the curve has a well-defined maximum and resembles the curves for the selective effect in the alkali metal cells.* With weaker fields the curve assumes a shape similar to the normal photo-electric effect. They have assumed that the electrons emitted in the selective effect have not sufficient velocity to obtain the full freedom necessary to act as conduction electrons. The strong electric field enables them to obtain this power. The same workers found that, in accordance with this view, a strong electric field applied to the blende during decay of phosphorescence caused a sudden increase in luminescence, followed by a more rapid decay than before the application of the field. It was also noted that there was an increase in conductivity after the original excitation had disappeared, if a beam of red light fell on the cell.

Stark's Theory.

We must now consider the various theories of luminescence. That due to Stark is of special importance, and will be discussed first. He imagines a limited number of valency electrons on the surface of the atom, which can of course become detached from the surface. As we have seen in previous discussions, these valency electrons may leave one atom, and become attached to others. This explains the formation of positive and negative ions, as in ionisation by collision, which we discussed last month. According to Stark's view, the valency electrons form the characteristic band spectra, and that the carrier of the band spectrum is a molecule composed of several atoms.



BAIRD TELEVISOR—1924 MODEL.

The carriers in the case of the line or series spectrum are single atoms which have lost valency electrons, and are thus positive ions. Fluorescence or phosphorescence which is connected with band spectra is supposed to be that emission of light accompanying the restoration of valency electrons. The difference between the two is not basic, but dependent only on the time during which the separation of the electron continues. With fluorescence this time is an infinitesimal quantity, with phosphorescence, a finite quantity, depending on the electrons of which the material is composed.

Phosphorescence is thus bound up with photo-electric emission, while fluorescence does not necessarily imply photo-electric activity; in general, however, there is an associated photo-activity. This theory accounts for the difference in frequency between the incident and the fluorescent light, discovered by Stokes. Einstein has expressed Stokes's law mathematically. If ν_a is the frequency of the exciting light and ν_f that of the fluorescent light, the energy of the carriers will be $h\nu_a$. This energy is imparted to the electron, and the available emission energy in the restoration of valency electrons cannot exceed this.

Thus $h\nu_f \leq h\nu_a$ so that $\nu_a \geq \nu_f$, which is the same as $\lambda_a \leq \lambda_f$, the wave-length of the activating light is smaller than that of the fluorescent light.

Stark recognises short-wave and long-wave bands. In the former the intensity of absorption and emission diminishes as one passes from short to long wave-lengths. In long-wave bands the intensity increases in passing from long to short wave-lengths. The two are dynamically coupled, so that the emission of one is accompanied by an emission of the other. Fluorescence and photo-electric effect are closely connected with the absorption bands towards the red, for when light is absorbed in such a short-wave band it excites fluorescence both in the short and the coupled long-wave band. Absorption of light in long-wave bands approaching the ultra-violet, results in neither fluorescence nor photo-electric effect.

Lenard and Saeland, whom I have already mentioned, connect phosphorescence with the photo-electric effect. Substances such as sulphides of calcium, etc., which are usually good insulators, emit electrons under the influence of light, acquire a positive charge, and thus neutralise to some extent the external field which is applied with a view to measuring the photo-electric activity.

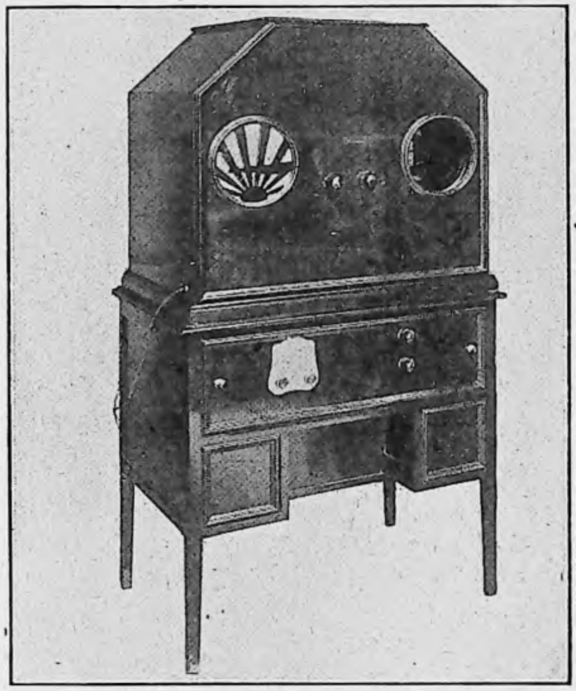
*TELEVISION, September 1928, p. 14.

The photo-electric effect is assumed to be concentrated at certain molecular groups or centres. Under the influence of light there is an emission of electrons from the metal atoms of these groups, which become thereby positively charged. The liberated electrons are either captured by sulphur atoms or scattered among the surrounding atoms unattached. Whenever a recombination takes place between the centres and the electrons, phosphorescence is stimulated, for he holds that when *photo-electrons* return to the atom *emission* electrons are caused to vibrate, and thus emit radiation.

Considering the variation with temperature, Lenard concluded that for each band in the spectrum of a body there is a certain range of temperature corresponding to phosphorescence, above and below which there is little or no phosphorescence. By increasing the temperature the collisions are made to occur more frequently, and the electrons can return more easily to the atom. The action of infra-red and red radiation is supposed to have a similar effect, and set in motion larger aggregates, consisting of sulphur atoms with attached electrons by resonance; the free period of the aggregates being large, they respond readily to long waves. This increase in the number of collisions causes a momentary increase in phosphorescence, and at the same time makes the decay more rapid.

