TELEVISION

TO-DAY & TO-MORROW

SYDNEY A. MOSELEY

AND

H. J. BARTON CHAPPLE

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BY

SYDNEY A. MOSELEY

AND

H. J. BARTON CHAPPLE

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SIEMENS MEMORIAL MEDALLIST AND PREMIUM HENRICI MEDALLIST

WITH A FOREWORD BY

JOHN L. BAIRD

THIRD EDITION

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MR. JOHN LOGIE BAIRD

Frontispiece

TO FRIENDS AT
THE B.B.C.
WHO MADE THE FIGHT FOR
TELEVISION
SO INTERESTING

PREFACE
TO THE THIRD EDITION

WHEN I first mooted this book, friends admired my temerity. Television, they said, was a chimera; some, indeed, said it was a ramp. Well, in a very short time television has more than justified itself. It is in the homes, and this book, dealing purely with the historical and technical side of the science, goes into the third edition.

I have to thank my collaborator, Mr. Barton Chapple, upon whom the burden of bringing this book up to date fell. *Television: To-day and To-morrow* was the first standard work on television, and this edition makes it the most authoritative work on the subject. Need I say more?

SYDNEY A. MOSELEY.

LONDON.
January, 1933.

PREFACE
TO THE SECOND EDITION

It is naturally gratifying to the authors that a second edition of *Television: To-day and To-morrow* is called for so soon after its initial publication.

Despite the short space of time between the original publication and the date on which the new edition has been called for, so much progress has been made in television that the authors have taken the opportunity of bringing the work thoroughly up to date.

For instance, the very latest information is included regarding the big screen, which created a sensation on its introduction at the London Coliseum, and at the Scala Theatre, Berlin; while complete details are given of the latest commercial "Televisor" set, which has been given to the public since the publication of this work.

In other respects the book has been comprehensively revised, so that the reader may rest assured that he has before him the latest technical and general information on the subject.

SYDNEY A. MOSELEY.
H. J. BARTON CHAPPLE.

London.
April, 1931.

FOREWORD

THE past three years have seen enormous developments in television, but I think many must have been bitterly disappointed at the long delay in placing receiving apparatus in the hands of the public.

In 1926 television was demonstrated for the first time, and there seemed little reason why the apparatus should not come into public use without undue delay. Three years have passed, however, and only now are television receivers becoming generally available. One of the reasons for this delay was that in the original television apparatus synchronizing was by means of synchronous motors, and automatic synchronism had to be brought into being before a television set suitable for the home could be provided. The chief cause of delay in bringing television to the public was, however, the difficulty experienced in obtaining facilities for broadcasting.

The general public are of the impression that television was first broadcast through the B.B.C. only a few months ago, and it will be a surprise to many to learn that this is not the case, but that the first broadcasts of television through 2LO actually took place as far back as 1926. In July of that year we applied to the B.B.C. to be permitted to send out television from Motograph House, which was then the headquarters of the company, and this permission was granted to us, on the condition that we should not use it for propaganda purposes. Several transmissions took place through 2LO, and were received by us. These transmissions were, however, brought to an abrupt conclusion by the Post Office authorities, and we resolved to send out our own television programmes. We applied for a licence and obtained the licence 2TV, authorizing us to transmit television on a power of 250 watts and a wavelength of 200 metres. Our experience through the B.B.C., however, short as it was, had been sufficient to show definitely that the waveband of 2LO was amply sufficient to send out television images. There was, in fact, no difference whatsoever between the images received through 2LO and the images we were receiving by land line. That was in 1926.

Having definitely witnessed television sent out successfully through 2LO, although not permitted to mention this, I was amused at times by the dogmatic assertions of various "authorities," who, by making elaborate calculations based on the entirely erroneous assumption that television was transmitted by dots, "proved" to their own complete satisfaction that television on a waveband of 10 kilocycles was utterly impossible.

Unfortunately, a breach arose between ourselves and the B.B.C., and we continued to develop entirely independently. The struggle to obtain broadcasting facilities is described in the first chapters of this book, and I will say nothing more about it here.

The present images are restricted to simple scenes, such as head-and-shoulder views, or a few people seated close together. This limitation is imposed upon us by the narrow waveband available, but we are making experiments on the short wavelengths, which provide a much larger available waveband without causing interference.

To what extent pictures may be improved within the limitation of 10 kilocycles is a matter upon which it would be a mistake to dogmatize—for example, it must not be taken for granted that television is bound by the same laws which govern cinematography. There is no necessity to send as many as 22 pictures per second. We send only 12½ at present, and if we use a screen upon which is impressed a permanent or semi-permanent image, the recording point being preceded by an obliterating point, that is to say, that on each traversal of the screen the previous image is obliterated by a point immediately preceding the recording point, then the limit of picture speed is fixed by the rapidity of movement of the person or scene being televised, and not by any question of flicker.

I may say that in the laboratory we have transmitted pictures at as slow a speed as three per second, and these pictures have been visible as a united whole. At that speed, however, rapid motion is impossible, and a man who turns his head rapidly gives the impression of having left his nose behind, or a hand moved up and down looks as if the fingers were made of sealing wax. As I say, however, the speed of picture transmission in television is not bound by the laws of cinematography, and those who endeavour to fix limitations to the progress of television, basing their arguments upon established arts, may fall into as grave errors as those who based their calculations upon half-tone blocks, and assumed the television image to be made up of dots.

I have indicated one line of future development, and would like to conclude by saying that I see no insurmountable barrier in the way of the advancement of television to a perfection rivalling the cinematograph.

John L Baird

1930.

Mr. Baird was the first to effect practical television and to inaugurate a new departure in electric technics which will have immense developments in present and future years.

SIR JOHN AMBROSE FLEMING.

CONTENTS

PAGE

PREFACE TO THIRD EDITION vii

PREFACE TO SECOND EDITION viii

FOREWORD ix

INTRODUCTION xxiii

CHAPTER I

HISTORY OF TELEVISION 1

Early theorists—First demonstration of television—Praise from independent critics—Similarity to present-day apparatus—The first model—The vision of objects in total darkness—First television demonstration outside Britain — Using service telephone lines — Baird startles the world with epoch-making experiment—Reception in mid-ocean—The first daylight television—Television in natural colours—Stereoscopic television—The B.B.C. and the Baird Co.—An inaugural ceremony—Television transmissions successfully received in the provinces—A dual transmission—Television broadcast with sound—The first play—Introducing the big screen—Zone television—Televising the Derby—Transmissions from Savoy Hill—The modulated arc—*Ultra*-short waves—The Derby on a big screen—A new model "Televisor"—Television transmissions taken over by B.B.C.—The big screen in Copenhagen

CHAPTER II

THE GENERAL DETAILS 32

First-hand information—A definition of television—Does any relationship exist?—Conveying complete intelligence—The work of the photo-electric cells—A process of conversion—Forming a picture—The picture canvas—Creating form from strips of light—The co-operation of amateurs needed

CHAPTER III

THE BAIRD TELEVISION DISC TRANSMITTER . 40

The original specification—introducing the scanning disc—A standard form of Baird transmitter—The number of disc holes—Correctly shaping the disc holes—

PAGE

Graduated exploration—The shape of the light area—Overcoming flicker—How black and white lines appear—Meet the "television eye"—Selenium unsuitable—The reason for using a travelling light spot—Hearing the television note—Imparting "movement" to the televised subject—Criticism based on false foundations—An accommodating human eye—What of the frequency limits?—The dot theory fallacious—The effects of frequency cut-off—Vertical scanning

CHAPTER IV

THE BAIRD "TELEVISOR" DISC RECEIVER . . 58

Revealing the secrets of the mechanism—The essential parts—The best type of motor—Arranging the components—Exposure and re-exposure—A reversed effect—Curing the trouble—A peculiarity which sometimes happens—A remote happening—The disc "Televisor"—Operation—A wealth of detail revealed

CHAPTER V

SYNCHRONISM IN TELEVISION 70

Isochronism but not synchronism—The conditions for synchronism—Several devices suggested—Bristling with difficulties—An historic occasion—Using part of the picture signal—Introducing the black band—Relay synchronizing—Working details—Changes in motor torque—Practical drawbacks—A better method—Two special magnet coils required—Analysing the action—A retarding impulse—Proof of the efficiency—Removing a misunderstanding—Framing the image

CHAPTER VI

PHOTO-ELECTRIC CELLS AND NEONS . . . 85

The photo-electric cell's real purpose—Sensitivity of prime importance—Magnifying the current—Amplification necessary—Connecting the cell in circuit—How the neon lamp works—Points of great importance—Where to place the neon lamp

CHAPTER VII

THE WIRELESS RECEIVER FOR TELEVISION . 93

Give your own verdict—Signal strength required—The best type of detector—Taking each form in turn—Maintaining proportionality—Grid leak rectification—Possible distortion—One or the other—Another point of view—Seeking the best—Useful operating details—Considering the H.F. side—A basic principle—Using transformers—Avoid cheap components—Amplifier details—A good

PAGE

resistance capacity coupled amplifier—Using a pentode valve—Dual vision and sound receivers—The output to the neon lamp—A negative image—Correct signal direction necessary—A small refinement

CHAPTER VIII

TELE-CINEMA AND TELE-TALKIES . . . 115

First steps in the evolution—The talking film explained—Using normal television receiving apparatus—An ingenious cinematograph projector—Describing the transmission process—The operator has complete control—Suiting any type of projector—Producing the sound effects—Synchronizing voice and subject movement—The first public demonstration—Film broadcasting

CHAPTER IX

NOCTOVISION AND THE "NOCTOVISOR" RECEIVER. 124

Overcoming personal discomfort—Improvements effected with *infra* red rays—Obtaining an *infra* red image—Shortcomings of the earlier photo cells—Fog penetrative powers—A unique demonstration of the latest "Noctovisor"—Overcoming the mariner's worst enemy—A more detailed explanation—Special discs—Every avenue must be explored

CHAPTER X

DAYLIGHT TELEVISION AND PHONOVISION . . 134

Reversing the process—The same final result—A milestone of progress—A street scene by television—People easily identified—The Derby of 1931—Preliminary tests—A change of vista—Watching the horses—A promise fulfilled—"Bottling-up" pictures—Synchronizing unnecessary—Reproducing from a record—What of the future?

CHAPTER XI

COLOUR AND STEREOSCOPIC TELEVISION . . 147

Special light filters required—Two light sources in use—Vivid portrayal of colours—What is stereoscopic relief?—Two separate explorations must be made—Colour combined with stereoscopic relief

CHAPTER XII

LATER DEVELOPMENTS 153

The big screen—Method of operation—Great brilliance—Making its debut—Transportable nature—Working details—Signal tests—Operating the controls—Convincing the sceptics—The first public theatre tele-talkie

PAGE

—Demonstrations in Europe—Screen television—An acute question—Zone television—Describing the apparatus—Zones not limited—A noteworthy feature—Direct arc modulation—A B.A. demonstration—Apparatus used—*Ultra* short waves—A step forward—Standard vision signals—Programme transmitted—New aerial employed—An outstanding feat—Introducing the experiment—The horses seen—Describing the apparatus—At the receiving end—Centre zone broadcast—Studio transmissions—A new model "Televisor"—An ingenious arrangement—Using a mirror drum—Operation—The B.B.C.'s attitude—Television apparatus at Broadcasting House—Following artist's movement—Special amplifiers—London to Copenhagen—Public demonstration—Outstanding developments

CHAPTER XIII

TELEVISION IN OTHER COUNTRIES 188

Early pioneer efforts—A mirror and cathode ray combination—Two-way vision and telephony—The apparatus used—"Invisible scanning"—Jenkins's work in the U.S.A.—Mihaly and his "Telehor"—An obvious defect—Work of the Fernseh A.G.

INDEX 197

ILLUSTRATIONS

FIG. PAGE

1. A Pictorial Impression of how Television Transmissions Take Place 35
2. The Elements of the Baird Transmitter. . . . 40
3. The Small Square Holes in the Scanning Disc Showing the Spiral Arrangement 42
4. Showing how the " Light Area " on the Back Screen is Made Up of Strips of Light 46
5. Indicating how Underlap and Overlap can Occur with Inaccurate Hole-positioning on the Disc . 48
6. A Sectional Diagram of the Baird Disc " Televisor " 59
7. Illustrating what happens if the Disc is Mounted the Wrong Way Round on the Shaft 63
8. A " split picture " in a " Televisor " Screen . . 64
9. How an Image Appears Under Certain Extreme Conditions 66
10. The Narrow Black Band which Provides the Synchronizing Impulse in the Baird System . . 74
11. The Salient Details of the Baird Relay Synchronizing System, Shown in Diagrammatic Form . . 75
12. The Arrangement of the Latest Baird Magnetic Toothed Wheel Synchronizer, which is Automatic in Action 80
13. How the Cogged Wheel Synchronizer Works . . 81
14. A Picture Incorrectly " Framed " Gives this Appearance on the Screen 84
15. Details of one type of Osram Photo-electric Cell . 86
16. One Way of Connecting Up the Photo-electric Cell to its Amplifier 88
17. Simple Methods for Joining the Neon Lamp to the Output Valve of the Wireless Set Receiving Television Signals 91
18. One Way in which it is Possible to Connect Up a Detector Valve for Anode Bend Rectification . 95
19. Diagrammatically Illustrating how Rectification Takes Place in a Valve Working on the Anode Bend Principle 96
20. Two Methods for Joining Up a Valve to Work as a Grid Leak Rectifier 97
21. The Best Point to Work for Grid Leak Rectification is Shown at Point *P* 98
22. Useful Refinements in an Anode Bend Detector Valve Circuit 101

FIG. PAGE
23. A Suggested Arrangement Capable of Giving Good Results for the High-frequency Side of the Receiver 102
24. A Successful Low-frequency Amplifier 106
25. Component Values of a very Efficient R.C. Coupled L.F. Television Amplifier 108
26. Two Individual Valves are Used here for Handling the Vision and Synchronizing Signals . . . 110
27. Suitable Connections for a Pentode Valve in the Output Stage 110
28. A Complete Circuit for a Dual Vision and Sound Wireless Receiver 111
29. A Schematic Representation of how Cinema Films are Televised 118
30. Showing how the Picture is Projected on to the Rotating Disc and Scanned by the Spiral of Holes 119
31. How the "Sound Effects" on the Film are handled by the Photo-electric Cell 121
32. Showing how the *Infra* Red Rays Play on the Person being Televised 126
33. Details of one Form of Baird " Noctovisor " . . 130
34. Two Forms of Discs Used for Breaking Up the Continuous Rays into Pulses 131
35. The Arrangement of the Viewing Screen whereby the Bearings of the Light can be Ascertained . . 132
36. Representing Pictorially how a Street Scene was Transmitted by Daylight Television 137
37. Showing how it was Possible to watch the Derby Race by Television 141
38. How Phonovision Recording Takes Place . . . 143
39. The Simple Scheme Adopted to Reproduce the Image Previously Made on the Record 145
40. A Triple Spiral Disc Covered with Red, Blue, and Green Filters is Required for Colour Television . 147
41. A Commutator is Employed to Change Over from the Neon Lamp to the Mercury and Helium Lamps 148
42. Two Separate Spirals on the Same Disc are Necessary for Stereoscopic Television 151
43. The Double Beam of Light at the Transmitter for Stereoscopic Television 151
44. Sketch of the Arrangement Adopted at the Receiving End 152
45. Note How the Commutation and Selector Mechanism are Electrically Connected to the Honeycomb of Lamps 155
46. A Pictorial Sketch Representing the Three-zone Television Scheme Demonstrated by the Baird Company 164

FIG. PAGE
47. A Schematic Diagram Drawn to Illustrate the Method Employed for Direct Arc Modulation . 168
48. Scenes from the Derby being Reproduced by Three-zone Television (Daylight) in a Distant Cinema . 175

PLATES

facing page
Mr. John Logie Baird . . . . *Frontispiece*
A Screen Model Baird "Televisor" which uses the New Grid Cell and gives a Black and White Image . . 1
The Historic Television Receiving Apparatus with which Mr. Baird gave his Demonstration to Members of the Royal Institution in January, 1926 2
Mr. J. L. Baird with his Original Television Apparatus, which is now in the South Kensington Museum. . 4
At the Leeds British Association Meeting in 1927 Sir Oliver Lodge was Successfully "Noctovised" . . 6
Successfully Receiving the Television Transmission by Land Line from London to Glasgow 8
The Scene on the Liner "Berengaria" on the Historic Occasion when Television Images Transmitted from London were Seen in Mid-Atlantic 10
Mr. Jack Buchanan Posing before the Daylight Television Transmitter in July, 1928 12
Sir John Ambrose Fleming Sitting Before the Television Transmitter, when the B.B.C. Inaugurated Television Transmissions from 2LO, on 30th September, 1929 . 14
Mr. H. J. Barton Chapple (Seated) Giving the First Wireless Demonstration of Television to be Received in Bradford from the B.B.C. London Station. . . . 16
The First Television Play to be Broadcast through the Medium of the B.B.C. Station was Called "The Man with the Flower in His Mouth" 18
Showing the Big Screen in the Baird Laboratories Prior to its Demonstration at the Coliseum 20
The Baird Daylight Television "Caravan" Against the Rails at Epsom, Prior to the Successful Televising of the Derby in 1931 22
One of the Artists who Took Part in the First Television Transmission from the No. 10 B.B.C. Studio . . 24
Boldly Advertising the Fact at the Metropole Cinema that Television was Being Shown during Derby Week, 1932 26
Mr. Baird Being Congratulated after the Great Derby Television Experiment of 1932 28
Mr. Baird with the Mayor of Hastings on the Occasion of the Unveiling of a Plaque to Honour Mr. Baird's Work on Television in that Town 30
A Peep Inside the Present Control Room of the Baird Co. 34

facing page

The Baird Television Studio as it Appeared in 1928 at Long Acre, London, W.C.2 36
One Form of "Portable" "Televisor" Used for Demonstration Purposes 38
One of the Earlier Models of the Dual Baird Disc Machine 38
The Old Control Room at Long Acre from which the Daily Broadcasts of Baird Television were sent through to the B.B.C. The Projector Stand is seen on the Left . 42
A Disc Television Transmitter as Developed by the Baird Television Corporation of America 44
A Photograph of a Disc Transmitter with the Amplifier Boxes and Controls Housed on an Adjoining Table . 50
A Transmission in Progress at the Television Studios and Transmitting Room of the Baird Television Corporation of America in New York City 52
Lieut.-Commander W. W. Jacomb, R.N. 54
The Inside of an Early Large Model Baird "Televisor" . 60
This Photograph was Taken During the Baird Co.'s First Official Demonstrations of Television Transmission and Reception in Berlin 62
An Historic Photograph, taken in 1926, when Mr. Baird gave the First Demonstration of True Television . 64
Untouched Photographs of Various Subjects as they Appeared on the Screen of a Baird "Televisor" Receiver in 1928 66
The Baird Disc "Televisor" Receiver with Cover Removed, showing all the Internal Mechanism . . 68
The Aperture on the Left Indicates How the Neon is Scanned Vertically in the Disc "Televisor" . . 68
The Disc Model Baird "Televisor" 72
The Mechanism and Controls in the Early Baird Relay System of Automatic Synchronizing 78
Note How the Motor and Synchronizing Equipment are Mounted Together, while below is the Laminated Cogwheel 80
The Motor and Synchronizing Gear of a Baird "Televisor" Dismantled 82
The Construction of a "Televisor" from a Kit of Parts is a very simple matter, and above we see an Example of this Work 84
Two Types of G.E.C. Photo-electric Cells 86
The Position of the Photo-electric Cells is clearly shown in this early picture of Miss June Collyer being Televised at the Studio of the Baird Television Corporation of America 88
A Few Representative Types of Neon Lamps Used in Television Investigations 90
The Versatile Nature of the Television Programmes can be realized by this photograph of the London Marionettes which have featured in Television Broadcasts . 92

facing page

A Baird Dual Receiver Model which contains two Receiving Sets, one for Speech and one for Vision . . . 94
A Happy Group: Mr. H. J. Barton Chapple, his Wife and Family enjoying the reception of Television in the Comfort of the Home 98
A Suggested Lay-out for an H.F. and Detector Unit Specially Designed for Receiving Television Signals . 102
A good example of a Resistance Capacity Coupled L.F. Amplifier Designed Specially for Television . . 104
Indicating what a Negative Image will look like on the Vision Screen 112
The Experimental Apparatus used when the first Public Tele-talkie Demonstrations were given in the Baird Laboratories 116
A Tele-talkie machine in the Control Room of the Baird Television Corporation of America 118
The First Tele-talkie to be Publicly Demonstrated (the Inimitable George Robey as a Bride) 120
This Tele-talkie Apparatus has been designed by the Fernseh A.G. of Berlin 122
The 1927 "Noctovisor," showing the arrangement of the Ebonite Filters 124
The Latest Type of "Noctovisor" shown in Operation with Mr. Baird Manipulating the Controls . . . 126
A Graduated Scale at the Base of the Instrument gives the exact bearing of a light in relation to it . . 128
This photograph of Arthur Prince and his Famous Ventriloquial Doll being Televised gives an idea of the Intense Lighting required in the Early Days for "Flood Light" Television 134
The Scene in Long Acre showing the "Caravan" drawn up outside the Baird Co.'s premises for Daylight Television 136
The Daylight Television "Caravan" at Epsom in 1931, showing the Grand Stand in the background and the Special Swing Mirror 138
A Phonovision Record made by the Baird Television Co. 142
The Transmitting End of the Phonovision Process Recording a Dummy's Head on an Ordinary Record. 144
A Stage in the Phonovision Process, showing some of the Early Experimental Apparatus 146
The Commutator necessary for changing over to each Light Source in turn is clearly seen in this photograph. 148
Some of the Original Baird Apparatus used for giving demonstrations in Stereoscopic Relief 150
The Honeycomb Arrangement of the Bank of Lamps Screen which gave such good results 152
A Special Commutator and Selector Mechanism is used in conjunction with the Baird Lamp Screen . . . 154

facing page
When arranged in a Caravan Trailer and moved to the Coliseum Stage the Big Screen gave this appearance . 156
Some of the Artists who participated in the Screen Demonstrations in Berlin are here seen in the Studio . 158
Illustrating how the Image appeared on the Lamp Screen at the Scala Theatre, Berlin 160
Illustrating how the Image of Mr. Strudwick appeared on the Screen of the Experimental Receiving Apparatus in the Three-Zone Television Demonstration . 162
The Coliseum by Night on the occasion of the demonstration of Baird Screen Television 164
Part of the Receiving Equipment used in connection with the demonstration of Direct Arc Modulation for Television Reception with a Large Screen . . 166
The Special Aerial erected for *Ultra*-short Wave Television Transmissions 168
A Section of the Daylight Television Transmitting Equipment Inside the "Caravan" at Epsom . . 170
The New Television Screen Receiving Apparatus in Course of Installation on the Stage at the Metropole Cinema. Note the position of the Large Deflecting Mirror 172
A "Dress" Rehearsal early on Derby Day morning (1932) prior to the Ambitious Three-zone Experiment 176
Mr. Baird with a Screen Model "Televisor" being filmed in the Gaumont British Studios at Shepherd's Bush . 178
Nipkow's name will always be associated with Television, for to him must be credited the First Scanning Disc. He is here seen in Berlin with Dr. P. Goerz (left) and Mr. Moseley (right) 180
Two Views of the Ingenious Television Transmitter supplied by the Baird Co. and installed at Broadcasting House for the Regular Television Broadcasts now sent out by the B.B.C. 182
Some of the Transmitting and Receiving Apparatus employed in the Experimental Laboratories of the German Post Office 188
In the top illustration is seen a person holding a Two-way Television and Telephony Conversation, while below is the Combined Television Transmitter and Receiver seen from the rear 190
Two examples of Television Receivers made and demonstrated by Fernseh A.G. 194

INTRODUCTION

To prophesy is a dangerous venture, but it seems customary to commence volumes of this sort with some nightmare prophecy—a plumber's vision of a world filled with weird mechanism, with thought-reading machines, with all sorts and conditions of apparatus for propelling the body from one end of the earth to the other, enabling us to see what goes on in Mars and planets, and moving us with the velocity of light for week-end trips to Uranus.

As fantastic as all these things may appear, one has only to look back even for a hundred years and consider the stupendous advancement of knowledge and accretion of powers which have been acquired by the human race—we cannot, it is true, project our bodies through space to the Antipodes, but we can and do project our voices, and we can and have projected our images, so that we can be seen and heard over these vast distances, although, as yet, we cannot be felt. With the further step whereby the transmission of touch can be added to the transmission of sight and sound, we might be seen, heard, and felt over any distances.

What then remains? Our personalities are only cognizable to our fellows by the senses, so that if we can transmit the sensations of sound, vision, and smell, we have to all intents and purposes solved the problem of transmitting our bodies corporeally over space.

In jest it has been suggested that the time will come when we shall be able to read each other's thoughts by the aid of some diabolical mechanism.

This dream is by no means so weird or so impossible of realization as it might at first sight appear, for all thought is, in analysis, only an electrical disturbance of our nerves.

Impulses pass along our nerves as a series of electrical telegraph signals, and our thought itself is nothing more or less than a conglomeration of these impulses.

Our brain has been compared to a stupendous telephone exchange.

We have the incoming signals—messages from the outer world; they are received in the brain, sorted out by the operator whom we term our consciousness, and this operator sends out corresponding messages, telling the various organs of the body what they must do in answer to the incoming messages which he has received. The operator is in many cases entirely dismissed, when the incoming signals themselves operate the corresponding outgoing signals. We put our foot in the fire, and without any conscious effort it is withdrawn. The whole body is, indeed, but a complex combination of physical and electrical reflexes, and there are many who consider that consciousness itself does not exist, but is a mere phenomenon of this complex combination of reflexes which constitutes our mentality.

We have at our disposal the most amazingly delicate apparatus for detecting electrical disturbances of all kinds, and this apparatus in the laboratories of physicists has already enabled the nervous impulses to be detected, so it is no strange thing for the physicist to hear the sounds caused by the rushing of pain impulses through the nervous system. He can apply his headphones to his ear and hear pain send its signal along the nerve to the brain.

Very well, then. Is it not legitimate to imagine that with a developed apparatus in time to come we may hear not only pain impulses, but the impulses of love, of hate, of desire, rushing headlong through that complex nerve structure to the brain, and that hearing these impulses we may learn that a certain definite conglomeration of sound caused by the nervous impulses corresponds to hate, that another combination of sounds caused by another set of impulses in the brain corresponds to love, and further still shall recollect that all thought in the brain of the thinker is cognized in terms of words?

We think, and as we think we speak, but our speech is not audible. Our thought may, indeed, be augmented by imagery. We may think both in images and words, but the great bulk of mankind, and mankind's clearest thinkers, think almost entirely in words.

Sometimes we may hear a man think, walking along a desolate or deserted road. Many a deep thinker thinks audibly, but in company and generally these thought impulses which we have heard audibly are inhibited. He forms his thoughts into words, but these words are never given breath to. Nevertheless, although not audibly uttered, they have existed as nerve impulses, and these nerve impulses might, with a properly constructed and sufficiently delicate apparatus, be turned into a conglomeration of sounds—of sounds, it is true, bearing no definite resemblance to the speech which they represent, but which would correspond to it and could, with the necessary knowledge, be interpreted.

There, then, we have a theory and practical facts upon which the constructon of a thought-reading machine may be visualized.

What, then, of the future with its thought-reading machines, with its space-destroying machines, and even, perhaps — who knows? — its time-destroying machines!

Such visions may intrigue the mechanically-minded, but to others they bring neither inspiration nor hope, but only that terrible question: " To what end? "

* * * *

To many wireless experts some of the points included here may appear elementary, but I am providing for the reader whose knowledge of the technical side of television is limited.

I ought to add that I started out to write a piquant history of television as I knew it at first hand, but the subject has grown out of hand.

I found history was being made even as I wrote.

On the top of this came the publication of certain books on television, written by Americans and published by English houses who were not, apparently, aware of the incomplete nature of their knowledge of the subject.

It was also very evident from these works that only the American side of television was stressed, and an altogether insufficient tribute was given to the man who had done more for television than any of his contemporaries. It is only meet, therefore, that we should balance matters by telling the story of the progress of Baird television, and give in the simplest language possible an explanation of " how the thing is done."

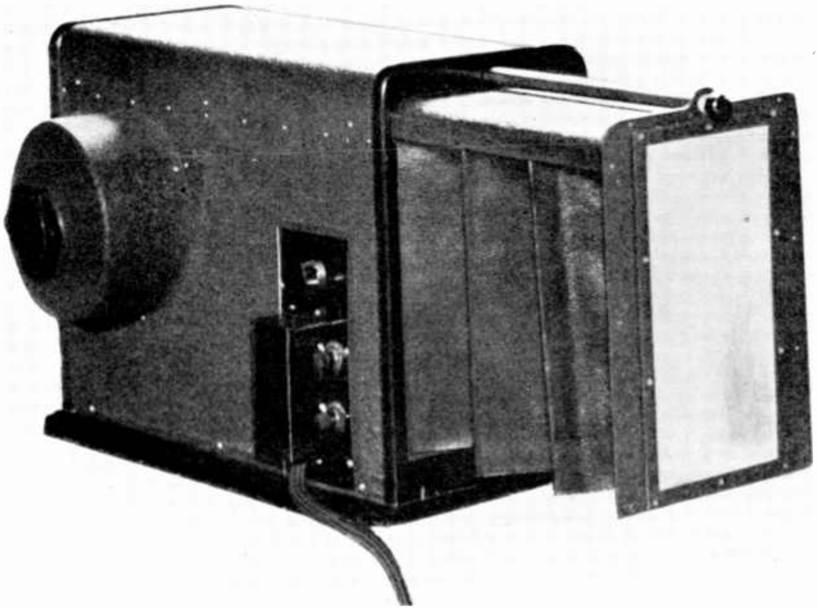
The scope of this work has also been extended so as to include the very latest developments in regard to noctovision, phonovision, and tele-cinema. With the desire of making it as complete and as up-to-date as possible, I have called in the aid of a young technical journalist, Mr. Barton Chapple, who has been one of the foremost among writers on the subject.

I am also deeply indebted to Mr. Baird, who has glanced through the proofs, and to the Chief Engineer of the Baird Company, Commander Jacomb, who has been intimately associated with Mr. Baird in his work. Commander Jacomb read through the technical chapters of the work, and has offered many interesting suggestions.

I have dedicated the book to my friends of the B.B.C., since no book purporting to tell the story of television would be complete without mention of the bright and interesting chapter of history in this connection.

SYDNEY A. MOSELEY

PRESS CLUB,
LONDON, 1930.



A Screen Model Baird "Televisor" which uses the New Grid Cell and Gives a Black and White Image

TELEVISION
TO-DAY AND TO-MORROW

CHAPTER I

HISTORY OF TELEVISION

TELEVISION as an idea dates back over half a century, when Bell's invention of the telephone, in 1876, created a stir in the scientific world.

This event was followed almost immediately by the publication of numerous theories for the transmission of sight by electricity. These theories, strangely enough, were, in the main, identical in conception with the most important principles on which television to-day operates.

Early Theorists

It is one thing, however, to postulate a theory, and quite another to produce an actual working mechanism. Bell's telephone had been anticipated in theory, so were Edison's phonograph and Marconi's wireless experiments, yet many years had to elapse before the theory of television reached practical accomplishment. The man who succeeded in that vital step was Mr. John Logie Baird, upon whose work this book is founded.

To go back again to the early theorists, the outstanding name of Nipkow must be mentioned. It is his spiral disc which forms a prominent part in the present-day television apparatus. Weiller's name must not be forgotten, as he was the originator of the mirror drum, which forms the basis of certain apparatus now emerging from the experimental stage; but although these theorists were early in the field with a description of their apparatus, nearly thirty years elapsed before television was actually achieved.

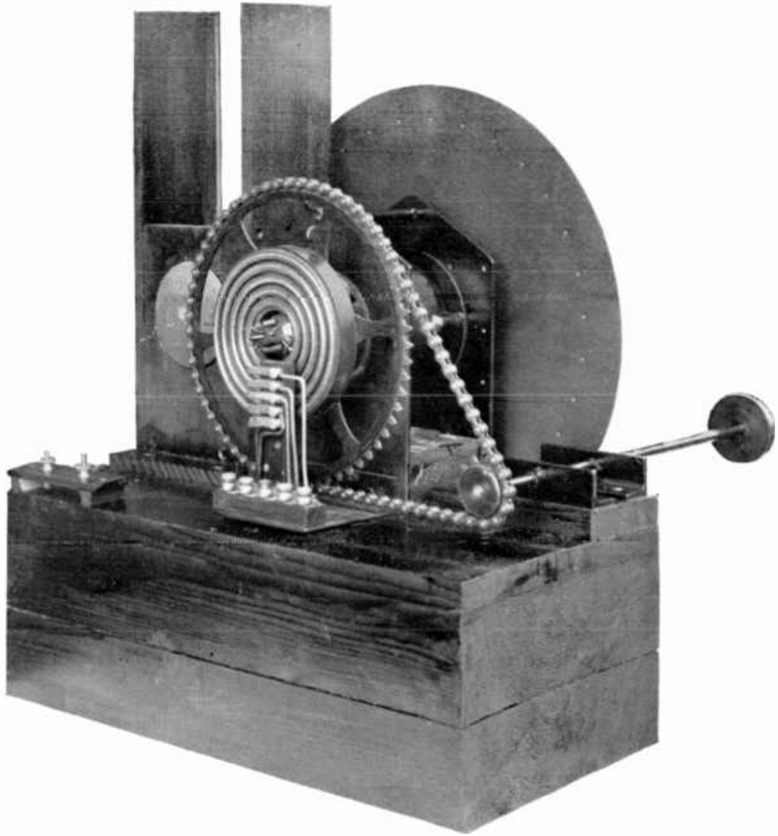
A public demonstration of the transmission of outlines was given at Selfridge's in April, 1925, when Mr. Baird, with the crudest of apparatus, transmitted by wireless the outlines of simple objects.

First Demonstration of Television

In addition, silhouettes were transmitted in America by Mr. C. F. Jenkins in July, 1925, but it was not until January, 1926, that true television was accomplished, and the gigantic step made from the transmission of silhouettes to the transmission of real images.

On 27th January, 1926, Mr. Baird gave a demonstration to some forty members of the Royal Institution, and showed them the transmission of real images between one room and another by television—the living human face being transmitted. Since it is our claim that this was the first time in history that actual television had been demonstrated, it is useful to quote the account of the demonstration given in *The Times* of 28th January, 1926—

> Members of the Royal Institution and other visitors to a laboratory in an upper room in Frith Street, Soho, on Tuesday saw a demonstration of apparatus invented by Mr. J. L. Baird. . . .
>
> For the purpose of the demonstration the head of a ventriloquist's doll was manipulated as the image to be transmitted, though the human face was also reproduced. First on a receiver in the same room as the transmitter, and then on a portable receiver in another room, the visitors were shown recognizable reception of the movements of the dummy head and of a person speaking. The image as transmitted was faint and often blurred, but substantiated a claim that through the "Televisor," as Mr. Baird has named his apparatus, it is possible to transmit and reproduce instantly the details of movement, and such things as the play of expression on the face.



THE HISTORIC TELEVISION RECEIVING APPARATUS WITH WHICH MR. BAIRD GAVE HIS DEMONSTRATION TO MEMBERS OF THE ROYAL INSTITUTION IN JANUARY, 1926

This model is now in the South Kensington Museum, London

Praise from Independent Critics

Demonstrations were also given to representatives of the technical and scientific Press, and since rival claimants are making their tardy appearance, an account which appeared in *Nature* of 3rd July, 1926, written by Dr. Russell, F.R.S., the Principal of Faraday House, is worth quoting—

> We saw the transmission by television of living human faces, the proper gradation of light and shade, and all movements of the head, of the lips and mouth, and of a cigarette, and its smoke were faithfully portrayed on a screen in the theatre, the transmitter being in a room at the top of the building. Naturally, the results are far from perfect. The image cannot be compared with that produced by a good kinematograph film. The likeness, however, was unmistakable, and all the motions are reproduced with absolute fidelity. This is the first time we have seen real television, and, so far as we know, Mr. Baird is the first to have accomplished this marvellous feat.

Evidence from the United States, where the growth of interest in television is manifest, may be seen in the *Radio News* (America's foremost radio journal) of September, 1926, which sent a special commissioner to investigate Mr. Baird's claim—

> Mr. Baird has definitely and indisputably given a demonstration of real television. It is the first time in history that this has been done in any part of the world.

Similarity to Present-day Apparatus

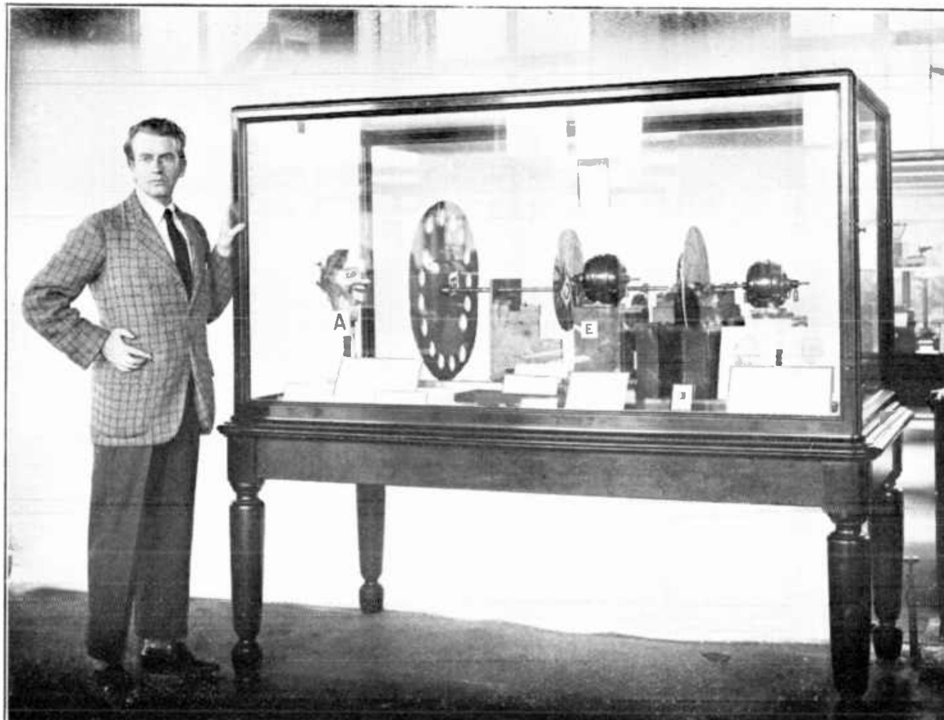
In recalling these past events, it is of great importance to note that the apparatus used by Mr. Baird in these experiments is almost identical with that now in common use. The receiving apparatus consisted of the same disc, with a spiral arrangement of holes (the Nipkow disc). Behind this was the same neon tube, and a synchronous motor was used to obtain synchronism.

The device is described in *Nature* as follows—

A series of demonstrations was given by Mr. J. L. Baird, of an experimental apparatus of his own design for wireless "television" (i.e. the simultaneous reproduction at a distance of an image of a fixed or moving object). The inventor does not claim any great perfection for his results, but we have seen the production in the receiver of a recognizable, if rather blurred, image of simple forms, such as letters painted in white on a black card, held up before the transmitter. Mr. Baird has overcome many practical difficulties, but we are afraid that there are many more to be surmounted before ideal television is accomplished.

In the transmitting apparatus, the object, strongly illuminated, is placed opposite a revolving disc provided with a series of lenses, each a little nearer to the centre than the last, which project a series of moving images upon a selenium or other photo-electric cell, each a little displaced laterally from the last. This is the equivalent of passing the cell over the whole surface of the object in a succession of close parallel lines. The light thus reaching the photo-electric cell is rhythmically interrupted by a rapidly revolving slotted disc, and the result is that owing to the variations of resistance of the cell, undulations at an audio-frequency are produced in the current through it, whenever a bright part of the object is being dealt with. These are amplified and supplied to a simple wireless transmitter, which is caused to emit corresponding signals.

In the receiving section of Mr. Baird's television apparatus, the signals sent out from the transmitter are detected and amplified by very powerful valves, until they are strong enough to light up a neon tube when a signal is received, i.e. when a bright part of the object is being dealt with by the transmitting apparatus. A disc, with lenses or holes corresponding to the lenses of the transmitting disc, is rotated synchronously with the transmitting disc, causing spots of light produced by the neon tube to appear upon a screen in positions corresponding to the part of the object being dealt with. With a sufficiently rapid rotation of the discs, a recognizable image of the subject is produced. A duplicate of the receiving apparatus is provided at the sending end with its disc mounted on the same shaft as the transmitting disc, to enable the necessary adjustments to be made. Synchronism between the sending and receiving discs is obtained by a little alternator with a frequency of about 300 geared to the revolving system, which causes signals to be sent out by another



Mr. J. L Baird with his Original Television Apparatus, which is now in the South Kensington Museum, London wireless transmitter at this frequency. These are received and amplified at the receiving station to an extent enabling a similar little alternator connected to the receiving discs to be synchronized with them.

(Extract from *Nature*, 4th April, 1925.)

The First Model

It is of interest to the reader to know that Mr. Baird's original apparatus, with which he gave the first demonstration of silhouette television at Selfridge's, is now in the South Kensington Museum, London, and the following is an extract from the description attached to the model by the Museum authorities—

ORIGINAL TELEVISION APPARATUS

MADE BY J. L. BAIRD, ESQ.

Lent by Messrs. Television, Ltd.

This is the transmitting portion of the original apparatus used by Mr. J. L. Baird in experiments which led him from the wireless transmission of outlines in 1925 to the achievement of true television nine months later, when, on 27th January, 1926, the transmission of living human faces with light, shade, and detail was demonstrated before members of the Royal Institution, this being the first demonstration of true television ever given.

Baird's priority was clearly recognized in the U.S.A. The *New York Times* of 6th March, 1927, gave a whole page to the subject, and referred to the fact that—

No one but this Scottish Minister's son has ever transmitted and received a recognizable image with its gradation of light and shade.

The Vision of Objects in Total Darkness

The next noteworthy step in the progress of television took place on 30th December, 1926, when Mr. Baird demonstrated the vision of objects in total darkness, by applying the *infra* red rays to television. Here is an eye-witness's account—

It may be of interest if I give a brief résumé of the demonstrations Mr. Baird has given to me at Motograph House. Last June he gave a demonstration of the transmission of the images of living people, showing gradations of light, shade, and detail. An account of this demonstration was published in *Nature* of 3rd July, 1926.