Lenard has a very reasonable explanation of Stokes's law. When a photo-electron returns to the atom it is caused to vibrate with a large, but continually decreasing, amplitude. The period decreases with the decrease of amplitude, so that the photo-electron can only cause excitation of the emission electron when its frequency has become identical with that of the emission electron, and can thus cause resonance. The photo-electron can thus bring about emission only when it has finally a smaller frequency than the emission electron. This means that the frequency of the exciting light which releases the photo-electron must be greater than the frequency of the phosphorescent light. (Or the wave-length must be less.)

Lenard distinguishes between three different processes in the decay of phosphorescence: (*a*) The short "Momentanprozess" or m-process which obeys a logarithmic decay law, and which is observed when the exposure to the spectrum is of very short duration. (*b*) The more lasting "Dauerprozess," called in England the d-process, in which the intensity varies inversely as $(c+at)^2$, where t represents the time of excitation, usually of a few minutes' duration. (*c*) The third or u-process is brought about by the action of ultra-violet radiation. Without going deeply into the mathematics of the subject, it must suffice here for me to mention that in many cases the intensity of phosphorescence I can be represented by the formula $I=\frac{a}{(c+at)^2}$, t being the time and a and c are constants.



BAIRD TELEVISOR—1928 MODEL.

Other workers have shown that there was no photo-electric effect corresponding to the m-process, which shows that no electrons are emitted from the luminous centre in fluorescence (m-process).

Other less important theories have been suggested by workers such as the resonance theory of Lommel, but though this in part explains Stokes's law, there are innumerable difficulties both practical and theoretical which make its acceptance impossible.

Wiedemann has brought forward additional hypotheses in order to assist the theory, and suggests that the fluorescing molecule is capable of existing in several conditions. Under the influence of light a transformation may take place from state A to state B, and fluorescence may occur either in change from A to B or in retransformation from B to A. This transformation may be either chemical change, intra-molecular re-arrangement, or an ionisation. This idea supports Nichols and Merritt's suggestion that excitation produces an electrolytic dissociation of the active substance, and that luminescence results from vibrations set up by dissociation or association of the ions.

In the future development of the theory of luminescence, it seems highly probable that it will be necessary to make fuller use of the quantum theory. Space does not permit that I should develop this idea, and, indeed, it would be difficult to do so without first acquainting the reader with the modern conceptions of atomic structure and a simplified view of the quantum theory. In completion, therefore, I will ask those of my readers who are unacquainted with this theory to bear with me but a few moments; a complete understanding of the following will be forthcoming when they know more of the mysteries of the atom.

Baly has shown that there is a relation between absorption and luminescence bands and their arrangement in series. The equations which he obtained can represent with great accuracy the frequency of the bands. Thus $\nu=K\nu_0\pm mb$, k and m are both whole numbers and ν_0 is the frequency of an infra-red band. The symbol b is called the basis constant. In certain cases there may be two basis constants, which are supposed to be related to the moment of inertia of the rotating molecule.

I trust that this short dissertation has brought to the notice of readers the existence of yet another branch of the subject of light and photo-electricity, that it may be the means of stimulating still further researches into its mysteries, and that it may deepen the understanding and realisation of the wonders of the Infinite.

The Televisor Solves a Mystery

By EDWARD J. DUTTON

SIR WYNDHAM RUDD was worried. As he sat in his library at his house in Curzon Street his eye glanced round at numerous little wall cabinets that occupied spaces between the sets of bookshelves. In those cabinets reposed the most magnificent collection of rubies in the world. The Rudd Collection was famous and unique.

For several days past certain peculiar events had caused the collector a vague uneasiness. Now that uneasiness had developed into a concrete fear. Of course, he reflected, the rubies were insured for a very respectable sum, but no amount of insurance could recompense him for the loss of certain of his gems; they were irreplaceable.

The happenings that had caused the baronet a sense of irritation were not in themselves suspicious. In fact, even now, when his trained mind told him that all these little things added together made one suspicious whole, he was inclined to laugh at his own fears and put them down to a slightly torpid liver.

But, as he told himself, it would never do to take the risk of remaining inactive in the face of his discoveries.

It had started a week ago, this chain of unaccountable things. In the first place a dirty footprint had been found on the pale ground of the pile carpet immediately in front of one of his cabinets. Nothing, apparently, had been disturbed, and there were no other imprints elsewhere; merely this impression of a male boot or shoe.

The same night the butler, locking up, had discovered the lock of a small, little-used door at the rear of the house had been tampered with. It was replaced. Two days later the new lock was found to have been carefully unscrewed, false screwheads placed in all the holes except one, in which the original screw had been loosened so that a mere push would have opened the door with perfect ease.

Yesterday, on going to his cabinets, Sir Wyndham had found that an effort had been made to hide certain scratches on one of the panels with new polish. That the scratches had not been there the previous day the collector was certain. Someone had tampered with the case.

Sir Wyndham gazed thoughtfully at his diary in which he had recorded these happenings. Who could be responsible for them? They bore every indication of being the work of some amateur thief. And yet, they were so patently obvious that they might well be intended to throw dust in his eyes. A sort of criminal red-herring to hide some more subtle move of a clever gang.

His mind ran over the inmates of his household: His wife, a *grande dame* of the old school, whose caustic wit and clever epigrams made her the lioness of the big social functions which she graced. She could be ruled out. Mavis, his daughter, a brighter replica of her mother, was likewise off the list.

Dakin, his confidential secretary, seemed all that such a one should be; a tall, straight-limbed, clear-eyed, clean-living youngster, whose past life Sir Wyndham had probed into with scrupulous care before engaging him for the post.

There remained only Scott, his butler, and Ellen, the housemaid. These were the only two of the indoor staff of servants whose duties brought them to the library.

Sir Wyndham tapped his teeth with his pencil as he closed the book. He would have liked to have discussed this problem with somebody, he thought. Somebody who could understand. A fellow collector for choice; old Baumstein, for instance.

Baumstein wouldn't sympathise, though. Jealous old fox. Just because he had outbid him for one or two prize gems at various times. Wonderful pieces, which Baumstein had coveted with the covetous greed that can overcome even the most level-headed of collectors. Sir Wyndham chuckled: "No! no use taking my worries to Baumstein; he'd just secretly rejoice."

With a look of sudden decision in his eyes he rose and pressed a bell.

To Ellen, who answered his ring, he spoke more sharply than was his wont, causing the girl's eyes to widen in slight astonishment. As a rule the master was courtesy and consideration themselves for his servants, and they all worshipped him for it.

"Tell Jones to bring the car round at once. I am going to Scotland Yard." He looked deeply into the wide clear eyes before him, but if he hoped to surprise a look of guilt or fear there he was disappointed. All he saw was respect and a mild reproach. With a murmured "Yes, Sir," the girl went out and the baronet cursed himself for a fool.

* * *

The grim, grey buildings by the Embankment which house the most efficient criminal investigating machine in the world, seemed awe-inspiring to Sir Wyndham Rudd on this, his first visit, as he stepped into the reception hall. These tall, keen-eyed men, who continually passed in and out, gave him a feeling of diffidence. He sent his name up to the Assistant Commissioner, who was a fellow club-member of the Pythagoras.

The room into which he was ushered was large and airy, but its furnishings were clearly designed more for utility than for comfort. A couple of roll-top desks with their attendant deep-backed chairs, a long filing cabinet, a huge map of the British Isles on the wall, and three or four leather-seated, Windsor-type chairs comprised the equipment.

At the desk against the fireplace sat Major Dalton, the Assistant Commissioner of Police. A hawk-faced man of thirty-five, with a military moustache, and the unmistakable bearing of one born to command. In a far corner, a white-haired individual was doing something with several boxes and pieces of wire. He took no notice of the new-comer, and Sir Wyndham, after a curious glance, went forward to meet his friend.

"Well, well, Sir Wyndham, what brings you to this den of iniquity?"

"In a far corner a white-haired individual was doing something with several boxes and pieces of wire."

smiled Dalton, as he shook hands. Rudd drew forward a chair and, placing his hat and stick on the floor, recounted his suspicions to the man whose name had power to put the fear of God into every criminal in Europe.

"I am pretty sure," he concluded, "that an attempt of some sort is being made to steal my rubies. I wish you could give me some assistance to catch the person responsible."

Dalton nodded gravely. "Right," he said, "I will send one of our best men along to your place this evening. But . . . hold on a moment," he glanced thoughtfully over to the man in the corner.

"Drew," he called, and the white-haired stranger ambled over to the desk.

"This is Sir Wyndham Rudd, Drew. Someone is trying to pinch his collection of rubies. I've got an idea this is the opportunity you have been asking for." He turned to Rudd: "Meet Professor Drew of the National Television Laboratory," he said.

The baronet found himself shaking a cold, lifeless hand, and looking into a pair of pale, dreamy eyes, behind which, however, there gleamed the fires of genius. He had heard much of the remarkable discoveries in the new science of television, due in great measure to the indefatigable research work of this odd-looking man.

Dalton repeated all that Rudd had told him for the information of the Professor and waited, a query in his eyes.

"Yes, yes," concurred the grave voice of the scientist. "Whatever is done to try and catch this mysterious person red-handed must be done secretly. On no account must anyone, not even the members of Sir Wyndham's own family, know what is being arranged."

"That is so," agreed Dalton. "From evidence which Sir Wyndham has given me I am inclined to the belief that it is what we call an inside job, that it is someone inside the house who is the culprit, or who is in league with the actual thief. The tampering with the lock on the back door is merely a blind."

"Then you think you can help me, Dalton?" queried the baronet, in relieved tones.

"I think Drew will certainly be able to help you," replied the Major. "And at the same time prove the utility of his latest invention in the detection and prevention of crime."

Rudd looked his mystification.

"Perhaps it would be as well if I explained," suggested the television expert, mildly.

"I daresay you are aware," he proceeded, "that, so far, television has advanced to the point when a regular service can be received, on quite small portable television receivers, broadcast from a main transmitting station which is housed in one building, and consists of a quantity of cumbersome plant with massive aerials and other heavy gear.

"My latest discovery is a step ahead of this. It consists of a small, portable transmitting station which can be carried about from place to place, and, so long as my Electric Eye can see the scene, will faithfully transmit to an ordinary receiver whatever is in front of it.

"As an aid in the detection of crime it will, I am sure, prove invaluable. Placed on standards where crowds congregate, pickpockets will be detected in the act by the Electric Eye. Fixed wherever there is danger of a theft being committed, as in your case, it will record the whole crime to a watcher at the receiver. The criminal will be identified, and can be arrested as he leaves the place with the goods on him."

Sir Wyndham smiled his approval. "And there is no danger of its presence being suspected?" he asked.

"None whatever," replied the inventor. He shuffled with his curious ambling gait over to his boxes. "See," he said, returning, in one hand an ordinary suitcase, and in the other what appeared to be a small travelling clock. "In this case is the actual transmitter. This can be attached to the house lighting circuit, or run off batteries inside the case."

He placed the case on the floor in front of the desk. The clock-like apparatus he held up for Sir Wyndham's inspection. Now the baronet saw that the glass front of this object was really a thick lens. Professor Drew pressed a catch, and swung the front open. "Behind this lens," he explained, "is the rotating scanning disc turned by means of a very small electric motor. In each of the spiral apertures there is a special double-roof prism of my own design, the two long faces of this prism being made up of four inclined faces which meet in twin median ridges at an angle of ninety degrees.