The images, naturally, were not comparable with those shown on a modern cinema screen, but the likenesses were unmistakable. The person whose image was transmitted sat in a flood of brilliant light. Mr. Baird has now developed a method by which the image of the person is transmitted, although he is in complete darkness. This result is obtained by flooding the "sending" room by *infra* red rays. On the 23rd November, 1926, Mr. Baird gave a demonstration to Mr. W. R. Crookes and me. One of us stayed in the sending room with a laboratory assistant in apparently complete darkness. In the receiving room, on another floor, the image of the assistant's head was shown brilliantly illuminated on a screen, and all the motions he made could be readily followed.

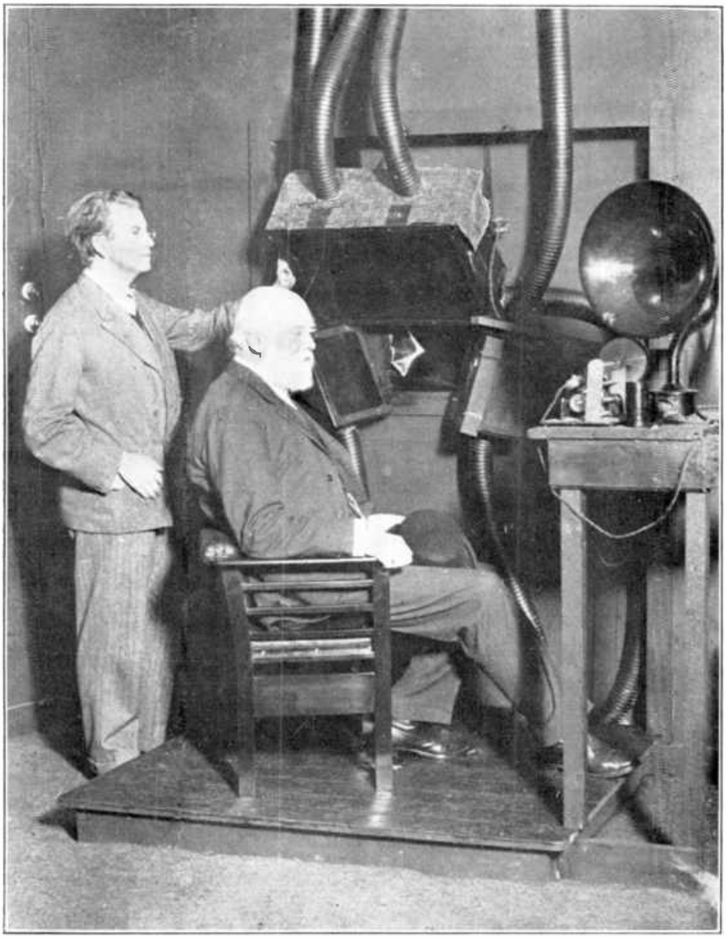
These images were not outlines or shadowgraphs, but real images by diffusely reflected rays. The application of these rays to television enables us to see what is going on in a room which is apparently in complete darkness. So far as I know, this achievement has never been done before.

We had the impression that the image on the screen was not quite so clearly defined as when visible rays were used, but we easily recognized the figures we saw, and made out their action. The direct application of Mr. Baird's invention in warfare to locating objects apparently in the dark seems highly probable, but I hope that useful peace applications will soon be found for it.

ALEXANDER RUSSELL.

FARADAY HOUSE,
SOUTHAMPTON ROW, W.C.1.
28*th January*.

(Extract from *Nature*, 5th February, 1927.)



At the Leeds British Association Meeting in 1927 Sir Oliver Lodge was Successfully "Noctovised"

The First Television Demonstration Outside Britain

In April, 1927, the American Telephone and Telegraph Co. staged a most elaborate demonstration of television, the first to be given outside England. At this demonstration images were sent between New York and Washington, and the experiment was staged with the greatest publicity and the utmost elaboration, occupying in all the services of 1,000 engineers. The remarks of Dr. Dauvillier, an independent French scientist, writing in the *Revue Générale de L'Electricité* (7th January, 1928) upon this achievement, need no further comment.

ÉTUDE DES DIVERS PROCÉDÉS PROJETÉS OU RÉALISÉS

PAR M. A. DAUVILLIER

Para. 26. Procédé de la Bell Telephone Company. Enfin, la Bell Telephone Company a récemment réussi à transmettre à grande distance, sans fil, le visage humain en utilisant (sans le dire !) le procédé Baird.

TRANSLATION

SURVEY OF THE DIFFERENT SYSTEMS, SUGGESTED OR CARRIED OUT

BY M. A. DAUVILLIER

Para. 26. "The Bell Telephone Company's System." Finally, the Bell Telephone Company recently succeeded in transmitting to a considerable distance, by wireless, the human face, using (without saying so !) the Baird system.

Using Service Telephone Lines

The American Telephone and Telegraph Co.'s demonstration was followed by Baird's transmitting images between London and Glasgow, over the ordinary service telephone lines. Baird accomplished this with the aid of only two operators, his receiver consisting of a simple apparatus placed in the sitting-room of the Central Station Hotel, Glasgow. On this apparatus Baird and others were seen and recognized by leading scientists and city men of Glasgow. Professor Taylor Jones, who holds the Chair of Physics at Glasgow University, described the demonstration in the following words—

On the 24th and 26th May I proceeded, at the invitation of Mr. John L. Baird, to the Central Station Hotel, Glasgow, to witness demonstrations of television between London and this city. I was received by Mr. Baird's colleague, Captain Hutchinson, who explained that the transmission was to take place over the telephone line, Mr. Baird, in his laboratory in London, being in charge of the transmitting apparatus.

The earlier apparatus devised and used by Mr. Baird has been described by him in the *Journal of Scientific Instruments* for February, 1927. A model of the original transmitting apparatus is in the possession of the University of Glasgow, of which Mr. Baird was a former student. The following additional information as to the method has been supplied by him—

The method used in the London-to-Glasgow demonstration consisted in passing an image of the object being transmitted over a light-sensitive cell in a series of strips. The modulated current from the cell was transmitted over the ordinary trunk telephone line, and at the receiving station in Glasgow was used, after amplification, to control the light of a glow discharge lamp, a modified form of neon tube, giving a light of intense brilliance, being employed. By means of a revolving slotted shutter a point of light from this lamp was caused to travel over the field of vision in exact synchronism with the traversal of the image over the cell at the transmitting station, complete traversal taking place in about one-eighth of a second.

The receiving apparatus was set up in a semi-darkened room, the lamp and shutter being enclosed in a case provided with an aperture. The observer looking into the aperture saw at first a vertical band of light in which the luminosity appeared to travel rapidly sideways, disappearing at one side and then reappearing at the other. When any object having "contrast" was placed in the light at the sending end, the band broke up into light and dark portions forming a number of "images" of the object. The impression of sideway movement of the light was then almost entirely lost, and the whole of the

Television from London to Glasgow. Professor Taylor Jones, Sir John Samuel, Sir John Henderson and other prominent Glasgow citizens watching the reception.

SUCCESSFULLY RECEIVING THE TELEVISION TRANSMISSION BY LAND LINE FROM LONDON TO GLASGOW image appeared to be formed simultaneously. The image was perfectly steady in position, was remarkably free from distortion, and showed no signs of the "streakiness" which was, I believe, in evidence in the earlier experiments. The size of the image was small, not more than about 2 in. across when the "object" was a person's face, and it could be seen by only a few people at a time. The image was sufficiently bright to be seen vividly even when the electric light in the room was switched on, and I understand that there is no difficulty in enlarging the image to full size. I was told also that arrangements will soon be made for transmitting larger "objects," and for increasing the number of appearances of the image per second.

The amount of light and shade shown in the image was amply sufficient to secure recognizability of the person being "televised," and movement of the face or features was clearly seen. At the second demonstration some of those present had the experience of seeing the image of Mr. Baird transmitted from London while conversing with him (over a separate line) by 'phone.

My impression after witnessing these demonstrations is that the chief difficulties connected with television have been overcome by Mr. Baird, and that the improvements still to be effected are mainly matters of detail. We shall doubtless all join in wishing Mr. Baird every success in his future experiments.

(Extract from *Nature*, 18th June, 1927.)

Baird Startles the World with Epoch-making Experiment

On 9th February, 1928, the public were startled to learn that the Atlantic had been spanned by vision. Using a short wave station, situated at Coulsdon, Baird had succeeded in transmitting images to Hartsdale, a suburb of New York. Note the remarks of the *New York Times* of 11th February, 1928, in regard to this demonstration—

Baird was the first to achieve television at all, over any distance. Now he must be credited with having been the first to disembody the human form optically and electrically, flash it piecemeal at incredible speed across the ocean, and then reassemble it for American eyes.

His success deserves to rank with Marconi's sending of the letter " s " across the Atlantic—the first intelligible signal ever transmitted from shore to shore in the development of transoceanic radio telegraphy. As a communication, Marconi's " s " was negligible; as a milestone in the onward sweep of radio, of epochal importance. And so it is with Baird's first successful effort in transatlantic television.

Reception in Mid-ocean

The transmission across the Atlantic was followed almost immediately by the transmission to the " Berengaria " in mid-ocean, where the chief wireless operator of this ship was enabled to see his fiancée in Long Acre, London. In an interview with a representative of the *Television Magazine*, Mr. Brown, chief wireless operator of the " Berengaria," said—

> It was a wonderful experience to be able to see Miss Selvey like that in mid-Atlantic, and the achievement clearly demonstrates the enormous progress which has been made in television.

The First Daylight Television

In June, 1928, television by daylight was accomplished in the Baird laboratories, and it is pleasing to note Sir Ambrose Fleming's remarks on this achievement, as published in the *Television Magazine* for July, 1928—

> The writer has had the opportunity of seeing in practical operation in Mr. Baird's laboratory a very striking advance in the apparatus for television which has been recently made by Mr. Baird.
>
> In this vast improvement it is not necessary for the face or object, the image of which is to be transmitted for television, or " televised " (if one may venture to coin such a word), to be scanned by a brilliant beam of light traversing it, or to be flooded by powerful infra-red rays as explained below. The object whose image is to be transmitted can be simply placed in diffused daylight, just as if the ordinary photograph of it had to be taken. The transmitting apparatus is then placed near to the object, and the image of it appears on the screen

THE SCENE ON THE LINER "BERENGARIA" ON THE HISTORIC OCCASION WHEN TELEVISION IMAGES TRANSMITTED FROM LONDON WERE SEEN IN MID-ATLANTIC at a distance when proper synchronism is secured. The advantage of this important advance will be clear. It means that the face of a singer or speaker can be transmitted by television at the same time that the voice is being picked up by a microphone for ordinary wireless broadcasting. It means a great step forward in the possibility of transmitting to a distance the image of moving objects or persons as seen in ordinary daylight, without exposing them to rapidly moving beams of light, or to dazzling illuminations or dark heat radiation.

The television transmitter becomes, in fact, a more complicated kind of camera, in which the screen on which the image appears is not immediately behind the lens, but may be miles or hundreds of miles away.

Television in Natural Colours

In August, 1928, Mr. Baird demonstrated television in natural colours, and the report of this achievement is proof of the interest it created—

We have seen Baird's method of producing colour television. The process consists in first exploring the object, the image of which is to be transmitted, with a spot of red light, next with a spot of green light, and, finally, with a spot of blue light. At the receiving station a similar process is employed, red, blue, and green images being presented in rapid succession to the eye.

The mechanism used at the transmitter consists of a disc perforated with three successive spiral curves of holes. The holes in the first spiral are covered with red filters, in the second with green filters, and in the third with blue. Light is projected through these holes, and an image of the moving holes is projected on to the object. The disc revolves at ten revolutions per second, and so thirty complete images are transmitted every second—ten blue, ten red, and ten green.

At the receiving station a similar disc revolves synchronously with the transmitting disc, and behind this disc in line with the eye of the observer are two glow discharge lamps. One of these lamps is a neon tube, and the other a tube containing mercury vapour and helium. By means of a commutator, the mercury vapour and helium tube is placed in circuit for two-thirds of a revolution and the neon tube for the remaining third. The red light from the neon tube is accentuated by placing red filters over the view holes for the red image. Similarly, the view holes corresponding to the blue and green images are covered by suitable filters. The blue and green lights both come from the mercury helium tube, which emits rays rich in both colours.

The colour images we saw which were obtained in this way were quite vivid. Delphiniums and carnations appeared in their natural colours, and a basket of strawberries showed the red fruit very clearly.

(*Nature*, 18th August, 1928.)

Stereoscopic Television

After Mr. Baird had successfully demonstrated both daylight and colour television, demonstrations on similar lines were staged in the U.S.A., but, as in other cases, to Mr. Baird must be accorded the credit of accomplishing them first.

This was followed almost immediately in August, 1928, by a demonstration of television in stereoscopic relief. The remarks of Professor Cheshire, C.B.E., A.R.C.S., F.I.P., writing in the September, 1928, issue of the *Television Magazine*, are worth quoting—

These pictures, when viewed by an ordinary stereoscope, gave a picture in relief of the object—a human head—transmitted. In this simple way has another milestone been passed on the way to the achievement of that magical combination of the wireless transmission of perfect hearing with that of perfect seeing.

The B.B.C. and the Baird Co.

After a year of bitter controversy between the Baird Co. and the British Broadcasting Corporation as to the commercial practicability of television, the questions as to whether television could be broadcast inside the normal broadcasting band, as allotted to public service stations, and as to whether a separate wave-length was required for synchronizing, were finally and definitely settled when the Baird Co. gave a demonstration of

Mr. Jack Buchanan Posing before the Daylight Television Transmitter in July, 1928 television through 2LO, before a representative committee of the engineers of the Post Office and B.B.C. and Members of Parliament. Television was received on portable " Televisors " both at the Post Office and at Savoy Hill, no separate synchronizing signal being transmitted, and only the ordinary broadcast service channel as used for speech being employed—thus establishing once and for all that television could be broadcast under commercial conditions. This demonstration was hailed by the Postmaster-General and his Committee as "a noteworthy scientific achievement."

An Inaugural Ceremony

On 30th September, 1929, the lengthy negotiations between the B.B.C. and the Baird Co. were brought to a successful conclusion, and an experimental television service through 2LO was inaugurated.

The event was made the subject of a special programme, the details of which we give below—

11.4 a.m. MR. SYDNEY A. MOSELEY opened the proceedings with the following announcement—

LADIES AND GENTLEMEN: You are about to witness the first official test of television in this country from the studio of the Baird Television Development Company and transmitted from 2LO, the London station of the British Broadcasting Corporation.

On this inaugural occasion we are very fortunate in having with us Sir Ambrose Fleming.

I must explain that as the facilities for broadcasting both *speech and vision simultaneously are not yet available*, we shall transmit first of all speech, and afterwards those of you who have " Televisors " will have an opportunity of seeing the speakers. Listeners not yet in possession of "Televisors" should leave their sets tuned in, in the ordinary way.

Before asking Sir Ambrose to address you, I have a message from Mr. William Graham, the President of the Board of Trade, which I shall read to you.

MESSAGE FROM THE

RT. HON. WILLIAM GRAHAM, P.C., M.A., LL.D., M.P.

President of the Board of Trade, Member of the British Cabinet

It was with great pleasure I received the invitation to speak and be seen on this occasion of the first public experimental broadcast of television, and I deeply regret that circumstances prevent me from being present.

I look to this new applied science to encourage and provide a new industry, not only for Britain and the British Empire, but for the whole world.

This new industry will provide employment for large numbers of our people, and will prove the prestige of British creative energy.

In this first public broadcast, we have a beginning which will be historic in the evolution not only of a science, but of an art which will encourage closer relations between communities at home and abroad and provide a new avenue for educational development.

11.8 a.m. ANNOUNCER: Sir Ambrose Fleming will now be televised for two minutes.

11.10 a.m. ANNOUNCER: It is now my pleasure to call upon Sir Ambrose Fleming to address you. It is hardly necessary for me to say that it was due to the untiring work of Sir Ambrose, in the early days of wireless, that radio broadcasting, as we understand it to-day, has become possible. Now Sir Ambrose Fleming will say a few words.

SIR AMBROSE FLEMING: As President of the Television Society, I have great pleasure in saying a few words of congratulation both to the Television Company and to the British Broadcasting Corporation on the inauguration of a new departure in the art of television. It will, I am sure, contribute to the pleasure of countless persons and assist in the creation of a new industry which owes so much to the genius of Mr. Baird.

11.12 a.m. ANNOUNCER: Professor Andrade will now be televised for two minutes.

11.14 a.m. PROFESSOR E. N. DA C. ANDRADE: I am glad to be able to take part in this interesting experiment, which may be compared with the occasion on which the records of the early phonograph were publicly tried. The voices that then issued from the horn were not of the clarity which we now expect, and the faces that you will see to-day, by Mr.

Sir John Ambrose Fleming Sitting Before the Television Transmitter, when the B.B.C. Inaugurated Television Transmissions from 2LO, on 30th Sept., 1929

Baird's ingenious aid, are pioneer faces, which will, no doubt, be surpassed in beauty and sharpness of outline as the technique of television is developed. One face, however, is as good as another for the purpose of to-day's demonstration, and I offer mine for public experiment in this first television broadcast.

ANNOUNCER: Now we come to the second half of the proceedings, which I fancy will be in a rather lighter vein.

11.16 a.m. SYDNEY HOWARD: Televised for two minutes.

11.18 a.m. SYDNEY HOWARD: Gave a comedy monologue.

11.20 a.m. MISS LULU STANLEY: Televised for two minutes.

11.22 a.m. MISS LULU STANLEY: Sang " He's Tall and Dark and Handsome " and " Grandma's Proverbs."

11.24 a.m. MISS C. KING: Televised for two minutes.

11.26 a.m. MISS C. KING: Sang " Mighty like a Rose."

11.28 a m. MAJOR A. G. CHURCH, M.P.: This is the first official occasion on which the features of living persons have been transmitted through the British Broadcasting Corporation's station by arrangement with the Baird Television Development Company.

It is a great occasion, and one on which it is a great privilege to be present. As the General Secretary of the Association of Scientific Workers, I welcome this triumphant application of science to life. Mr. Baird's is a comparatively new invention. He does not assert that the images which you who are in possession of " Televisor " receivers see, are the final product of his brain, or those of other inventors interested in the development of this new means of communication. You yourselves will appreciate the nature of his triumph. You will not be satisfied until you can have transmitted to you visible images of activities in which so many of us are interested; for example, a classic horse race, the Boat Race, a football match, or a great public ceremony.

We have heard recently a great deal about conversations across the Atlantic. The development of television will enable people not only to converse over great distances, but also to see each other at the same time. The influence this may have upon the relations between the heads of States throughout the world is incalculable. It must be beneficial.

I desire to congratulate Mr. Baird warmly on the success which has attended his efforts. I should also like to express the hope that those who wish to see this new industry developed, and television must be regarded as a new industry, will, so soon as possible, install a receiving apparatus in their homes.

Television Transmissions Successfully Received in the Provinces

These original experimental television transmissions were from the old 2LO with its relatively small power, but, even so, the signals were well received all over this country and abroad. As indicative of what could be accomplished with these first broadcasts, extracts from a column appearing in the *Bradford Telegraph and Argus*, dated 8th October, 1929, will no doubt serve as a valuable guide—

History was made in Bradford to-day. Television transmissions from London were received in Bradford.

In simpler language, a man, easily recognizable, was seen to be making grimaces and turning his head despite the fact that the man was in London and the witnesses in Bradford.

A *Telegraph and Argus* reporter was privileged to-day to witness this, the first wireless transmission of television to be received in the provinces from the B.B.C. London Station.

Mr. H. J. Barton Chapple was in charge of the experiment, and was assisted by Mr. Sidney R. Wright, of Bradford, at whose home at Nab Wood the experiment was conducted.

The first difficulty was in securing the London transmission at loud-speaker strength—wireless enthusiasts will appreciate this. This part of the task was in the hands of Mr. Wright, who succeeded with the aid of a screened grid set in securing sufficient strength.

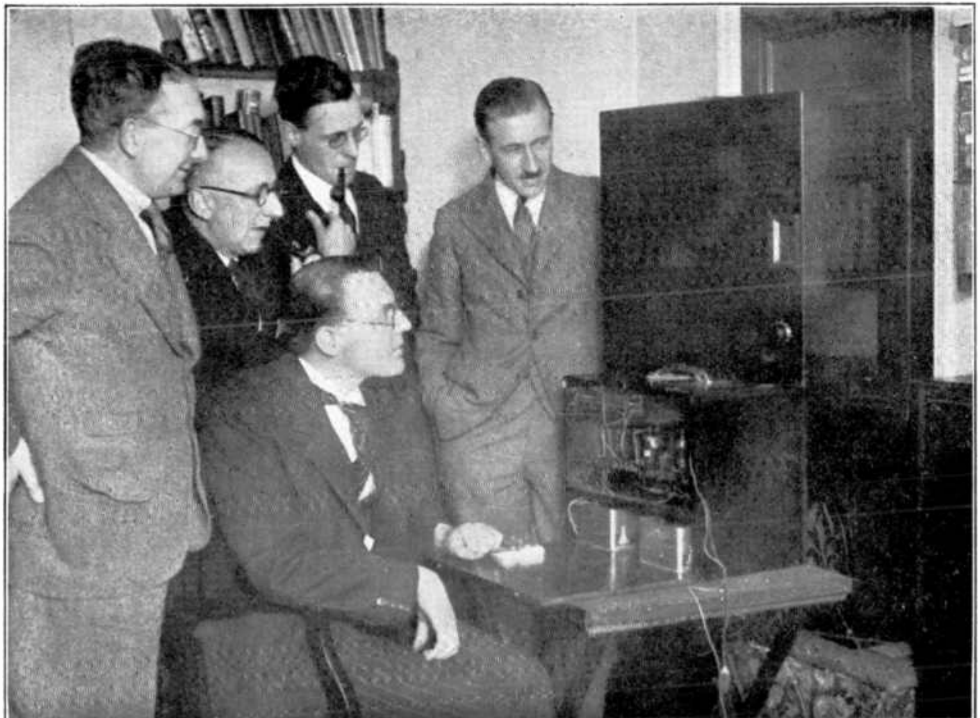
This set was coupled with another three-valve amplifier which carried the output to the portable "Televisor," which was manipulated by Mr. Barton Chapple.

At 11 o'clock the announcement was made that the television transmission was to commence. The loud-speaker was switched off and the "Televisor" switched on.

Through an aperture measuring, roughly, four inches by two—it can, of course, be enlarged to suit requirements—dots of orange light appeared. Quickly the dots flashed past the eye until nothing but a square of orange light was to be seen.

An adjustment here, and then the dots formed themselves into the shape of a man's face. Another adjustment, and then the face became recognizable.

Enthralled, the three or four people in the room watched



Mr. H. J. Barton Chapple (seated) Giving the First Wireless Demonstration of Television to be Received in Bradford from the B.B.C. London Station this individual as he turned his head first to one side and then the other, opened his mouth, raised his eyebrows, laughed and scowled. It was difficult to imagine that this vision was being flashed 200 miles through the air. The man disappeared.

In its place there came another vision. Still a man's face, which in a moment was easily recognizable as a profile of the Prince of Wales. He was without a hat, and his collar and tie were easily seen.

Listeners who know the difficulty in getting the London transmission will realize that a distinct triumph was secured in attaining such excellent results, and it is evident now that television has reached such a stage as to be of great entertainment value.

It should also be added that the transmission and reception was in full daylight.

A Dual Transmission

The next milestone was the dual transmission—speech and sight simultaneously—which took place on 31st March, 1930.

One cannot do better than to quote the account of this historic event as it appeared in *The Times*.

Television Broadcast with Sound

SUCCESS OF THE BAIRD EXPERIMENTS

(*From our Wireless Correspondent*)

The B.B.C. twin wavelength station at Brookman's Park broadcast sound and vision simultaneously at 11 a.m. yesterday. It is the first station to do so. Speech and music were transmitted in the usual way by the London Regional transmitter on 356 metres, while the television images of those before the microphone were simultaneously sent out by the National transmitter working on the wavelength of 261 metres. The programme broadcast originated in the studio of the Baird Television Company in Long Acre, from which the television and sound signals were conducted by separate lines through the B.B.C. control room at Savoy Hill to Brookman's Park, where they were radiated on the separate wavelengths.

The whole transmission was very successful, and at a receiving station in the centre of London the whole programme was followed with great interest. By means of a Baird "Televisor" and a little adjustment of the two knobs which respectively control the synchronization and the "framing" of the picture, the rapidly swirling pattern was resolved into a steady head and shoulders image of the speaker. Two wireless sets were used, one for receiving the television signals and the other for the reception of the sound signals. A particularly noteworthy feature of the dual transmission was that there was no lag between vision and sound such as often destroys the illusion of the "talkies." Such exact synchronism is, of course, brought about automatically by the practically instantaneous transmission of both television and sound signals.

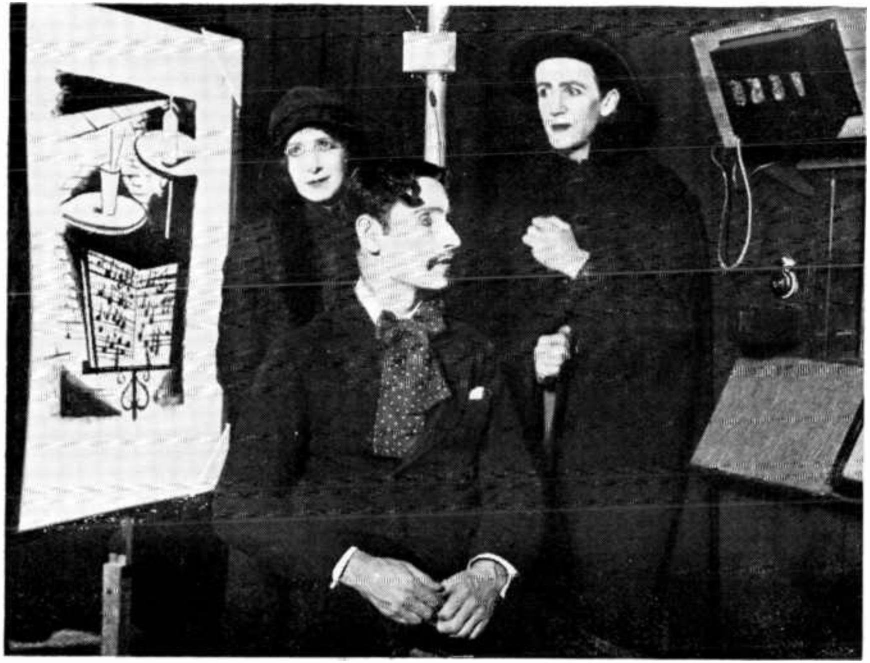
The Programme

The programme yesterday consisted of introductory remarks by Mr. Sydney A. Moseley, who is largely responsible for starting the present series of dual tests, followed by short speeches by Sir Ambrose Fleming, the well-known inventor of the thermionic valve, and Lord Ampthill, the chairman of the Baird International Company. Songs by Miss Annie Croft and Miss Gracie Fields then followed. Mr. R. C. Sherriff, who was to have spoken, was unavoidably prevented from coming to the studio.

Although it was noticed in the transmission yesterday that some faces appear to "televise" better than others, the detail of the images transmitted by the Baird system is remarkable and, to the technically minded, is indeed surprising, considering the relative simplicity of the receiving apparatus. The simplicity is largely due to the fact that the synchronization of the movement of the spot of light which scans the subject televised with that which finally produces the picture is automatic, and does not necessitate the use of a separate wireless channel.

The future of the broadcasting of television in this country is difficult to foresee. At present the material that can be transmitted is naturally limited, and television of such an event as the Boat Race is out of the question. But it is important to note and to register appreciation of the important progress that has been made by Mr. Baird in his efforts to bring about television in the home.

Television sets such as were used in yesterday's reception in London are to be sold for 25 guineas, though many amateurs will, no doubt, wish to buy the kit of parts for home construction, which are being sold in the London stores for 16 guineas. These "Televisors" are designed to work in conjunction with a wireless receiver capable of delivering good quality output of the order of 1½ watts. Since it is important that the



THE FIRST TELEVISION PLAY TO BE BROADCAST THROUGH THE MEDIUM OF THE B.B.C. STATION WAS CALLED "THE MAN WITH THE FLOWER IN HIS MOUTH"

The artists are shown before the transmitter lower modulation frequencies shall be preserved in the amplifier stages, resistance-capacity amplifiers are specially recommended for use in this connection.

Lord Ampthill's Speech

Lord Ampthill, before the transmitter, said that this was a very memorable occasion for all those who were interested in television, or indeed in the progress of science, as they had reached a goal at which they had been striving for a long time, and were actually inaugurating the double wave transmission. He desired to offer his hearty congratulations to Mr. Baird and to all those who had assisted him in the development of his wonderful invention. As chairman of the Baird International Television Company he welcomed this opportunity of thanking the B.B.C. for all that they had done to assist them. As they might know, this transmission had been made possible by the close co-operation of the B.B.C. engineers with the engineers of the Baird companies.

The First Play

On 1st July we saw another big advance made when, on the roof of the Baird Company in Long Acre, Mr. J. L. Baird showed a screen approximately 2 ft. by 5 ft., on which could clearly be seen living images of extraordinary brilliance.

This was the demonstration to the Press representatives of the screen which soon afterwards made history when it was shown at the London Coliseum.

July 14th proved another red-letter day, for the first play to be televised was transmitted under the auspices of the B.B.C. It was called, "The Man with a Flower in his Mouth," by Pirandello. The producer was Mr. Lance Sieveking of the B.B.C., aided by Mr. Sydney A. Moseley, Director of Programmes of the Baird Company.

Special scenery was painted by that famous artist, Mr. C. R. W. Nevinson, the four scenes designed for this first television play being—

1. Conductor's score and café tables.

2. The dark street outside the café.

3. The table at which the man is sitting; with glass, etc.

4. Close-up of tumbler into which he stares.

The members of the caste, Mr. Earle Grey, Mr. Lionel Millard, and Miss Gladys Young, contributed very largely to the success of the production.

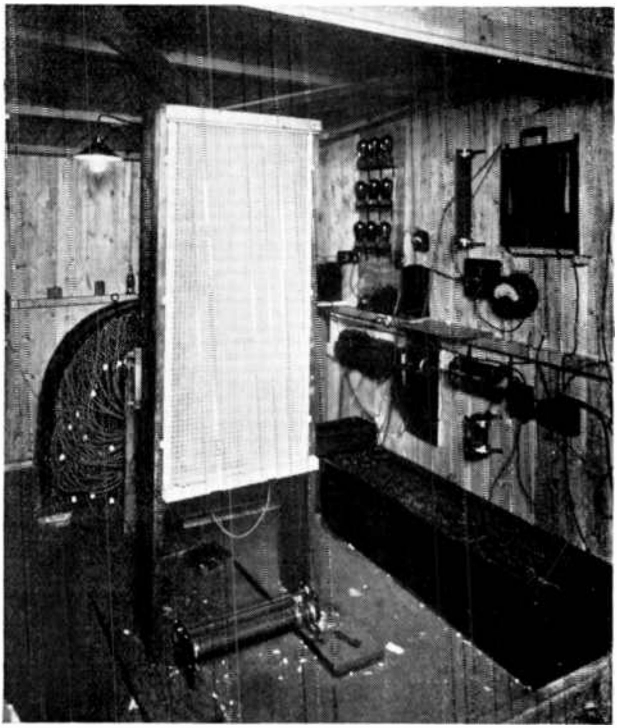
Introducing the Big Screen

On Monday, 28th July, 1930, for the first time in the history of the world, television and tele-talkies were included in the public programme of a theatre.

Sir Oswald Stoll, who has always been such a staunch supporter of Britain and of everything British, arranged with the Baird Company to allot part of the programme of each performance at the London Coliseum for a period of two weeks to demonstrations of this marvel of science, transmission of television on to a large screen.

Eminent men and women in politics, sport, law, literature, the stage, and other spheres, sat before the transmitter in the Baird Studios in Long Acre, and spoke for two minutes on their own special subjects. By this means the audience at the Coliseum were able to see and hear, while they were actually speaking, those great personalities about whom one reads in the newspapers, but rarely has the privilege of seeing.

Amongst the many celebrities who were televised during that period were: Sir Francis Goodenough, Lt.-Commander Kenworthy, Robert Young, M.P., Lord Baden Powell, Rt. Hon. George Lansbury, M.P., Lord Marley, Frederick Montague (Under-Secretary of State for Air), Col. L'Estrange Malone, M.P., Young Stribling, Sir Nigel Playfair, H. W. Austin (tennis champion),



Showing the Big Screen in the Baird Laboratories
Prior to its Demonstration at the Coliseum

Herbert Morrison (Minister of Transport), Miss Ishbel MacDonald, Miss Ellen Wilkinson, M.P., Sir Oswald Mosley, M.P., Bombardier Billy Wells, A. V. Alexander, M.P., The Rt. Hon. Lord Mayor of London, Miss Irene Vanbrugh. A talking film was also televised.

So great was the public interest in these demonstrations that the "house full" notice became a common sight during the fortnight's visit of the television screen to that theatre.

This success was followed by similar demonstrations at the Scala Theatre, Berlin, which opened on 18th September, showing twice daily for seven days a week until 30th September.

Just as British celebrities had appeared at the Coliseum demonstrations, so in the same way German celebrities, including several Cabinet Ministers, were televised to the Scala.

Many difficulties were encountered in Berlin, but these were successfully overcome, and when the screen was seen for the first time in public, general amazement was expressed, not only by the lay public, but by the big body of interested scientists both in Berlin and other parts of Germany.

In all, twenty-six performances were given, and from beginning to end there was not a single hitch. In fact, it was the unanimous opinion of the Baird Engineers that the images were better than those shown at the Coliseum.

Following these performances in Berlin, the big screen journeyed to Paris, where it was shown in the Olympia Cinema, and then on to the Röda Kvarn Cinema at Stockholm.

In spite of difficulties associated with the transport and erection of the apparatus in these cities owing to the small size of the stage entrances, the demonstrations were a great success, and amazing enthusiasm prevailed.

Zone Television

In an endeavour to increase the scope of the scene which can be successfully televised, the Baird Company took steps to develop what is known as Zone television.

The first of this apparatus was demonstrated to the Press in the Baird Laboratories on 2nd January, 1931, and showed projected on to a small glass screen images of full-length figures of as many as eight persons. The scene was split up into three sections and transmitted side by side.

On this occasion the scene transmitted was not scanned by a rapidly moving spot of light, but was illuminated by ordinary flood lighting such as is used on the theatre stage. As will be seen by referring to Chapter XII, this demonstration was hailed as an amazing new development.

On the same day a disclosure was made of another notable advance, namely, modulating the light of an arc direct by means of the television signal. The image produced in this manner was of an intense brilliancy, but, although shown to a few members of the Press, it was not until September, 1931, that the arc was shown publicly. This is referred to later on in this chapter.

Televising the Derby

The next item of importance to record deals with daylight television. On Friday, 8th May, an actual street scene was transmitted by television. Prior to that date the bulk of the transmissions put out by the

THE BAIRD DAYLIGHT TELEVISION "CARAVAN" AGAINST THE RAILS AT EPSOM, PRIOR TO THE SUCCESSFUL TELEVISING OF THE DERBY IN 1931

22

Baird Company had been confined to subjects arranged in the studio; and, although television by daylight was demonstrated for the first time as a laboratory experiment in June, 1928, as recorded on page 10, sufficient progress had not been made with the apparatus to enable scenes from everyday life to be transmitted in ordinary daylight.

A few days previous to the demonstration in question, an experimental transmission had been made, through the B.B.C. station, of a scene on the roof of Long Acre; and on 8th May the Press were invited to witness scenes from Long Acre by television.

Drawn up outside the Baird offices in Long Acre was a caravan housing the transmitting apparatus. From the van's open door the "scene" was picked up and sent along a short length of land line to "Televisors" in the Baird Company's Demonstration Room. In these receiving instruments could be identified easily the people who were passing down the street: business men, Covent Garden porters, a policeman who had obviously come along to see what was happening and why the crowd had congregated—all were quite visible in the receiving apparatus.

It was expected that important developments would arise from the demonstration of this new type of apparatus, but few anticipated that Mr. Baird would take such a bold stride as to attempt to televise the world's greatest horse race, namely, the Derby. On the 3rd of June, 1931, however, Mr. Baird fulfilled a long-standing promise, to the confusion of the sceptics.

The same caravan which had been used for the daylight scene in Long Acre was moved to the racecourse at Epsom, and positioned against the rails opposite to the Grand Stand and winning-post. The vision signals were passed from here to the Control Room at Long

Acre and from thence to Savoy Hill, and finally to Brookman's Park, from which station they were broadcast by the National transmitter on a wavelength of 261 metres.

The parade of the horses was seen in both directions, and finally the horses were witnessed as they flashed past the winning post. Several "Televisors" had been arranged at the Demonstration Room in Long Acre, and the wireless signals received from the London National transmitter were passed on to these machines and shown to a large number of Press representatives in the room.

An idea of the success of this experiment—the first of its kind in the history of this science—may be gathered from the two newspaper extracts printed below—

"THE TIMES," 4TH JUNE

Yesterday afternoon the Baird Television Company, in co-operation with the B.B.C., broadcast a television transmission of scenes from the Derby, including a parade of horses before the start and the scene at the winning-post during the race. This broadcast is important in that it is the first attempt which has been made, in this or any other country, to secure a television transmission of a topical event held in the open air, where artificial lighting is impossible.

"THE DAILY TELEGRAPH," 4TH JUNE

Fifteen miles from the Course, in the Company's studio at Long Acre, all the Derby scenes were easily discernible—the parade of the horses, the enormous crowd, and the dramatic flash past at the winning-post. After the transmission Mr. Baird said that he was quite satisfied with the experiment.

"This marks the entry of television into the outdoor field," he said, "and should be the prelude to televising outdoor topical events."

Transmissions from Savoy Hill

The long anticipated closer co-operation between the B.B.C. and the Baird Company made a definite step

One of the Artists who Took Part in the First Television Transmission from the No. 10 B.B.C. Studio forward when, on 19th August, the usual half-hour morning programme, instead of being sent from the Baird studio by land line to Savoy Hill, took place from the B.B.C.'s No. 10 Studio near Waterloo Bridge.

This was the first time, under conditions of this nature, that a transmission had been effected within B.B.C. portals, and was taken by all concerned as a sign of definite friendliness in place of the one-time bowing acquaintance. Members of the Press were present in the Studio, and from their vantage point were able to watch the actual transmission take place through the medium of a portable transmitter.

The difference between this machine and those which were doing service at the Baird Company's premises was that in place of the revolving disc was substituted a drum with mirrors. Furthermore, it was possible to follow the artistes' movements with reasonable ease by adjusting the position of the mirror drum transmitter; and, according to reports which were received, the transmission proved to be one of the best yet experienced.

Following on this in October, 1931, the portable transmitter was installed at Savoy Hill itself, and there were weekly transmissions effected from this building, in which it was possible to show actual B.B.C. artistes while carrying out their normal broadcast for sound purposes.

The opening ceremony at Savoy Hill had for its subject Jack Payne and the B.B.C. Dance Band, and those in possession of "Televisors" were able to witness this popular artiste in their machines.

The Modulated Arc

In September, 1931, the Baird Modulated Arc, referred to on a previous page, was shown publicly for the first time at the British Association Meeting in the section devoted to Mechanical Aids to Learning. With this modulated arc it was possible to obtain a brilliantly illuminated image which could be projected successfully on to a large screen. It was shown several times per day at this British Association meeting, both the transmitter and receiver being housed in the same building, with ordinary land lines forming the link between the two ends. A standard light spot transmitter was used, while at the receiving end, behind the screen, was a mirror drum before which was a lens concentrating the light from the Baird modulated arc on to the mirrors. As the drum revolved, the light spot was made to traverse a screen in a succession of thirty parallel lines, the light from the arc lamp flickering in and out corresponding to the light and shade of the transmitted image.

Thus another step forward was made in overcoming the brilliancy question, which had tended to stand in the way of successfully projecting television images directly upon a large screen.

Ultra-Short Waves

The world's first public demonstration of ultra-short wave television transmission was given on 29th April, 1932, by Mr. J. L. Baird in London.

This historic event took place between the Baird premises in Long Acre, where the ultra-short wave transmitter had been erected, and a receiver installed at Messrs. Selfridge in Oxford Street. Not only was this a big development at the transmitting end, but a great advance was indicated by the entirely new receiver upon which the picture was seen. This latter showed the image on a screen instead of in a lens, as in the disc model "Televisor," and the size of the image

BOLDLY ADVERTISING THE FACT AT THE METROPOLE CINEMA THAT TELEVISION WAS BEING SHOWN DURING DERBY WEEK, 1932 was many times larger, thus allowing a roomful of people to see the image simultaneously.

The ultra-short waves, that is to say, those below a length of 10 metres, form an alternative method of broadcasting which does not in any way interfere with the present B.B.C.'s service.

The transmissions have the additional advantage that they allow television pictures of much finer detail to be transmitted, and provide a reliable local service absolutely free from fading and atmospheric disturbances.

The Derby on a Big Screen

The next historic transmission to which reference must be made was the Derby of 1932. This was outstanding, inasmuch as not only was a wireless transmission effected on lines similar to that in 1931, but a three-zone land line transmission was made from the Epsom Downs to a screen 10 feet wide and 8 feet high located in the Metropole Cinema, Victoria, London.

Details concerning this will be found in Chapter XII, but it is necessary to point out that the signals were transmitted in three zones over separate telephone cables to the stage of the cinema, where they were translated into visual images by means of an entirely new development in projection apparatus. The signals were made to modulate beams of light from three powerful arc lamps through the medium of three Baird grid cells interposed in their path.

On the day in question over two thousand people paid for admission to participate in this gigantic public experiment. Everyone agreed that it was a most remarkable achievement, and when Mr. Baird was persuaded to show himself on the stage after the race had been run, he was greeted with tremendous applause.

He smiled, but did not say a word. He had scored a triumph and left it at that.

The experiment was repeated with the Oaks on 3rd June and, although the visibility was not so good as that on Derby Day, it was attended with equal success.

In support of these two outdoor events, transmissions were effected from the Studio in Long Acre to the Metropole Cinema three times daily throughout Derby Week. In addition to ordinary artists, many celebrities appeared before the transmitter and addressed the audiences from the screen, and it is interesting to record that not a single hitch occurred during the whole week.

A New Model "Televisor"

At the end of this same month, a party of engineers and journalists were invited to witness a private demonstration of the latest model Baird "Televisor" at the Baird offices in Long Acre.

This machine had several distinctive features. Instead of being seen in a lens, which rather restricted the view to two or three persons at a time, the image was thrown upon a screen about 9 inches high by 4 inches wide. It could be seen all over a large room, and was sufficiently bright to be visible even with normal lighting present. The red colour of the neon lamp had been eliminated, giving instead a brilliant image in black and white. This was brought about by incorporating the newly developed Baird grid cell. Hitherto one of the great difficulties in using the ordinary Kerr cell or light valve has been that very high voltages are required, and such voltages make it impossible to construct a model suitable for use in the home.

MR. BAIRD BEING CONGRATULATED AFTER THE GREAT DERBY TELEVISION EXPERIMENT OF 1932

By using a special patented construction, the Baird Company has overcome this difficulty, and on every side this machine was hailed as being the greatest step forward since the original disc machine was marketed.

Television Transmissions Taken Over by B.B.C.

The progress which had been made steadily by the Baird Company had been watched very carefully by the B.B.C., and they came to the conclusion that sufficient advance had been recorded to make possible an extension of the facilities which had previously been enjoyed by that Company.

Up to this time transmissions had taken place from the Baird Studio, which provided the programme. They started on 30th September, 1929, for vision alone; and from 31st March, 1930, for dual sound and vision. These were regularly broadcast in the mornings, being supplemented with afternoon and midnight transmissions, but the bulk of the programmes were outside normal B.B.C. broadcasting hours.

An entirely new order of things has now taken place. The programmes, hitherto provided by the Baird Company, are now in the hands of the B.B.C., and the transmissions at present are effected on four nights a week at 11 o'clock. Vision is broadcast on 261 metres and the accompanying sound on 399 metres.

For this purpose the Baird Company have built and installed in Studio BB at Broadcasting House a mirror drum transmitter of very special type. It is suitable for both close-up and extended scenes, and this also is manipulated to follow artistes' movements with absolute ease.

The first programme transmitted from Broadcasting House took place on 22nd August, and was opened with Mr. Roger Eckersley, the Director of Programmes, introducing Mr. Baird. The announcement was as follows—

> "We are about to give the first of the new B.B.C. series of Television transmissions by the Baird process. Although television is still feeling its way, it has such potentiality that the B.B.C. is lending as much of its time and resources as is consistent with the normal demands of the programmes.
>
> "As it is the Baird process which is being used we are glad to welcome its inventor in the person of Mr. J. L. Baird, who will now be televised."

Mr. Baird, opening the programme, said—

> "I wish to thank the B.B.C. for inviting me here to-night and to express the hope that this new series of television transmissions will lead to developments of broadcasting, increasing its utility and adding to the enjoyment of the great listening public."

The Big Screen in Copenhagen

In bringing this historic survey to a close, it is necessary to mention two other demonstrations which have been given of the new type big screen. The first of these was at Messrs. Selfridge, where nine performances of 15 minutes duration were given daily from 15th August to 3rd September. During that period the images were watched by over 40,000 people, and following on this the same screen was taken to Copenhagen and shown at the Arena Theatre in that city.

The transmitting studio was in the offices of the newspaper *Politiken*, under whose auspices the demonstrations had been arranged. The images were shown in conjunction with cinema films twenty years old and, as on previous occasions, the land line demonstrations proved a great success.

The outstanding feature, however, took place on

MR. BAIRD WITH THE MAYOR OF HASTINGS ON THE OCCASION OF THE UNVEILING OF A PLAQUE TO HONOUR MR. BAIRD'S WORK ON TELEVISION IN THAT TOWN

8th November. On this day the normal television broadcasts emanating from the television Studio at Broadcasting House, London, were picked up in Copenhagen, some six or seven hundred miles away, passed through to the amplifier, and thrown on to the screen to be witnessed by a public theatre audience which had assembled for this purpose.

Mr. Carl Brisson made his first appearance before the microphone in order to participate in this experiment, and was seen in his native country and, curiously enough, in the very theatre in which he made his *debut.*

This transmission was amazingly successful and demonstrates once more how television can be employed over long distances. Both Danish and British experts were unanimous in stating that the result was an excellent one, the accompanying sound being heard in the Arena Theatre as well as the normal television image.

Sufficient conclusive proof has now been furnished to indicate exactly when Mr. Baird gave to the world the products of his fertile brain, and it is to be hoped that the collation of these reports will accord to this British pioneer the status which is his by right in the successful development of commercial television.

CHAPTER II

THE GENERAL DETAILS

A PERUSAL of the preceding chapter, dealing with the historical progress of Baird television, will have whetted the appetite of the reader for more details of a new science which must, in its final achievement, impinge upon our daily habits. Living in an age of miracles, we are inclined to take so much for granted. For the moment, at any rate, television is regarded with either incredulity or scepticism. This book will enable the reader to come down to brass tacks.

First-hand Information

The authors' intention is to place in the hands of the public the most up-to-date, first-hand information concerning the Baird system of television. Unfortunately, much information published is useless. Readers of the book may acquaint themselves with the apparatus and theory without having to spend time in reading about "obsolete" methods which, while reflecting credit on the efforts of the designers, have failed to stand the test of practical working under everyday conditions. What succeeds in the confines of the laboratory may be valueless outside.

While it is never wise to run before one can walk, the best purpose will be served in reviewing briefly the system as a whole, so that the general scheme will be plain; for this is the best condition of the mind for absorbing the more detailed explanations of the apparatus used in achieving this reproduction of sight.

A Definition of Television

First, a simple definition of television. By the aid of television we can visually witness what is happening at some distant place, just as if we were eye-witnesses on the spot. In its strictest sense, we can define *true television* as the ability to see, with the aid of electrical methods of transmission, a reproduction on a screen of the image of moving or stationary objects situated at any distance from the observer.

Of course, as we shall see later in the book, there are countless ramifications which broaden the possibilities of the scheme, but that in no way alters the definition.

Now, is this seeing by means of land line cables or wireless any more complicated than listening on the telephone, or hearing by wireless? At the present stage of the development of the science it would be foolish to reply in the negative; but let it be said immediately that the extra complications are only of a relatively minor order as far as the actual operator at the receiving end is concerned. This point should never be lost sight of by the amateur.

Does Any Relationship Exist?

Is there any relationship existing between aural broadcasting as we know it to-day, and the transmission and reception of television? Yes, there is, and that is why the progress in this science has been more rapid than one at first would be led to expect.

When a voice is being broadcast from a wireless transmitting station, the person stands or sits before a sensitive microphone, somewhat similar in principle to the mouthpiece of an ordinary desk telephone, and the sound waves produced by the voice are converted by this mechanism into varying electrical impulses. These minute variations are then amplified and made

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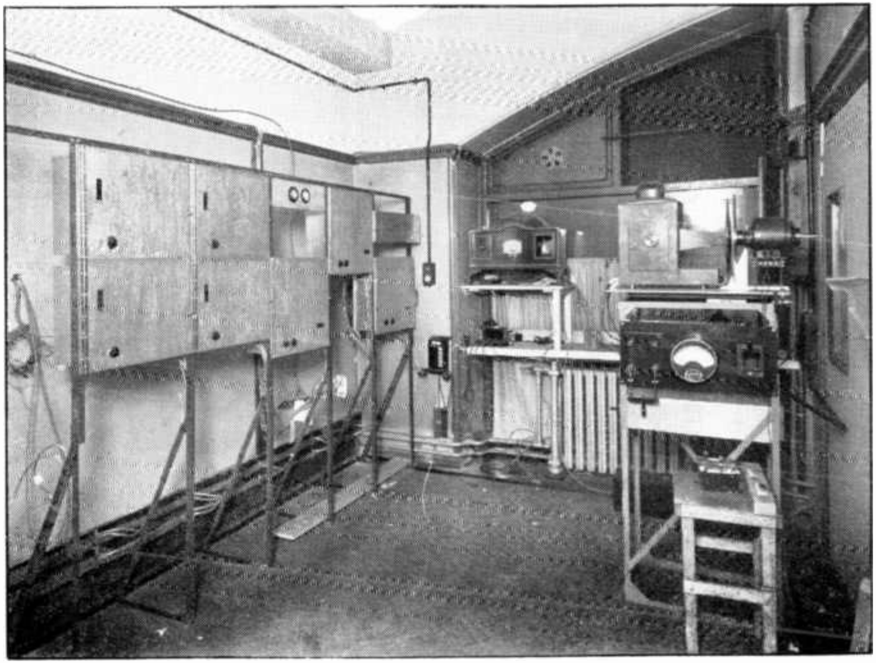
to modulate, that is, they are superimposed upon, the high frequency carrier wave of the station, and pass into space from the transmitting aerial as electromagnetic waves radiated in every direction.

These "wireless waves" produce extremely small voltages in the receiving aerial tuned to the transmitting station's wave-length, and these are amplified and rectified by the wireless receiving set, passing finally to the loud speaker, where they are again reconverted into sound waves. Providing the receiver and associated apparatus are of sound design, they act as an agent whereby an aural replica of what is happening at the distant studio is reproduced in the home, but they appeal to one sense only, namely, hearing.

Conveying Complete Intelligence

What modifications are necessary to enable us to bring into being our sense of sight instead of letting it lie dormant? To convey *complete* intelligence, it is no good relying upon speech alone any more than it is wholly satisfactory to have sight alone and be dumb. Some may query as to which of these two senses is of greater importance, but no one will deny that both together ensure a proper understanding. For that reason alone the addition of sight to our existing broadcast or telephoned speech is of the utmost importance, whether viewed from the entertainment, educational, or commercial angle.

Now, in the Baird television system, the person to be televised stands or sits before a number of light-sensitive or photo-electric cells. These cells, as we shall see later, have the wonderful property of responding in an electrical sense to varying amounts of light and shadow, and converting them faithfully into electrical variations of corresponding strength. In other words, they can be



A PEEP INSIDE THE PRESENT CONTROL ROOM OF THE BAIRD CO.

looked upon as acting in the nature of a very efficient light microphone, in a somewhat similar manner to the speech microphone.

Located behind these cells, but in front of the televised object, there is an optical apparatus consisting of a rapidly revolving metal disc, around whose periphery is arranged a series of 30 holes in the form of

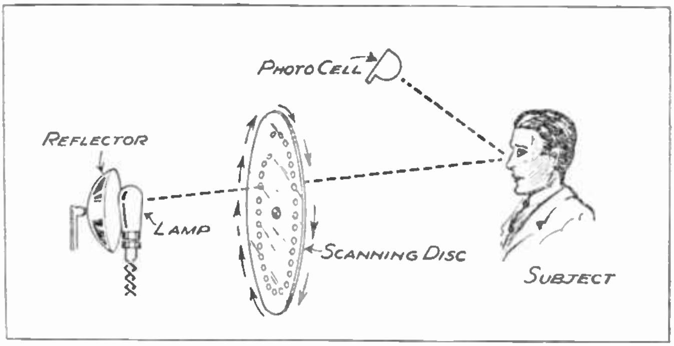


FIG. 1. A PICTORIAL IMPRESSION OF HOW TELEVISION TRANSMISSIONS TAKE PLACE

a spiral. Through these perforations are focussed rays of light from a high candle-power lamp, so that they are projected upon the person sitting in front of the apparatus. A reference to Fig. 1 will give an impression of what has been described.

The Work of the Photo-electric Cells

Owing to the revolving disc, the narrow pencils of light pass over the person's face and subdivide the features into a number of strips, and it will be seen that every part of the face is successively illuminated by a small point of light, the speed with which this process takes place being dependent upon the disc revolutions per minute. Depending upon what part of the face the light spot is moving over, so a variation of light and shade is thrown back or reflected on to the photo-electric cells. Thus, on the forehead a considerable amount of light would be reflected, whereas, when the spot traversed black or dark hair very little light would be thrown back. According to the amount of reflected light picked up by the cells, so it is converted into electrical currents of proportionate amplitude, and, therefore, as the spot of light makes a complete traversal of the subject image, a current of varying intensity is sent out from the cell. No personal discomfort is experienced by the person being televised, and the resultant current variations, owing to their minute nature, have to be amplified and then made to modulate a high frequency carrier wave at the transmitting station, and finally are propelled into space as waves similar to the speech waves. Anyone tuning in his wireless set to this transmission will be rewarded with a distinctive note emanating from the loud speaker—something like a high-pitched drone.

A Process of Conversion

The next point that arises, of course, is: how can we reconvert this to a plainly visible reproduction of the person at the studio, knowing that the television electric eye in the shape of photo-electric cells has provided the gradations of light and shade that enable us to distinguish form?

To digress for a moment, have you ever tuned in a strong signal on your wireless set, and then substituted a neon lamp—one of the familiar beehive pattern will do for this purpose—for the loud speaker? If this is done, the signals become visible instead of audible, for the set-owner will see the flickerings of the lamp in place of hearing the vibrations of a diaphragm. But supposing you had tuned in a television transmission,

THE BAIRD TELEVISION STUDIO AS IT APPEARED IN 1928 AT LONG ACRE, LONDON, W.C.2

The person being televised is seated before the aperture in the draped wall what then? Why, the flickering of the lamp with the varying signal intensity is reproducing the reflected light from the original object.

Forming a Picture

All that remains is to arrange the series of light flashes over a surface or area corresponding to that occupied by the object. That is, a picture must be formed out of the succession of light and shade, just as the artist forms his picture from a succession of brush touches on a canvas, bearing in mind that we are to take advantage of the peculiar property of this neon lamp, which responds instantly to the varying currents in the output circuit of the last valve of the wireless receiving set.

Obviously, our requirements call for a duplication of the transmitter scanning disc; that is, it must have the same number of holes as the transmitter disc, although its size can be adjusted to any proportional dimension. Another factor is that both the transmitter and receiver discs must revolve in synchronism, or, in simpler language, the discs must run at the same speed and be in the same phase relationship. The extreme importance of this item (indeed, we can regard it as the crux of our television system) will be gathered when attention is turned to the detailed description of synchronizing in Chapter V.

The Picture Canvas

Provided these conditions are satisfied, and if we regard the glowing plate of our neon as the canvas for our picture, then with the receiver disc revolving in front of the neon, the light from this lamp passes through the holes of the disc and reaches the eyes of the observer.

When the first hole of the transmitter disc explores a line across the object, and lets the beams or pencils of light fall in succession on the photo-electric " microphone," so the receiver disc has a hole which explores a line across the glowing plate of the lamp, and it is seen bright in one spot and brighter or darker in another as it flickers.

There must be perfect synchronism between the two discs, so that the line viewed across the glowing plate varies in light intensity exactly as does the line explored across the object. A succession of such lines side by side will make an image having the same gradations of light and shade as the original object, owing to the phenomenon known as " persistence of vision." This natural property of the eye makes the whole image appear simultaneously, and resembles that of the principle whereby, in cinematography, owing to the rapidity of motion we view one moving continuous whole, and not a succession of still pictures.

Creating Form from Strips of Light

Our previously disintegrated object is now reintegrated, and built up completely by the succession of impulses we have spread over a surface, thus creating form. It must be carried out quickly enough—generally at the rate of 12½ complete picture explorations in one second, corresponding to a speed of 750 revolutions per minute—so that the eye does not have the opportunity of dwelling on the mechanics of the process, but sees only the flashes in their proper place, rather than as a sequence.

We can look upon the revolving disc and neon lamp which recreate the image as serving the eye in a similar manner as the loud speaker serves the ear, and just as in the case of a first-class wireless receiver and associated

One Form of "Portable" "Televisor" Used for Demonstration Purposes

One of the Earlier Models of the Dual Baird Disc Machine

The picture is seen on the right while the loud speaker is behind the left-hand grille loud speaker, we are struck with the quality of reproduction as judged by the ear, so with television one cannot fail to appreciate the beauty of detail as revealed to the eye.

The Co-operation of Amateurs Needed

Have you paused to consider the vastness of the new field of investigation opened up to the amateur? Bear in mind that the unstinting efforts made by amateurs in the early days of wireless, contributed in no small measure to the rapidity of progress made in wireless transmission and reception, and undoubtedly with television the aid of the experimenter will be enlisted. The collation and analysis of reports, either of individual research or of the reception of television transmissions, under a variety of climatic conditions and environment, will be instrumental in furnishing valuable data to the authorities and companies responsible.

What further inducement is needed to make all desirous of examining the problems with whole-hearted endeavour? The race to perfect television is proceeding apace. First honours to us, for it was a Scot who first achieved real television! Let it be through the co-operation of British amateurs that this new science forges ahead and makes its presence felt throughout the world.

CHAPTER III

THE BAIRD TELEVISION DISC TRANSMITTER

In the last chapter we took a rather condensed survey of what actually happens in the process of real television. It is now essential to concentrate on detail, and follow the whole scheme from beginning to end, to ascertain the purpose and normal function of each piece

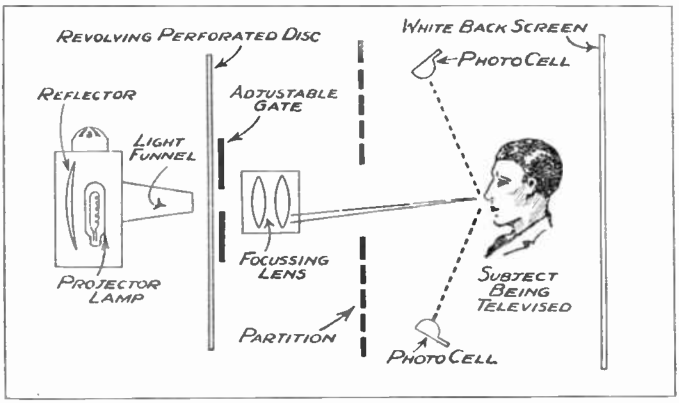


FIG. 2. THE ELEMENTS OF THE BAIRD TRANSMITTER

of the apparatus. To do this we must devote our attention first of all to the transmitter.

The Original Specification

The principle on which the Baird Television transmitter operates is perhaps best described as the spotlight system, and, quoting from Mr. Baird's patent specification of 28th January, 1926, No. 269658, we find the following—

At the transmitter, the scene or the object to be transmitted is traversed by a spot of light, a light-sensitive cell being so placed that light reflected back from the spot of light traversing the object falls on the cell.

Thus, the person need not be subjected to the intense glare of flood lighting (see Chapter X), for although the spot itself is very intense, as it has to move over the whole screen at immense speed, the actual average illumination appears quite small to the person being transmitted.

Since the spot has its light distributed over the whole area of the picture, the average illumination of that picture is the area of the spot divided by the area of the picture. Thus, to take an example, if the picture was made up of 2,000 elementary squares, then the size of the spot would be one two-thousandth of the size of the picture, and the average illumination would be one two-thousandth of the brilliance of the spot.

Obviously, then, our first requirement is a source of illumination, and since the rays of the light must be forced through the small holes of a revolving disc, it follows that *the lamp or arc must be capable of great brilliancy* and be as concentrated in illumination as possible.

This is mounted in a metal projector cover, complete with chimney and funnel.

Behind the lamp is secured a concave reflector, and it must be possible to move this reflector in every direction with reference to the light source, so that the focussing lens (see Fig. 2) is " filled " with light.

Introducing the Scanning Disc

When the rays of light emerge from the projector funnel they play upon a flat metal disc, purposely made heavy, so that when run up to normal speed it tends to remain running at this speed owing to an inherent flywheel action

This scanning, or exploring, disc, as some people prefer to call it (let us hope television nomenclature will be standardized in the near future), is specially constructed in so far as it has 30 square holes pierced through the disc.

The perforations *have equal angular displacements*

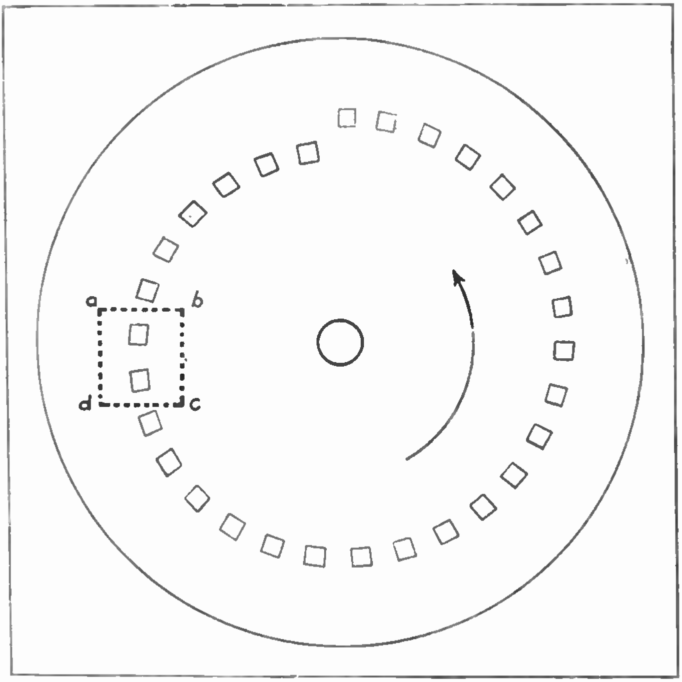
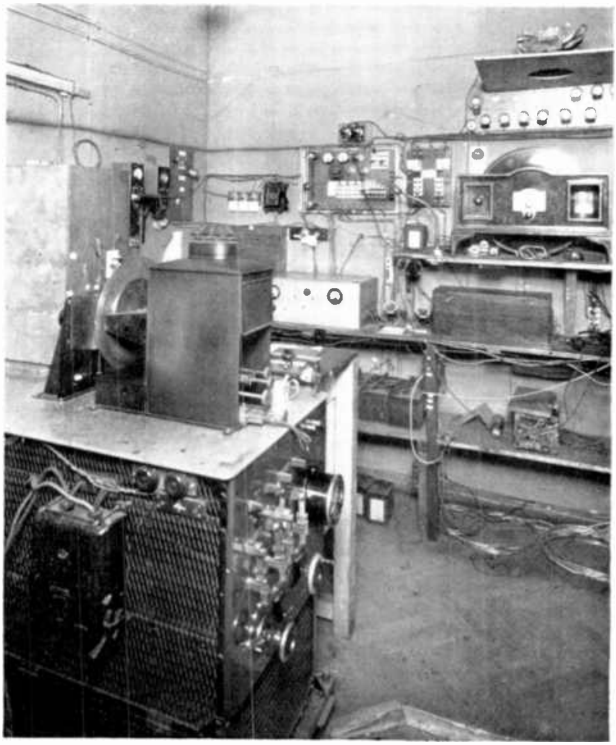


FIG. 3. THE SMALL SQUARE HOLES IN THE SCANNING DISC SHOWING THE SPIRAL ARRANGEMENT

around the periphery, and are arranged in the form of a spiral somewhat as shown in Fig. 3.

We shall revert to disc details later, since this item is of extreme importance.

By correctly mounting the disc, the beam of light can throw a ray through each hole, as it sweeps through the light area *abcd* of Fig. 3 when the disc is revolving.



The Old Control Room at Long Acre from which the Daily Broadcasts of Baird Television were sent through to the B.B.C. The Projector Stand is seen on the left

The disc is driven by a very efficient constant speed shunt motor, any necessary speed variations being made through the medium of a shunt resistance mounted on the transmitter table.

In the Control Room of the Baird Company at Long Acre, there is a tuning fork in operation to ensure the motor being run exactly at 750 r.p.m.

A Standard Form of Baird Transmitter

Naturally, this sweeping light ray *must be focussed on the subject being televised*, and the inclusion of a focussing lens (see Fig. 2) enables this to be effected with extreme accuracy.

The object scanned is placed in front of a large white screen, and the lens adjusted to the best mean focus according to the distance separating the disc and object.

Now, of course, we must so place our photo-electric cells that they are influenced by the light reflected from the object, and, according to the type of cells used, and the size of the scene televised, they are placed above and below the object.

This is shown diagrammatically in Fig. 2.

One of the accompanying photographs also shows a complete projector stand, which has been standardized and used by the Baird Co. for quite a long time now.

It is usual to partition off the televised object and photo cells from the projector itself, and arrange that *no direct light, other than that of the travelling light spot, plays upon the object.*

The reason for this will be obvious, for it is essential to have the photo-electric cells influenced only by the light reflected from the spot purposely illuminated.

The Number of Disc Holes

Now let us consider the disc itself for a moment.

First of all, as to the number of holes. Baird, after considerable experiment in the early days, *decided upon the number of* 30, and it is interesting to note that the German Post Office adopted this as standard in that country for the medium wave transmissions.

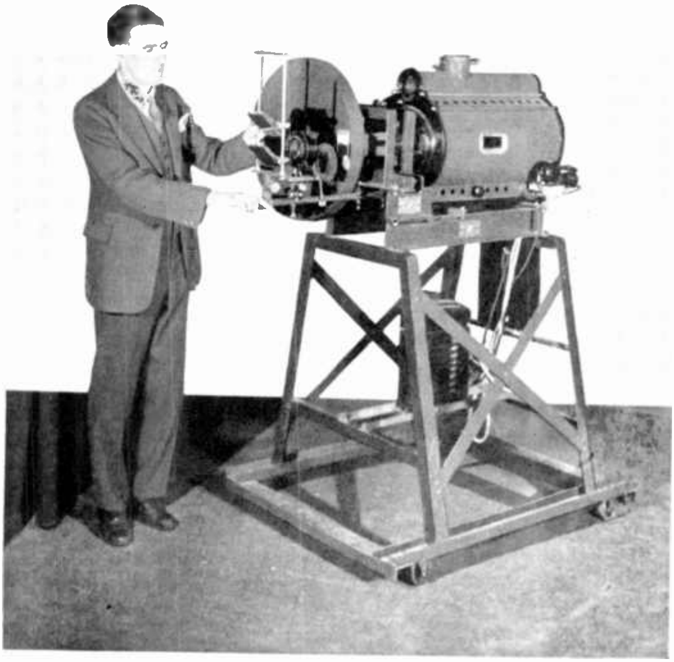
In the United States of America, we have Jenkins using 48 holes, and this number is advocated by the Radio Manufacturers' Association of America. The General Electric Co. use 24 holes, and the Radio Corporation of America go to the other end of the scale and take 60 as their standard.

Naturally, we shall have the 30 holes standard in this country, at least to start with, and as we shall see later, since the detail of our resultant picture is limited by the sidebands allowable to each broadcasting station by the Prague plan (9 kilocycles at present), it is obvious that there must be an optimum value in the number of holes best suited for this detail. It is, therefore, somewhat extraordinary that this optimum value should prove to be obtainable with exactly the same number of holes as used by Baird in his earliest days, namely, 30, and furnishes further evidence of the far-seeing character of the inventor's deliberations.

Correctly Shaping the Disc Holes

What of the shape of the hole? Are the best conditions met by one of a peculiar shape, or will a standard hole satisfy? Looked at from the point of view of the passage of the greatest amount of light for a given width, a square hole is best suited, and in actual practice this is employed.

On the other hand, if we remember that there is a spiral formation used for positioning the disc perforations, then theory demands a slight wedge shape with curved inner and outer edges, together with a slightly decreasing area for each hole, as we pass



A DISC TELEVISION TRANSMITTER AS DEVELOPED BY THE BAIRD TELEVISION CORPORATION OF AMERICA

Showing the periscopic scanner fitted to the machine from that nearest to the disc periphery to that farthest from it.

Anyone with a mechanical turn of mind will agree that to stamp or punch out disc holes to this degree of precision is not a commercial proposition, and, indeed, if it were, the advantage over a standard sized square hole would be imperceptible.

Graduated Exploration

There are many experts working in the field of television, particularly in America, where they content themselves with round disc perforations. To our mind, however, the square hole is the best.

With the detail limited by the sideband available as mentioned previously, the Baird Co. have developed what may be termed " graduated exploration." With this the transmitting disc has three rectangular holes at the beginning and end of the spiral; that is, at the outer and inner edges of the light area. Square holes are used for the remainder, and by this means the grain on the outside of the picture is coarser than the grain at the centre. This gives the effect of concentrating the available detail to some extent in the centre of the picture, where it is most useful. It is claimed quite rightly that this scheme uses the present allocated kilocycle sideband to the maximum effect, and is therefore of great importance.

The Shape of the Light Area

Picture what happens now as our disc revolves. According (*a*) to the distance separating the lens from the background, (*b*) the difference in radial length between the first and last hole, and (*c*) the circumferential distance between each disc hole, *so we shall have a definite light area covered on the screen.*

Its shape will be somewhat as indicated in Fig. 4, the picture ratio being 7 to 3.

A "gate" or mask is arranged as close to the disc as possible, and consists merely of two metal shutters, one of which moves up and the other down, and this governs the height, or, shall we say, depth, of the light beam.

With the fixed light source and the moving disc, the actual object is scanned by the spot of light moving

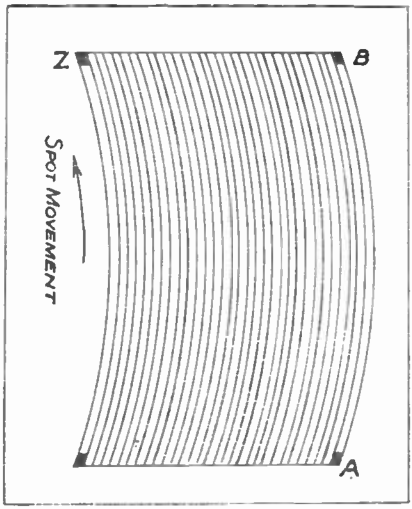


FIG. 4. SHOWING HOW THE "LIGHT AREA" ON THE BACK SCREEN IS MADE UP OF STRIPS OF LIGHT

from right to left and bottom to top; in other words, starting in the bottom right-hand corner (*A* of Fig. 4), and finishing at the top left-hand corner (*Z* of Fig. 4). According to the position of the projector lamp on the right or left of the scanning disc motor, so the motor will have to revolve clockwise or anti-clockwise to give this effect, bearing in mind, of course, that the focussing lens actually reverses the light spot direction.

The first light strip traversed is that shown as *A B*, and it is necessary to adjust the "gate" so that one hole just leaves the screen at the top a moment before another appears at the bottom. In other words, the gate depth is slightly less than the distance between two adjacent holes, thus giving a condition that for a very short time there is no spot on the screen at all.

The reason for this will be made clear in Chapter V, on "Synchronism."

Overcoming Flicker

Our second hole in the disc, therefore, describes another light strip immediately adjacent to the first strip, and with each complete revolution we produce an illuminated area, shaped as in Fig. 4.

If the disc is revolved slowly, then naturally we can follow the light spot movements across the screen, but at the normal running speed of 750 revolutions per minute there is practically no perceptible flicker—the area appearing as being flood lighted, owing to the speed of the operation, just as the rapidity of the changes in alternating current prevents discernible flickering in an ordinary electric lamp.

How Black and White Lines Appear

The reader will see now how necessary it is for the square holes in the exploring disc to be accurately positioned.

There must be no underlapping or overlapping between the outer edge of one hole and the inner edge of the following hole; otherwise the junctions between the light tracks become visible.

A reference to Fig. 5 will show exactly what is meant.

Taking the holes marked 1 and 2, it will be seen that the track made by the inner edge of the first hole does not quite meet the track made by the outer edge of the second hole.

This will cause a thin black line to appear on the screen, its width depending upon the amount of underlap.

On the other hand, with holes 2 and 3 we have overlap, and *this will result in a narrow white line making its appearance.*

Unless the errors are gross ones, however, these black and white lines are not very conspicuous, but they enable one to judge the degree of efficiency with which the disc has been made.

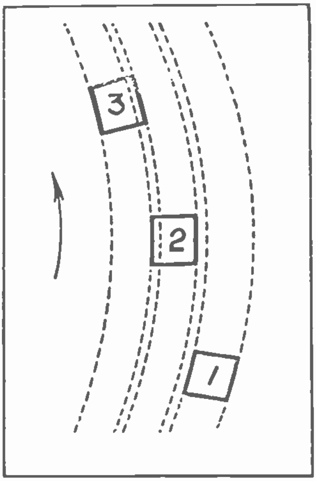


FIG. 5. INDICATING HOW UNDERLAP AND OVERLAP CAN OCCUR WITH INACCURATE HOLE-POSITIONING ON THE DISC

So far so good; for it is to be hoped that the reader will have grasped how the travelling light spot is made to function.

Meet the "Television Eye"

The next point that arises is whether it is necessary to resort to such a scheme in order to televise, say, the features of a living artist.

The object upon which the dissecting light strip plays will naturally reflect a certain small proportion of this light—the exact amount depending upon the colour, nature, and contours of the reflecting surface.

How can we convert this reflected light into some form of intelligible electrical variation, which, in turn, can be made to modulate the high frequency carrier wave of an ordinary wireless broadcasting station?

It is here that we make our formal acquaintance with the "television eye," as it is sometimes popularly called, or the "light microphone," as we referred to it in the last chapter.

Since the principles of photo-electric cells are dealt with later on in the book, we shall confine ourselves to a passing comment on their function.

Selenium Unsuitable

No doubt many readers can recall the discovery, made some years ago now, of a substance called SELENIUM. This had the peculiar property of responding in an electrical sense to light and shade; that is to say, if it were connected up in a circuit and exposed to light, a current would flow in the circuit of which it formed a part, but on shielding the selenium from the light rays the current flow would cease.

Furthermore, the magnitude of the current flow was dependent upon the amount of light to which the selenium was exposed.

What a vista to the science of television this new field of enterprise opens up! That must have been the first thought of scientists who made investigations into this substance of selenium. Unfortunately, their hopes have remained unfulfilled. There is a time lag or inherent sluggishness in the response of the current flow to light exposure, and although many ingenious schemes have been propounded in an effort to cure this trouble, they have not met with any measure of success.

Television demands the reduction of this time element factor to a zero quantity.

The science, therefore, lay dormant until photo-electric cells made their appearance on the scene, and put an entirely different complexion on the whole question.

These cells, while possessing the same property of current flow to light exposure, *are instantaneous in their action*, at least so far as modern methods of measurements have been able to tell.

The Reason for Using a Travelling Light Spot

While the magnitude of the resulting current for a given light flux is considerably smaller than with selenium, this is counterbalanced quite easily by pressing into service a multi-stage valve amplifier which can be made to increase the current variations to almost any strength desired.

A moment's thought should be sufficient to convey to the reader the absolute impossibility of one or more photo-electric cells converting an entire scene or image into terms of electrical current variations.

There are far too many differing light values spread over the area within its compass, and in consequence we have to analyse our subject to be televised into a large number of elemental areas.

These areas will each possess a definite reflected light value when illuminated by the travelling light spot, and the cell is then capable of responding to each light value in turn.

This gives us the reason for adopting the BAIRD TRAVELLING LIGHT SPOT.

At one instant we have a minute square area illuminated, and the reflected light produces a current variation in the circuit containing the one or more photo-electric cells.

Hearing the Television Note

At the next instant, the actual time taken depending upon the speed with which the disc rotates, an adjacent elemental area in the light strip is illuminated, and our cell makes an instantaneous response.

A Photograph of a Disc Transmitter with the Amplifier Boxes and Controls Housed on an Adjoining Table

This process is continued, spot by spot and strip by strip, until *the whole of the area has been disembodied into values of light and shade and corresponding current values until one complete picture conversion takes place.*

We have, therefore, a definite number of current variations flowing in the cell circuit, which can be actually heard in a pair of telephones as a " musical " note.

Of course, the larger the number of elemental areas into which we can dissect our televised object, the greater will be the detail in the received picture. Really, however, it is astonishing how even a coarse-grained picture possesses sufficient detail to make it immediately recognizable and intelligible to the observer.

This is all very well, you will say, for an object or scene which is quite steady, but *what happens when movement is imparted to the subject?* Obviously, the greatest proportion of subjects we shall see through the medium of television will have life, and thus not remain stationary.

Imparting " Movement " to the Televised Subject

The condition is fulfilled very simply *by arranging the speed of the disc to give at least* 10 *complete explorations in one second.*

In practice, 12½ pictures per second is the usual number, corresponding to a disc speed of 750 revolutions per minute, and if this is done the human eye, which is characterized by an inherent lag in its response to light, will observe what is practically a harmonious movement with negligible flicker, instead of a number of still pictures rapidly displayed.

We are familiar with a similar process in ordinary cinema photography, and at this speed the mechanics of the process are lost on the observer.

So much then for the *modus operandi* of the transmitter itself.

The discriminating reader will now be anxious for elucidation on the conflicting reports he has heard concerning possible distortion in the television picture, where it is likely to arise, and if it is serious.

Although this side of the question is wrapped up in both the transmitting and receiving ends, it is felt advisable to dispose of the question at this juncture.

Criticism Based on False Foundations

Unfortunately, most of the criticism levelled at television has emanated from sources or individuals who have examined the matter entirely from a theoretical standpoint, and for reasons best known to themselves have not sought enlightenment in the form of a practical demonstration.

This state of affairs is to be deplored. It places them in a false position as critics, and, while criticism of a constructive nature is valuable, anything of a destructive nature, based on false foundations, is likely to do harm unintentionally.

Now where is television likely to fall short in its aim to give faithful replicas of any transmitted subject?

The answer is, when an effort is made to televise objects *where the detail is extremely small in relation to the spot of light itself which is projected upon it.*

If the whole of the detail of a body came *within* the bounding compass of the square spot of light, then, obviously, *provided the body was stationary*, the cells picking up the reflected light would tend to produce an object slightly deepened and widened.

Again, consideration must be accorded to the building up and dying away effect in the cells when the light

A TRANSMISSION IN PROGRESS AT THE TELEVISION STUDIOS AND TRANSMITTING ROOM OF THE BAIRD TELEVISION CORPORATION OF AMERICA IN NEW YORK CITY spot encounters and leaves a body having a very sharply defined outline.

There will then be a tendency towards a mean current value, and this in turn will give a somewhat softening effect to the outline.

Are these items in actual practice such as to cause serious defects in the resulting image?

The answer is "No."

An Accommodating Human Eye

This arises partially from the tolerance and the self-accommodating character of the human eye, and also from the fact that in actual television, as it is being transmitted daily, either at the Baird laboratories or over the wireless, most of the subjects undergo movement.

This gives the light spot and cells an opportunity to perform their natural functions in a faithful manner.

As proof of the smallness of detail that can be shown, it may be mentioned in passing that no difficulty is experienced in noting the position of the hands on a watch!

What methods may be resorted to should it be desired to give still greater detail?

One way would be to *increase the number of holes in the transmitting disc*, and thus make the grain of the screen finer.

Assuming the disc diameter to remain unaltered—for, of course, we cannot go on increasing this beyond a certain economical limit without making the apparatus unduly bulky—then the resulting picture is going to be smaller, owing to the reduction in circumferential distance between holes.

Greater lens magnification would then be necessary to bring the picture up to the size of the previous one.

According to the spiral formation, so the shape of the picture can be altered at will, but this would only tend to introduce complications from the manufacturing standpoint. This must never be encouraged. Rather should the aim be towards standardization, as this will cheapen production and keep down prices.

What of the Frequency Limits?

Since we have shown that the current resulting from the reflected light variations is extremely minute, it follows that these variations *must be amplified by means of a multi-stage amplifier.*

Here, again, we are faced with an important detail.

A knowledge of the frequency limits is demanded in order to design the amplifier to accommodate them all before *any marked falling off in the amplifier characteristic.*

This is a problem which cannot be dismissed in any light-hearted fashion. The maximum frequency will not only depend upon the number of current values produced in the photo-electric cells in one second, but also upon the number of holes in the transmitting disc, the speed of rotation of the disc, and the shape of the picture.

Since every televised subject brings its own light and shade variations, it will be seen that any mathematical calculation is extremely complicated, and has to take account of the disc dimensions.

Yet in spite of this, and bearing in mind that this little treatise makes no pretensions towards being an *advanced* analytical and mathematical study, how can we convince the reader that distortion exists more in theory than in fact?

The Dot Theory Fallacious

Any attempt to formulate the dot theory which some have favoured in the past, whereby the picture is

LIEUT.-COMMANDER W. W. JACOMB, R.N.

Chief Engineer of the Baird Company, whose work in the past few years has been in research and development treated as being made up of a series of small dots like newspaper illustrations, falls to the ground *owing to the light and shade being distributed throughout the picture in the form of a wash drawing or continuous surface.*

For example, during one period of movement, the light spot may be exploring an area which is wholly or almost black, so that no light is reflected back.

Then, maybe, this is followed by a comparatively long period of white on an object, when we shall have a relatively large current response from the cell.

The actual wave form of our resulting current is, therefore, complicated in the extreme, and due to this we must have a fundamental frequency with a plethora of harmonics if an identical reproduction is required, since it is the combination of a fundamental wave form and the harmonics which together go to make up our peculiar wave form.

Naturally, the lower the cut off of the higher frequencies *the greater will be the rounding off and smoothing over of any sharp contours*, so that very small details are apt to be lost.

With an amplifier which does not cut off below 20 kilocycles, the *wealth of resulting detail is astounding.*

We are, nevertheless, at once up against the 9-kilocycle limit now allowed to broadcasting stations.

Even with this cut off artificially imposed as a result of deliberations based entirely upon the considerations of aural broadcasting, the detail which comes over is particularly good.

It is to be hoped the interests of regular television services will be catered for at an early date by a special or increased side band allocation.

The Effects of Frequency Cut-off

It is found in practice that the best results are achieved by resorting to relatively low amplification per valve stage with several stages, rather than by attempting all the amplification desired in two, or perhaps three, stages.

Resistance capacity coupling with certain modifications is advisable.

At the other end of the scale we must not lose sight of the fact that frequencies as low as 20 or 30 will have to be handled, and, in consequence, the transmitting amplifier calls for the exercise of technical skill both in its design and construction.

Should there be any loss of the low frequencies in the amplifiers or the land line to the transmitting station, this will evidence itself in the picture as undesirable dark shadows, while the presence of pure white or any strong surfaces tend to throw these up somewhat.

With a loss of the higher frequencies the picture tends to look rather " woolly," and detail is partially lost.

With the present 30-hole Baird disc used in this country, vertical scanning is employed, since it is claimed, quite rightly, that this gives greater detail when televising the subjects which are now possible with the present state of progress.

A certain amount of controversy exists as to whether horizontal or vertical scanning best serves the interests of the science, and in this connection the question of " hunting " has to be considered.

By hunting we mean any to-and-fro movement of the picture for horizontal scanning, and up-and-down movement for vertical scanning.

Vertical Scanning

We are fairly well accustomed to moving our heads from side to side somewhat quickly. Indeed, most of our everyday movements take place in a horizontal plane, but when we see these natural movements made artificial by the increased movement imparted by the horizontal hunting, it appears very marked and almost ludicrous. With vertical scanning the combination of the vertical picture movement with the horizontal natural movement gives a rounder or smoother effect to the eye.

Hunting, therefore, in a *horizontally explored television image* tends to become a more noticeable feature than is the case with vertical scanning.

Anyone who has had the opportunity of witnessing both methods of exploring can prove this peculiar feature for himself.

Having efficiently amplified the signal impulses emanating from the travelling light spot, they are made to modulate the high-frequency carrier wave of the transmitting station in a similar manner to speech currents from a microphone.