"As the light emanations from the subject are reflected through the front lens they are picked up by these prisms, which reflect the rays impinged on their faces and pass them out, with double their original intensity, on to a bank of photo-electric cells, whence they are emitted as sound waves to the transmitter in the suitcase which, in its turn, sends them out to be picked up by the receiver.

"You will observe that this Electric Eye is no bigger than an ordinary microphone, but it is, believe me, extremely sensitive. It can be placed on the mantelpiece or on top of a cabinet, and connected to the transmitter by these two lengths of twin flex wire."

Sir Wyndham looked on with astonishment, whilst Major Dalton smiled tolerantly at the enthusiastic and permissible note of pride in the inventor's voice. Half an hour later Rudd left the Yard with the Professor's wonderful suitcase and the Electric Eye riding safely beside him on the seat of his car.

* * *

Outside the library window of the house in Curzon Street the star-spangled sky was veiled at times by scurrying wisps of cloud. From below, a dull glare came from a street lamp a few yards away.

Inside the room the darkness was tinged with grey, so that the furniture took on queer, black shapes, and assumed terrifying proportions. In the corners farthest from the window the blackness was intense. Not a sound broke the stillness of the night.

In his bedroom, Sir Wyndham Rudd, aquiver with excitement, sat before the standard television receiver that he had surreptitiously brought upstairs from the drawing room earlier in the night. He had managed to make the necessary arrangements without a soul in the house being one whit the wiser: one Electric Eye opposite the door at the rear of the house; another one to one side of the window of the library, so that it commanded a practically complete view of the room. Lengths of twin cable laid carefully under linoleum and carpets led from each Electric Eye to the Professor's suitcase, ensconced under a large easy chair. Everything was ready.

He had arranged to ring up Dalton at the Yard as soon as the thief made his appearance. Dalton had a Flying Squad van in readiness to rush round to Curzon Street should it be needed.

Some sort of intuition told Rudd that an attempt on the actual theft would be made to-night. He looked into the screen of his televisor, and pulled the 'phone nearer. He had already put out the lights in his bedroom so that now the whole house should be in darkness.

His mind ran over the inmates of the house again. Lady Rudd had been to a bridge party that night, returning an hour and a half ago, and retired to her own room. His daughter had elected to stay at home. He smiled at the thought that this mystery would have pleased her mightily, for she was an omnivorous reader of detective stories.

Dakin, the secretary, had been out but had come in fairly early, and Sir Wyndham had not seen him since about ten o'clock.

The butler and the rest of the staff were away in their own part of the house, and the baronet had made sure of locking the communicating door before he retired himself.

"How old Baumstein would chortle if he knew," thought Rudd, grinning ruefully to himself in the dark. A clock, somewhere, struck two, and the watcher checked it with the watch on his wrist.

Suddenly, in the screen of the televisor, a flickering shadow crept across the glass. Sir Wyndham, with a hand that trembled from pure excitement, took a cigarette from a box on the table and lit up; he found it steadied his nerves.

The vision in the screen had become clearer now, and he could see the back door plainly. Someone had broken the thread which started the transmitting mechanism, and bathed the scene in invisible infra-red rays. Slowly the door opened and a figure, indistinct against the shadow of the outer porch, slipped smartly inside, closed the door, and stood listening. The scene faded as the intruder passed up the passage towards the library.

Sir Wyndham unhooked the receiver. Within a minute he had spoken to Dalton and had been assured that the Flying Squad was on its way. Again he looked into the televisor.

The opening of the library door snapped the thread operating the second Eye, so that now he could see the room containing his precious rubies as though he were standing by the window himself.

Over against the cabinet which housed the pick of his collection the figure of the mysterious marauder crouched, working at the lock with some instrument. Sir Wyndham watched, grimly smiling at the surprise in store for the spoiler, content to wait and watch while Dalton and his merry men made their arrest.

Outside so that it might, or might not, have been a car stopping, a slight screech sounded. It had not reached the ears of the man downstairs, who still probed at the case with his back to the inquisitive Eye that watched his every movement.

Then, in the doorway, men

"Suddenly, in the screen of the televisor, a flickering shadow crept across the glass . . . . . . slowly the door opened and a figure . . . . . . slipped smartly inside."

appeared. Silently, with Dalton at their head—keen-eyed, grim-mouthed men, whom nothing baulked.

Rudd dashed for the stairs. He wanted to be in at the death. When he reached the library the detectives had got the fellow, and he now sat on one of the chairs, his manacled hands to his face, head between his knees, broken, finished.

Something about the figure—the shape of the grey, bowed head, now that the hat was off—seemed vaguely familiar to Rudd.

Then the man looked up and stared at the baronet with dazed eyes.

"Baumstein!" gasped Rudd, incredulously.

The figure in the chair groaned, then: "Tamn you, Rudd. Always you rob me. Rob me of the treasures that I set my heart on. The peautiful rubies, like drops of liquid fire. Always for the best ones you, mit your great wealth, outbid me. Me, I cannot afford to go so high . . . and so . . . I lose. And then I come . . . I cannot resist. I want one of your peautiful ones for myself . . . to put in my collection . . . to feast my eyes on it every day. And now . . . I am a felon. A tief . . . I shall go to the prison. Never more shall I see the lovely jewels. . . ." The voice of the old man broke off into convulsive sobbing.

Rudd looked at him with troubled eyes. Then he spoke to Dalton in a low tone. At a sign from their chief the Yard men left the room. Then Dalton addressed the moaning creature in the chair.