They are then broadcast into space.

CHAPTER IV

THE BAIRD "TELEVISOR" DISC RECEIVER

So much for the transmitter, which we hope has been presented in a sufficiently simple form to enable the reader to understand the subject.

And now, what about the receiver, which, from the point of view of the average reader, is the more important?

It is the receiving set which, after all, is going to be installed in every home, and about which the amateur will manifest the greatest interest.

Revealing the Secrets of the Mechanism

Let us see whether we cannot offer the reader some simple explanation of this part of the problem.

We have seen that the trains of impulses, representing the electrically dissected image from the transmitter, are broadcast into space as a modulated carrier, or sent along a land line.

It now becomes necessary to study the means adopted for reassembling the subject at the receiving end.

Naturally, if wireless is the medium adopted for propagating the current pulses, and this is the one that concerns us most, then *a wireless receiving set is called for*. The actual details of this receiver are discussed fully in Chapter VII.

Here, first of all, we purpose examining the "Televisor" itself, which, contrary to general expectation, we shall find is *a very simple mechanism in the disc form*; far less complicated to handle actually than a normal wireless receiver.

The Essential Parts

The essentials are—

(1) A *scanning disc*, proportionately dimensioned to the one used at the transmitting end, and, of course, possessing its spiral of small square holes.

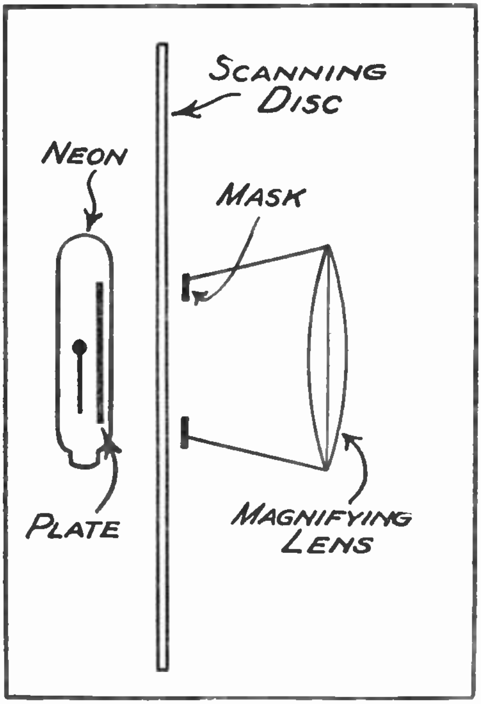


FIG. 6. A SECTIONAL DIAGRAM OF THE BAIRD DISC "TELEVISOR"

(2) A *driving motor* for the disc.
(3) A *synchronizing mechanism.*
(4) A *neon lamp*, with or without metal cowl or hood.
(5) A *framing mask.*
(6) A *magnifying lens.*

The motor should be of the shunt wound type and capable of developing a speed up to about 900 revolutions per minute, bearing in mind that the normal running speed is generally 750 revolutions per minute. Naturally, the best purposes are served by incorporating a motor capable of running steadily at its synchronous speed for long periods at a stretch.

While, as we shall see later in the next chapter, the synchronizing mechanism has the primary function of ensuring exact speed and phase relationship between transmitter and receiver discs, matters are helped considerably if the "Televisor" motor itself eschews any tendency for sporadic speed changes.

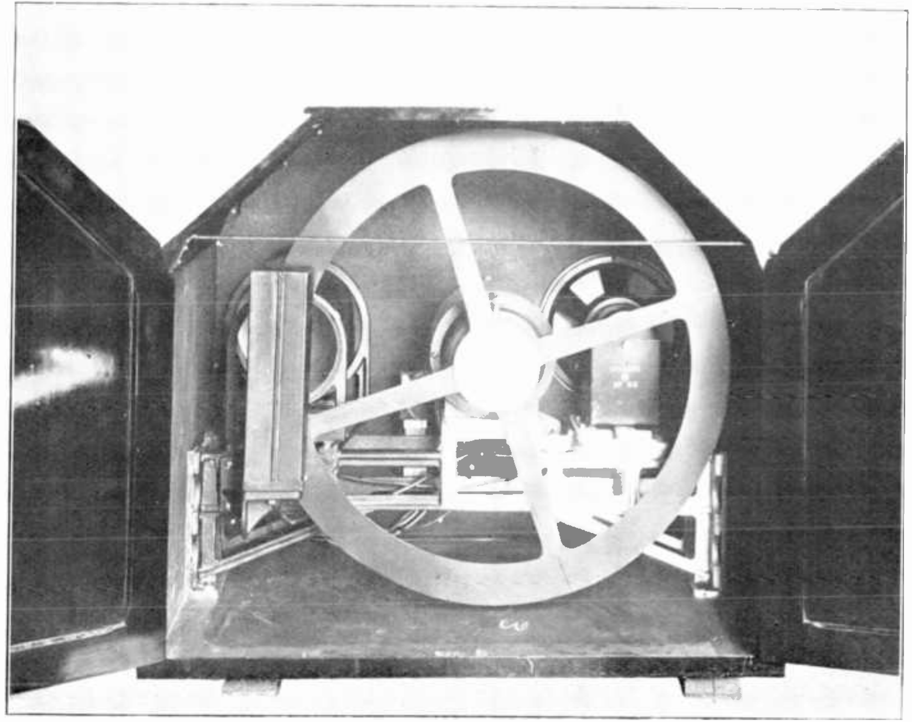
The Best Type of Motor

This will lighten the load on the synchronizing mechanism, which after all is only meant to be a form of speed control within limits, and makes no pretence to be anything in the nature of a drive, and hence under normal working conditions any tendency to "picture hunt" will be nullified.

If there is a house electric light supply available, then the motor can derive its power therefrom. To suit both alternating and direct current mains a *universal motor* is ideal, and this form of motor was included in the commercial "Televisors," which have been available to the public for some time. On the other hand, for those situations without an electric supply, a 6- or 12-volt motor can be employed.

To give a slight idea of the lay-out of the disc "Televisor" itself, a reference can be made to Fig. 6, together with one or two of the accompanying illustrations, which show different models.

With the vertical scanning employed we have a tubular form of neon lamp with a flat rectangular-shaped cathode which, of course, glows when the



THE INSIDE OF AN EARLY LARGE MODEL BAIRD "TELEVISOR" appropriate striking voltage is applied across its electrodes.

According to the strength of the signal passing through the wireless receiver, so the intensity of this plate glow is varied, it being appreciated that the neon is connected in the output circuit of the last receiver stage, being either directly-coupled or choke-coupled, as explained in Chapter VII.

Arranging the Components

Immediately *in front of this glowing neon plate*, and revolving at synchronous speed, is the spirally perforated disc, and in order to give a correct picture size, and so that it may block out any stray light from the neon, a *framing mask* with a rectangular hole cut in the centre is placed *in front of the disc*.

According to the particular model "Televisor" in use, a lens is sometimes mounted a *short distance away from the mask* to enlarge the image.

In the illustration facing page 50 may be seen a view of the inside of a large old model "Televisor," the neon lamp itself in this particular case being housed in a cowl having a rectangular aperture in front.

Provided the transmitting and receiving discs are *in exact synchronism* at any one instant, a perforation or hole in the receiver disc will expose an elemental area on the neon plate, and this will correspond to one at the transmitting end in an exactly similar position. Since the neon glow at that instant is directly proportional to the amount of light reflected from the illuminated spot on the televised object, we shall observe a degree of light or shade of corresponding intensity.

Exposure and Re-exposure

This process of exposure at the transmitting end and re-exposure at the receiving end takes place for each spot and strip, and the resultant effect to a person looking into the " Televisor " is to see this succession of light strips built up into an intelligible picture. As in the case of the transmitter, the process is effected at such a rapid rate that the reproduction has the appearance of a continuous image showing all the movement, light, shade, and contour of the subject sitting before the photo-electric cells.

Now there are one or two interesting facts which must arise in connection with the " Televisor," and these it is necessary to explain in the simplest possible terms. Until the reader is made conversant with the causes and the cures of certain little happenings, he is bound to be puzzled, particularly if he be among the uninitiated.

We shall not deal with negative images, since these are a product of the wireless receiving set itself, as explained in Chapter VII, but we will turn our attention first of all to what may be termed " reversals."

A Reversed Effect

It has been pointed out that the televised object is scanned by a spot of light starting in the bottom right-hand corner of the light area, and travelling upwards as a spot direction and from right to left as a strip direction, finishing finally at the top left-hand corner of the light area.

The direction of rotation of the transmitter disc, the position of the projector lamp on the right or left-hand side of the motor shaft, and the reversal of direction brought about by the focussing lens are all properly related to one another to give this standard mode of exploration.

Turning now to the " Televisor," it is the practice of the Baird Co. to *mount the neon on the right-hand*

This Photograph was taken during the Baird Co.'s First Official Demonstrations of Television Transmission and Reception in Berlin *side of the cabinet*, so that the direction of rotation of the motor is anti-clockwise with the disc hole spiral cut as shown in Fig. 7(A), bearing in mind that the neon is behind the disc. This will ensure that the scanning operation is performed in a manner identical with that at the transmitting end, and our resultant image has normal and correct movement.

What will happen if by error the disc is mounted

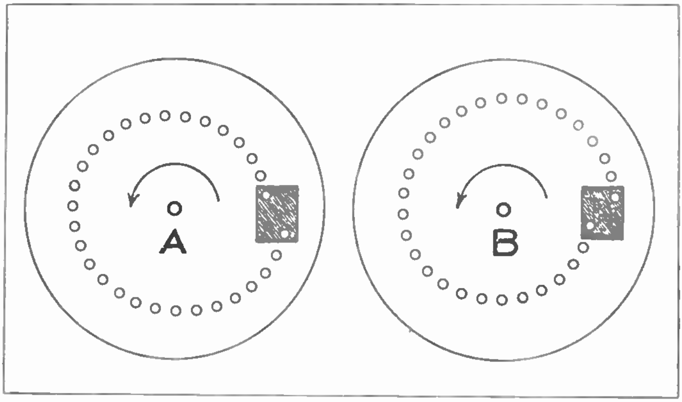


FIG. 7. ILLUSTRATING WHAT HAPPENS IF THE DISC IS MOUNTED THE WRONG WAY ROUND ON THE SHAFT

on the motor shaft the wrong way round, so that the spiral of holes is now in the position as indicated in Fig. 7(B)? The motor direction is unchanged and also the neon position.

Curing the Trouble

Why, the glowing neon plate will be scanned from bottom to top just the same, but *the spiral movement will be from left to right instead of from right to left.*

If a person, therefore, at the transmitting end moved his head from right to left, in the "Televisor" the movement would be reproduced left to right, that is, all horizontal movement would be reversed.

This is especially conspicuous when the moving printed script in the form of a news bulletin is transmitted ("telelogoscopy" is the official term applied to this particular use of television), for the letters, since they are moving backwards, look most uncanny, and it is almost impossible to read the message. It is very simple to rectify matters; *just reverse the disc on the motor shaft* and normality is regained.

Then we are sure to come up against the experience of " splitting the picture."

As we shall learn in Chapter V, synchronism between transmitter and receiver is obtained by *running the receiver motor approximately up to its correct speed by adjusting the field rheostat control,* mounted on the front of the " Televisor " cabinet, and then the synchronizing device comes into play and holds it there automatically.

FIG. 8. A " SPLIT PICTURE " IN A " TELEVISOR " SCREEN

But supposing the scanning disc is pulled into step when the strips are not in their original order from right to left. To illustrate our meaning, we can imagine the case when the first strip from the right of the neon plate is held in step with, say, the middle strip of the transmitter.

A Peculiarity which Sometimes Happens

Now, since this middle strip of the transmitter is exploring the centre of our televised subject, the results of this exploration will appear as a strip on the extreme right of our " Televisor " screen.

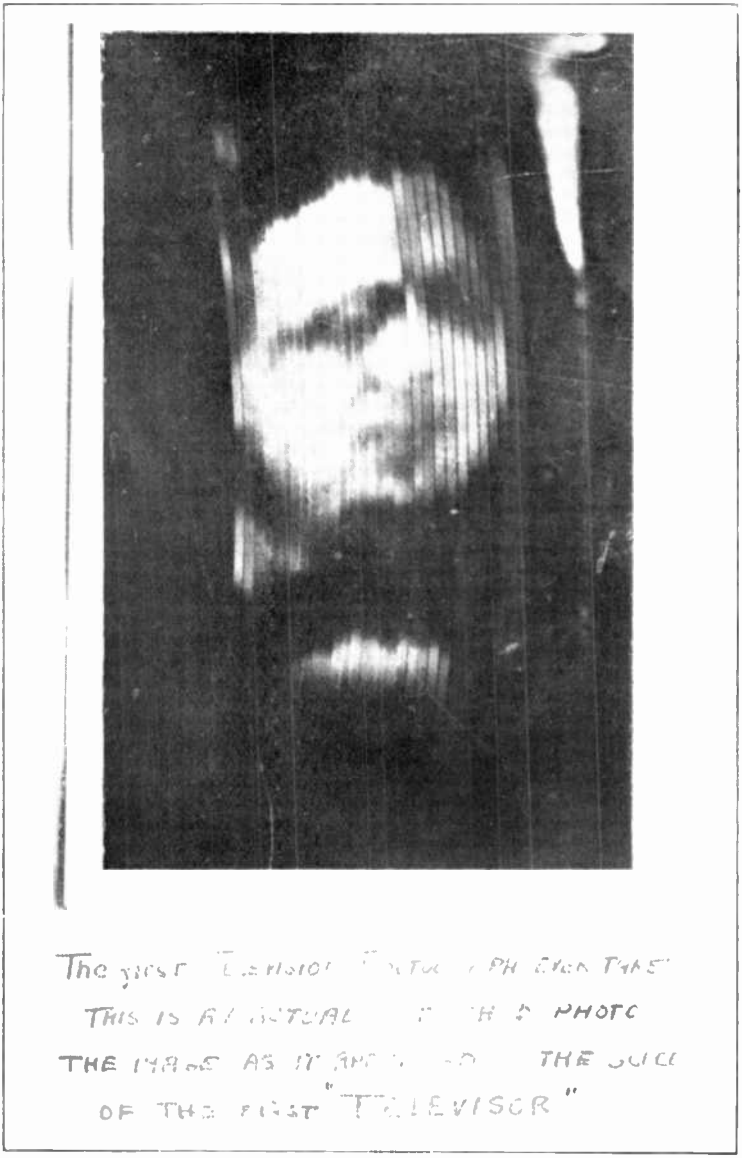


Photo by *Lafayette*

An Historic Photograph, taken in 1926, when Mr. Baird gave the First Demonstration of True Television

The received image will therefore be split down the centre, and will resemble that shown pictorially in Fig. 8.

Of course, this can take place at any relative position of the scanning operation, and to rectify matters the disc speed must be increased or decreased slightly so that it "slips" relatively to the transmitter until the image is correctly positioned in the centre.

A very careful manipulation of the speed control on the motor will bring this about.

In addition to splitting the picture, it is possible to turn it upside down! This is brought about when the neon lamp is mounted on the left-hand side of the "Televisor" instead of on the right, the direction of disc rotation being kept the same, namely, anti-clockwise.

A Remote Happening

A reference to Fig. 9 will be almost self-explanatory.

A represents the transmitting end with disc and subject being televised, while *B* shows the receiving end, the "Televisor" screen (or neon plate) being shown as the small rectangle on the left of the disc.

The first strip created by No. 1 hole at the transmitting end will explore the extreme right-hand side of the picture, but at the receiving end this will be reproduced by strip No. 16, which, of course, will mean that the picture will start being created at the centre of the neon plate, assuming, of course, that synchronizing has been set for normal working.

Furthermore, hole No. 1 is travelling upwards, whereas hole No. 16 is travelling downwards, and hence our picture in addition to being split is turned upside down as indicated.

A picture would be seen anywhere round the disc that the neon happens to be placed, but the picture will be turned round the farther we progress from its correct position, the case illustrated being that for a 180 degrees phase displacement.

There is the matter of "framing the image," but this

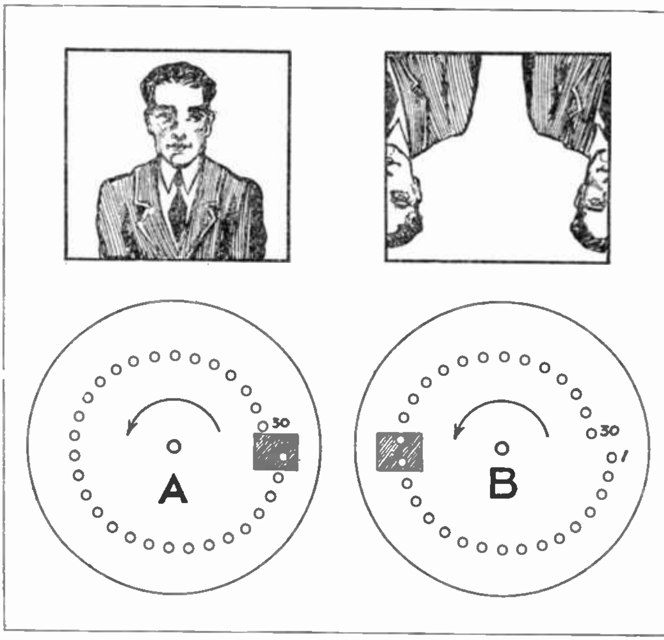
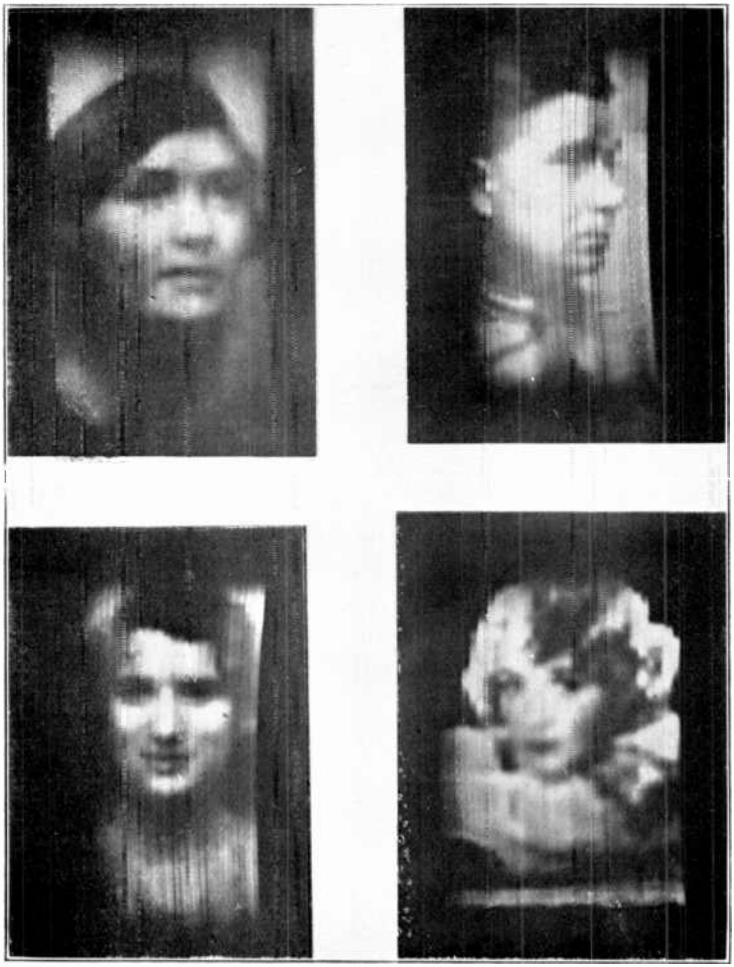


FIG. 9. HOW AN IMAGE APPEARS UNDER CERTAIN EXTREME CONDITIONS

is essentially wrapped up in the question of synchronizing, and, therefore, will be dealt with fully in the next chapter.

An examination of some of the accompanying illustrations indicates various models of the "Televisor" which have been demonstrated by the Baird Co., but in operating principle they are identical, so that it is unnecessary to deal with each one separately.



UNTOUCHED PHOTOGRAPHS OF VARIOUS SUBJECTS AS THEY APPEARED ON THE SCREEN OF A BAIRD "TELEVISOR" RECEIVER IN 1928

That on the bottom right-hand corner is an ordinary flat magazine cover portrait

The Disc "Televisor"

It is appropriate here, however, to give a few details of the Baird "Televisor" disc machine, which has been on the market for some time at a cost of eighteen guineas. It consists of a universal motor coupled to a Baird graduated scanning disc, and behind this disc and on the right-hand side of the instrument is the neon lamp, while in front of the disc and in line with the lamp is the lens system through which the image is viewed. These points will be made clear by reference to the photographs showing this particular device.

The motor is designed to run at 750 revolutions per minute when fed from 100 volts 50 cycle A.C. mains or 45 volts D.C. mains, and, in order that the machine may be run from existing house mains, a resistance system is provided inside the "Televisor" cabinet. The current consumed by this motor is approximately one-third of an ampere.

A small terminal panel is provided at the back, and by consulting the chart to be found inside the terminal cover of the "Televisor," it can be ascertained to which terminal must be joined the wander lead in order to make the speed of the motor approximately correct for the particular supply voltage in use.

Operation

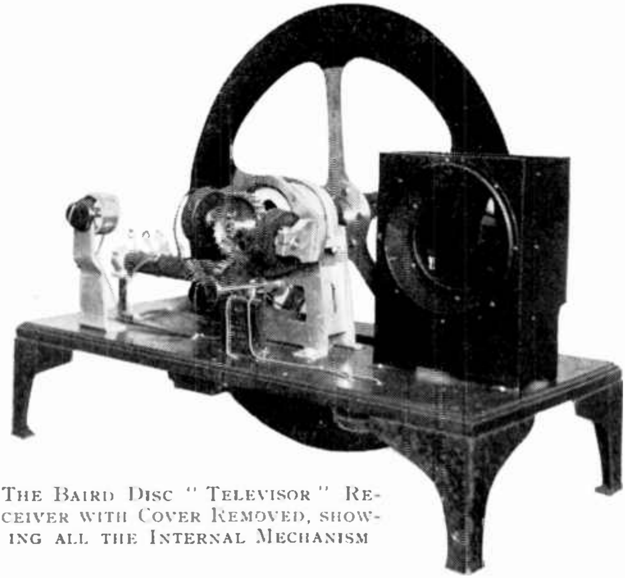
The operation of the "Televisor" is quite simple and straightforward. Assuming that the motor has been started and that television signals are being fed through to the neon and synchronizing system, on looking into the opening on the right-hand side one should see some form of image (probably distorted) having a dull red background. Assuming that the variable resistance, that is the left-hand knob control, was in its minimum position, that is turned round to its extreme travel in an anti-clockwise direction, the next step to take is to rotate this resistance knob gradually in a clockwise direction in order to increase the motor speed.

A series of black lines will then appear and sweep downwards across the lens. At first these lines will be only slightly inclined from the vertical, but they will gradually, with increasing motor speed, assume a more horizontal inclination, the picture, meantime, appearing between them.

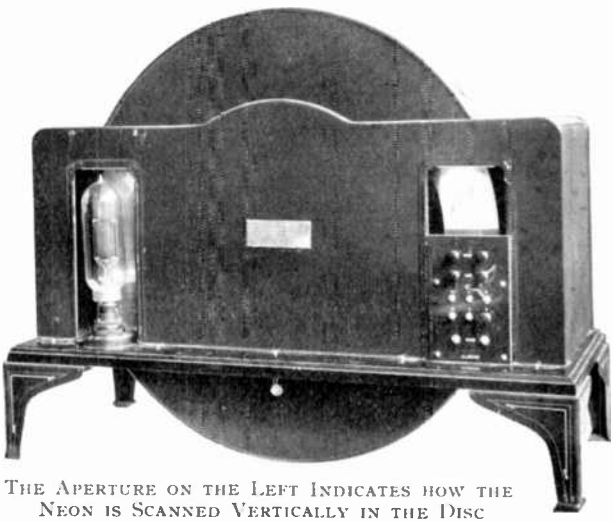
The speed of the motor must be increased until these lines lie horizontally, and once this state of affairs is reached the "Televisor" is synchronized and the synchronizing gear should now automatically maintain this condition. If in the course of operating the resistance control one overshoots the mark by increasing the motor speed too much, the lines will appear to sweep upwards across the lens and a readjustment must be made. A factor to bear in mind is that lines which sweep *downwards* signify that the motor is running too *slowly*, and that the knob must be turned in a clockwise direction. On the other hand, lines which sweep *upwards* indicate that the motor is running too *fast* and the knob must be rotated in an anti-clockwise direction. It will be seen from this that to overcome "image drift" it is necessary to turn the knob slightly in the same direction as this "image drift." The question of phasing and framing, of course, applies to this particular model "Televisor," but since these will be dealt with in the next chapter, there is no necessity to go into them now.

A Wealth of Detail Revealed

Some doubt would appear to exist as to whether the detail of the picture, as seen on the "Televisor" screen, has improved, and the best way to answer this is to



The Baird Disc "Televisor" Receiver with Cover Removed, showing all the Internal Mechanism



The Aperture on the Left Indicates how the Neon is Scanned Vertically in the Disc "Televisor" ask the reader to refer to the illustration (facing page 64) of an untouched photograph of the first image that appeared on the " Televisor " screen.

It is recognizable, perhaps, but compare it with those representing untouched photographs of the image in 1928 (see plate facing page 66).

Note the wealth of detail revealed and the half-tones, and yet these latter photographs are the work of amateurs, and make no pretence at being professionally finished products.

The difficulties which beset the photographer taking a subject such as is provided by the image of a scanned neon plate are enormous, and in the cases shown the exposures were of the order of 6 to 8 seconds.

Analyse them carefully, and see if you can detect any " movement " such as would be provided by lack of synchronism—there is none. Of course, the pictures as seen by the naked eye are superior to those obtained with the camera, owing to the persistence of vision, but even so, it must be admitted that remarkably good progress has been made.

CHAPTER V

SYNCHRONISM IN TELEVISION

WHEN Mr. Baird decided, in the latter part of 1929, to disclose his jealously guarded secrets of synchronism, the world of amateurs was aghast.

Up to that time it is beyond dispute that Mr. Baird had achieved, by his method of synchronism, a system which gave him a definite lead over those who were working on television abroad, and, after all, *synchronism was the crux of the television problem.*

It has always been one of the outstanding problems, and it was the difficulty of discovering a solution in this direction that prevented television from becoming a commercial reality.

Isochronism but not Synchronism

Some have gone farther and have said that it was perhaps *the* outstanding problem. Nevertheless, let us not overrate its importance to the detriment of television itself. After all, as we shall see in the ensuing chapter, we are enabled, once we understand the principles involved, *to achieve a distinct measure of success even when true synchronism is absent.*

Let us, therefore, first of all get a clear impression of what is meant by synchronism.

Supposing there were two accurate clocks, one situated in London and another in New York, the angular movement of the hands would be identical, but the actual times would be different.

Two wheels of equal diameter on a bicycle will revolve at the same speed, but it is long odds against them being in synchronism.

The condition which these two cases quoted have fulfilled is that of *isochronism*.

The Conditions for Synchronism

The mechanisms are running at the same speed, but there is another condition to fulfil before synchronism is achieved, and that is they must be "in step," or in the same phase relationship.

With the clocks, then, the hands must not only move at the same rate but point to the same time, and with our bicycle the wheels must fulfil the condition that similar spokes in the wheels must be pointing in the same angular direction at the same instant.

Thus we can achieve isochronism without synchronism, but never synchronism without isochronism, and the bearing that this has upon our received television images will be made clearer later in the chapter.

Essentially, the main problem to start with is to ensure isochronism between transmitter and receiver discs, although the two pieces of apparatus may be separated by hundreds of miles. *Unless this is accomplished nothing in the nature of a commercially practical television scheme will be possible.*

Several Devices Suggested

Many and varied have been the methods proposed and put into practical operation, but they have not survived the rigorous conditions of commercialism.

For example, one can call to mind the use of alternating current synchronous motors.

This device gives quite successful results, *but it necessitates the use of a separate channel of communication* for the alternating current driving the two motors, as both motors must be driven from the same source of power (unless worked from the same A.C. mains).

In America use has been made of the alternating current mains. Where the transmitter and receiver motors can be connected to the same supply network, simple synchronism may be achieved by this means.

In this country good progress is being made with the "grid" system, whereby all the mains (time-controlled) will be linked up. Once this is done, more machines can be used working with synchronous motors, but this is not yet possible.

Another suggestion, also emanating from the U.S.A., is to transmit a synchronizing signal of definite frequency, and tune both the transmitter and the receiver mechanisms to this.

Bristling with Difficulties

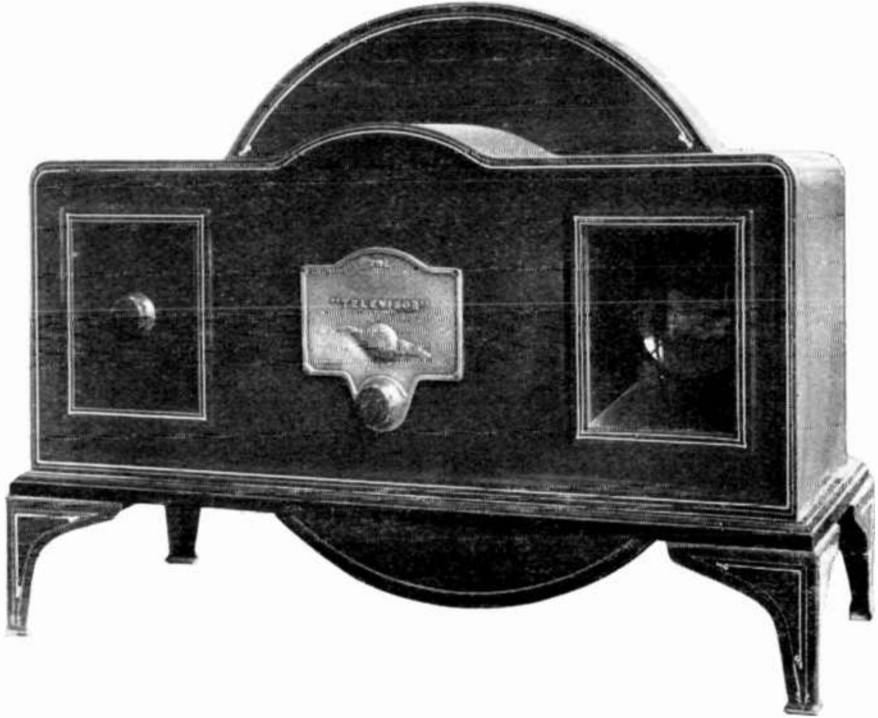
But the idea fairly bristles with practical difficulties, quite apart from the fact that another wave-length is required for transmission purposes.

Then we can cite the efforts made to obtain synchronism by means of independent oscillating systems, such as oscillating crystals, tuning forks or oscillating valves, the alternating current generated by these devices being amplified and used to supply synchronous motors.

Such devices are extremely complex and expensive, and are only suitable for operating under laboratory conditions, or where an expert staff is available.

In consequence these are quite impractical for general public use.

Therefore, before television could become commercially practicable for broadcasting to the home, *some form of synchronism had to be invented which would not necessitate the use of separate channels of communication*, and furthermore would be sufficiently simple and inexpensive to come within the scope of the domestic user.



The Disc Model Baird "Televisor"

This was accomplished by Mr. Baird, and was shown in operation during the Radio Exhibition in London in September, 1928, and was further publicly shown at the demonstration given in March, 1929, before the Committee of Members of Parliament and Post Office and B.B.C. Engineers.

An Historic Occasion

On this historic occasion television was transmitted through 2LO and received at St. Martin's-Le-Grand, before Lord Clarendon, the Postmaster-General, and engineers and Parliamentary Committee, and was received simultaneously at Savoy Hill before Sir John Reith, Director-General, and other officials of the B.B.C.

On these occasions no separate synchronizing signal was sent out, the picture being transmitted through 2LO, and the speech through the Marconi station on a separate wave-length. The picture itself provided the synchronizing impulses necessary to keep the receiver in step with the transmitter. The means used to accomplish this have only recently been disclosed fully, and are, therefore, exceptionally interesting, and are the result of months of patient investigation on the part of Mr. Baird and his engineers.

Now, is there any component part of our television signal which possesses an unvarying characteristic, or one that varies exactly in accordance with our transmitter disc?

The answer—there is.

The actual strip sequence, which occurs thirty times for every revolution of the 30-hole scanning disc, *is the only part of our television signal which does not depend upon the light, shade, or contour of the subject being televised.*

Using Part of the Picture Signal

Can we, therefore, in any way take from the picture signal part of the current, and use it to keep the receiver mechanism in step with the transmitter mechanism?

There is a signal radiated no fewer than 375 times per second (assuming that 12½ pictures per second are

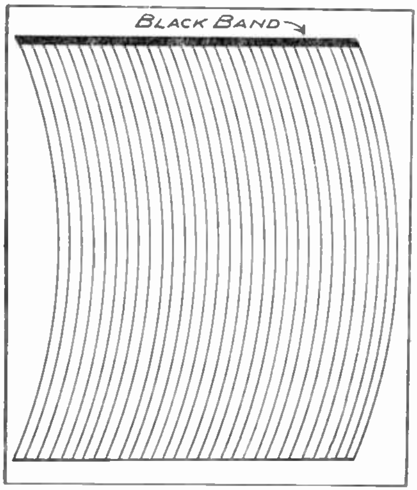


FIG. 10. THE NARROW BLACK BAND WHICH PROVIDES THE SYNCHRONIZING IMPULSE IN THE BAIRD SYSTEM

being transmitted). This signal has a *very well-defined beginning and ending,* with a definite intervening period.

And it is this fundamental component which we press into service.

If you observe a televised picture in a Baird "Televisor" receiver, you will notice a thin black horizontal band at the top marking the boundary between one picture and the next.

This is shown diagrammatically in Fig. 10, and the depth of the band is approximately equal to one hole of the scanning disc.

It is artificially introduced by means of the "gate" we mentioned in Chapter III, the depth between the two movable portions being carefully adjusted for this specific purpose.

Introducing the Black Band

Actually it means that for a very minute fraction of a second *there is at the top of the spot light sweep no*

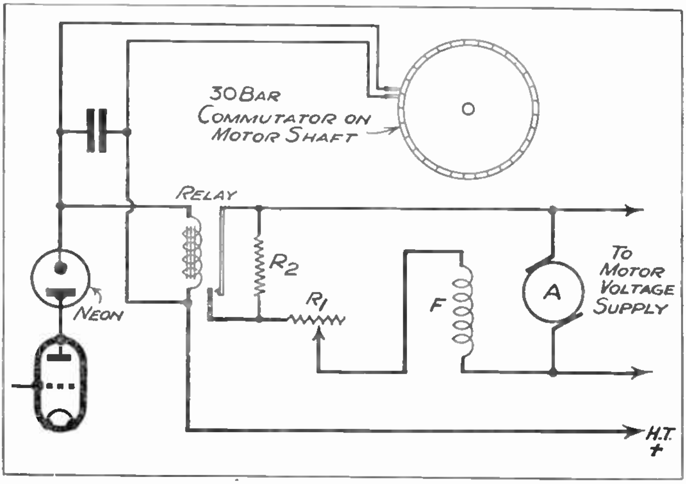


Fig. 11. The Salient Details of the Baird Relay Synchronizing System, Shown in Diagrammatic Form

illumination, either on the televised subject or on the white back screen, and thus no current flow in the photo-electric cell circuit.

It constitutes a definite signal depending absolutely on the transmitter mechanism, and if we can make our receiver in some way respond to this, *isochronism is assured.*

Until quite recently, what is known as the relay synchronizing system functioned from this signal, and although this method has now been definitely abandoned in favour of a simpler but more effective device, the ingenuity of the arrangement warrants mention in this book.

Fig. 11 gives the salient details of the apparatus. It depends for its successful action upon the control of motor speed by cutting out part of the motor field resistance as occasion demands.

If the circuit is traced out, it will be seen that there is a variable resistance R_1 and a fixed resistance R_2 in series with the shunt motor field.

Relay Synchronizing

Across this fixed resistance, however, we have the contacts of a small relay, so that when current passes through the energizing coil of the relay the contacts close and the fixed resistance is " shorted out."

This would increase the motor field current and reduce the motor speed.

The output plate current from the last valve, or valves, of the wireless receiver passes through the neon of the " Televisor," and thence to H.T. + via the path provided by the energizing coil of the relay.

Note, however, that this relay coil has across its ends two leads, which pass to two phosphor-bronze brushes slightly staggered with reference to each other, and bearing on a 30-bar commutator, which is attached to that end of the " Televisor " motor shaft remote from the disc.

Consider now the action.

The commutator with its 30 bars, corresponding to the 30 holes in the disc, is so positioned on the shaft that, during the period that current is flowing in the neon circuit, as a result of cell activation at the transmitting end while the light spot is travelling up the unshaded strip area of Fig. 10, *the relay coil is short-circuited owing to the two brushes bearing on the same bar of the commutator.*

During this time, therefore, the relay arm is not pulled over, and the fixed resistance R_2 remains in series with R_1 and the motor field winding.

Working Details

At the same instant that a change-over is effected on the commutator (so that one brush is bearing on one bar and the other brush is bearing on the next bar), *signal current ceases to flow in the plate circuit*, because we have reached the scan of our masked picture strip, that is, the top shaded portion of Fig. 10.

Thus, although the short-circuit is removed from the relay coil, *it does not function owing to this cessation*, momentary, of course, of the signal current.

If, therefore, the " Televisor " motor had originally been run up to the speed of the disc at the transmitting end, by adjusting the variable resistance R_1 (actually this is a panel control), and the two motors are in step, the relay arm is not pulled over and *isochronism is established.*

Now, what will happen if the "Televisor" motor through some agency, say a slight variation of supply voltage, experiences a small increase in torque, and thus tends to run faster than the transmitter motor?

While the brushes of the relay mechanism are " shorted " nothing can happen. At the transition period, however, when each brush bears on a separate commutator bar, the scanning at the transmitting end, since it lags on the receiving end, has not reached the top black section of our scanning area.

Changes in Motor Torque

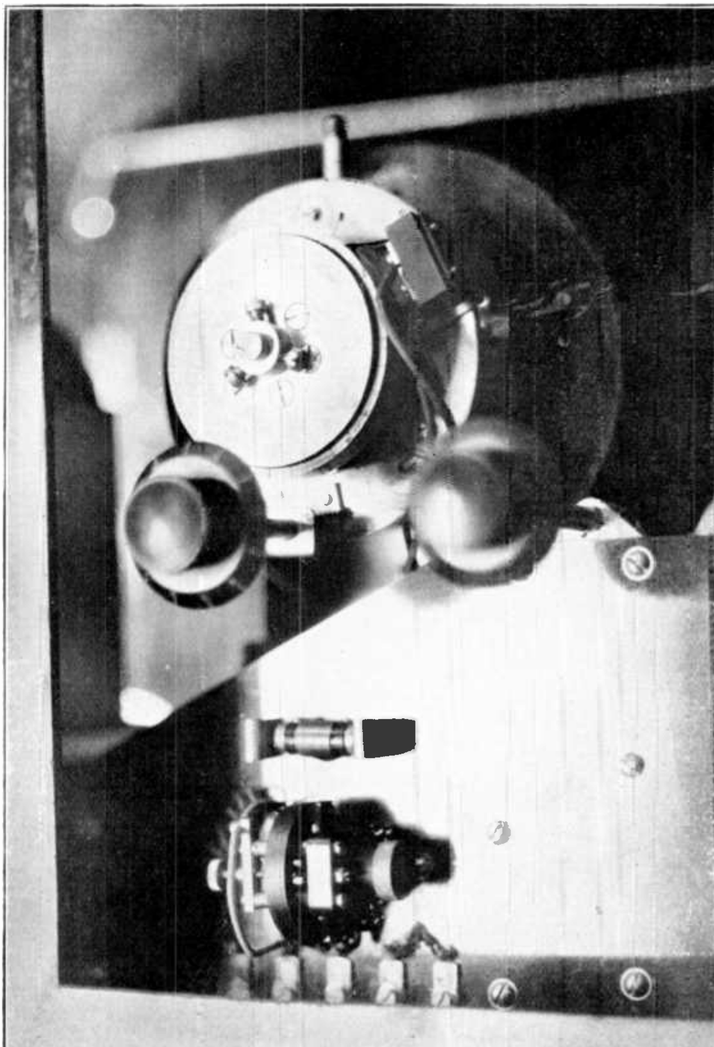
Signal current is still flowing in the neon circuit, therefore, and our relay contact closes because the commutator and brush short is removed. The closing of the relay short-circuits the fixed resistance R_2, field current in the motor circuit increases, and the motor slows down slightly.

If the " Televisor " motor happens to experience a slight drop in torque, then the relay action, which in effect acts as an electrical brake, tends to make matters worse, although normal running speed is frequently restored after the " Televisor " motor has slipped an amount equivalent to one or two holes in the receiver disc. Although this most ingenious Baird relay synchronizer provided the necessary control for the bulk of the demonstrations and work up to the advent of the improved method, it will be seen to possess several drawbacks of a very practical nature.

Practical Drawbacks

First of all, consider the number of changes which have to be effected during that very small interval of time when the brush short-circuit is removed, and the relay is brought into action. Current has to be built up in an inductive coil, that is, the relay coil, the relay arm pulled over, and the resistance R_2 " shorted out." Current now has to rise in another inductive circuit, the field circuit of the motor, and a corresponding decrease of speed registered owing to this larger field current. Once the relay arm is released normal conditions have to be re-established. This continual braking of the motor produced rather a bad " picture hunt," that is, the received picture had an unpleasant habit of rising and falling about a mean position in a sort of rhythm corresponding to the correcting impulses given to the motor.

Not only that, but the relay needed constant attention, and had to be adjusted and set up at frequent intervals, the contacts required cleaning and adjusting, and the brushes caused uneven wear on the commutator



The Mechanism and Controls in the Early Baird Relay System of Automatic Synchronizing owing to their staggered arrangement, which resulted in sparking, and affected the picture.

A Better Method

Generally it was found best to adjust the value of the variable resistance R_1, so that the "Televisor" motor tended to run slightly faster than the transmitter motor, and, as was mentioned earlier, in spite of its apparent defects, it constituted the only form of automatic television synchronizing which stood the test of wireless demonstrations under stringent conditions.

As a result of intensive investigation into this synchronizing problem, the Baird Co. evolved a far more effective method of "holding the picture steady," and yet its construction is very much simpler.

It is called the MAGNETIC TOOTHED WHEEL SYNCHRONIZER, and takes the form of two small electro magnets, so mounted on a metal frame-work that they are diametrically opposite to one another. This frame-work, in turn, is mounted on the front of the "Televisor" motor, so that a mild steel wheel having 30 evenly spaced teeth cut in its periphery, and mounted on the motor shaft, can rotate between the poles. The shape and facet area of both the poles and teeth are identical, and only a very minute clearance is allowed between teeth and poles as the wheel rotates.

Two Special Magnet Coils Required

The cogged wheel is definitely different in action and construction from the well-known "phonic wheel," which is merely a simple form of synchronous motor. The teeth of a phonic wheel are equal in width to the gaps, and it must be driven by current of approximately sine wave form. The cogged wheel has teeth very narrow in comparison with the spaces, and is a purely correcting device, operated by the very brief impulse given by the line at the top of the picture. It is essentially similar in principle to the relay synchronizer. This is important, as a phonic wheel operated from the picture will not be successful.

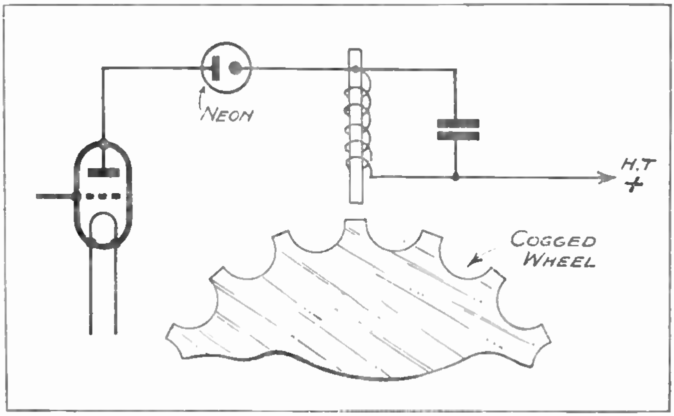
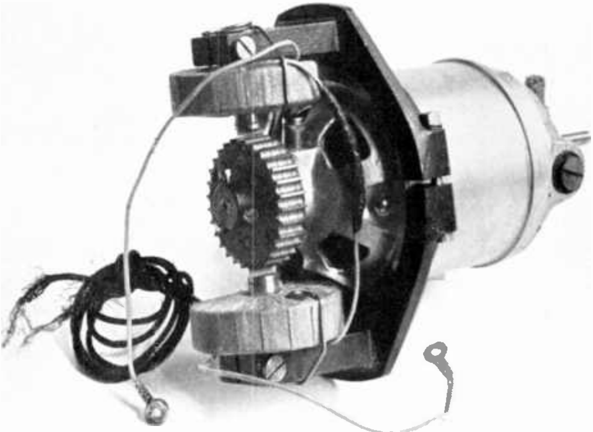


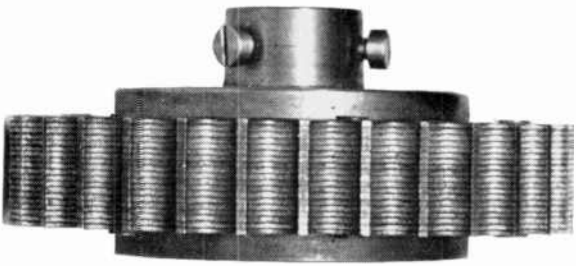
FIG. 12. THE ARRANGEMENT OF THE BAIRD MAGNETIC TOOTHED WHEEL SYNCHRONIZER, WHICH IS AUTOMATIC IN ACTION

The relative positioning of the cogged wheel, with reference to the pole pieces, is such that a tooth facet and pole face are exactly opposite to one another (see Fig. 13) when the scanning hole is just cut in halves by the bottom edge of the black band shown in Fig. 10.

Analysing the Action

Examining the action a little more carefully, we see that as the teeth *b* and *y* of Fig. 13 are approaching the poles, which are made of north and south polarity by the signal current flow, they are attracted, and, in consequence, there is an accelerating action, and at the moment teeth *b* and *y* are half their facet width past these poles the maximum accelerating force has been reached. This point corresponds to the instant when





NOTE HOW THE MOTOR AND SYNCHRONIZING EQUIPMENT ARE MOUNTED TOGETHER, WHILE BELOW IS THE LAMINATED COGWHEEL the scanning operation is just wholly on the black band of our scanning area shown in Fig. 10.

When past this point, and signal current again flows through the poles, there will be a retarding force on teeth *b* and *y*, but when treated as a whole, however,

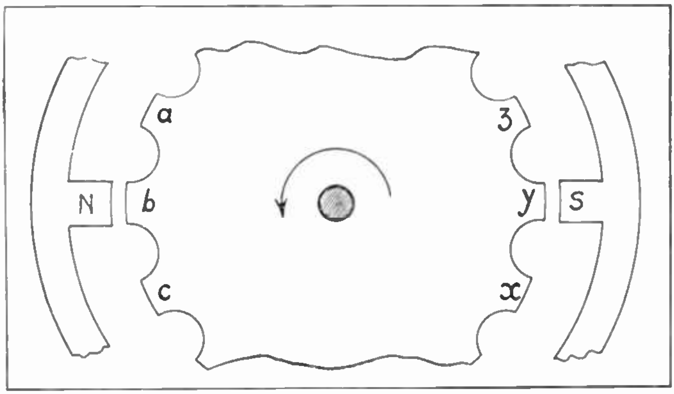


FIG. 13. HOW THE COGGED WHEEL SYNCHRONIZER WORKS

and bearing in mind the effects produced on each tooth in turn, then the wheel and, in consequence, the "Televisor" disc exhibit a marked tendency to be held in step with the transmitter motor, retarding and accelerating forces cancelling out for each cycle of changes.

A Retarding Impulse

Supposing the "Televisor" motor does tend to run a little faster, what will happen? Why, instead of the period of no signal current occurring at the point where teeth and poles are leaving, it will occur when they have passed. But once the teeth start to pass the poles there is a magnetic attraction tending to pull them back, whereas at synchronous speed this retarding impulse occurred later in the cycle of changes. With the teeth

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endeavouring to run ahead, therefore, the retarding impulse predominates, and the wheel gives way to the braking action and drops to its normal speed.

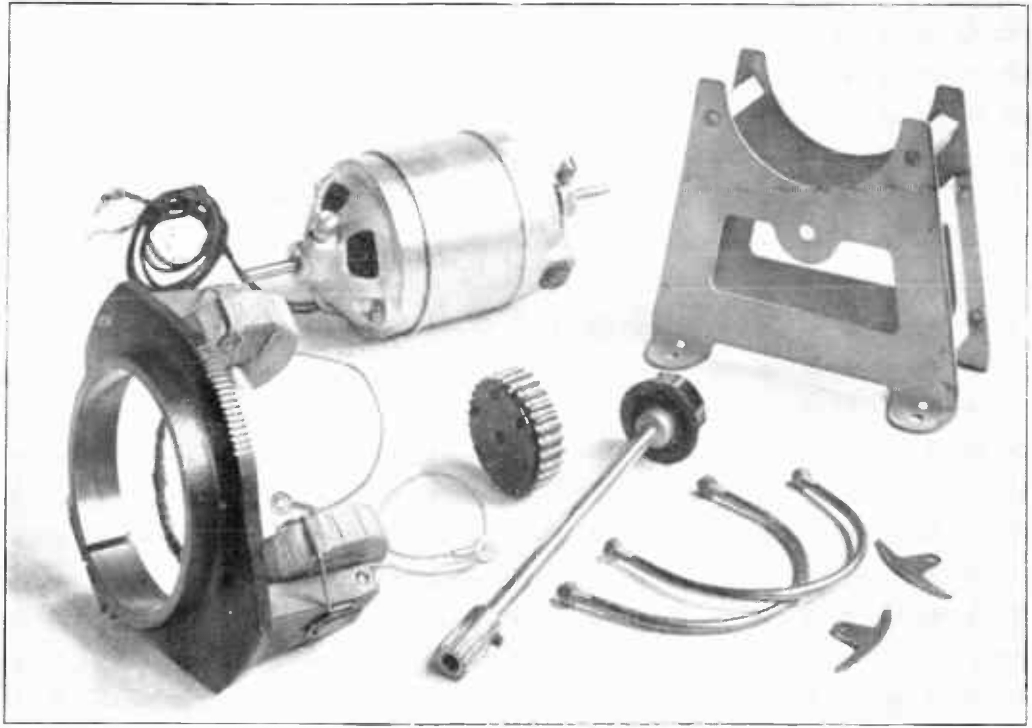
Short of an actual demonstration, it is difficult to realize the holding force of this latest form of Baird synchronizer. The picture remains steady for extremely long periods, the previous " hunt " or " swing " being conspicuous by its absence or only slightly apparent. Should the motor tend to retard its speed an amount sufficient to "slip a tooth," the accelerating impulse after this one tooth has slipped will again predominate, and pull it into the isochronous speed.

Proof of the Efficiency

The system, therefore, bids fair to remain the standard for some time to come, and has many advantages to recommend it, amongst which may be mentioned cheapness, ease of manipulation, simplicity, absence of an impedance being constantly inserted in series with the neon circuit as was the case with the relay synchronizer, and absence of " wearing parts."

As proof of its steady picture holding, one has only to examine the photographs of televised subjects shown in the plate facing page 66. The exposure was of the order of 6 to 8 seconds, and although the photographs are untouched, it is almost impossible to detect any " movement " of the subject.

Now let us clear the air a little as to what would happen if perfect synchronization was not present in our televised picture. Unfortunately, a number of wrong impressions have got abroad as to the principles involved, and, strange to say, these frequently have been shared in prominent technical circles. Enough has been said in preceding paragraphs to indicate that if the *speeds* of the transmitter and "Televisor" disc



THE MOTOR AND SYNCHRONIZING GEAR OF A BAIRD " TELEVISOR " DISMANTLED are different, the picture instead of having a rectangular outline, will appear to be diamond-shaped and all the details twisted. Of course, if the difference in speeds is very high, then the whole image will dissolve into a blur of moving spots.

Removing a Misunderstanding

To be strict in definition, both the relay and cogged wheel systems just described are used to promote isochronism, that is, give a perfectly steady picture of rectangular outline. As we have seen in Chapter IV, however, isochronism can be established, and yet the picture may be " split " about a vertical dividing line. This is really a difference of *phase*, and some critics have gone so far as to say that a small difference of phase is sufficient to spoil the definition of the received image. Obviously, this statement is ridiculous, for a difference of phase in the synchronizing mechanism does not affect definition, but merely causes a displacement of the image to right or to left. This is rectified by altering slightly the speed of the "Televisor" motor, either electrically or mechanically, so that it " slips " the requisite number of holes to bring the picture to normal positioning. Once this has been done, the knack is soon acquired, *we have the conditions of both phase and isochronism established, and we can then say truly that both mechanisms are in synchronism.*

Framing the Image

There is another effect which has to be provided for, and that is " framing the image." No doubt most people can recall having seen pictures on the cinematograph screen, where the actor's feet are at the top of the screen and the head at the bottom. The picture has not been framed properly, and in the picture seen in the " Televisor " screen this sometimes happens, and we view, say, a woman's head and shoulders split horizontally somewhat as depicted in Fig. 14. To rectify matters in the case of the cogged wheel synchronizer, a knob is provided at the front and in the centre

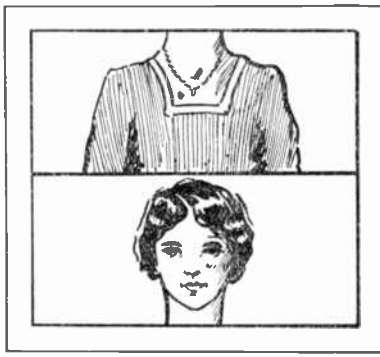
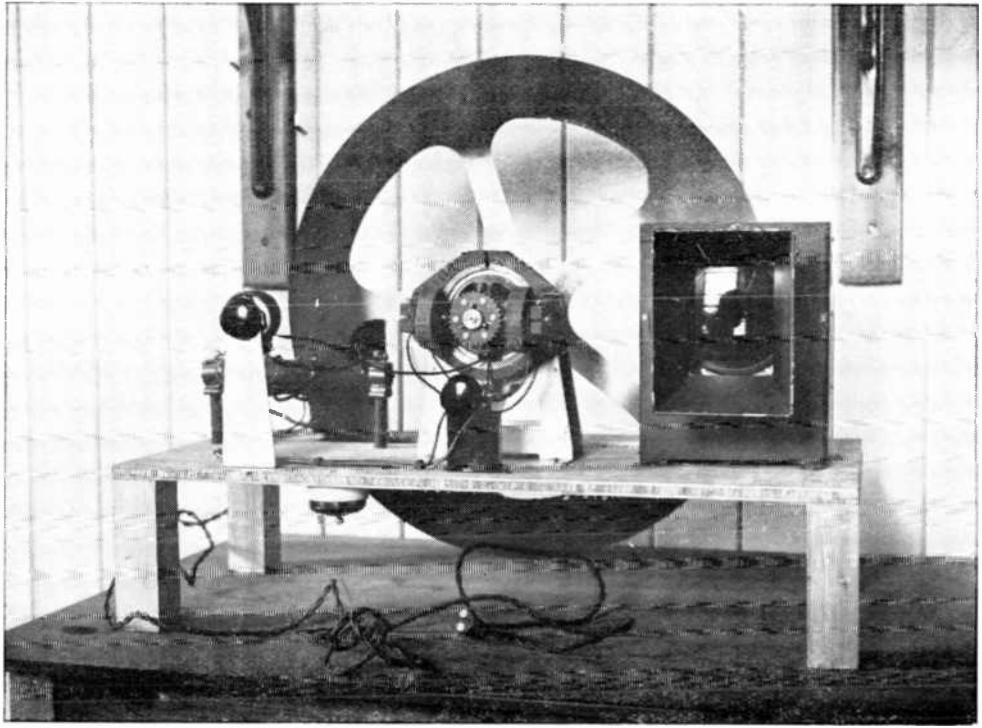


FIG. 14. A PICTURE INCORRECTLY " FRAMED " GIVES THIS APPEARANCE ON THE SCREEN

of the " Televisor," and on turning this in either direction as desired, the whole of the synchronizing mechanism is rotated bodily in a special mounting, and this will reset the picture.

With the older type of synchronizing, that is, the relay method, a little rack and pinion was operated from the front of the " Televisor " by means of a small knob, and this bodily moved the two staggered brushes round the commutator a small distance, and the picture moved up or down on its screen until it was accurately framed within the mask provided.

The importance of *automatic synchronizing* cannot be over-emphasized, and of all television systems throughout the world that evolved by Mr. Baird and his engineers is the *only* automatic one of universal application which has worked satisfactorily.



THE CONSTRUCTION OF A "TELEVISOR" FROM A KIT OF PARTS IS A VERY SIMPLE MATTER, AND ABOVE WE SEE AN EXAMPLE OF THIS WORK

CHAPTER VI

PHOTO-ELECTRIC CELLS AND NEONS

In earlier chapters we have made the formal acquaintance of both photo-electric cells and neons, and while it is not intended in any way to go at all deeply into these two important links in our television chain, it is felt that the reader would welcome the opportunity of gaining a little further knowledge of their prime functions.

Let us deal with the " eye of television " first, for within the last few years the photo-electric cell has come to be recognized as one of the most important of modern scientific devices. Until its advent television seemed becalmed, but when its properties were thoroughly appreciated its superiority over sluggish selenium made television a practical proposition instead of a scientific toy.

The Photo-electric Cell's Real Purpose

Stated simply, its prime function is to convert light variations into current variations, and some of the best cells for this purpose are those manufactured by the G.E.C. Two quite different models are shown in the accompanying photograph, and it must be borne in mind that actually there are available both vacuum and gas-filled cells.

In a vacuum cell the size and the form of the bulb and electrodes have no effect upon the current obtained with a given amount of light incident on the cathode; but, of course, if the cell should be exposed to diffused light, the larger cathode will give the greater current because it receives more light.

A cell in which the cathode is not part of the wall of the bulb is more regular in action, it being remembered that with the vacuum cell the current is that carried by the electrons directly liberated from the cathode by the light. This type of cell is preferable in everything but sensitivity, and the emission varies very greatly both with the material used for the cathode and with the quality of the light.

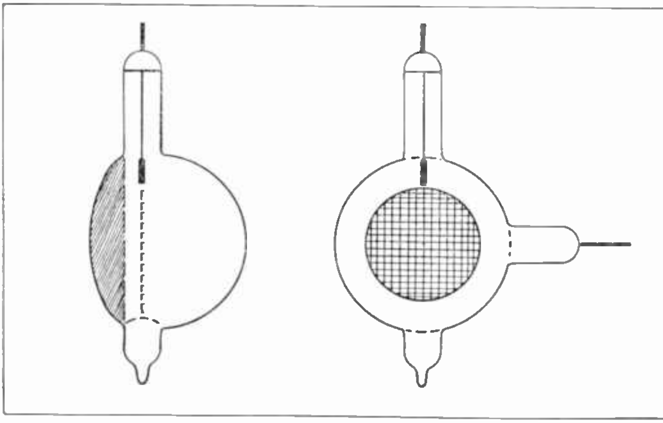
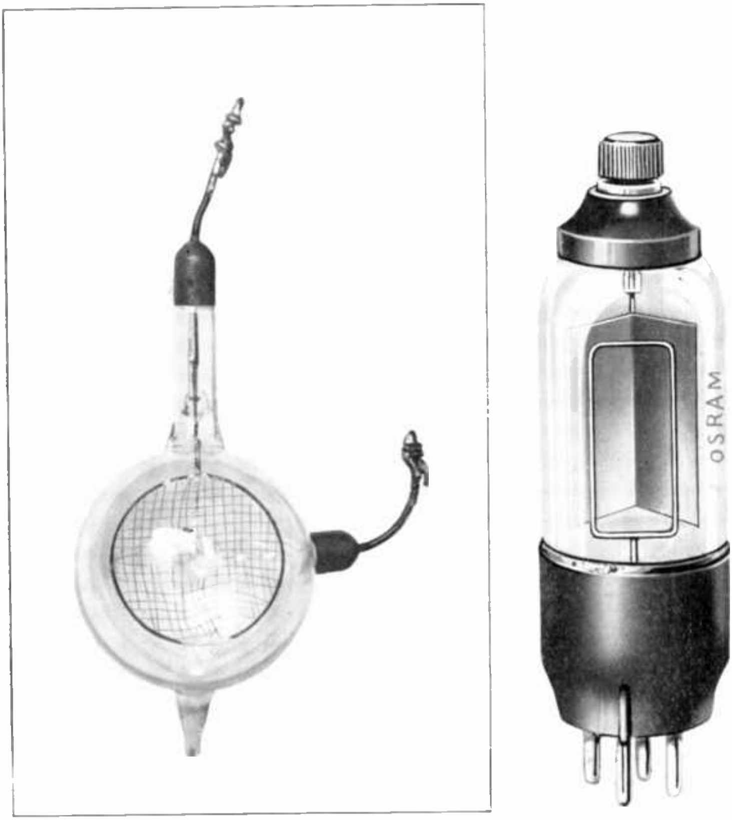


FIG. 15. DETAILS OF ONE TYPE OF OSRAM PHOTO-ELECTRIC CELL

Sensitivity of Prime Importance

The light sensitive metal used for the cathode may be potassium, sodium, rubidium, or caesium. For television purposes where sensitivity is of prime importance, owing to the very small amount of light reflected from the televised object, gas-filled cells are to be preferred. In these the primary current is magnified by the production of secondary electrons when the primary electrons travel through the gas.

Furthermore, the size and form of this type of cell may make a considerable difference to the magnification of the primary current by the gas-filling. One type of Osram photo cell has a cathode of potassium sensitized



TWO TYPES OF G.E.C. PHOTO-ELECTRIC CELLS by a discharge in hydrogen, and is filled with argon. The cathode is a layer deposited on the silver coating on the bottom of the cell, while the anode is a ring, covered with gauze, parallel to it, and Fig. 15 shows the shape and appearance of this particular type.

Magnifying the Current

The purpose of the argon filling is to magnify the primary photo-electric current, which consists of a stream of electrons emitted from the cathode when light falls on it. These electrons travel through the gas under the attraction of the positive potential, which must be applied to the anode, ionize the molecules of the gas, and set free other electrons which are added to the primary stream. The amount of this magnification depends greatly upon the voltage applied between cathode and anode, and a careful consideration of this is, therefore, necessary before actually putting the cell into commission. Since, however, this is essentially a matter for the transmitting side of the television system, a dissertation on the characteristics, precautions to adopt, "flashing," etc., would only be out of place in these pages.

What must be mentioned, however, is the fact that the cell has to be connected to an amplifier to obtain normal working outputs, for although the current through the cell increases when the light incident on the cathode is increased, the current obtained with such light as is usually available does not exceed a few hundredths of a micro-ampere, and is often much less.

Amplification Necessary

In the application of photo-electric cells to television, there are light variations occurring at frequencies up to at least 20,000 per second, and these have to be translated into corresponding variations of amplified current. The problem, therefore, resembles very closely that of audio-frequency amplification, with the proviso

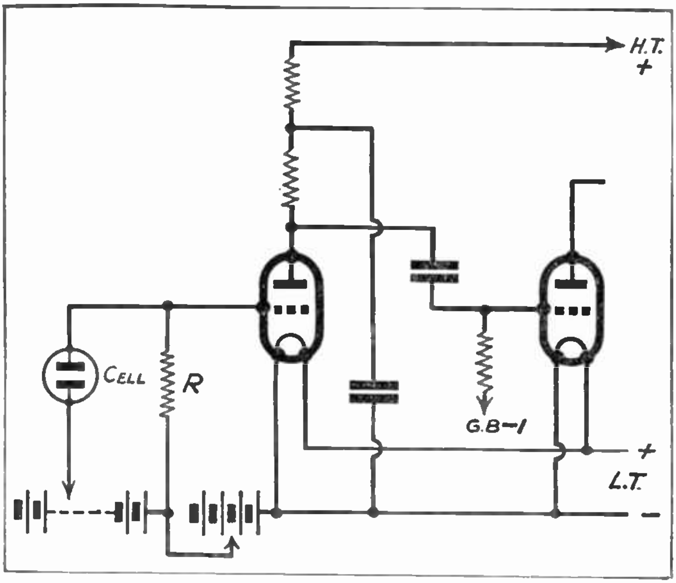


FIG. 16. ONE WAY OF CONNECTING UP THE PHOTO-ELECTRIC CELL TO ITS AMPLIFIER

that frequencies outside the audible range must be catered for in the amplifier.

This calls for a multi-stage resistance capacity amplifier, with special methods adopted for handling the higher frequencies. The number of stages in the amplifier must be settled by the degree of overall amplification required before the signal pulses are fed to the line, and the Baird Co. have developed a special amplifier which gives a remarkably even amplification for all frequencies within the range desired.

Connecting the Cell in Circuit

The resistance *R*, shown in Fig. 16, which gives one form of coupling, requires special consideration, for the

THE POSITION OF THE PHOTO-ELECTRIC CELLS IS CLEARLY SHOWN IN THIS EARLY PICTURE OF MISS JUNE COLLYER BEING TELEVISED AT THE STUDIO OF THE BAIRD TELEVISION CORPORATION OF AMERICA greater its value the greater will be the variation of the grid potential of the first valve produced by a given photo-electric current, and the greater, therefore, the sensitivity. A limit is set, however, by distortion at the higher frequencies. Capacity effects are likely to prove troublesome, and the cell should be mounted as close to the grid of the first valve as conveniently possible, so that lead capacity is at a minimum.

As far as can be measured with modern instruments, there is no time lag in the primary photo-electric current response to a light pulse. Anything in the nature of an apparent lag is traceable generally to the presence of a condenser capacity which the minute photo-electric current takes time to charge, and this has to be guarded against.

How the Neon Lamp Works

Coming now to neon tubes, we are all more or less familiar with those patterns used for advertising purposes in the form of shaped letters, and also the beehive pattern so popular as night lights. At the receiving end we saw the necessity for a form of illumination, which would not only be instantaneous in its response to the current variations produced by the television signal, but would also withstand the rapidity of these fluctuations.

This is supplied by the neon lamp, which, according to the specific television purpose for which it is required, can take several forms. Evidence of this is furnished by the group photograph of neon lamps (facing this page), all of which at some time or other have been used by the Baird Co. in the course of their investigations.

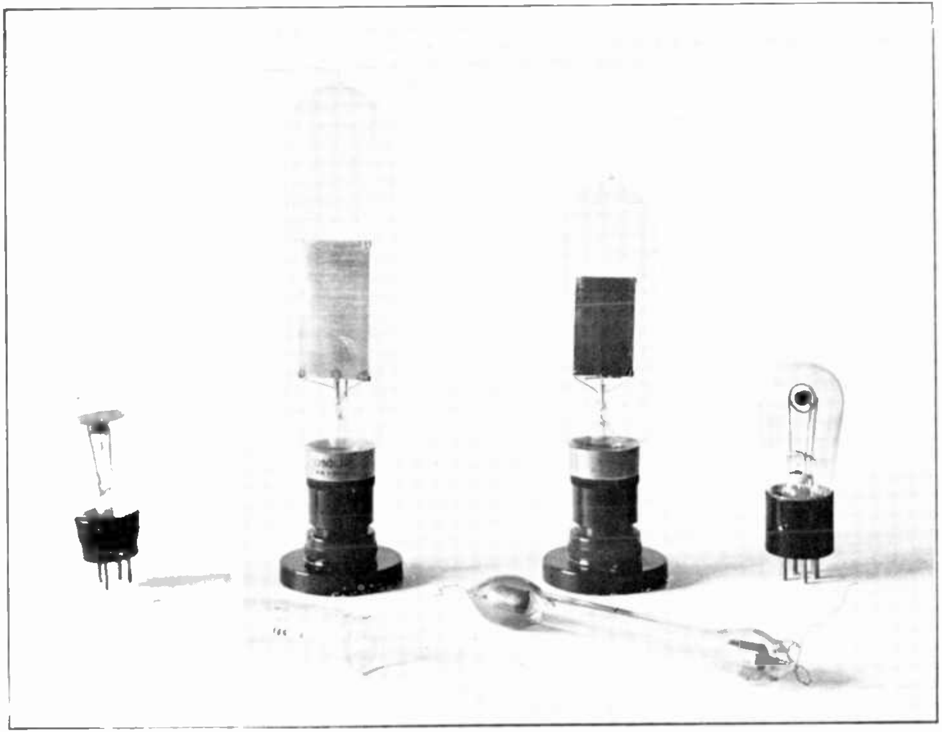
No attempt will be made to discuss the theory underlying the action of this tube, since it brings in such things as Crookes's dark space, negative glow, positive column, Faraday's dark space, ionization, etc. Suffice to say that the lamp is filled with a gas, called neon, generally obtained from the atmosphere, at a very low pressure. This is the same as saying that the number of atoms of neon present inside the glass bulb is relatively small. In order to ensure constancy in its normal functioning it is essential that this gas pressure should have a certain exact value in each lamp, so that care and precision are called for in manufacture.

If a certain definite voltage of the order of 160 volts is applied between the electrodes of the lamp, a current is forced through the lamp, and, due to atomic bombardments and ionization, the neon atoms become heated and glow with a reddish orange colour which is the characteristic of the lamp.

Points of Great Importance

There are two points of great importance which should be noticed, the first being that the neon tube possesses no appreciable time lag or inertia, and thus responds instantaneously to the passage of an electric current. This is a remarkable feature when we realize that it has been shown possible to light or extinguish the lamp at the enormous rate of one million times per second. Our next point is that the intensity of the glow is directly proportional to the current strength.

For the normal television purposes, such as we have discussed in earlier chapters, there is one type of neon lamp which meets the case admirably. This is shown in the pair of neon lamps in the centre of the group photograph. The negative electrode is made in the form of a rectangular metal plate (nickel is the metal usually employed for this purpose). This is mounted vertically as shown, and the positive electrode consists of a short metal rod mounted immediately behind and in the



A Few Representative Types of Neon Lamps Used in Television Investigations centre of the plate, the two electrodes being separated by a small distance.

Where to Place the Neon Lamp

When constructed in this way and the correct striking voltage is applied, the whole of the neon plate glows

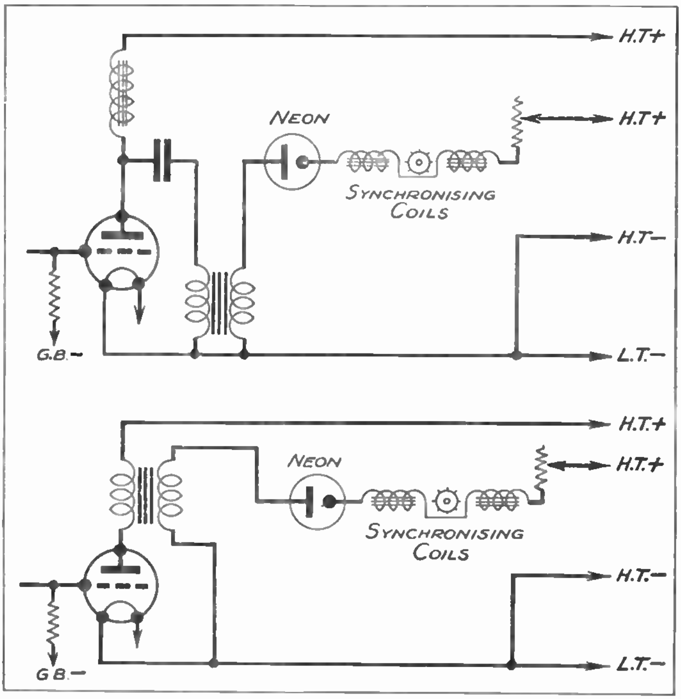
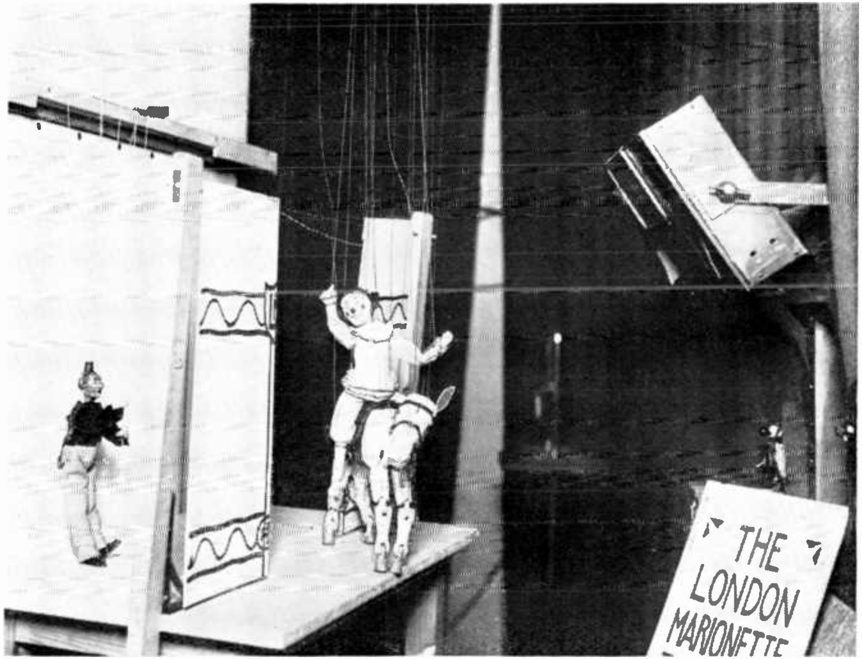


FIG. 17. SIMPLE METHODS FOR JOINING THE NEON LAMP TO THE OUTPUT VALVE OF THE WIRELESS SET RECEIVING TELEVISION SIGNALS

and a certain current flows through the circuit of which it forms a part. Therefore, if we connect this neon tube in the output circuit of our wireless receiver, and vary the current flow by the television signal pulsations, we have the glow of the lamp varying as the original light pulses from the transmitter. As we have learnt, these rapid light changes are viewed through a scanning disc, and produce the effect of a built-up picture on the rectangular-shaped anode itself.

The smaller type of plate neon illustrated can be operated successfully from an amplifier using no more than 300 volts, and the current is furnished adequately by valves of the LS5 class. This is effected by choke coupling the neon, so that it is not directly in series with the plate circuit of the last valve.

One or two methods for carrying this out are shown in Fig. 17, and it is best to arrange a variable resistance in circuit as shown, so that the voltage may be adjusted carefully. Do not have the plate too dark, and bear in mind that the grid biasing voltage to the last valve (or valves if in parallel or push-pull) must be adjusted jointly with the neon voltage, in order to get the most efficient results when the neon is in series with the valve. The higher the biasing voltage for a given electrode voltage, the darker the appearance of the neon plate, and if this is pushed too far, dark shadows will appear and spoil the television picture.



THE VERSATILE NATURE OF THE TELEVISION PROGRAMMES CAN BE REALIZED BY THIS PHOTOGRAPH OF THE LONDON MARIONETTES WHICH HAVE FEATURED IN TELEVISION BROADCASTS

CHAPTER VII

THE WIRELESS RECEIVER FOR TELEVISION

WE have seen that the use of a wireless receiver is necessary for the reception of television. Comes the question: Which wireless receivers will be suitable for this purpose?

The average wireless listener will ask himself whether his wireless receiver, which has done yeoman service in receiving aural broadcasting, will be equally suitable for the reception of television broadcasting?

Give Your Own Verdict

Obviously, the answer to that question is bound up primarily in the type of receiver which has sufficed so far, and the best interests will be served, therefore, if we take each section of the wireless receiver, that is, high frequency side, detector, and low frequency, and analyse these carefully. Then the reader will be in a position to pronounce his own verdict, it being at once apparent that a poor wireless receiver can only result in poor pictures, more so than in ordinary broadcasting, for while the eye is accommodating in many respects, generally it is more critical than the ear, with a normal person.

With both speech and picture being transmitted on separate wave-lengths, it is at once apparent that two receiving sets will be necessary, so that if the reader is already in possession of one set, he is recommended to let the successful reception of television signals be his criterion in purchasing or making the second set, leaving the old set to continue its normal function of serving the ear.

Signal Strength Required

Leaving quality for the moment, and turning to the strength of the received television signals, for, of course, they can be heard as a distinctive note on the loud speaker, perhaps the simplest way of judging the receiver's merits is to say that these signals must be of *good* or *strong* loud speaker strength.

Of course, if you substitute a neon lamp for your loud speaker, you can watch it flickering with relatively small inputs, but if you attempted to resolve this into a picture by scanning it with a perforated disc, the result would be a very faint picture or even no picture at all, and obviously this is not what is wanted. The output power from the set has to operate the neon lamp in a healthy manner, and, even with the smaller type flat plate neon, this power has to be of reasonable dimensions to make it function satisfactorily. The stronger the signals the better the picture up to a point, but if there is too much output the picture will be " cooked," that is, there will be such a brilliant contrast between light and shade that detail will be lost. It is the same when we attempt to overload our loud speaker quality reproduction being then at a discount.

If we take the case of the Baird commercial " Televisor " then the required receiver output is of the order of 1½ watts, and this figure will act as a guide for your own experiments.

The Best Type of Detector

So much for the first criterion; what is the next point to consider? Preference will be given to the detector stage, and issue must be joined with the protagonists of either grid leak or anode current rectification, since these are the two most popular methods now in use.

As we all know, the detector valve in a wireless set

A BAIRD DUAL RECEIVER MODEL WHICH CONTAINS TWO RECEIVING SETS, ONE FOR SPEECH AND ONE FOR VISION has only high frequency oscillations applied to it, and its purpose is to convert these into a pulsating unidirectional current, which usually is amplified by further stages of low frequency coupled valves. The amount of modulation of the high frequency carrier is varying throughout the time a broadcast is taking place, but

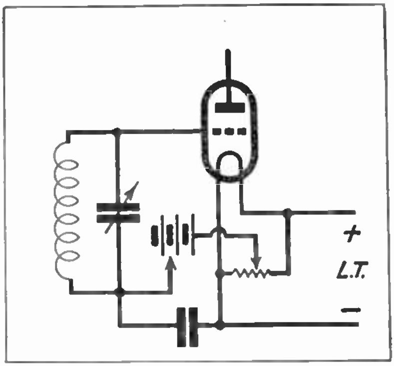


FIG. 18. ONE WAY IN WHICH IT IS POSSIBLE TO CONNECT UP A DETECTOR VALVE FOR ANODE BEND RECTIFICATION

effective measures are adopted to prevent the wave being over-modulated, as this would of itself introduce distortion, and distortion at all costs must be avoided. Our detector valve, therefore, has to deal faithfully with the signal impressed upon its own grid, and pass on to the grid of the first low frequency valve an output which is a true representation of this signal.

Taking Each Form in Turn

What is the prime difference between the two methods of detection? Apart from circuit details, this can be answered quite simply. In the case of grid leak rectification, the actual process takes place in the grid circuit of the valve and the resulting low frequency currents undergo magnification in the valve itself, whereas with the anode bend arrangement the reverse holds, that is, the high frequency currents are amplified in the valve first and are then rectified in the plate or anode circuit.

Let us deal with each system in turn, taking anode bend rectification first.

We use the bottom bend of the anode current/grid voltage characteristic to effect the actual rectification,

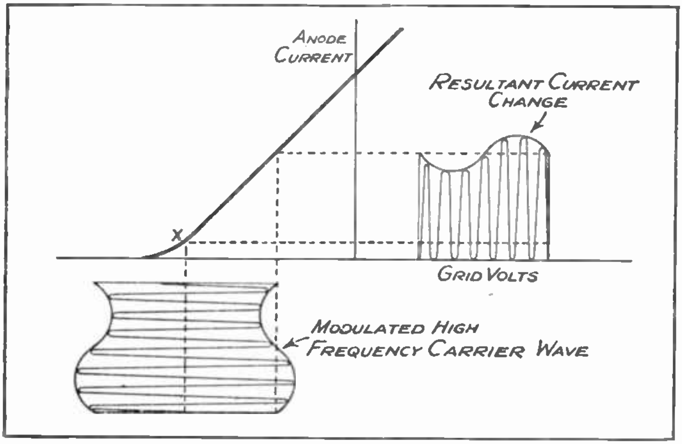


FIG. 19. DIAGRAMMATICALLY ILLUSTRATING HOW RECTIFICATION TAKES PLACE IN A VALVE WORKING ON THE ANODE BEND PRINCIPLE

and, in consequence, sufficient negative grid bias must be applied to work at the proper point, the exact value, of course, being contingent upon the plate volts fed to the valve. A reference to Fig. 18 will give one quite satisfactory method of connecting up the valve for this type of rectification, the potentiometer across the low tension supply giving the fine control of the biasing voltage.

Maintaining Proportionality

Fig. 19. is drawn to illustrate simply how rectification actually takes place. Assuming a modulated high frequency carrier wave is applied to the grid, which has

been biased to the point marked X, then the resultant plate current change due to the modulation (and, after all, this is in effect our electrically disembodied picture) takes place on the straight part of the characteristic. There is then absolute proportionality between input and output signals; the only difference lies in increased strength due to valve amplification, and, in consequence,

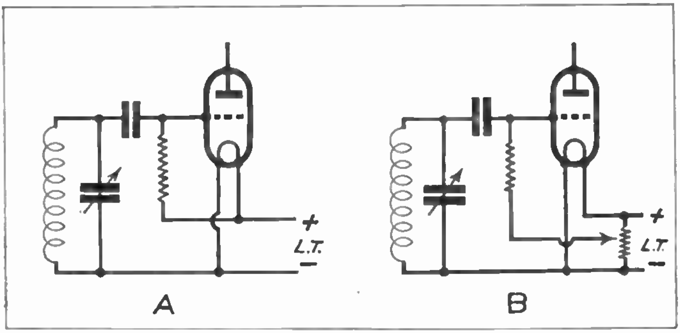


FIG. 20. TWO METHODS FOR JOINING UP A VALVE TO WORK AS A GRID LEAK RECTIFIER

we have no distortion. Note that the impression of the signal has caused an *increase* in mean anode current. Should the modulation be too strong with the particular setting chosen, or if the plate and grid voltages are too low, then it will be quite obvious that the voltage swing on the grid will run on to the positive side of the characteristic, and grid current flows with resultant distortion, for the condition of proportionality is lost when this happens.

On the other hand, we can see from the diagram that if signals should happen to be weak, then the curved portion of the characteristic is brought into use and distortion occurs again, since there are not proportional plate current changes to grid voltage changes.

Now what of the other form of rectification?

Grid Leak Rectification

A fixed condenser of about ·0002 to ·0003 mfd. is inserted in circuit, as shown in Fig. 20(A), to offer a high impedance to the low frequency modulation of the carrier wave, while the valve grid itself is connected through a resistance of about two megohms to L.T. + so that grid current flows. When the high frequency signals are impressed through the tuned circuit, oscillations pass to the grid through the small grid condenser but owing to the high impedance of the grid leak and to the varying grid current produced by the signal, the grid voltage varies in accordance with the low frequency portion of the signal. Actually, the grid condenser when working collects charges of electricity which reduce the normal grid voltage, and, of course, the anode current *reduces* in sympathy, as will be seen if a milli-ammeter is joined in the plate circuit of that valve.

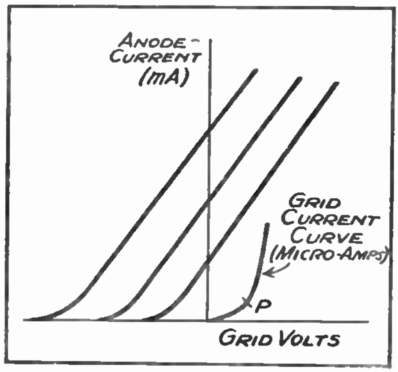


FIG. 21. THE BEST POINT TO WORK FOR GRID LEAK RECTIFICATION IS SHOWN AT POINT *P*

On the grid side adjustments must be such that grid current can flow, but in addition the plate voltage must be so determined that the valve works on the straight part of its plate current/grid voltage characteristic. Furthermore, excursions must not be made into the curved portions of the characteristic, otherwise a secondary rectification (actually anode bend) will take place, and distortion occurs. Since it is frequently advantageous to adjust critically the grid voltage, the provision of a

A HAPPY GROUP: MR. H. J. BARTON CHAPPLE, HIS WIFE AND FAMILY ENJOYING THE RECEPTION OF TELEVISION IN THE COMFORT OF THE HOME potentiometer as in Fig. 20(B) is useful. Arrange the value of the grid leak and grid voltage so that the grid is working on the most sharply curved portion of the grid current/grid voltage curve (see point *P* of Fig. 21).

Possible Distortion

Should a strong signal be impressed upon the grid, the grid circuit is liable to choke, and distortion will accrue, but with relatively weak signals the system is very sensitive and is productive of good results, as we all know from our own wireless sets.