"Baumstein, listen to me. Sir Wyndham declines to prosecute you for this night's work. As a fellow-collector he feels that he knows you were only actuated by your jealousy. I think that is very handsome of him. In the eyes of the law you are a thief, Baumstein, and I'm not sure that I'm not compounding a felony in agreeing to let you go. Anyway, I think this should be a lesson to you to curb your covetous acquisitiveness in the future." He took the handcuffs off and followed his men.

Baumstein looked up at Rudd as the door closed behind the Assistant Commissioner. "My friendt . . . how . . . how can I thank you?"

Rudd smiled his genial smile as he patted the old man's bent shoulder.

"That's alright, Baumstein," he said, easily. "Come round to-morrow and tell me what you think of my new nickel-steel cabinets."

IF I WERE JOHN BAIRD

By NÖEL SWANNE

"*If you were Mr. Baird . . .*" began Marjorie, and paused.

* * *

I must have a wonderful mind, because the number of things I thought of during that short pause would, if placed end to end, be as long as a grandfather cod-fish weighs ounces.

If I were Mr. Baird. . . . Well, of course, to begin with, I should have a little holiday. I should feel that I deserved it. When I got back . . . perhaps I might never come back. You know, these millionaire people can have those holidays of the never-come-back type.

I have been told that Mr. Baird is not a millionaire, but it is hard to believe. The man who sells me nice, fresh cauliflowers picked that very morning from the pile of stuff left over from the week before last, spends his Sundays in a most beautiful limousine. He never says "Sir" to me when he passes my baby car. Now the relative merits of cauliflowers and television is as the square root of a Kontinuum is to a far-parallelism, as Mr. Einstein would say.

Anyway, if I did get back, I should have a jolly good rest. I should probably come back on a Tuesday and I should not invent anything for two whole months, and then I should invent something that a woman can smear on her face. That's the way to make money. Never mind about television.

Then I should have another little holiday to get over the strain, and when I got back I should pal up with a marquis. Dukes and earls are all right as far as I know, but give me a marquis every time. It sounds so good. The word conjures up the delicacy of mediæval colour and manners. One fancies one hears the click of rapiers, and sees the sunlight glancing off their keen points. I should choose a marquis who began life as a butcher.

You see the connection? Get the best society interested. Can't you see the reporters rushing along, and an army of press-photographers lining up. Then to-morrow the purple press comes out in spots, which you recognise as a picture of the Marchioness using her private televisor to watch her children chopping up a dead dog. (Article by Professor Wottle on literary page on "The Influence of Heredity.")

Mrs. Booker, of Tooting, will immediately look up the stores catalogue and see what televisors cost, and order two . . . the thing is done with then. As far as I can see, there would be nothing more to do but go away to Brighton and sign receipts.

One couldn't just leave it at that. After a time I should put up the price of televisors, and let the world know what Mr. Everyman thought of my methods and my plain cases. I should also add a few useful gadgets to the thing, such as replacing the front panel by a neat little shaving mirror, and a device on the right into which one slips a penny and gets a hot drink—American models would just be the case, with all the television stuff taken out of it, fitted up with convenient places for storing bottles.

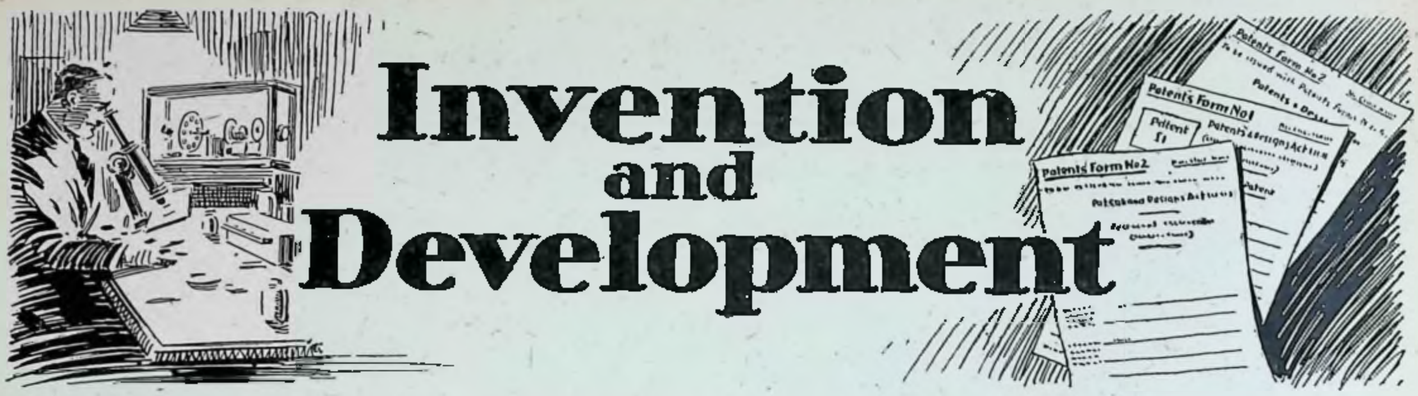
It would then be a really brilliant step to call on the B.B.C. and tell them about television. Joking apart, I think they ought to know something about it. Another long holiday would then be necessary to get over the strain—" but don't you see, Mr. Eckersley, the interference of the scanning device will heterodyne the immobile inductance by an amount equal to $\pi^3\sqrt{}yx^{d}_{x3}$ and so the . . . Well, anyhow it is all dam silly." Fancy keeping that sort of stuff up for long!

By this time the face cream, the shaving mirror, and the hot-drink business should be coming home nicely, and one could give up worrying about television. After all, who wants television? Everybody, of course. Well, they can't have it, and that is very good for them. My grandmother used to take cake away from me for the same reason, and she lived to be eighty-three. I wonder if Mr. Baird wants to live to be eighty-three? It's a great age.