Another point worthy of mention is that since a condenser is present in the grid, there is likely to be frequency distortion, for with increase of frequency the impedance of the condenser falls off. Since previous chapters have emphasized that it is the higher frequencies which add to the wealth of detail in our televised picture, it is as well to note that improvements can sometimes be effected by lowering the capacity value of the grid condenser or grid leak resistance, or by readjusting both plate and grid voltages.

One or the Other

Having assimilated the brief fundamentals of the two methods of rectification, which is best suited to our television requirements? A reference to Fig. 19 will show that the peak value of the modulating signal with anode bend rectification may be as much as twice the normal value of the carrier wave, but in order not to overstep the mark and prevent the flow of grid current, which in this system would introduce distortion, it is advisable either to have some means of regulating the strength of the signal applied to the detector or, alternatively, to use sufficiently large values of high tension and grid bias that grid current does not flow.

With strong signals grid leak rectification causes distortion, and, in consequence, is only efficient with a relatively weak input. On the other hand, the reverse is the case with anode bend, and the input must be so large that with normal values of modulation only the straight part of the characteristic is used.

Another Point of View

Before coming to a definite conclusion on these controversial matters, let us approach the question from another angle. How are we going to make the absence of distortion compatible with an adequacy of signal strength, which, as we saw earlier in the chapter, is essential, and yet keep the number of valve stages in our receiver within economical limits?

If you are close to the station transmitting the television signals, then the actual voltage induced direct in the aerial will give the strength required for working a detector valve direct, but what of the majority of situations which are generally more distant? Either high frequency amplification must be used or some form of reaction control incorporated. But we know from the experience gained with aural reception that reaction is a notorious agent for introducing distortion, so the best solution would appear to lie in the use of high frequency amplification and a reduction of reaction control to the barest minimum, or, better still, do away with it altogether.

Seeking the Best

Up-to-date practice has proved that one stage of screened grid high frequency amplification brings in all the stations really worth hearing, and consequently worth seeing if they are broadcasting television. This means that a strong signal input will be applied to the grid, and we must, therefore, employ anode bend detection if the best, that is distortionless, output is desired. Of course, this reasoning does not rule out the use of grid leak rectifiers, but since we are seeking the best let

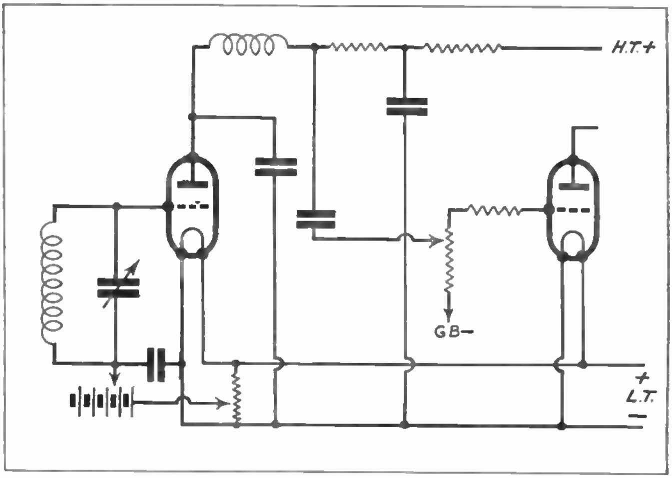


FIG. 22. USEFUL REFINEMENTS IN AN ANODE BEND DETECTOR VALVE CIRCUIT

us rely on methods which, for our specific purpose, lend the greatest aid.

Useful Operating Details

Now just a brief résumé of the main points to be borne in mind when using anode bend detection, as this will no doubt render assistance to the operator.

Use a valve of moderate impedance and amplification factor.

Follow this with a stage of resistance capacity coupling.

Remember that by increasing both the plate and grid volts within the rated limits of the valve, it is possible to deal with high frequency inputs of any magnitude, sufficient to obtain, with the minimum of low frequency stages, an output which is capable of operating the neon satisfactorily.

Although its inclusion gives a tendency to cut off some of the higher frequencies, it is generally advisable

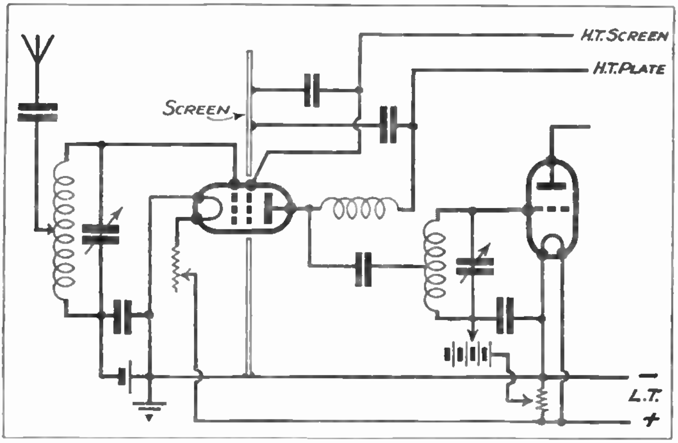


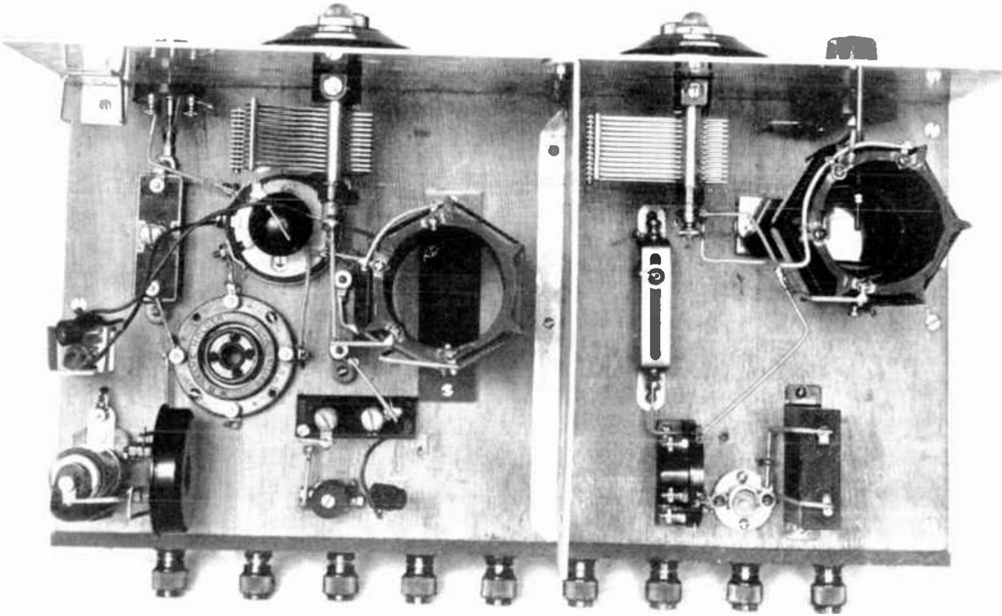
FIG. 23. A SUGGESTED ARRANGEMENT CAPABLE OF GIVING GOOD RESULTS FOR THE HIGH-FREQUENCY SIDE OF THE RECEIVER

to *insert a by-pass condenser* between plate and filament (see Fig. 22).

A semi-variable condenser of ·0003 mfd. to ·001 mfd. will be found suitable; then adjustments may be made under working conditions.

Other refinements are as indicated in Fig. 22.

Include an H.F. choke, a decoupling arrangement, a volume control by using a high resistance potentiometer as the grid leak for the first L.F. valve, a "stopper" resistance of about 100,000 to 250,000 ohms between the grid and coupling condenser of this same L.F. valve, and, of course, the voltage gradation potentiometer of about 400 ohms to ensure correct biasing to the detector valve grid.



A Suggested Lay-out for an H.F. and Detector Unit Specially Designed for Receiving Television Signals

Considering the H.F. Side

Turning for a moment to the high frequency side of the set, *do not have the tuning circuits too sharp*, otherwise this will cut off the higher frequencies.

As to the method of coupling between the screened grid and detector valves, many ways are open to the choice of the reader. *That illustrated in Fig. 23 has proved to be extremely good in practice.*

See that the two tuned circuits are *adequately screened from one another*, using, say, a "step" screen if the H.F. valve is mounted vertically, or a plain cross screen with a hole to accommodate the valve if the latter is held horizontally.

Naturally, if the set is to be used for "distant" reception, the coils should be of the highest efficiency, and those made of Litz wire will be best suited.

The rheostat in the filament lead of the H.F. valve serves as an admirable volume control for use when required.

We come now to the low frequency side.

A Basic Principle

Let us take for our basis the fact that *distortion is avoided if the increased signal from the output stage differs from the original only in being greater in magnitude*; that is, the output current in the plate circuit of each valve must be directly proportional to the input grid voltage.

To ensure this important detail, the total input volts grid swing to each valve must operate well within that part of the straight characteristic situated on the negative side of the "curve."

By following this principle, it will also prevent the grid from assuming a positive charge.

This factor must be rigidly guarded against, and calls for a careful study of each valve's characteristics, so that adequate plate voltages are applied to the anode of the valve, together with the appropriate grid bias —neither too much nor too little.

Note that the H.T. voltages applied to the set itself *do not represent* the true-plate voltages.

There is always some form of impedance present in the plate circuit, and this will account for a certain voltage drop, small in the case of inductive impedances but large *when using resistance capacity coupling*.

The actual anode voltages differ, therefore, from that applied to the set terminals.

In choosing the correct negative grid bias, it is the true-plate voltages which must be worked upon, and *not* the battery voltage.

To ascertain what these anode changes are, it is a good proposition to purchase a reliable high resistance voltmeter.

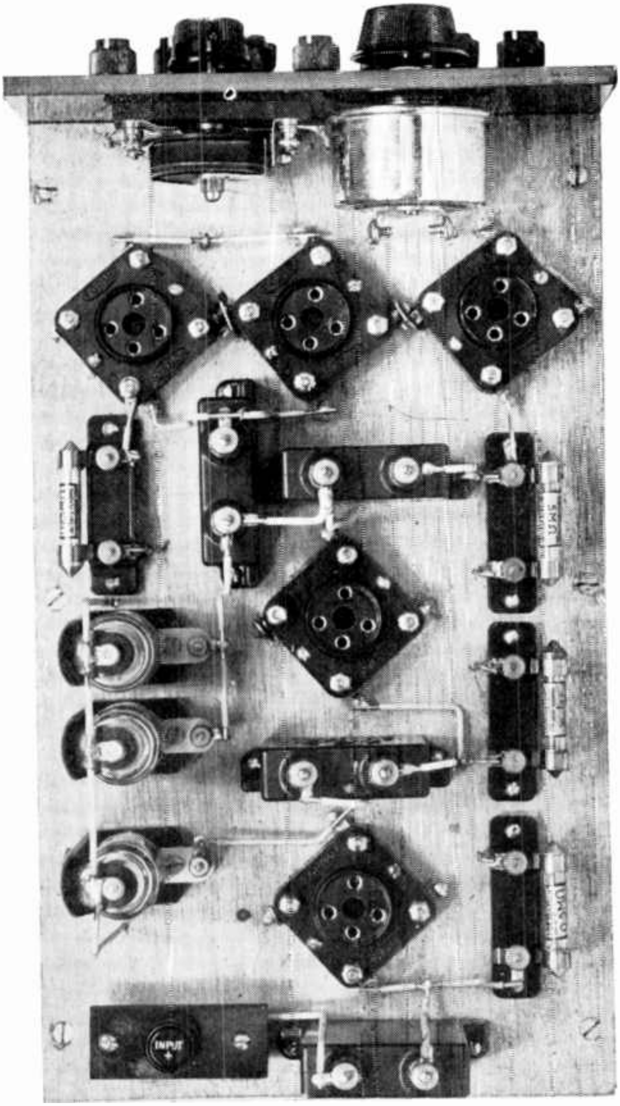
Using Transformers

It is generally accepted that if an amplifier can be made which *does not deviate more than* 10 *per cent from the ideal*, the ideal being one in which every frequency is amplified to the same extent, then the acutest ear or the sharpest eye would be unable to detect any difference.

If an iron-cored transformer is used in the valve plate circuit, we are faced with the fact that theoretically the impedance changes with every change of frequency.

Furthermore, the magnitude of the impedance is dependent upon the mean plate current flowing through the valve. Can we, therefore, expect to approach straight line amplification?

For frequencies up to about 9,000, fortunately, the answer is in the affirmative. This is due to the fact that our low frequency transformer is not quite such a simple instrument as one at first imagines.



A Good Example of a Resistance Capacity Coupled L.F. Amplifier Designed Specially for Television

One of the main features in the design of this transformer is to *keep the impedance of the primary as high as possible* at low frequencies consistent with small self-capacity at the high frequencies.

By careful design, and bearing in mind that in addition to the inductance of the primary and secondary windings we have present a leakage inductance, primary and secondary resistance, and primary and secondary winding self capacities, it is possible to produce a component which gives a reasonably steady amplification value up to the frequency limit mentioned earlier.

Avoid Cheap Components

Obviously, a cheap transformer cannot be designed to approach this degree of accuracy, and hence distortion takes place, so to avoid any trouble in this direction choose a reputable make, and use push-pull amplification in the last stage.

To achieve the best results in low frequency amplifiers for television work, however, where the frequency range to be covered for amplification exceeds that of the audible frequency range, *it is found that resistance capacity coupling meets the case in a really excellent manner.*

To avoid distortion here, it is necessary to note that the real secret of success lies primarily in the selection of suitable valves and component values.

Above all, *use valves in each coupled stage which are fully capable of dealing with the relatively large power inputs to their grids without any suggestion of overloading.*

Those falling in the LS5 class are admirably adapted for this purpose.

Amplifier Details

Make the coupling condenser of high capacity value; up to ·1 mfd. is satisfactory, but, of course, in this

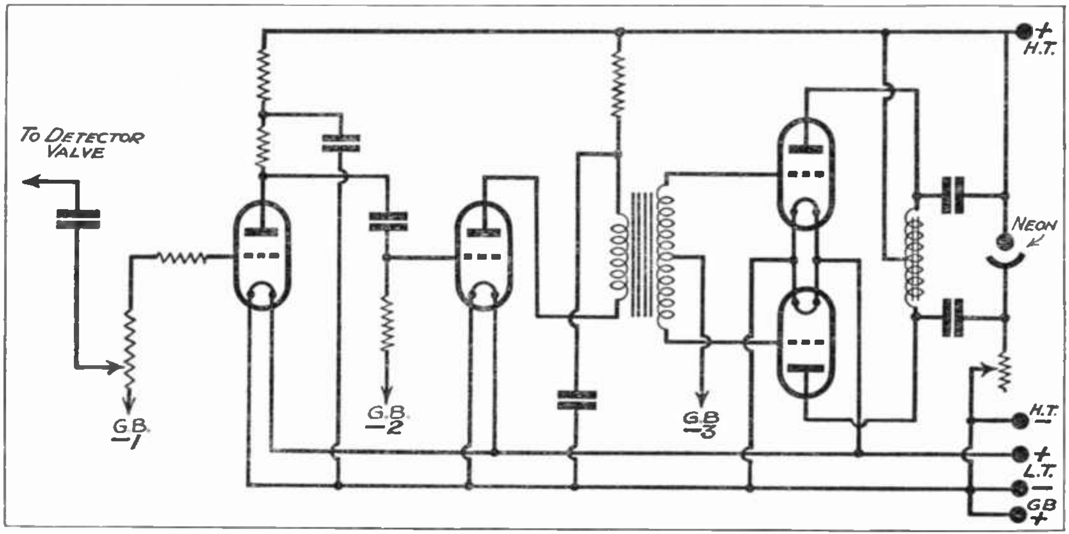


FIG. 24. A SUCCESSFUL LOW-FREQUENCY AMPLIFIER

connection it must be borne in mind that the anode resistance, coupling condenser, and grid leak are all inter-related.

At least, have the first low frequency stage following the detector valve resistance capacity coupled, and, since three normal L.F. stages are sufficient for securing the power to operate the neon, *endeavour to make the second stage resistance coupled,* with the last stage either push-pull or two large power valves in parallel.

To secure some idea of the type of amplifier which has given good results, reference can be made to Fig. 24.

The last two valves are here shown in push-pull, the neon lamp itself being isolated from the actual plate circuits of the push-pull valves.

With a 300-volt H.T. supply, this amplifier will work admirably, and, where possible, the high tension voltage should be derived from a mains eliminator of good make.

Needless to add, the actual design is capable of many variations, and if desired, resistance coupling can be used throughout.

A Good Resistance Capacity Coupled Amplifier

Since resistance capacity coupling has proved so efficient for television working, it was felt that readers would welcome details of a complete circuit together with component values which could be used for coupling after the detector valve.

This is shown in Fig. 25 and, in addition, one of the photographic illustrations shows exactly how this low-frequency amplifier can be laid out.

The valves suggested are an LS5B for the first stage, an LS5 for the second stage and an LS5A in the neon output stage. It will be noticed that in order to make

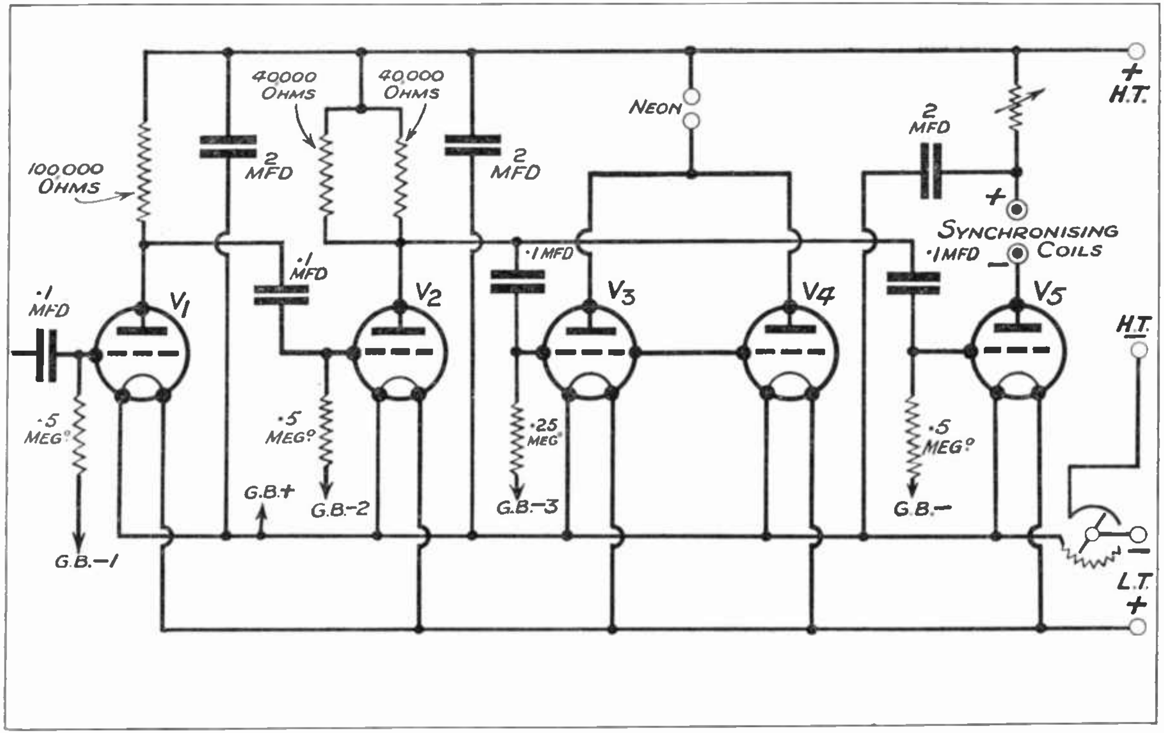


FIG. 25. COMPONENT VALUES OF A VERY EFFICIENT R.C. COUPLED L.F. TELEVISION AMPLIFIER

this amplifier "elastic," a separate synchronizing valve has been included to feed the synchronizing coils.

Frequently this method shows an advantage over what may be termed the more orthodox method of joining both neon lamp and synchronizing coils in series in the plate circuit of the normal output valve. By this means the synchronizing control can be effected independently of the neon lamp, and it is thus possible to strengthen or weaken the synchronizing " hold " just as necessity dictates without in any way upsetting the magnitude of the neon current and, of course, the neon glow. Obviously, the addition of this separate control demands a higher H.T. consumption, but, if the wireless set is being fed from the mains, this will make little difference to the total power required.

Using a Pentode Valve

The elasticity of this amplifier is further emphasized by the inclusion of two valves in parallel at the output stage to the neon. This is sometimes advisable when using valves capable of giving a smaller output than those of the LS5 class, say, for example, two P 625's in parallel.

To assist the reader further, reference can be made to Figs. 26 and 27. In the case of the former the two individual valves are shown separately, one for feeding the neon and one for feeding the synchronizing coils. This simple diagram will enable the reader to see exactly how the necessary connections can be effected. If one should be within reasonable range of the television broadcasting station, it is sometimes found possible to work the " Televisor " with only a pentode valve following the detector valve. To meet cases of this character, Fig. 27 indicates how the pentode valve should be joined up in order to feed appropriately the synchronizing coils, neon, valve plate, and valve grid. Voltages of the order of 450 should be applied to the valve plate circuit and 250 volts to the grid circuit

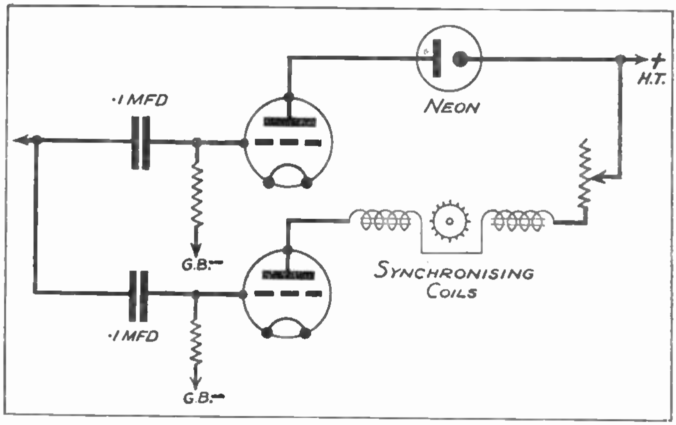


FIG. 26. TWO INDIVIDUAL VALVES ARE USED HERE FOR HANDLING THE VISION AND SYNCHRONIZING SIGNALS

through the appropriate variable resistance of 10,000 ohms. Any good 6-volt pentode valve is suitable.

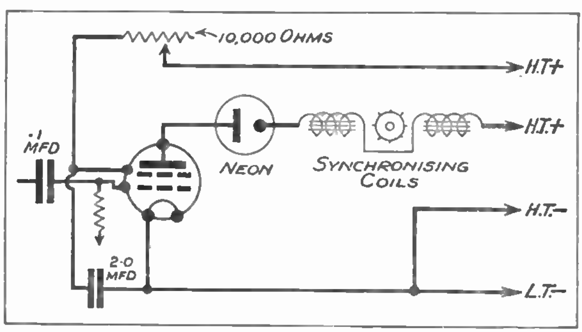


FIG. 27. SUITABLE CONNECTIONS FOR A PENTODE VALVE IN THE OUTPUT STAGE

Dual Vision and Sound Receivers

Many readers may have wondered whether it is possible to work both the vision and sound wireless receivers from the same aerial and H.T. and L.T.

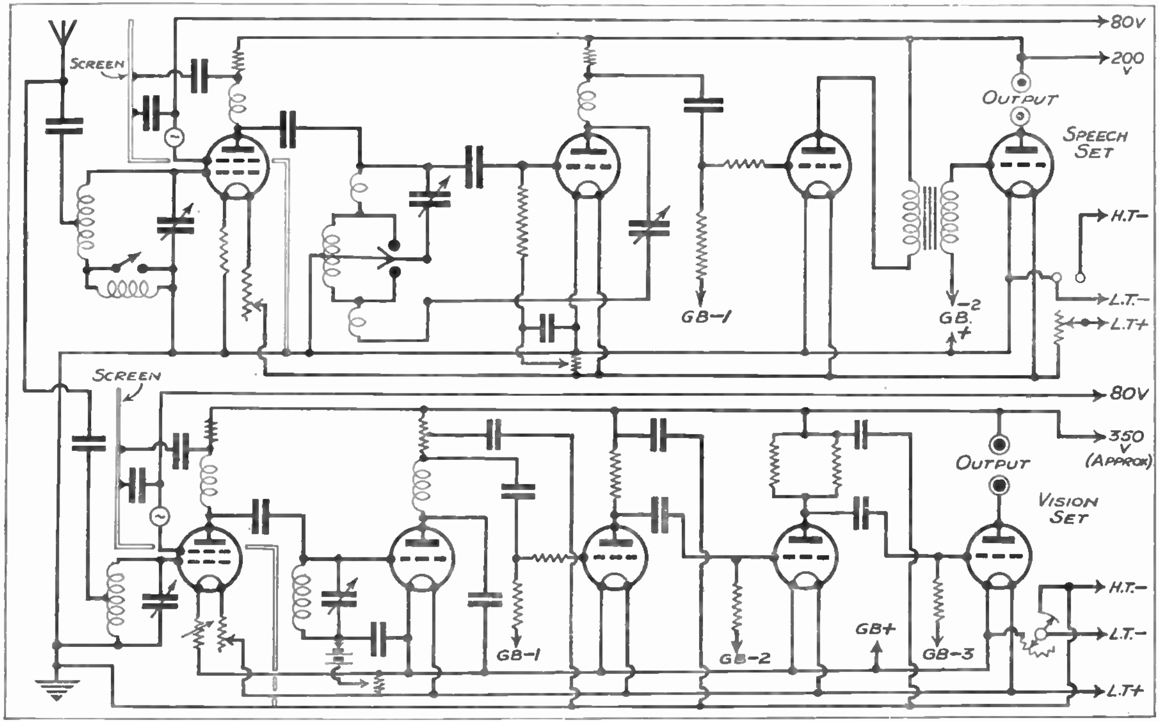


FIG. 28. A COMPLETE CIRCUIT FOR A DUAL VISION AND SOUND WIRELESS RECEIVER

supplies. This can be carried out quite efficiently, provided certain precautions are taken, and Fig. 28 shows a circuit for a complete dual receiver working on these lines. The top part of this diagram is devoted to the sound set, while the bottom half represents the vision receiver, it being noted that the coupling to the common aerial is carried out by means of two small fixed condensers of the order of ·00005 mfd. capacity. This particular arrangement has proved very satisfactory on test. Actual component values are not given since these have been dealt with separately in the earlier parts of this chapter, it being noted that the L.F. amplifier of the vision set is almost identical with that which has just been described.

The Output to the Neon Lamp

If economy in H.T. voltage is desired, then it is *recommended that the neon lamp be fed through some form of efficient filter circuit.*

The question of neon lamps was discussed fairly fully in Chapter VI, but in connection with the receiving set there is a point which must be mentioned.

Provided the output valve, or combination of valves, is such that *it possesses a "grid swing" of between* 30 *and* 40 *volts*, satisfactory results may be assured.

The bias on this last stage should be so arranged that *the neon lamp glows whether the receiving set is tuned to the incoming television signal or not.*

Then, when actually in tune, the signal will cause the current passing through the lamp to alter proportionately to its variations, i.e. a strong variation heightening the brilliance, and a weak variation dimming it.

It is advisable to see that the output impedance does not exceed 2,000 *ohms.*

INDICATING WHAT A NEGATIVE IMAGE WILL LOOK LIKE ON THE VISION SCREEN

Another factor which may appropriately be dealt with here is that arising out of " negative images."

A Negative Image

Anyone who has compared a photographic plate or film with the print made from it, will know what is meant by the relationship between positive and negative pictures.

If you hold the plate up to the light you will notice that all the dark patches seen on the print are light on the negative, and vice versa.

That is elementary. Imagine the confusion that may arise if your received picture, say of a man's head and shoulders, appeared as a negative! What steps can be taken to rectify this puzzling feature, and how is it brought about?

Perhaps you have overlooked the fact that if you have a receiver in which the first low frequency stage is resistance capacity coupled, and the second stage transformer coupled, the signal on the plate of the detector valve is then in the opposite direction from that on the plate of the output valve at the same instant.

Should both stages be transformer coupled, however, the *signal is in the same direction.*

Correct Signal Direction Necessary

This reversal of signal direction through successive low frequency stages may not have any effect as far as aural reproduction is concerned. But when looking at a televised picture the signal direction must obviously be correct.

Again, we have seen earlier in this chapter that in the detector stage, grid leak rectification causes a drop in the mean anode current on receiving the signals; whereas *anode bend causes an increase.*

Thus we have two possible signal directions, according to the type of rectifier in use, so that if one gives a positive picture the other must perforce produce a negative.

Under normal transmitting conditions a positive picture is assured with an anode bend detector, followed by three stages of resistance capacity low frequency coupling.

If grid leak detection is substituted, then it will be necessary at the receiving end to add or subtract one R.C. stage to rectify matters.

If a transformer is included on the low frequency side, then the change from positive to negative is brought about simply by reversing either the primary or secondary connections, *but not both*.

Should the reader, therefore, at any time tune in one of those negative pictures, he has one or two alternatives open to him for putting matters right.

A Small Refinement

The main point to keep uppermost in one's mind is the assurance that the receiving set is capable of delivering the power required with the minimum of distortion.

With these two criteria provided for, all is plain sailing.

Some may prefer to include a form of change-over switch in the output circuit, so that the television transmission may be tuned in as an audible note initially, after which the neon can be brought into circuit.

This is quite simple.

Remember, nevertheless, that generally it will be necessary to have an increased negative bias on the output valve, or valves, when the loud speaker is functioning than is the case when the neon itself is in circuit.

This can be provided for in the operation of the change-over switch.

CHAPTER VIII

TELE-CINEMA AND TELE-TALKIES

AN extraordinary situation in the fascinating history of television was the development of what is now called the tele-cinema. One found in Berlin, where the liveliest interest has always been manifested in television, that the Germans paid more heed to this branch of the science than to television proper. In other words, they saw more immediate entertainment value in the presentation of a television film than in the televising of a living image; and there is all the difference in the world between transmitting the one and the other.

The attitude adopted by Mr. Baird was that he had gone beyond the stage of televising films and that, in fact, the tele-cinema was, from the scientific standpoint, a retrograde step. The attitude of the Germans was consistent on this point, inasmuch as they declared that before television proper could be perfectly achieved it was better first of all to perfect a film image, using this stage as a stepping stone to higher things.

First Steps in the Evolution

The transmission of visual transparencies formed originally the first step towards television, and tele-cinematography, which involves only the transmitting of moving transparencies, is a very much simpler proposition, and was one of the first steps leading up to television.

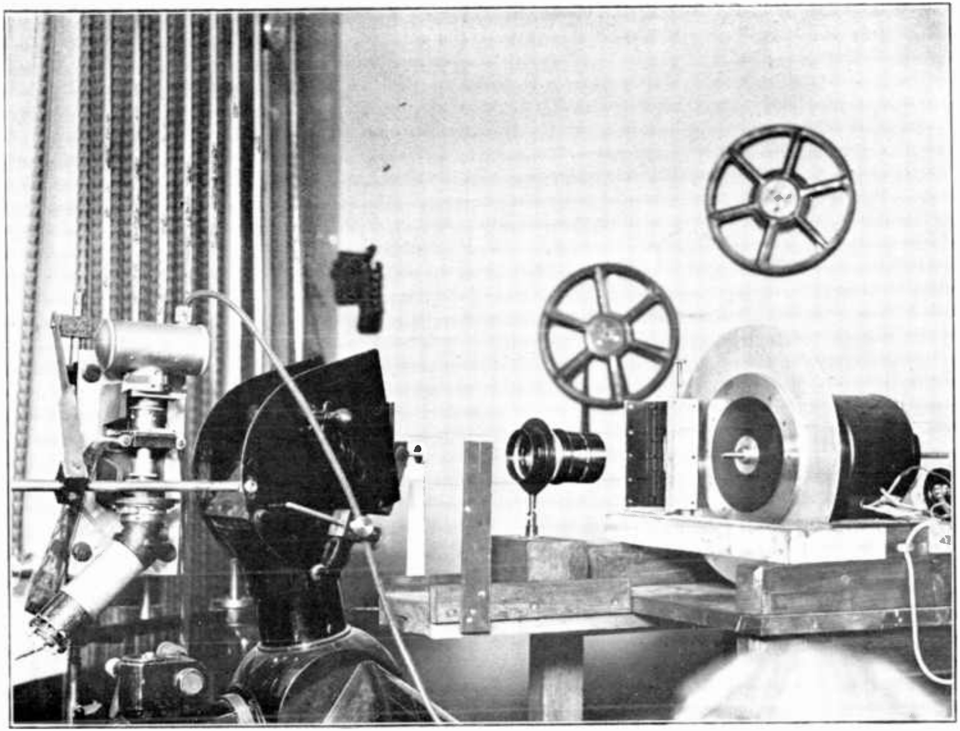
The reason it is much easier to transmit a transparency is that the light in this case passes through the object to be transmitted, and there is, therefore, a very large amount of light available. Thus, the problem of securing sufficient light to activate a photo-electric cell does not exist, although it was this problem which, in the early days of television, formed one of the chief barriers to its success.

The broadcast of films, unaccompanied by sound, proved in practice to have very little entertainment value, and the transmission of silent films does not appear to have any immediate promise of proving a competitor to television proper. The transmission of films accompanied by sound is, however, a very different proposition, and efforts have recently been made, therefore, to transmit talking films by television.

The Talking Film Explained

One modern form of talking films consists of an ordinary film, having printed along one side a ladder-like band of light and shade, representing the sound. This ladder-like band, as the film is projected, passes in front of a narrow ray of light, which is transmitted through the varying densities, and falls upon a photo-electric cell, setting up in the photo-electric cell an undulating electric current, which, after amplification, operates a loud speaker, and reproduces the sound accompanying the visual projection of the film.

In adapting this to television the visual effects are transmitted in the ordinary television manner—that is to say, by scanning the image at the transmitting end with the aid of a disc perforated with a spiral series of holes, and at the receiving station using a similar disc, in conjunction with a neon lamp, to reconstruct the image. The sound effects are simply picked up from the marginal record on the film in the usual way by means of a photo-electric cell, as used in standard talking picture practice, and these sounds are transmitted simultaneously with the film, either by wire or wireless.



THE EXPERIMENTAL APPARATUS USED WHEN THE FIRST PUBLIC TELE-TALKIE DEMONSTRATIONS WERE GIVEN IN THE BAIRD LABORATORIES

Using Normal Television Receiving Apparatus

Since tele-talkies are sent out in a manner very similar to the transmission of television, they can be received on the identical machine which receives television images. The standard films are used, but naturally subjects must be chosen which are suitable for transmission by television—say, for example, head and shoulder representations. As in television, larger scenes, such as boxing matches and plays, can be sent, but these transmissions are lacking in detail. The frequency band at present available for television is 9 kilocycles, as has been mentioned earlier, and this sets a limit to the amount of small detail which can be transmitted, but as the art progresses there can be no doubt that larger wave bands will be set aside, and images of larger scope will be broadcast.

Television programmes first sent out will consist chiefly of television proper, which is, of course, the most interesting—that is to say, the transmission of actual persons as they sit in front of the microphone, so that the audience can see on the screen of their " Televisors," and hear the person who is broadcasting from the studio, but as at present in sound broadcasting gramophone records are occasionally played, so also will television programmes be supplemented by the occasional transmission of tele-talkies.

An Ingenious Cinematograph Projector

The apparatus used for the transmission of talking films is shown in one or two of the illustrations. The cinematograph projector is one of the type which was popular some twenty years ago, and has no Maltese cross or shadow, the film moving continuously with the picture being changed, by means of an ingenious arrangement of rotating and cam-operated mirrors. This has the advantage that the television scanning disc, upon which the image of the film is projected, continuously explores an uninterrupted moving picture. The arrangement of the transmitter and receiver for tele-cinematography is identical with that of television by flood lighting, with the exception that the image projected upon

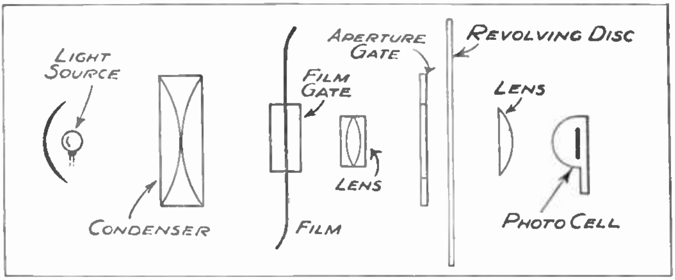


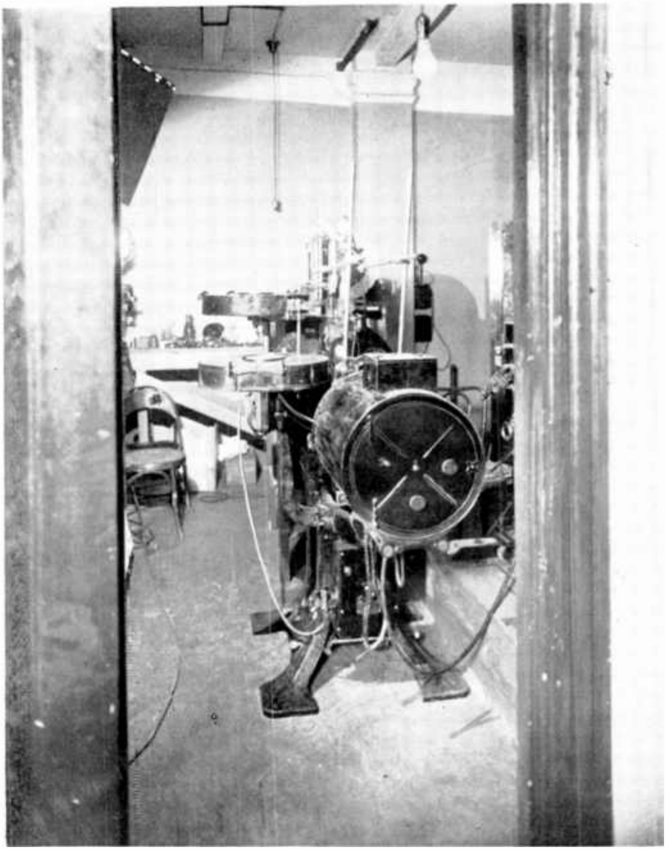
Fig. 29. A Schematic Representation of how Cinema Films are Televised

the transmitting disc comes from a film and not from a real scene.

Let us examine this a little more closely, for undoubtedly the scheme is a particularly interesting one, and it is to Mr. Baird that the credit must be accorded for successfully combining tele-cinematography together with speech reproduction (or tele-talkies, as they have been popularly called) for use with television apparatus. During some of his very earliest experiments he proved to his own satisfaction that his television methods, then just emerging from the chrysalis stage into a more concrete form, could be applied successfully to film reproduction. This was laid aside, however, so that full time could be devoted to the more acute problems of real television.

Describing the Transmission Process

In addition to the cinematograph projector itself, there will be required a condensing and projection lens,



A Tele-talkie Machine in the Control Room of the Baird Television Corporation of America a "gate" for controlling spot light depth, the usual rotating disc with a spiral of suitable perforations, and finally the photo-electric cell with its amplifier. Note that since there is ample light actually passing through the film and finally reaching the cell as direct light, and

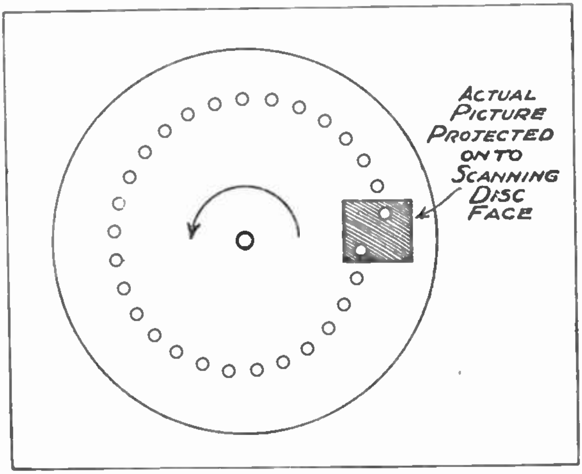


FIG. 30. SHOWING HOW THE PICTURE IS PROJECTED ON TO THE ROTATING DISC AND SCANNED BY THE SPIRAL OF HOLES

not reflected light, only one cell is required and not three or four as in television proper.

Fig. 29 gives a rough diagrammatic representation of the scheme adopted, although, of course, no mechanism is portrayed. After the rays of light have passed through the condenser they meet the film passing through its own gate or guide, and, with the aid of the lens shown, an actual image of the film is projected on to the scanning disc.

By turning to Fig. 30 you will see exactly what is meant, the shaded rectangle being the projected picture, and by revolving the disc it is possible to scan the projected picture. At any one instant that a hole is passing over the picture it will allow a certain light value to pass through according to the elemental area scanned, and this is made to influence the photo-electric cell, another lens being called into operation here to ensure that the light passing through the disc is " spread " over the active area of the cell.

The Operator has Complete Control

As in the case of ordinary television, this process takes place at a high speed, and spot by spot and strip by strip the cinema image is dissected and converted into its current pulses, and these, after being passed through the usual amplifier, are either sent out over a line or broadcast into space as desired.

The object of the aperture gate is to ensure that actually there is a very short yet definite period when no spot is traversing the picture, and thus produce the " dark strip," which as we saw in Chapter V is essential for synchronizing. In addition, the lens between the film gate and aperture gate is made adjustable in an horizontal direction. Then, by careful manipulation, it is possible actually to pick out a portion of the film picture, say an artist's face, and enlarge this to give a close-up which may be scanned in the normal manner. This is a very useful part of the whole scheme, and gives the operator complete control over his apparatus.

As was mentioned earlier, the particular cinema projector which lends itself best to television working is that in which the film passes through as one continuous, smooth motion, and has no shutter, the actual picture change being effected through the medium of cam-operated mirrors on a rotating shaft.