One can't go on thinking about things deeply in this manner without evolving in the end some great thought which illuminates all that was hitherto dark, and at this stage of my ruminations there came into my mind the glimmer of such a thought as Aristotle, Galileo, Newton, or Mrs. Meyrick had never thought, but Marjorie interrupted me . . .

* * *

"*. . . television would never have got so far ahead as it has,*" she concluded.



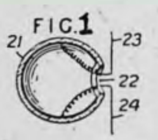
Invention and Development

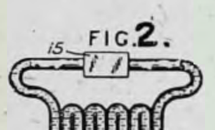
The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, W.C.2. Price 1s. each.

SELENIUM CELLS.—Progress in the design of these cells continues steadily. Even now they possess a degree of reliability which places them in serious competition with the less robust photo-electric cell, in such practical applications as burglar alarms and in some systems of sound production in conjunction with "talking films."

Their future usefulness in television systems is very largely dependent on improvements which can be made to overcome, or at least to minimise, parasitic noises emanating from within the cell itself. On the further question of the delayed action of selenium cells, which is commonly called "time-lag," it is to be understood that, provided the so-called "lag" is a constant for all working values, this in itself is not a serious defect.

Patent No. 300183 has recently been granted to J. L. Baird and the Baird Television Development Co. It is claimed that by the particular construction employed loss of light through reflection is reduced to a minimum. At the same time those changes of resistance due to light falling upon the cell, as well as changes of resistance due to temperature change within the cell, are both made to act in the same sense.

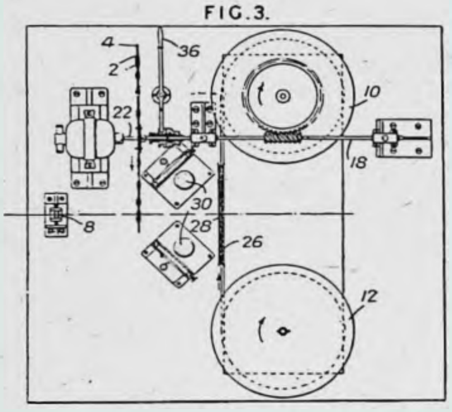




In order to eliminate loss of light by reflection the selenium or thallium sulphide forms a thin coating on the inside of a chamber (21) in Fig. 1, which is closed except for the window (22). Leading-in wires (23) (24) are connected to diametrically opposite points in the film.

In an alternative arrangement the chamber is made of metal, coated internally with selenium, and filled with a transparent electrically conducting fluid. One electrode is immersed in the fluid and the other is constituted by the casing.

Now if the mean temperature of the selenium or other light-sensitive film is suitably chosen, the change of resistance with temperature is added to the change of resistance due to light falling on the cell. In order, therefore, to secure a suitable working temperature within the cell, the latter may be completely immersed in a water jacket provided with a heating coil. According to the provisional specification



the cell may be enclosed in a vacuum or an atmosphere of inert gas.

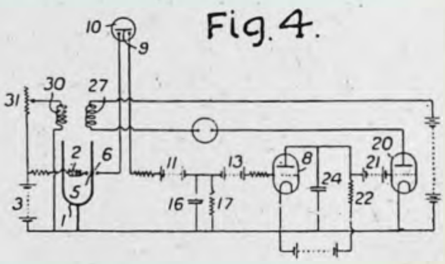
A novel form of *liquid exploring device* is the subject of a *Patent No.* 299402, recently granted to J. L. Baird and the Baird Television Development Co. A bubble of gas (16) is made to circulate through an opaque liquid contained within a set of tubes (10). These tubes are arranged side by side as shown in Fig. 2 to form an exploring screen, and circulation of the transparent gas bubble is brought about by means of a pump (15), so that as the bubble traverses the tubes (which are arranged in series) the object is explored by light passing through the bubble.

At the receiver a number of insulated electric conductors communicate with the interior of the tubes, which contain conducting liquid. An electric potential, varying in accordance with the incoming vision signal, is applied by means of a commutator to each of these conductors when its end in the tube is situated in a bubble. The image is thus built up by a succession of gas discharges taking place within the tube in accordance with the strength of the received signal at any instant.

Patent No. 299076 relates to improvements in picture telegraphy, whereby a picture of any desired size can be transmitted by cutting the photograph into strips, which are then joined end to end, and scanned in two dimensions. Fig. 3 is a plan of the transmitter, in which the picture in the form of a "ribbon" is wound off a drum (12) on to a drum (10) through a guide (26) and exposed to illumination by two lamps (30) through an opening (28). Spirally arranged lenses (2) in the scanning disc (4) throw an image on to a light-sensitive cell (8). A clutch handle (36) enables the tape-feed shaft (18) to be meshed with the motor-driven shaft (22). At the receiving station the picture is recorded in strip form. The strip is then cut up into lengths, which may be marked off by the synchronising signals and re-arranged to form the picture.

Refinements in magnetically sustained tuning-forks are of interest in considering synchronising methods. Fig. 4 illustrates a recent *Patent No.* 297762 granted to J. A. Smale, where a tuning-fork (1) is normally controlled at constant frequency by means of a coil (2) energised by a battery (3) and an intermediate contact (5). Further adjustment and control is provided by two damping coils (27) and (30). The latter, which is in series with a variable resistance (31), gives an initial adjustment of the normal frequency.

The coil (27) enables a finer adjustment to be secured. A contact (9) is closed once every second by a guaranteed time device such as a chronometer (10) for a definite short interval, and is in series with a



contact (6) closed at each vibration of the tuning-fork leg. When both contacts occur simultaneously at definite intervals, the resulting current through the coil (27) remains constant as this coil is inserted in the plate circuit of a valve (20) which is resistance-coupled to another valve (8). Should the contact (6) fall out of step with the chronometer contact (9) the effective duration of the impulse applied to the grid of the valve (8) is shortened. The resulting current-charge in the plate circuit of the valve (20) tends to maintain the frequency of the fork absolutely constant at a definite multiple of the speed of the chronometer.

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.
February 2nd, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

I must thank Mr. Wolfson for his very interesting letter, and I in return do acknowledge my false assumptions, and at the same time I take the opportunity of giving a few explanations and enlarging my previous idea if only to try and suggest other similar means to accomplish the end described in my last letter.

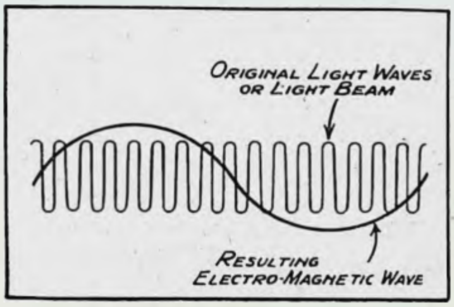
I agree that the frequency of one beam of monochromatic light cannot be altered by changing its velocity, as otherwise, as your correspondent rightly pointed out, the colour of the light would change according to the media of different refractive indices it passes through.

Nevertheless I still uphold that by means even of two identical monochromatic rays heterodyning can in a sense be effected by altering the velocity of one of them, or by altering the velocity of both by different amounts. The resulting ray may or may not be of a light frequency; but it will certainly be of a considerably lower one than that of the original monochromatic rays.

Imagine two glass parallelepipeds, each having a different refractive index, placed one on top of the other, and suppose that a perfect contact be made between two highly polished sides admitting no air between them. In practice this can be obtained by the fusion of two such glasses or by using a crystal having dissimilar refractive indices along two separate optical axes, or even a glue or gum which sticks to glass can be imagined.

Now into each of these two media direct two identical monochromatic rays, so that they meet under a very small angle at the two surfaces in contact. It is evident that owing to the two different speeds of the rays there will be moments when they are in phase and others when they are out of phase; in other words, a kind of stroboscopic action will take place. No one will deny that there will be a resulting ray; it will still, of course, be of electromagnetic nature, and presumably of a lower frequency; I cannot for myself conceive the opposite case. I shall now try and explain the reason for admitting a resulting ray of lower frequency, but would first mention that prior to the two rays entering the glass parallelepipeds it may be necessary, as is easily conceived, to polarise them.

Now it will be realised that when the rays are completely out of phase owing to the advance of half a wavelength of the one on the other they compensate each other and balance out. When they are in phase their effects are added and the maximum intensity is obtained. There will therefore result a final wave having a maximum of twice the intensity of, and a considerably lower frequency than, the original waves. As I said before, it may help your readers to compare this with a stroboscopic effect. The following is a diagram which may be of help:—



It is evident that I am not able to represent graphically the second monochromatic beam of the same frequency on account of the increased speed, but you can figure it in your mind, and I trust no reader will have any difficulty in seeing how the resultant wave is formed.

Let us examine this question from another point of view. According to Mr. H. Wolfson's letter, heterodyning can only take place with two wavelengths of different frequencies, but which may have identical speeds. In other words, two different wavelengths are required for this purpose, and I uphold that whether you change the frequency or speed heterodyning can take place. In other words, in order to be able to heterodyne two identical electromagnetic waves either the speed or the wavelength has to be altered; it *does not matter which.* Example:—

let λ be the wavelength of an electromagnetic wave;
v be the speed of propagation;
N be the frequency;

Then

$$\lambda = \frac{V}{N}$$

From this it is evident that by altering either V or N the wavelength must change; therefore, if you alter the speed of a light wave its wavelength must change. For heterodyning purposes your correspondent suggests that only the frequency N has to be changed while V may remain constant. By altering N heterodyning can therefore take place; but is this not also so by changing the speed (velocity) and keeping the frequency constant? In my opinion in this latter case heterodyning can and must also take place.

Now I entirely agree with your correspondent, but it seems to me odd that when the speed of monochromatic rays is altered by passing them through media of different refractive indices they do not change their colour owing to their different speeds. Yet is not every monochromatic colour characterised by its wavelength? Evidently there is a flaw somewhere! Will anyone of your readers offer an explanation or give the right one? Perhaps there really is a change in the wavelength, only no medium has a sufficiently pronounced refractive index to make the difference in the change of colour perceptible. If, as I presume, this difference is very small, we have here immediately an excellent means for heterodyning the rays, the right way to obtain a resultant wave of the order of a short wireless one. (May I add here that I should welcome an article in TELEVISION on Heterodyning in the widest sense of the word.)

Perhaps, on the other hand, the colour of light depends only on the frequency, and one definite primary colour can have different wavelengths under varying circumstances according to the medium it travels through. But if the relation $\lambda = \frac{V}{N}$ is examined from another point of view one is led to assume the exact opposite. From the expression $N = \frac{V}{\lambda}$ it is readily visible that if the wavelength is kept constant and the speed altered the frequency must change. This immediately leads to the contrary statement that the colour of light depends on the wavelength and not on the frequency. Now in wireless does the power to heterodyne depend uniquely on the frequency, or could an intermediate frequency be obtained by using two identical frequencies at different speeds? I fear not, for I see no means of changing the speed in a wireless circuit. And here I must disagree with the analogy raised by your correspondent; "velocity" is not synonymous to "quantity of electricity" as the quantity (ampères) can vary with the velocity the same way as in a waterfall the quantity of water can vary from season to season, but the velocity of the falling water is always the same and is independent of the quantity and obeys certain laws of gravitation.