Suiting Any Type of Projector

Of course, if the other type of projector is employed, that is, one in which the film is moved before the light

THE FIRST TELE-TALKIE TO BE PUBLICLY DEMONSTRATED
(THE INIMITABLE GEORGE ROBEY AS A BRIDE)
Note how the Sound Record Runs Down a Side-track in the Film

in rapid jerks, with the transition period from one picture to the next being masked off by having a synchronized shutter cutting off the light, then more accurate timing of the actual picture exploration is called for. One complete revolution of the disc must coincide with the complete exposure of each picture, and then the shutter operation can take place during

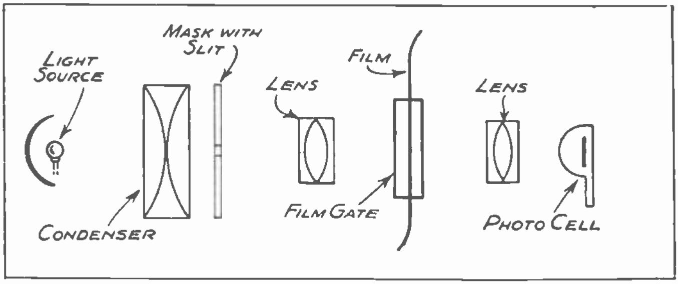


Fig. 31. How the "Sound Effects" on the Film are Handled by the Photo-electric Cell

the brief interval between the end of one spot traversal and the beginning of the next. Obviously, matters would be rather upset if spot scanning was in progress during the shutter period.

We now come to the sound reproducing side of the apparatus, and instead of using a scanning disc we must arrange to reconvert the sound record running down the side of the film into intelligible speech and music. A very good impression of what this sound record looks like in actual practice can be gathered from an examination of the photograph depicting the tele-talkie film of George Robey as the bride in a wedding scene. The varying density of the short horizontal lines is the "sound effect," and naturally the size of the picture has to be reduced slightly to accommodate this on the standard size film.

Producing the Sound Effects

A narrow slit of light passes through a specially cut mask (see Fig. 31) from the light source and condenser. A lens focusses and projects this light strip on to the narrow edge of the film passing through the gate shown.

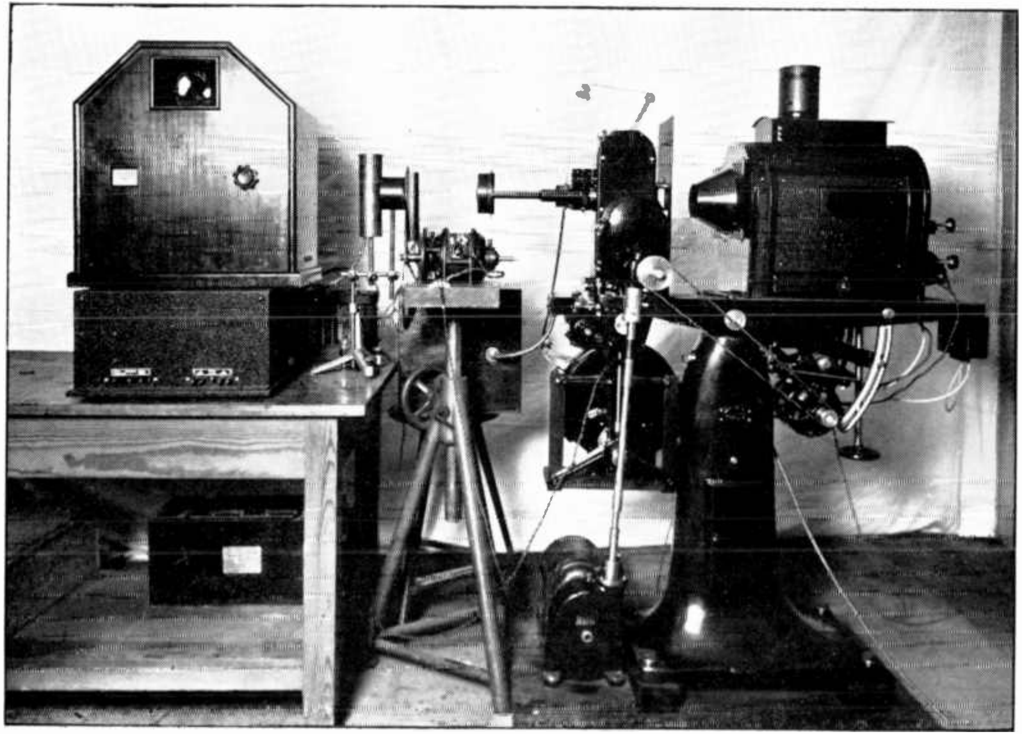
According to the overall density of the sound track, so a proportionate and continuously varying amount of light passes through, and by means of another lens is dispersed over the active area (the cathode) of the photo-electric cell as indicated. As in the case of the televised image, the light pulses are converted into current pulses, and, after amplification, pass to the line or wireless transmitting station.

Naturally, there must be synchronism between the voice or music and the actual symbolic movements of the film, and this is provided for on the actual projector itself.

Synchronizing Voice and Subject Movement

The sounds relating to any one particular picture have to be printed on a different portion of the film, either ahead or behind that picture, according as to whether the talkie apparatus reproduces after or before the picture. There is, therefore, a "floating" loop of film between the two positions for the respective cell activations, and this has to be adjusted to give the voice and subject movement synchronism required. Once set on any film it will run through satisfactorily.

Another point to note is that in those projectors possessing the shutter or jerky motion for the pictures, when it comes to reproducing the sound, the film motion must be smooth and continuous, and special provision has to be made for this in the apparatus mechanism itself.



THIS TELE-TALKIE APPARATUS HAS BEEN DESIGNED BY THE FERNSEH A.G. OF BERLIN

The First Public Demonstration

Tele-talkies were first publicly demonstrated in the Baird laboratories at Long Acre on 19th August, 1929, and since then have been the subject of much speculation in the press as to their future. Of course, they will have their special aspect in the apportionment of television programmes, but it would seem that their best use is in the form of " dovetails " in much the same way as gramophone recitals are now in aural broadcasting. In any case, they form a media for expressing certain events which cannot conveniently be done with ordinary television, and for this alone they will be welcomed, and add to the variety of fare which the home " Televisor " is capable of providing once the television transmissions become a regular feature of reasonable length. Until then, television proper undoubtedly holds the field.

Film Broadcasting

In conclusion, however, it is as well to record the period at which an actual television broadcast of a film took place. On 6th March, 1931, at the midnight transmission, a piece of test film was transmitted at the end of the programme. No public announcement was made of this test, so that in the circumstances it would not have been surprising if little or no attention had been paid to it. But the number of letters that reached the Baird Company after the transmission showed the enormous interest that had been aroused.

Encouraged by this success, a more formal transmission was given on 9th March, when a piece of an old Charlie Chaplin film was shown at the 11 a.m. transmission.

Reports received from various parts of the country were unanimously in praise of the innovation.

CHAPTER IX

NOCTOVISION AND THE "NOCTOVISOR" RECEIVER

LET us consider noctovision. While other competitors have arisen in the field of television, Mr. Baird has still a complete monopoly as far as noctovision is concerned.

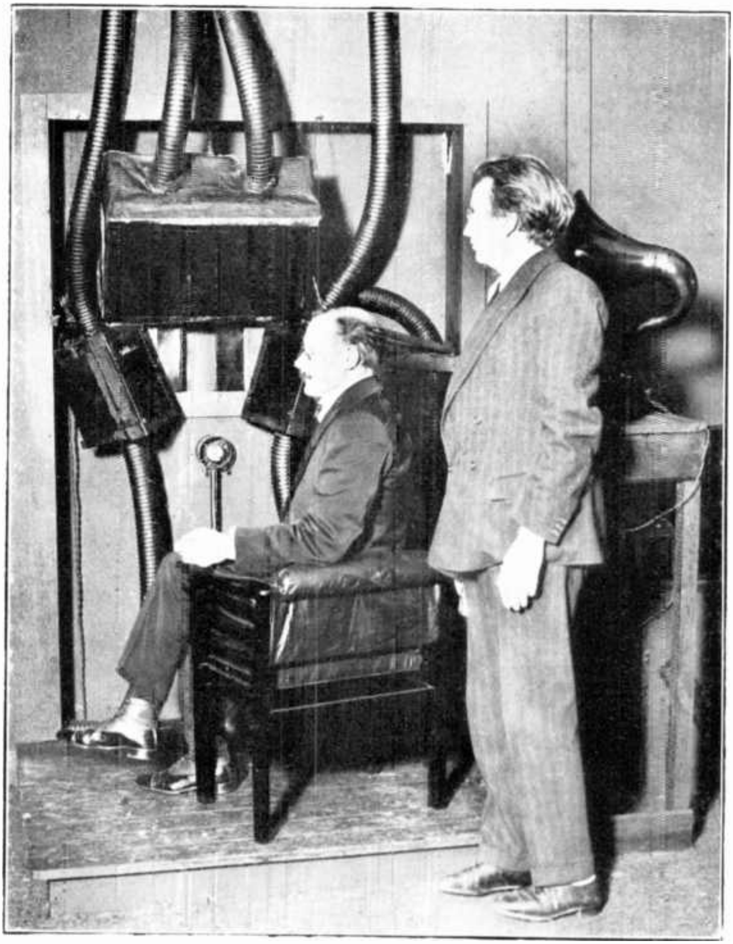
Even at the time of writing there appears to be no opposition to Mr. Baird's title as the originator of a science that bids fair to conquer darkness and fog.

Although, strictly speaking, noctovision forms a different invention from television, and one with a very different application, it is so similar in operation to the processes we have described, and is of such scientific interest, that its inclusion in these pages follows as a matter of course.

Overcoming Personal Discomfort

In his first experiments with television, Mr. Baird found the greatest difficulty in reducing the intensity of the light used to illuminate his subjects without impairing the efficiency of the apparatus as a whole. The persons who sat before the scanning disc suffered considerable discomfort, and, in endeavouring to find a way out of the trouble, the idea occurred to him to use invisible rays instead of visible light.

As readers are no doubt aware, visible light and the various invisible rays are in principle just like wireless waves, that is to say, they are vibrations in the ether. The visible spectrum contains colours ranging from violet at the high frequency end, passing to red at the low frequency end, the entire range of colours passed through being violet, indigo, blue, green, yellow, orange, and red.



THE 1927 "NOCTOVISOR" SHOWING THE ARRANGEMENT OF THE EBONITE FILTERS

The invisible *ultra* violet rays were first tried; then, finding that these were not only most objectionable to the sitter, but also suffered from the defect that the lenses filtered out quite a large proportion of the active rays, attention was turned to the other end of the spectrum, that is, the *infra* red.

Improvements Effected with Infra Red Rays

The *infra* red rays have very great penetrating powers and no bad effect on the sitter, but they have also a very small photo-electric response, and in the early days it was quite difficult to obtain satisfactory results with these rays. Efforts were, therefore, made towards increasing the efficiency of the optical side of the apparatus and also the sensitivity of the photo-electric cells, and, once this had been accomplished, it was possible to use the rays so that images could be seen with the object in total darkness!

Obtaining an Infra Red Image

Now how is this accomplished? Most sources of illumination generate these *infra* red rays, and to separate them from the luminous portion it is necessary to place an absorption filter in the path of the light, so designed that it will only pass these rays. One of the simplest and perhaps best known of these filters is thin sheet ebonite, so for the original noctovision tests Mr. Baird shielded all his "flood lights" with ebonite, so that the person being televised was seated in total darkness.

As indicated in Fig. 32, the *infra* red rays play on the person, with the result that an "*infra* red image" was focussed by lenses on to the scanning disc with its spiral of holes. The photo-electric cells were thus influenced by each elemental area of focussed image that passed through the perforations, and the resultant variations of current were amplified, transmitted by wire or wireless to the place of reception, and received on a normal "Televisor" in the usual manner.

Amongst the cells which are more sensitive to the *infra* red end of the spectrum we may mention hydrogen, caesium, thallofide, and rubidium, and really the

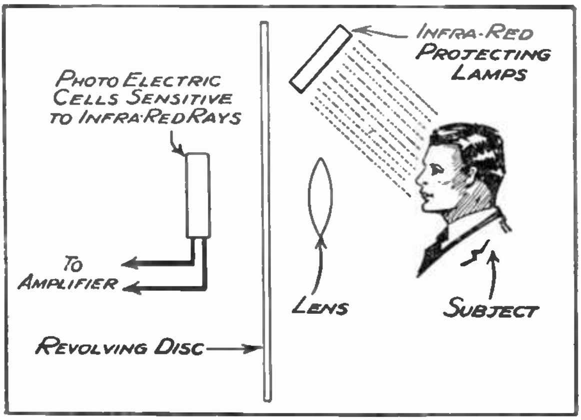


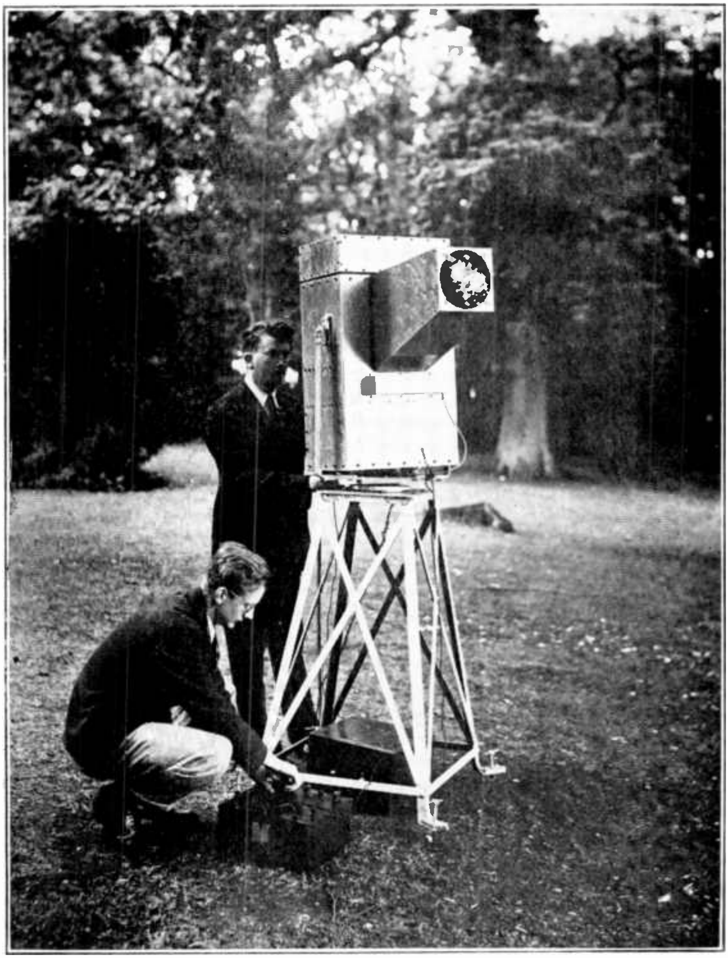
FIG. 32. SHOWING HOW THE *Infra* RED RAYS PLAY ON THE PERSON BEING TELEVISED

results of these early demonstrations created a stir in the scientific world.

For normal television purposes there was really no advantage to be gained by using *infra* red rays; in fact, they bring in their train certain disadvantages.

Shortcomings of the Earlier Photo Cells

First of all it was somewhat difficult to use the rays, and secondly, it is generally inconvenient for the subject to sit in total darkness. Furthermore, *infra* red rays with the older type of photo-electric cells did not give the correct colour values, red appearing as white, while blue did not appear at all. The effect, therefore, was



THE LATEST TYPE OF "NOCTOVISOR" SHOWN IN OPERATION WITH MR. BAIRD MANIPULATING THE CONTROLS to give a rather ghostly appearance to the image of the person being transmitted. Hence, although when noctovision was demonstrated at the British Association in Leeds in 1927 it proved such a popular scientific exhibit that the police had to be called in to regulate the queues, it really represented no advance for normal television purposes until the newer types of cells were developed. With these, excellent results are now being obtained, and noctovision is being " reborn."

Noctovision, however, has other potentialities quite apart from television, as, say, for example, the development of a means of vision which would enable attacking forces in wartime to be seen without their being aware of it.

Fog Penetrative Powers

Better still, the scope of its application has extended to a more useful commercial possibility which depends upon the fact that *infra* red rays penetrate fog. Actually, fog or mist is penetrated by light, or by ether waves, proportionately to the fourth power of the wavelength. That is to say, short waves of the *ultra* violet order are dispersed very quickly, while longer waves such as the *infra* red have great penetrative power.

The old observation that the sun turns red when it sets is simply an indication of this phenomenon, for the light from this source is passing through a great deal of fog, mist, and atmosphere, and all the visible light except the red is filtered out. The *infra* red rays possess that property proportionately, and they penetrate fog better than the red rays, just as the red rays penetrate fog better than the blue rays.

This has led to the development of the " noctovisor " receiver, which was first publicly demonstrated on 9th August, 1929, and, as can be gathered from the photographs, bears little resemblance to its prototype of 1927.

In effect the "noctovisor" receiver is an eye which sees by the invisible *infra* red rays, so that it can be used not only in the dark, but will see through fog that would be completely opaque to the unaided human vision. Fog is the mariner's worst enemy, and the one remaining obstacle to safe shipping. Directional wireless has given us a palliative to this, but not a cure—for directional wireless can only indicate a course, but cannot give anything approaching direct vision. The "noctovisor" receiver provides this, and on the date mentioned was witnessed what may well prove an epoch-making advance in navigation, both by air and by sea.

A Unique Demonstration of the Latest "Noctovisor"

On the top of Box Hill was erected a special instrument, consisting essentially of a television transmitter and receiver mechanically coupled together, and adapted to work upon *infra* red rays. This camera-like device was mounted upon universal pivots and provided with graduated scales, so that it could be pointed at any part of the horizon, and by means of the graduated scales the bearing of the exact spot at which it is pointed can be read off. On a little screen at the back of the "noctovisor" can be seen an image of any light which comes within its range, and this although the light is obscured by fog, or by any substance which cuts off all the visible light, provided that the substance allows the *infra* red rays to pass through.

As was mentioned earlier, one of the commonest substances of this kind is ordinary sheet ebonite, which acts in effect like an enormously dense fog, and this was the artificial fog used at the demonstration given at Box Hill, when from the Swiss Cottage, a chalet-like dwelling house on the highest point of Box Hill, the light of a car was clearly shown on the screen of the "noctovisor," and the bearing of the car ascertained, although the light was totally invisible to the unaided eye, being obscured by the sheet of ebonite. The test was equivalent to a test made on board ship, and formed a very convincing demonstration of the potential value of the remarkable device.

Among those who have witnessed demonstrations have been some of the leading navigators of the mercantile marine and the Navy, and they have been enthusiastic in their appreciation of its value.

Overcoming the Mariner's Worst Enemy

Picture the operation at sea, when the mariner sweeps the horizon with his "noctovisor" receiver and watches the while the little screen! Should the instrument in the course of its transit pass across the lights of a ship, these lights would appear upon the screen, although obscured to the eye of the mariner by the densest fog, for fog is transparent to the *infra* red rays. What does this mean? It means that fog, the greatest menace to navigation, has been overcome.

In aviation, the device may also be used with equal effect. A smaller form of "noctovisor" receiver could be made for aeroplanes, and would enable the aviator to pick out the lights of the aerodrome, obscured by fog, and invisible to the unaided eye.

Again, the watchers on land can locate an aeroplane hidden by a cloud bank, by means of *infra* red rays, and the uses in warfare, whether by land, air, or sea, must be very obvious. Here the "noctovisor" would be a potent weapon not only because of its fog-penetrating power, but also because of its power of seeing in darkness, for a hostile force equipped with such a weapon would be able to see without being seen, nor would they communicate their presence as a searchlight communicates its presence by means of beams of light, for the "noctovisor" receiver can operate by searchlights using invisible *infra* red rays, which would not betray their presence to the enemy.

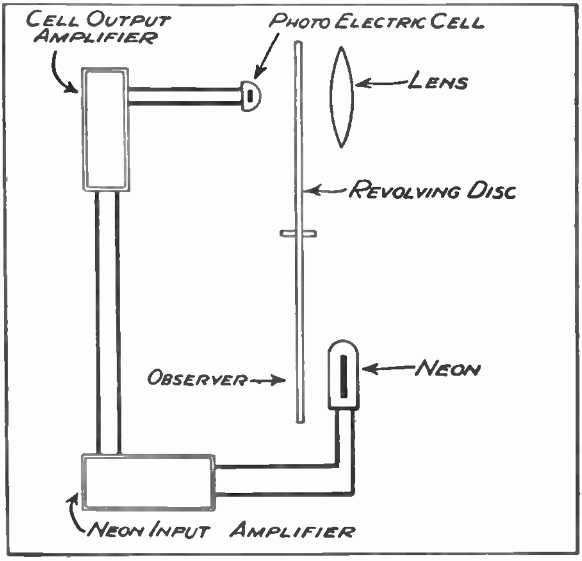


FIG. 33. DETAILS OF ONE FORM OF BAIRD "NOCTOVISOR"

A More Detailed Explanation

Realizing the potency of this apparatus, let us examine its details a little more closely, for they should now be made doubly interesting after studying its possible uses. Actually, the scheme is shown simply in Fig. 33, a lens concentrating an image of the light sought on to a rotating and perforated disc. Behind this disc we have the photo-electric cell specially sensitive to the *infra* red rays, and after passing through two independent amplifiers the converted light pulses of the cell are fed to the neon. Both cell and neon are diametrically opposite each other and work through the same disc, the neon plate being observed from the back of the instrument, as seen in an accompanying illustration.

With the " noctovisor " receiver we are not seeking a finely detailed picture of the obscured light, but merely wish to have evidence of its presence and to be able to

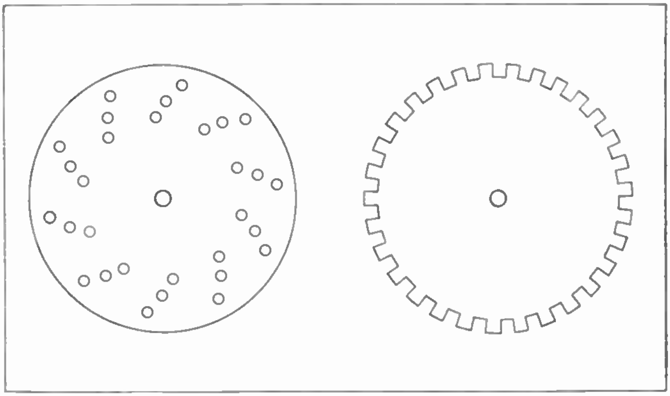


FIG. 34. TWO FORMS OF DISCS USED FOR BREAKING UP THE CONTINUOUS RAYS INTO PULSES

take its bearing. The perforations in the disc can, therefore, be larger than those employed in the normal disc of the spot-light system, for we are anxious to allow as much *infra* red rays to reach the cell as possible, and thereby increase the range of the apparatus.

Special Discs

Since the original demonstration several types of discs have been tried, two forms being indicated in Fig. 34. One is made up of ten sets of triple holes spaced somewhat as shown, while the other is a " chopper " disc to break up the continuous rays into pulses. Actually, a modified form of the chopper disc has given the best results so far, but it would be premature to give actual details until thorough comparative tests have been completed.

The disc diameter is governed largely by the overall size of the complete apparatus, while it must be possible to mount the neon sufficiently far from the cell to prevent any direct action one with the other. Both amplifiers are efficiently screened, and are housed inside the

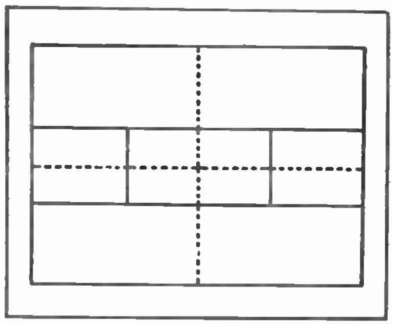


FIG. 35. THE ARRANGEMENT OF THE VIEWING SCREEN WHEREBY THE BEARINGS OF THE LIGHT CAN BE ASCERTAINED

movable body, while disc speed and type of disc perforation set a frequency limit to which these valve amplifiers must satisfactorily function.

The neon tube is coupled so that it glows only when a signal is recorded, and when once the presence of a light has been detected, by using the " noctovisor " receiver somewhat in the manner of a telescope sweeping the horizon, the apparatus is manipulated until the light appears as a spot in the centre of a viewing screen (see Fig. 35). As the whole unit is mounted and swivels on a calibrated base, the true bearings can be logged.

Every Avenue Must be Explored

Since it is desired to use the " noctovisor " receiver in times of fog occurring in daylight, special precautions have to be adopted to neutralize or cut out the " daylight signal," and while actual details of this cannot be divulged at the time of writing, the method adopted is most ingenious. The apparatus then becomes sensitive to points of light whose intrinsic brilliance is greater than their background of daylight, and obviously ships' masthead lights fall within this category.

With Britain as a pioneer maritime country we can hope that every avenue of use for the " noctovisor " receiver on board ship will be explored with painstaking care. We cannot afford to neglect anything which furthers the interest of " those who go down to the sea in ships," and while not suggesting that it should supplant any apparatus at present installed for their safety, we can at least anticipate that it will augment that already in use.

CHAPTER X

DAYLIGHT TELEVISION AND PHONOVISION

It will be noted that throughout this book, except, of course, for Chapter I, we have eschewed descriptions of apparatus which in comparison with that now in use can only be regarded as obsolete, but a description of daylight television demands something more than a passing reference to one of the earlier forms of television, namely, flood light television.

In our spot light system we had a powerful light behind a rotating disc, so that the subject's face was illuminated by a succession of light strips, and, in consequence, anyone sitting before the scanning disc suffered no discomfort, since the light only momentarily flashes before the eyes of the person.

Reversing the Process

In the original flood light television, however, the system was reversed, and the scene or object to be televised was flooded with a brilliant light. The intensity of the illumination was governed largely by the sensitivity of the light sensitive device employed to transform the light impulses into electrical impulses, and in those early days these cells were very inefficient.

Obviously, the person being televised suffered rather badly from this brilliant lighting, and one of the accompanying photographs conveys a vivid impression of the number of lamps used by Mr. Baird when conducting his experiments. It must be borne in mind that the light ultimately reaching the photo-cell is reflected light, and this, coupled with the cell's inefficiency, made flood lighting a case of " force puts no choice."

THIS PHOTOGRAPH OF ARTHUR PRINCE AND HIS FAMOUS VENTRILOQUIAL DOLL BEING TELEVISED GIVES AN IDEA OF THE INTENSE LIGHTING REQUIRED IN THE EARLY DAYS FOR "FLOOD LIGHT" TELEVISION

The Same Final Result

Having illuminated our object or scene, therefore, this was scanned by actually projecting it by means of a lens on to the scanning disc. This latter scheme resembles very much the tele-cinema arrangement, and as the disc revolves, the succession of small apertures, arranged in a spiral identical with those used in spot light transmission, emits light from every part of the picture in turn on to the photo-electric cell, and thus causes the cell to send out an undulating current proportional to the light and shade of the picture. This undulating current is identical with that obtained by the spot light method, and is transmitted and received in the same way and upon the same apparatus as that used in the spot light method.

With a period intervening when no improvement took place in photo-electric cells, the flood lighting was replaced by the spot light method, and there matters remained for a time.

Now it is obvious that in order to bring the utility of television to its highest point it is necessary to be able to transmit scenes in broad daylight. This, of course, could not be done with the spot light process, but all that was necessary was a modification of the flood light system, for daylight is rich in rays which affect the newer types of photo-electric cell.

A Milestone of Progress

The achievement of daylight television nevertheless marked a milestone in the progress of the art, and it was first accomplished in July, 1928, when Mr. Baird demonstrated the transmission of scenes illuminated only by daylight, before Sir John Ambrose Fleming, other scientists, members of the Press, and interested spectators. Brilliant sunshine is not necessary, for the apparatus functions satisfactorily on an ordinary day, and the scene of the first successful experiments was on the roof of the Baird Co.'s laboratories at Long Acre.

It will be obvious that as daylight has proved amply sufficient to give television, there is no barrier *as far as lighting is concerned* in the transmission of extended scenes, such as the finish of the Derby or the Boat Race, but the amount of detail which can be transmitted over the 9-kilocycle waveband at present available would be inadequate to represent properly such scenes.

As television advances, however, we may anticipate that larger wavebands will be granted, and these scenes should then come within the scope of the television broadcasts.

To use the words of Sir John Ambrose Fleming, we can anticipate the day when this type of transmitter becomes in effect a more complicated form of outdoor camera, in which the screen on which the image or scene appears is not immediately behind the lens, but may be miles or hundreds of miles away.

A Street Scene by Television

A step in that direction occurred on 8th May, 1931, when an actual street scene was transmitted by television. This new feature aroused an enormous amount of interest, the simple scheme of operations being shown in pictorial fashion in Fig. 36.

The apparatus differed from that employed in the ordinary studio. No travelling spot of light was used, but in place of this a large drum with mirrors fixed round its circumference, revolving at a high speed, projected a succession of images of the scene being transmitted upon a photo-electric cell. This photo-electric cell converted the moving images into a varying electric current, and this in turn was transmitted

The Scene in Long Acre Showing the "Caravan" Drawn Up Outside the Baird Co.'s Premises for Daylight Television

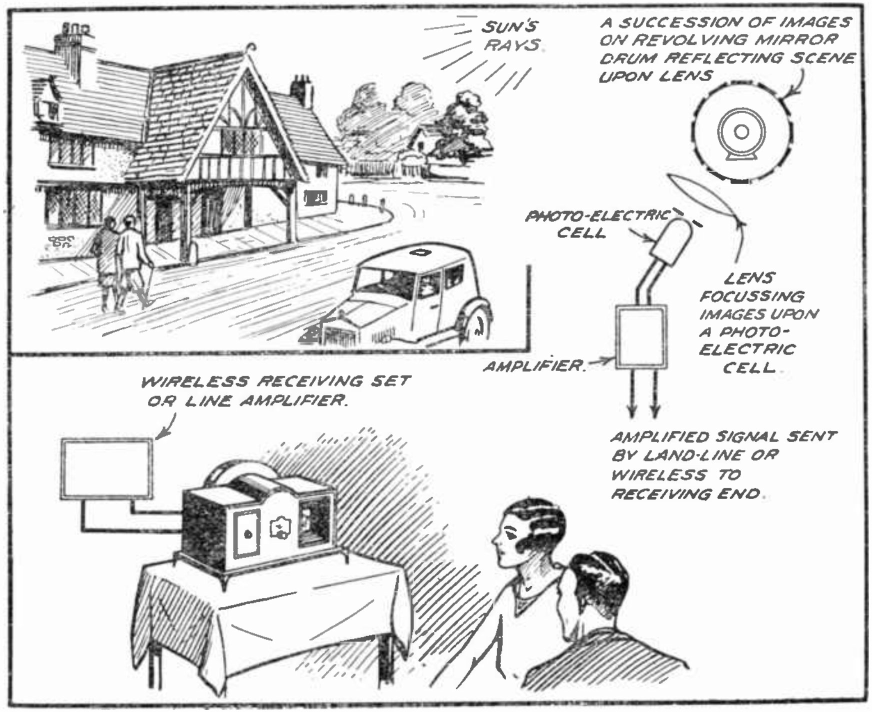


FIG. 36. REPRESENTING PICTORIALLY HOW A STREET SCENE WAS TRANSMITTED BY DAYLIGHT TELEVISION

by wire to the receiving set, where it was reproduced in the ordinary way. At the demonstration referred to above, an ordinary Baird disc "Televisor" receiver was used to reproduce the image.

A few days prior to this an experimental transmission was made through the B.B.C. of a scene on the roof of Long Acre.

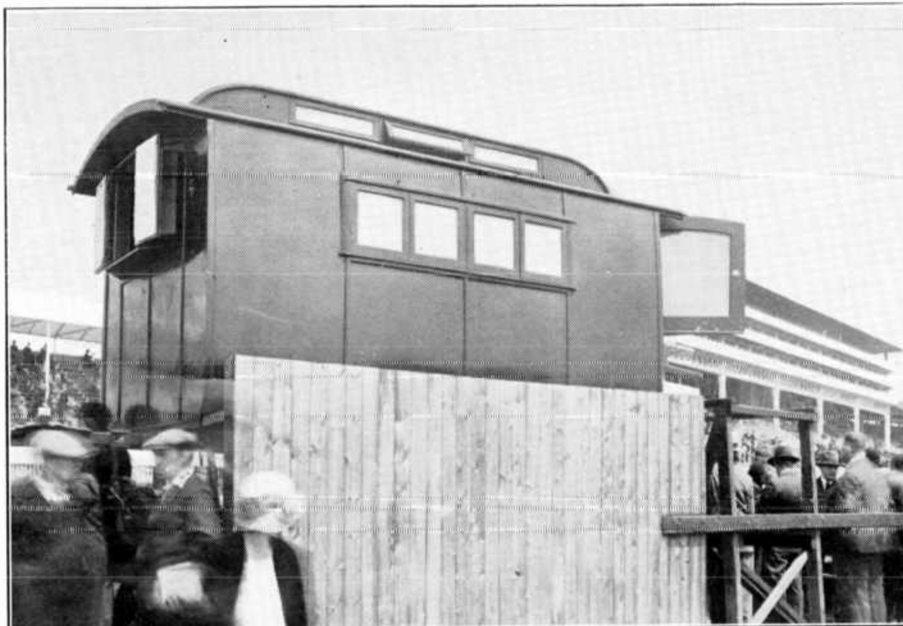
People Easily Identified

Returning to 8th May, a grey van housing the transmitting apparatus was drawn up outside the Baird offices in Long Acre. From the van's open door the "scene" was picked up and sent along a short length of land-line to "Televisors" in the demonstration room. In these receiving instruments could be easily identified the people who were passing along, and, during the course of the transmission, the Press had presented to their gaze business people, Covent Garden porters, a policeman who obviously had come along to see what was happening and why the crowd had congregated, etc.

As was to be expected in fickle May, the weather was not particularly good; the sun shone only on one or two rare occasions, and the sky was overcast. This was responsible for an alteration in signal strength, so that the quality of the images varied somewhat. However, the street scene was there, and with normal conditions the images are distinct and clear, with a background clearly recognizable.

The Derby of 1931

Now any mention of the Derby inevitably calls forth exciting visions and invokes the possibility of making a small fortune on the winner, but in the year 1931 the great race had an importance quite apart from its betting medium. It was the occasion of one of the



THE DAYLIGHT TELEVISION "CARAVAN" AT EPSOM IN 1931, SHOWING THE GRAND STAND IN THE BACKGROUND AND THE SPECIAL SWING MIRROR greatest experiments yet made in television—the first experiment of its kind in history. This scheme was built up in the brain of John L. Baird, and was carried out by the Baird Company in conjunction with the B.B.C. On the afternoon previous to Derby Day, preliminary tests were carried out, and a description of what took place is of paramount interest.

The Baird caravan—the same as had been used for the daylight demonstration just referred to—was moved to the racecourse at Epsom, and positioned against the rails almost opposite to the Grand Stand and winning post.

Post Office lines were laid under the course to the stands and from there they travelled direct to the control room in Long Acre. The signals were passed from here through to the B.B.C. and so to Brookman's Park, from which station they were broadcast by the National transmitter on a wavelength of 261 metres.

Preliminary Tests

The preliminary test excited the greatest interest in the minds of those who witnessed it. Both the transmitting and receiving ends of the experiment were fully revealed to members of the Press, who were invited to participate in this last-minute rehearsal. In the morning they were taken to Epsom to inspect the caravan and learn a little of the technical intricacies from the engineers on the spot, then a return was made to Long Acre, where a formidable array of "Televisors" gave a land-line picture of scenes from the Course within the natural range of the transmitting apparatus. The horses, jostling crowds—in fact, all the panoply of the famous racecourse—was plainly seen on the "screens" of the instruments in question; and, further to excite the senses, were the multifarious noises which go so far towards building up a picture of Epsom in full swing.

A Change of Vista

In order to secure a change of vista, an ingeniously contrived mirror had to be brought into play. The mirror was fitted on the side of the caravan farthest from the course and, when set at various angles, reflected different pictures of the adjacent activities. It was this reflected image that was scanned by the revolving mirror drum, carrying 30 mirrors around its periphery. This latter piece of apparatus was used, in place of the customary disc with its 30-hole spiral, each of the mirrors referred to being set at a slightly different angle from the preceding one. As the drum revolved, each mirror sent a strip of the scene through the lens on to the photo-electric cell, the individual mirror inclinations relative to each other being such that the picture was split up into thirty strips. The whole process was repeated twelve and a half times per second, and the electrical result of the image was sent along a line in the ordinary manner after being amplified. (See Fig. 37.)

Watching the Horses

The apparatus at the receiving end needed no amendment, and was thus in perfect readiness when the great hour arrived. At 2.45 p.m. on Derby Day the first scenes came through, and were built up in the "Televisors" in use at the Baird offices. These varied, sometimes showing clearly and at other times appearing somewhat indistinct. Occasionally interference from the telegraph and telephone lines wiped out the picture; but, in spite of this unavoidable fact, the parade of the horses and jockeys was seen by all present; while,

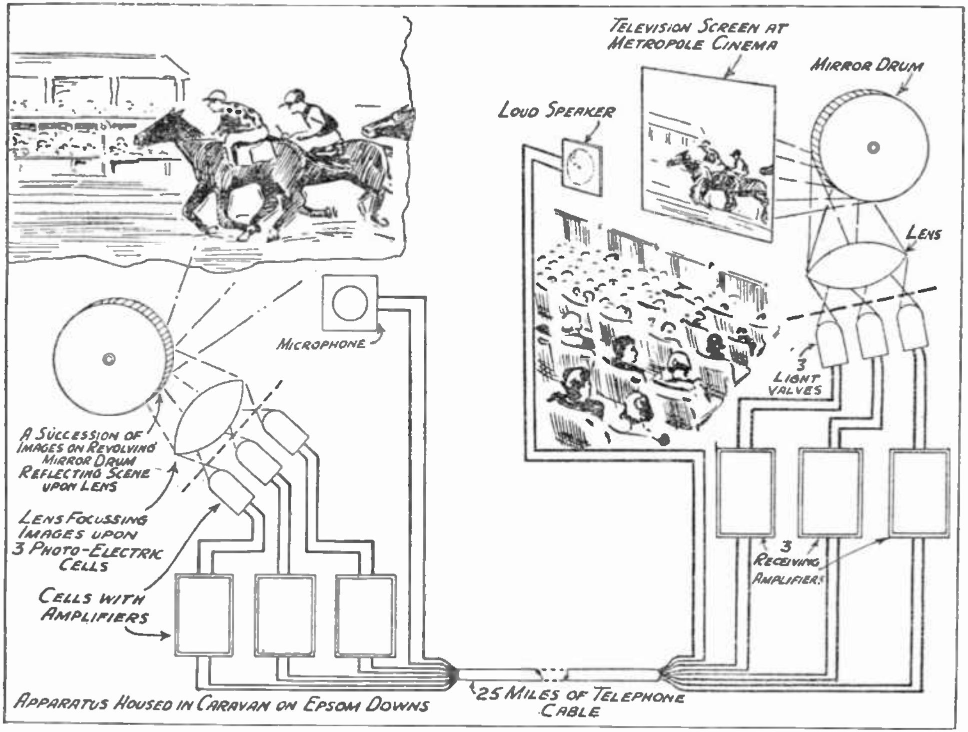


FIG. 37. SHOWING HOW IT WAS POSSIBLE TO WATCH THE DERBY RACE BY TELEVISION

now and then, the close-up of a man or woman passing across the line of vision showed on the screen.

A sport pause and then the announcer was heard to say that the horses were rounding Tattenham Corner, and in a few seconds the first three horses flashed by the winning post to the frenzied roar of the crowd. The rest of the field followed in close pursuit.

A Promise Fulfilled

And so those present were able to see what was happening at fifteen miles distance. The experiment proved beyond doubt to the most sceptical of die-hards that television had come out of the studio into the sphere of topical events. The restrictions of four walls and artificial light had been put aside, and Mr. Baird had fulfilled that promise which had once called down such a storm of disbelieving contempt on his head.

Two Press comments on this experiment were given in Chapter I, but in support of this it is as well to print what the wireless correspondent said in the *Daily Mirror*, 4th June—

> I did not go to Epsom for the Derby yesterday. Instead, I formed one of a score at an epoch-making gathering in the West End.
>
> Nevertheless, I saw Cameronian, closely followed by Orpen and Sandwich, win the great summer racing classic!
>
> This I was able to do by means of the two latest and greatest marvels of science—wireless and television. . . . At last the starter got the field away, a fact that was recorded on the "Televisor" by the crowd beginning to jostle and push one another for a good view.
>
> They were now at Tattenham Corner and racing down the hill for home!
>
> Then—two horses dashed across the centre of the picture we were looking at, closely followed by another. Cameronian and Orpen followed by Sandwich!

A Phonovision Record Made by the Baird Television Co.

" Bottling-up " Pictures

A development of fascinating importance occurred in the middle of 1928 that was the means of concentrating or bottling-up pictures—in a word, the discovery of phonovision.

At the time of writing, Britain again leads in regard to this science, inasmuch as Mr. Baird is the only inventor

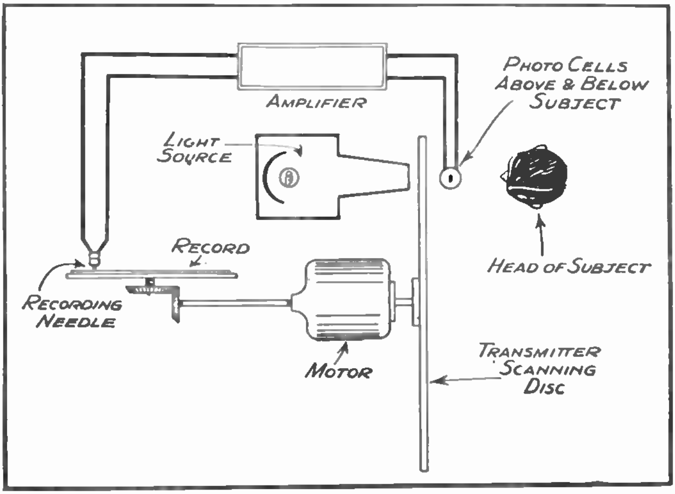


Fig. 38. How Phonovision Recording Takes Place

who has applied his knowledge of television to this most popular form of entertainment. What is phonovision?

In television the person or scene being transmitted is first of all transformed into an undulating electrical current, which is sent through the ether or along wire. Now this current can be heard just in the same way as the current giving rise to the sounds we hear on a telephone, so that anyone connecting a telephone in place of a " Televisor " hears, instead of sees, scenes which are coming through. A face, for example, is heard as a peculiar rhythmical humming, every face or scene having its own descriptive note.