Concerning the first point raised by your correspondent Mr. Wolfson. My idea of using a copper plate was only because I could think of nothing better. I hoped to get constructive criticism from other readers, and to see their own ideas expounded on this point. Anyway, it *is* conceivable that, if by some means currents having definite positions are produced in a copper plate, and the effect of these currents amplified and induced into a corresponding plate (copper wire grid), the new currents will take up identical positions to the first ones.

I shall be much obliged for any help or criticism Mr. Wolfson or any other correspondent can give, and I shall await with interest further letters in future issues of TELEVISION.

Yours faithfully,

E. P. ADCOCK.

Through the courtesy of the Editor of the WIRELESS WORLD *we are able to reprint the following two letters :—*

THE EDITOR, "WIRELESS WORLD."

DEAR SIR,

Mr. Cosens has fulfilled a public service in so clearly setting out in your correspondence columns the facts concerning the possibilities of radio television. It must not be forgotten that the Baird Company has made most explicit claims concerning the successful performance of their apparatus right from the start of their enterprise, and now that the argument concerning the problems of picture analysis has bought into prominence a serious difficulty, vague suggestions are thrown out regarding "frequency modulation" and "strip analysis." I ask that all readers of radio experience should carefully read the article by J. Robinson in the current issue of TELEVISION. The arguments and suggestions contained therein reveal clearly that a new system of picture analysis and radio modulation is essential or, in other words, that without some such development television is a failure. If Dr. Robinson has invented a device which provides a means of overcoming what have appeared to be insurmountable difficulties I trust that he will see fit to convert it into practical form. If his proposals are associated with the construction of practical apparatus, it is to be hoped that he will do one of two things: Get on with the job, or, alternatively, make his work the subject of a paper to be read before the Institution of Electrical Engineers.

Prolonged argument as to the feasibility of radio television shows conclusively the existence of serious difficulties. One might contrast the claims made for television with the achievements in the field of picture telegraphy and the success of the Fultograph. From the onset the Fultograph people have given radio demonstrations on all occasions, while we still await an actual radio demonstration of television, however crude, before, say, those responsible writers in our radio journals who will undoubtedly hail television as a new enterprise possessing unbounded possibilities.

It was stated in the *Wireless World* that the demonstrations given at Olympia last September were conducted between wire-connected stations, thus eliminating the real problems of television—modulation and synchronisation. That the public as well as the radio journals have no prejudice is indicated by the recent activity in picture reception, about which there is no doubt concerning technical details in view of the considerable activity among manufacturers. A boom in picture reception seems to be evident. Radio enthusiasts have given no more initial attention to picture reception than to television, yet of these two new developments the one is unanimously endorsed while the other is with almost equal unanimity neglected. That the judgment of the technical experts of the B.B.C. should be in keeping with this point of view is only further evidence that the Baird system presents special problems when applied to radio transmission, though in view of the weight of general opinion the decision of the B.B.C. need scarcely be added in arriving at a clear judgment in the television situation of to-day. Our leading radio journals and societies have adopted a similar attitude, while it is significant to note that the council and supporters of the Television Society have not sprung from among the leaders of radio interests.

Instead of further debating the possibilities of practical television, let us bear in mind that a single successful demonstration would be convincing. Let us remember also that this controversy could never have arisen had the sceptics been answered with technical argument and had the comments and challenges been combated.

A. MOIR.

February 6th, 1929.

THE EDITOR, "WIRELESS WORLD."

DEAR SIR,

I should not have troubled you with this letter had it not been for the gratuitous discourtesy of your correspondent, Mr. A. Moir, to the President and Council of the Television Society, published in your issue of January 30th. Mr. Moir observes that "it is significant that the Council and supporters of the Television Society have not sprung from among the leaders of radio interests," as if the study of the science and art of applied physics was wholly embraced by writers on "radio interests."

Whilst Mr. Moir's letter contributes nothing whatever to our knowledge of the subject under discussion, it is noteworthy for his ignorance of the many wireless television demonstrations given before competent physicists, including the President, Dr. Fleming, Professor Cheshire, and over eighty members of the Television Society, with visitors, at the December meeting, who greeted a wireless demonstration on the commercial televisor with expressions of satisfaction and astonishment at the marked advance evidenced by the active and full-toned images received.

Also a deputation of Post Office engineers officially attended a demonstration of the Baird apparatus and unanimously reported the demonstration by wireless to be satisfactory and suitable for a test through a broadcasting station. Whilst Dr. Fleming, who I suppose Mr. Moir will recognise as a leader in radio interests, has written with reference to sceptics of Baird's wireless demonstrations: "That recognisable images of moving and living objects such as human faces have been transmitted even to large distances by wire and by wireless, by Mr. Baird's methods, admits of no manner of doubt. Those who deny it have simply not seen it. There are sufficient credible witnesses of it to place it quite beyond the region of dispute."

Yours faithfully,

CLARENCE TIERNEY,
Chairman of Council,
The Television Society.

INTEREST IN CHANNEL ISLES.

29, HAUTEVILLE,
GUERNSEY.
January 13th, 1929.

THE EDITOR,
"TELEVISION."

DEAR SIR,

I feel compelled to enlighten your correspondent, John O. Le Lacheur, who believes that he is the only person in Guernsey interested in television. I am personally acquainted with several people in this island who are very interested in television, and feel sure that there are many others with whom I am not acquainted. Many of the above-mentioned people either possess sets now or intend to do so in the near future.

Yours faithfully,

A. R. YATES.

[Having recently visited the Channel Islands, we are in a position to confirm that there are many persons there who are very keenly interested in television.—ED.]

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