Synchronizing Unnecessary

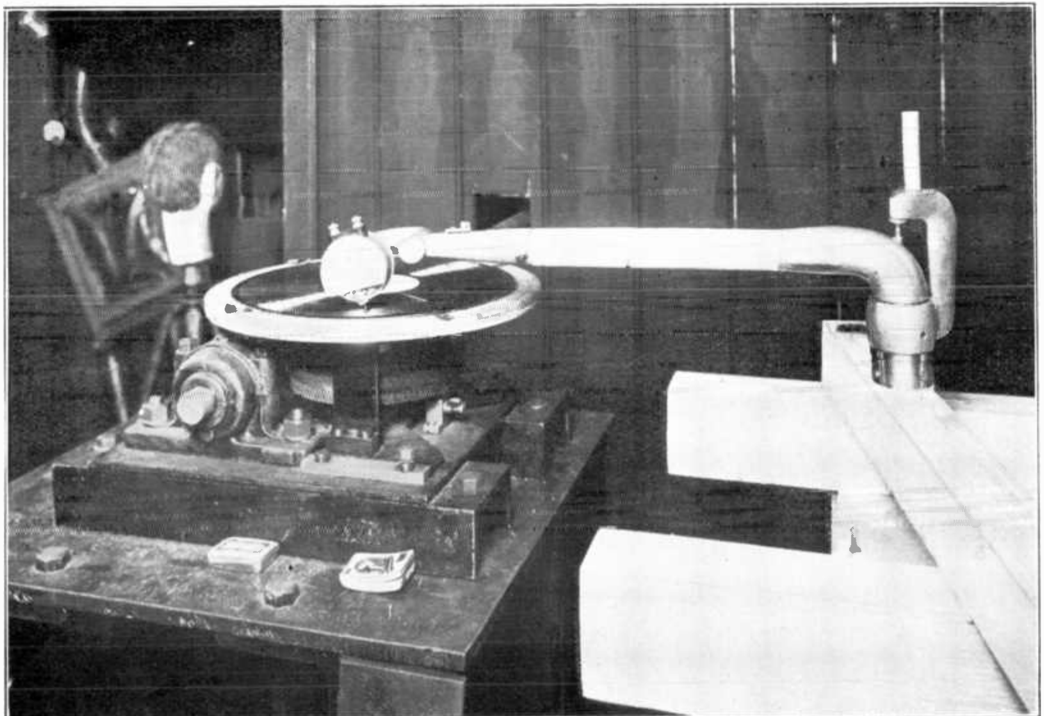
Now, if these notes are played into a recording gramophone they are recorded just as the ordinary sound is recorded, and if the record is then played with an electrical pick-up, the undulations on the record are turned back into electrical impulses similar to those which originally produced the undulations, and if in place of being connected to a loud speaker it is connected to a "Televisor," the original scene is reproduced. It is unnecessary to synchronize, as the scanning disc and vision record are driven from the same motor, so that the apparatus is quite simple in operation.

The schematic arrangement of the recording side is indicated in Fig. 38. Both scanning disc and record are driven from the same motor, and with the usual spot light arrangement the singer's face is broken up into light strips, the light pulses are handled by the photo-electric cells and the resulting signal current, after amplification, is passed to the recording needle, which makes indentations in the record.

Reproducing from a Record

If desired, a synchronized record can also be made of the voice and music, or, alternatively, a double track made on one record, one track taking the television signal and the other the aural signal.

When it is desired to reproduce this the simple scheme of Fig. 39 is employed. The electrical pick-up takes the signals from the record and these are then amplified and fed to the neon, the motor driving the record turn-table also driving the disc through suitable cog wheels to ensure picture synchronism. The means adopted for reproducing the voice will depend on whether a separate synchronized record is made, or whether a double track record is in use.



THE TRANSMITTING END OF THE PHONOVISION PROCESS RECORDING A DUMMY'S HEAD ON AN ORDINARY RECORD

The appearance of a phonovision record can be gathered from one of the accompanying illustrations, and it really is quite weird to listen to face movements or notice the changing of the note produced by smoothing, say, the chin by the hand or brushing back the hair.

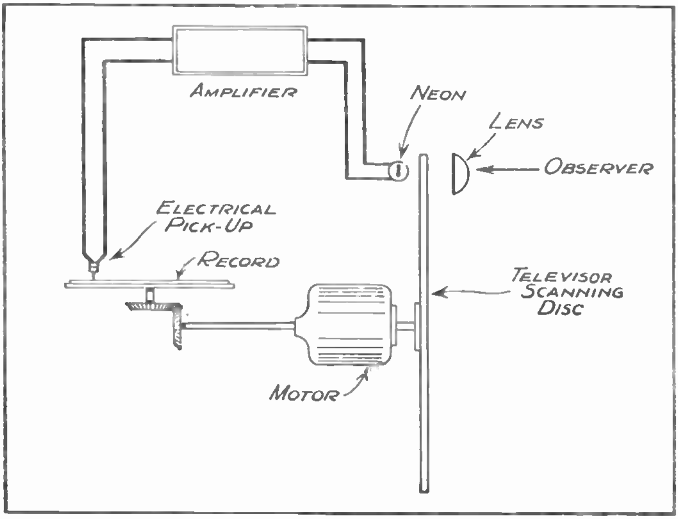
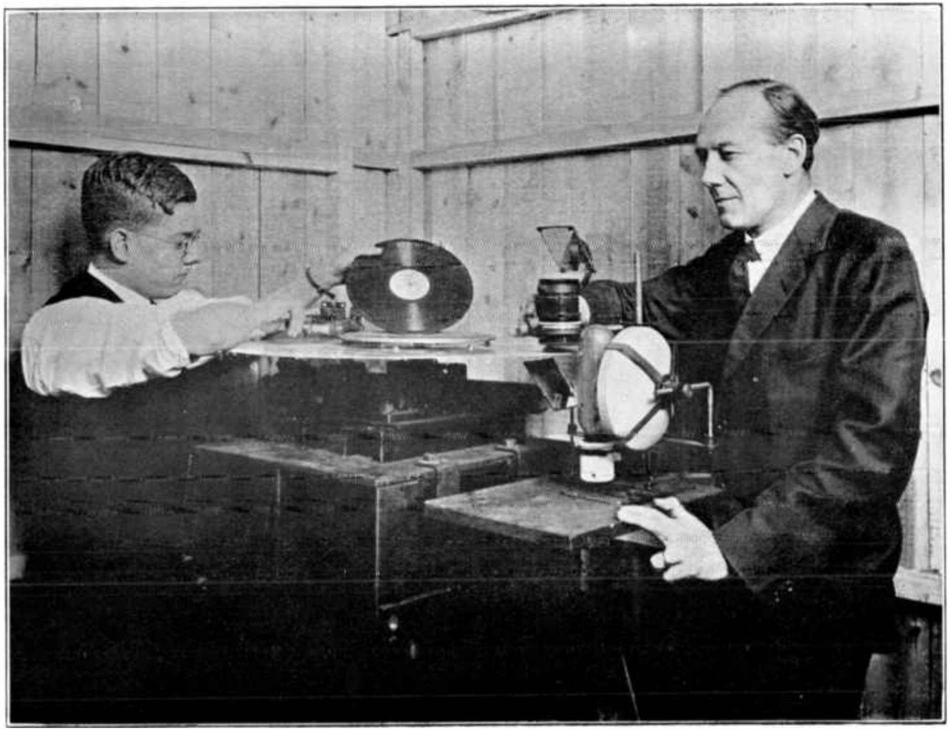


FIG. 39. THE SIMPLE SCHEME ADOPTED TO REPRODUCE THE IMAGE PREVIOUSLY MADE ON THE RECORD

What of the Future?

We have, therefore, an alternative device to the cinematograph, which gives us the means of recording faces or scenes upon gramophone records. Actually this device represents a very remarkable scientific achievement—we have light turned into sound, sound turned into mechanical indentations, the mechanical indentations turned back into sound, sound turned into electrical impulses, and the electrical impulses into the visual reproduction of the original image.

Now what the future holds for this device it is somewhat difficult to say. Had the cinematograph never been invented it would undoubtedly have been an invention of outstanding and immediate utility. As it is at present it is merely a scientific curiosity, but it has the advantage over the cinema in that it gives a much more convenient method of recording vision, for we can put vision upon a gramophone record and by putting the sound on the same record we have a remarkably convenient form of speaking "film" for the home.



A Stage in the Phonovision Process, Showing some of the Early Experimental Apparatus

CHAPTER XI

COLOUR AND STEREOSCOPIC TELEVISION

HAVING established the principles of television in general, and seen how they have been applied to seeing both in broad daylight and through fog, together with the "bottling" of images, there are still two more ramifications explored by Mr. Baird which are of equal importance. These are colour and stereoscopic television, the former being first demonstrated in July, 1928, and the latter in the following month, both these advances being shown at the meeting of the British Association in Glasgow of the same year.

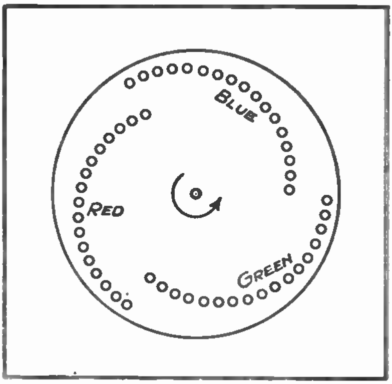


FIG. 40. A TRIPLE SPIRAL DISC COVERED WITH RED, BLUE, AND GREEN FILTERS IS REQUIRED FOR COLOUR TELEVISION

Special Light Filters Required

Taking advantage of the fact that red, green, and blue are the three primary colours from which every visual colour can be built up by combinations, Mr. Baird made up a triple spiral disc, each set of perforations being covered with red, green, and blue light filters (see Fig. 40). Using this disc on the spot light system, it was thus possible to transmit, via the photo-electric cells, current pulses corresponding respectively to the red, green, and blue parts of the scene or subject televised. Naturally, a geometrically similar disc, covered with the same colour filters, was employed at the receiving end, but it was essential to have a light source rich in red, green, and blue rays.

First of all a special glow discharge lamp containing a mixture of neon, helium, and mercury vapour was tried, but little success attended these efforts, so it was decided to have two separate light sources.

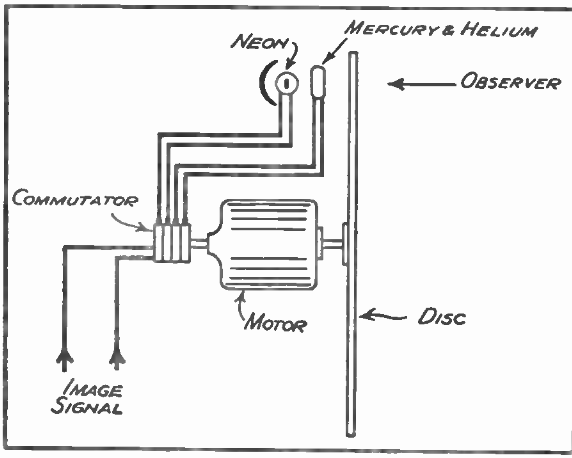


Fig. 41. A Commutator is Employed to Change over from the Neon Lamp to the Mercury and Helium Lamps

Two Light Sources in Use

Now the neon lamp itself is rich in the red rays, so an additional lamp, containing mercury and helium vapour, was constructed, the mercury vapour supplying the green light and also part of the blue, while the presence of the helium assisted in producing the blue light. Of course, the inclusion of two lamps at the receiver end complicated matters slightly, but this was overcome quite easily by using a commutator on the driving motor shaft, so that only the neon lamp was illuminated when the red filter holes were revolving in front of the observer, the mercury and helium lamp

THE COMMUTATOR NECESSARY FOR CHANGING OVER TO EACH LIGHT SOURCE IN TURN IS CLEARLY SEEN IN THIS PHOTOGRAPH taking its place as soon as the blue and green filter holes came into position.

A rough idea of the arrangement can be gathered from Fig. 41, the transmitter arrangements being identical with that for the ordinary spot light method, except for the special disc, while an examination of an accompanying photograph shows Mr. Baird with one of his hands close to the commutator and brush mechanism.

Vivid Portrayal of Colours

To give the same number of complete pictures per second, whether red, green, or blue, the speed of the transmitter disc should be increased three times, but in actual practice this was found unnecessary, owing to parts being common in the three coloured images.

Of course, it will be observed that the three individual signal images all pass along the same photo-electric channel, and thus only one wave-length is required for transmission purposes. This is important, and will correct the impression that has got abroad that three separate communication channels are necessary.

Using colour television, it is possible to portray fruit, flowers, and coloured clothing very vividly, and obviously developments in this particular sphere will have very far-reaching effects once all the details have been perfected. Imagine the appeal to the ladies, of a fashion display, say, in Paris, with arrangements made for televising the mannequins with the natural colours of the gowns appearing on the screen! A peep into the future, perhaps, but a pleasure to look forward to!

What is Stereoscopic Relief?

Not content with the success which crowned his colour television demonstration, Mr. Baird immediately turned his attention to television in stereoscopic relief.

First of all, what do we mean by stereoscopic relief? People with their eyesight unimpaired have an impression of stereoscopic relief, depth or distance, when they look at an object or scene, and the effect is brought about quite naturally by the combination of the separate images seen by our individual eyes.

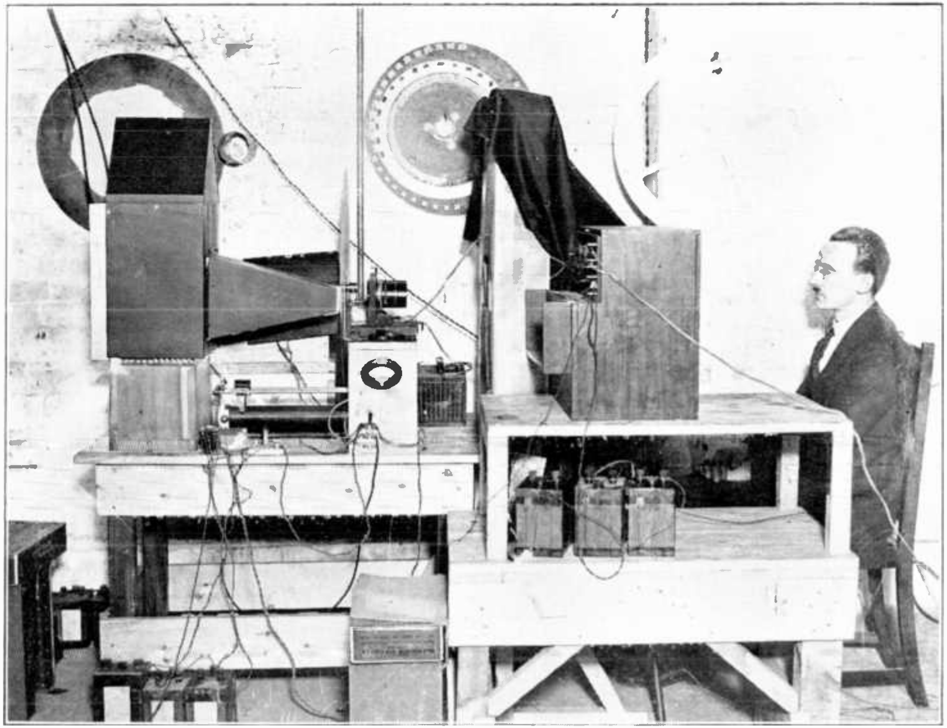
Look at an object placed about a yard from the eyes, and rapidly close one eye at a time, and you will have the impression of the object moving slightly from right to left and left to right, as each eye shuts in turn. Actually, the right eye sees a slightly different view of the object from that seen by the left eye, and these views are combined in the brain to give the depth, and enable us to judge distances and sizes.

The old stereoscope so familiar to the early Victorian parlour table was designed on this principle, two photographs side by side being viewed through prisms separated by about 2½ in., this being approximately equivalent to the separation of the human eyes, and the result was a true-to-life impression of the scene or objects photographed.

Two Separate Explorations Must be Made

Now, how can we secure this stereoscopic effect with television? Why, by having a disc with a double spiral, so that two separate scans or explorations of the subject are made, one to correspond to the image seen by the right eye and the other corresponding to the image seen by the left eye. The disc, therefore, resembles that indicated in Fig. 42, one spiral being located near the periphery and the other nearer to the centre.

There are two sources of illumination, and two lenses at the transmitting end, one beam of light being focussed through one spiral and the second beam through the remaining spiral, the scheme being made



SOME OF THE ORIGINAL BAIRD APPARATUS USED FOR GIVING DEMONSTRATIONS IN STEREOSCOPIC RELIEF clear by reference to Fig. 43. This double set of light impulses given to the photo-electric cells only needs

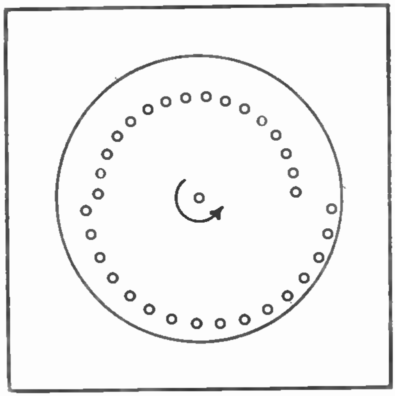


FIG. 42. TWO SEPARATE SPIRALS ON THE SAME DISC ARE NECESSARY FOR STEREOSCOPIC TELEVISION

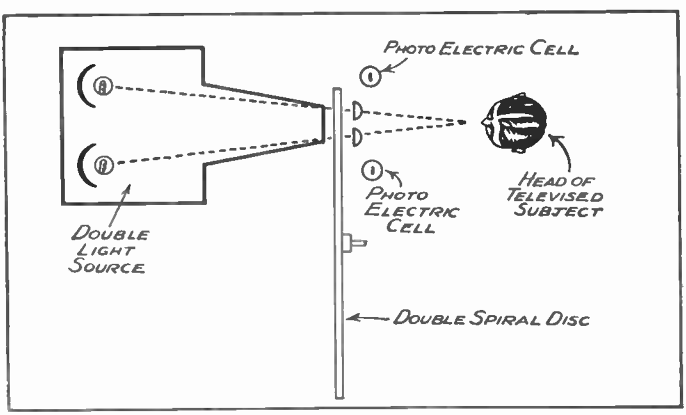


FIG. 43. THE DOUBLE BEAM OF LIGHT AT THE TRANSMITTER FOR STEREOSCOPIC TELEVISION

one channel of communication, and some idea of the first experimental apparatus used in achieving this stereoscopic transmission is shown in one of the accompanying illustrations.

Colour Combined with Stereoscopic Relief

At the receiving end we have a double spiral disc proportionately similar to the transmitter disc, and, in consequence, there are two slightly different images appearing on the screen. These are combined by means of an ordinary stereoscope, so that the observer gains his impression of depth and distance with the subject

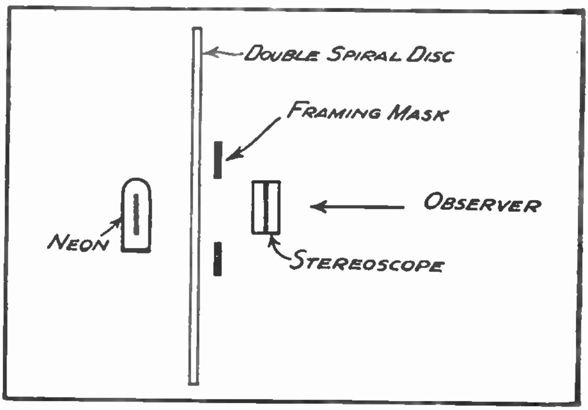
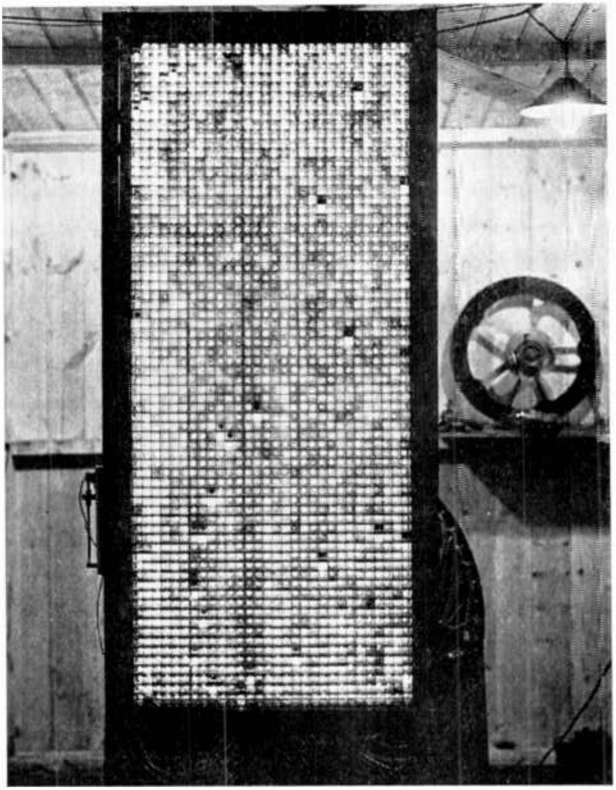


FIG. 44. SKETCH OF THE ARRANGEMENT ADOPTED AT THE RECEIVING END

before the transmitter exploring disc. Fig. 44 portrays the arrangement adopted, the only difference from the normal " Televisor " being the addition of the stereoscope to blend the two separate images.

The life-like appearance of the stereoscopic image when compared with the " flat " image is most marked, and it must be borne in mind that it is possible to achieve this effect with colours also. The transmitter and receiver discs, then, have two sets of triple spirals, with red, blue, and green filters instead of a single set.

Small wonder that one is inclined to say that television, with its ramifications, borders on the miraculous.



The Honeycomb Arrangement of the Bank of Lamps Screen which gave such Good Results

CHAPTER XII

LATER DEVELOPMENTS

ANY attempt to keep pace with television developments is fraught with difficulties. Month by month new ideas or advanced developments of old ideas make their appearance, and since the first two editions of this book made their appearance there have been many items of outstanding importance which has served to emphasize that Mr. John L. Baird has in no way been standing still. Up to the time of writing we can point to many new developments, and it was felt necessary to include a description of these in order to keep faith with readers and ensure that they have the very latest information to hand.

The Big Screen

First of all then the big screen. Hitherto it had been impossible to show brilliant images on a large screen. In previous television demonstrations on large screens, owing to the small quantity of light available, special transparent screens had to be used, and even then the images were so lacking in brilliance as to be unsatisfactory. This difficulty was first of all overcome by using (in place of the neon tubes and Kerr cells utilized in past experiments) ordinary filament lamps, arranged to form a screen.

These lamps are lit up one after another in rapid succession, and give a picture of a brilliancy rivalling that of the cinematograph. By their successful application to television, a great barrier to screen projection —lack of brilliancy—was removed.

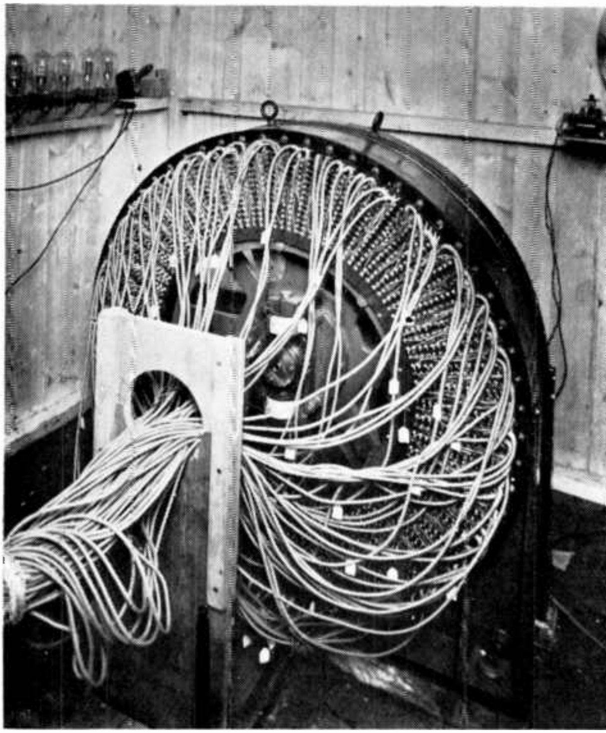
Although the device used was patented by Mr. Baird as far back as 1923, immense technical difficulties had to be overcome before anything in the nature of a practical apparatus could be constructed, and it was only seven years after the original conception of the idea that the inventor was able to put it into successful operation.

Method of Operation

This receiving screen was first demonstrated on 1st July, 1930, on the roof of the Baird Laboratories at Long Acre. It consists of 2,100 tiny metal filament lamps, each lamp being set in a cubicle, so that the screen appears like a gigantic honeycomb with 2,100 cells, the centre of each being the small electric lamp. The front of the cells is covered with a sheet of ground glass. Each of these lamps is connected to a separate bar of a large commutator, which switches on only one lamp at a time, and, as the contact of the commutator revolves, each of the lamps is switched on in succession. The contact switches on and off the whole of the 2,100 lamps in about one-twelfth of a second. As the selector revolves at 750 r.p.m., it will be seen that over 25,000 contacts are made every second.

In operation the incoming television signal is first of all amplified, and this powerful current is then fed to the revolving commutator, which switches it to every lamp in turn. (See Fig. 45.) The current is strong at a bright part of the picture and weak at a dim part, so that the small lamps are bright or dark accordingly, and the picture is built up of a mosaic of bright and dark lamps.

Synchronism is obtained with a synchronizing gear, differing from the standard Baird toothed wheel synchronizer in size only.



A Special Commutator and Selector Mechanism is used in Conjunction with the Baird Lamp Screen

Great Brilliance

This device differs from any other television device previously shown, in that the lamps are not instantaneous in their action, and remain alight for quite a

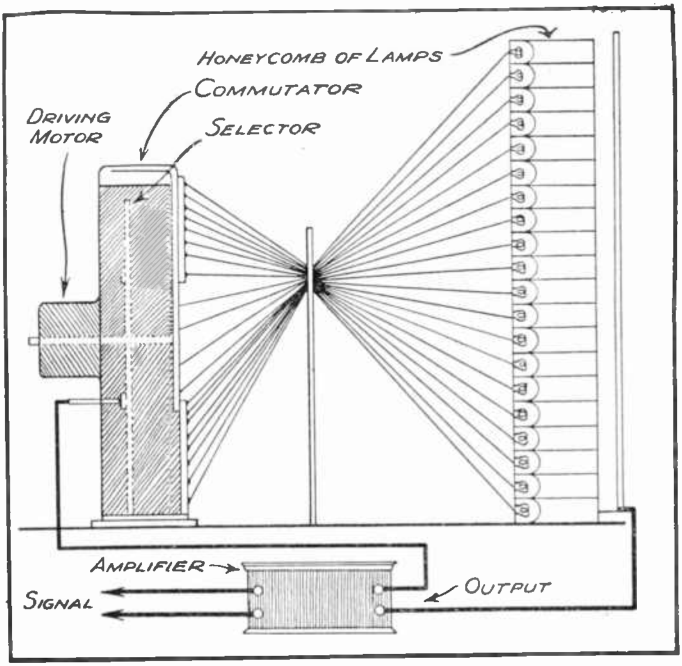


FIG. 45. NOTE HOW THE COMMUTATOR AND SELECTOR MECHANISM ARE ELECTRICALLY CONNECTED TO THE HONEYCOMB OF LAMPS

considerable time, and it was on this fact that, to a great extent, the success of the new device depended. Instead of, as in previous systems, the picture being reproduced by a minute spot of light, a large number of the little lamps are alight simultaneously, giving the effect of great brilliancy, and considerably reducing flicker.

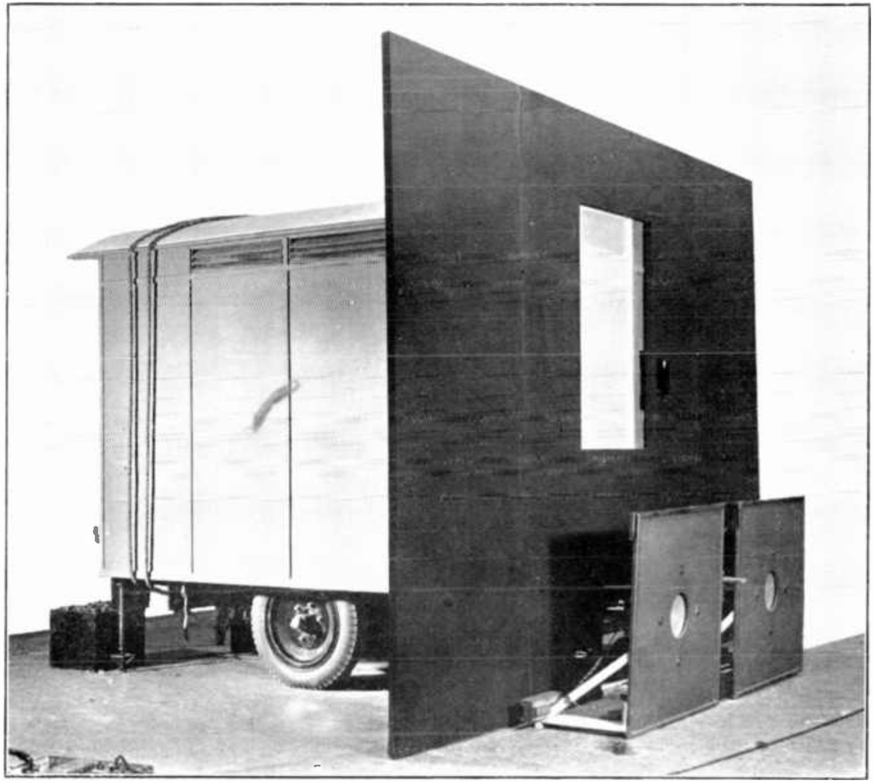
The screen shown originally was designed specially to receive the standard Baird transmissions now being sent out through the B.B.C., and as these transmissions are limited by regulation to a restricted amount of detail, the screen had, accordingly, only a limited number of lamps.

Making Its Début

After the first demonstration, which was confined to a few prominent people and members of the Press, it was arranged to install the apparatus at the London Coliseum, so that demonstrations of Baird television could form part of the normal programme to start on Monday, 28th July, 1930, three performances daily being the schedule. Previously all the apparatus had been contained in a temporary laboratory which held, in addition to the screen and commutator, a fairly extensive array of amplifiers, batteries, meters, switch-gear, etc. It was fairly obvious, therefore, that for the test in view the complete outfit would have to be portable as a single unit, and, in consequence, a large caravan trailer was decided upon as the best medium to press into service.

Transportable Nature

On the appointed day everything went like clockwork. The announcer, Mr. Radcliffe Holmes, appeared before the curtain and made a short introductory announcement as to the purpose and value of Baird screen television, *pointing out that it was the first time in the world's history that a paying theatre audience had been privileged to witness television on such a large scale.* The curtains parted, and on the screen the audience saw Mr. Sydney A. Moseley, holding a small telephone receiver to his ear, in order to keep in touch with Mr. Holmes on the stage. Mr. Moseley gave a brief but



When Arranged in a Caravan Trailer and Moved to the Coliseum Stage the Big Screen gave this Appearance general explanation of what the audience was seeing and hearing.

At this particular afternoon's performance Bombardier Billy Wells was also seen, and he gave his views on the Scott-Stribling fight, due to take place that evening at Wimbledon. Then followed songs by three artists and, naturally, the applause which followed this first demonstration was most encouraging to the staff who had spent so much time in erecting the apparatus.

The Press, in the reports which appeared up and down the country and abroad, were unanimous in stating that Baird screen television was the forerunner of epoch-making developments.

Working Details

Let us turn for a moment to the *modus operandi* which was followed for each performance. Telephonic communication with the Coliseum was effected through two distinct telephone lines. One of these passed from the control room at Long Acre to a control board at the Coliseum, from which the engineer in charge had full view of the stage. The second line was from the studio to the stage, it being possible for the announcer on the stage to ask questions of the particular person who was being televised at the transmitting end.

The procedure was much the same as for ordinary television transmissions. It should be noted, however, that for the first time in England a special method was employed for tilting the projection light, that is, raising or lowering the beam as required according to the different heights of the artists. This was effected by a special tilting head, and not by mirrors, as in America by the Baird Television Corporation.

Signal Tests

At about 3.15 the engineer at the back of the theatre asked Long Acre to put the signals on the lines. These were listened to and adjusted, and the O.K. or otherwise, given to the control room. Then, while the act preceding the television demonstration was finishing, occurred a wait until the cue was given from the Coliseum wings to the Long Acre studio, and the quality of the picture was reported upon. After Mr. Holmes had made his entry and introduced the subject, the curtains were swung back and the audience saw the television screen in the centre of the stage, the illuminated screen standing out in a black background.

Operating the Controls

One of the accompanying photographs shows quite clearly what the apparatus looked like on the stage, two loud-speakers of the public address type being seen beneath the screen itself. The portability of the apparatus can be easily gathered from the nature of the van's exterior.

The strength of the picture and the speech volume was controlled in the Coliseum itself, while in addition there was a line between the engineer watching the picture at the back of the auditorium and an assistant in the van itself. This assistant could see whether the picture was properly synchronized, by means of a "peep-hole" in the large black screen seen in the illustration.

Convincing the Sceptics

It is hardly necessary to add that every audience throughout the fortnight's run was keenly interested in the experiment, and delighted to see British television so far to the front. The turn lasted for about a

Some of the Artists who Participated in the Screen Demonstrations in Berlin are Here seen in the Studio quarter of an hour, and invariably concluded with "question time." This proved a very popular part of the demonstration, for members of the audience were invited to put questions to the announcer and, after these had been telephoned through to the Long Acre studio, they were answered from the screen. This was sufficient to convince anyone who displayed any scepticism.

The requests which were passed on generally took the form of "Put out your tongue," "Ruffle your hair," "Shut your eyes," "Put your hand in front of your face," ' Undo your tie."

On Saturday, 9th August, 1930, at approximately 3.30 p.m., the Coliseum audience received an additional surprise. The announcer had taken the artist's place, and told the audience that his image was about to vanish and another, from a talking film, would take his place, and that the film would not be in the theatre but only the televised image of it.

The First Public Theatre Tele-Talkie

Following this announcement Mr. Holmes introduced Mr. Moseley to the audience, explaining that they were about to see a talking film of Mr. Moseley by television, while they could see the original in the flesh on the stage. While Mr. Holmes was speaking, the image on the television screen remained silent, apparently listening with rapt attention. Suddenly the image vanished, and in a few seconds another came into view. First it introduced itself, then explained what was happening, how the film had been made the day before, how the audience must not expect to see the usual beam of light behind them from the projection box, and after expressing a wish, hoping the audience had been interested, the image vanished as suddenly as it had appeared. A talking film had been seen from afar by a *paying theatre audience* with the aid of television for the first time in the world's history. The picture was crude compared with that of the ordinary cinema film of to-day, but something definite had been done—another step made in man's means of inter-communication with his kind.

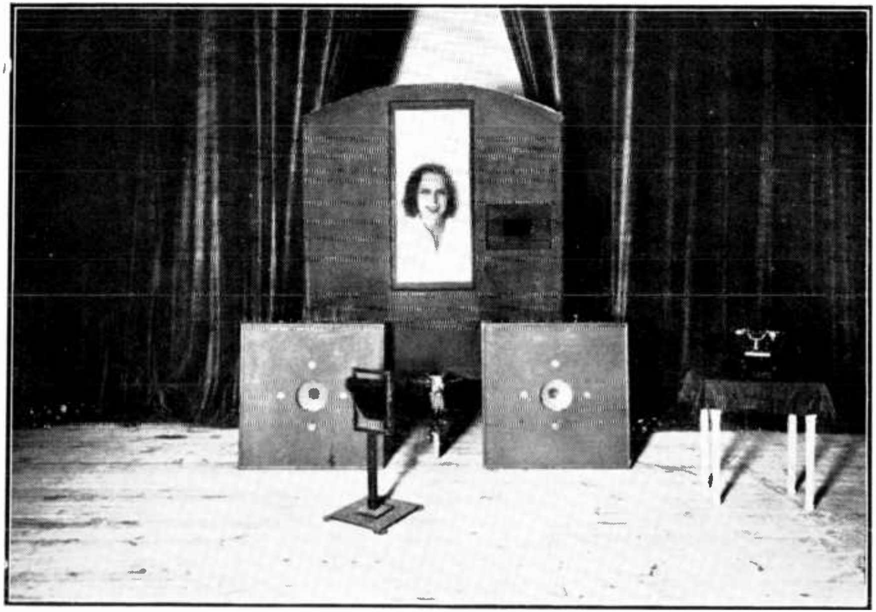
Demonstrations in Europe

As was mentioned in Chapter I, this demonstration in England was followed by similar ones at the Scala Theatre, Berlin, the Olympia Cinema, Paris, and the Roda Kvarn Cinema, Stockholm. In each of these countries amazing enthusiasm prevailed. All agreed that Baird screen television had taken the lead, and that the invention would open up a new field of entertainment and utilitarian value.

Screen Television

Dealing with screen television generally, we can say that three primary methods for projecting television upon a large screen have been demonstrated. The first method, which was shown by the American Telephone and Telegraph Company in 1927, consisted of a screen built up from a continuous neon tube, different areas of which were activated in sequence by means of a commutator. The second method was demonstrated in England by Mr. Baird, in America by the General Electric Company, and in Germany by the Telefunken Company, and depended upon the projection of a spot of light on to a screen, the spot of light being made to traverse the screen by means of one of the usual forms of scanning device.

The third method, described above, is, of course, fundamentally different from the two preceding



ILLUSTRATING HOW THE IMAGE APPEARED ON THE LAMP SCREEN AT THE SCALA THEATRE, BERLIN methods. As we have seen, a bank of lamps, having luminous inertia, is employed, that is to say, the luminosity of the screen persists, so that we do not have a travelling spot of light reproducing the image, as in the two previous methods, but a semi-permanent image remains on the screen, persistence of illumination supplementing persistence of vision.

An Acute Question

The question of brilliancy of the screen will become more acute as the quality of the transmission channels improves, since the greater the number of elements the picture contains, the less is the brilliancy where a travelling light spot is used. This is because the light spot becomes proportionately smaller in relation to the screen as the number of elemental areas contained in the picture increases. One way of overcoming this is by transmitting the picture in zones and using a plurality of light spots, but the transmission of the picture in zones by wireless is not an easy or straightforward matter, and its complexity is a very serious practical drawback. Where land lines are concerned, there is no difficulty in transmitting a series of zones, and this is the next development which must be described.

Zone Television

As has been stated, the chief difficulty in transmitting large images by television is finding sufficient space in the ether. It is for this reason that the images sent out by the Baird process by the B.B.C. are limited to restricted scenes. Where telephone lines are available, this restriction can be overcome by using several pairs of lines, and the Baird Company have developed an apparatus operating on this zone principle. It is hoped to make this apparatus suitable for use in theatres and cinemas, as apart from home television, for, where places of public entertainment are concerned, there is no objection to using telephone wires between a central studio and the theatres.

In this zone apparatus, the scene to be transmitted is not scanned by a rapidly moving spot of light, but is illuminated by ordinary flood-lighting, such as is used in theatres—or ordinary daylight is equally suitable. Full-sized scenes can be transmitted, and there is no limit to the amount of detail, so that there is nothing to prevent a development of this system showing views equal in size and detail to the cinematograph; it is entirely a matter of time and money.

Describing the Apparatus

The zone apparatus, which was demonstrated to the Press in the Baird laboratories on 2nd January, 1931, showed projected on a small glass screen images of full-length figures of as many as eight persons. These pictures were made up of three sections, transmitted side by side. The transmitter consisted of a large mirror drum with 30 mirrors which, revolving rapidly, caused a succession of images to be moved over three different apertures admitting light to three separate photo-electric cells. Each of these cells transmitted one-third of the total picture, the picture being split up into three adjacent zones.

At the receiving station the light from three neon tubes was controlled by the current from the corresponding cells at the transmitter, and the spots of light from these tubes were made to traverse the ground glass screen, building up an image of the scene in front of the transmitter. A reference to Fig. 46 will show in a pictorial manner how this process was brought about.

Zones Not Limited

There is no limit to the number of zones that can be used. The larger the picture, the greater the number of zones, and, of course, the greater the complication and expense. Complication and expense are, however, not serious matters where a public service, such as a theatre, is concerned, and it is for this purpose that zone television is primarily adaptable.

The system was described in one of Mr. Baird's patents taken out as far back as 1925, but has only recently been developed as it is unsuitable for wireless broadcasting, several channels being required. The success of the large screen demonstrations described at the beginning of this chapter, however, encouraged the Baird Company to undertake extensive development work in enlarged screens suitable for use in cinemas and theatres as distinct from television in the home.

A Noteworthy Feature

The apparatus demonstrated has this noteworthy feature. An ordinary floodlight is used in place of the moving spotlight hitherto employed, and this has the great advantage that the apparatus can be used with ordinary daylight, so that daylight scenes come within its scope.

A few of the Press comments on the demonstration of zone television are worth noting. *The Times* of 5th January, 1931, stated—

> The chief difficulty in broadcasting large images by television is that of the scarcity of available wavelengths. When the communication is by means of telephone lines, however, the difficulty is overcome by using several pairs of lines, each line being, as it were, responsible for a portion of the picture.
>
> A demonstration of such zone television was given by the Baird Company, when Mr. H. Strudwick, the England and Surrey cricketer, was "televised" in action as a batsman.

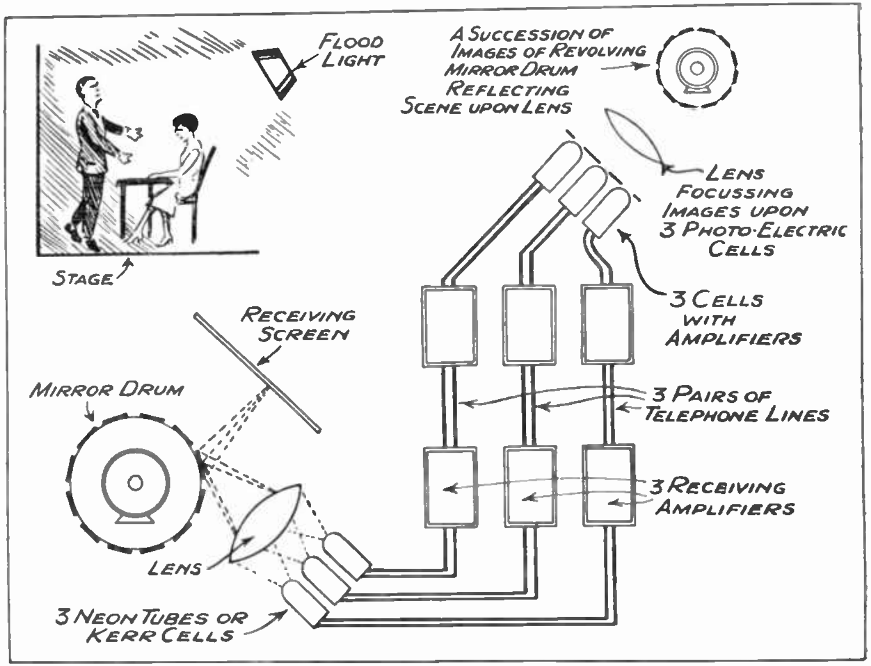
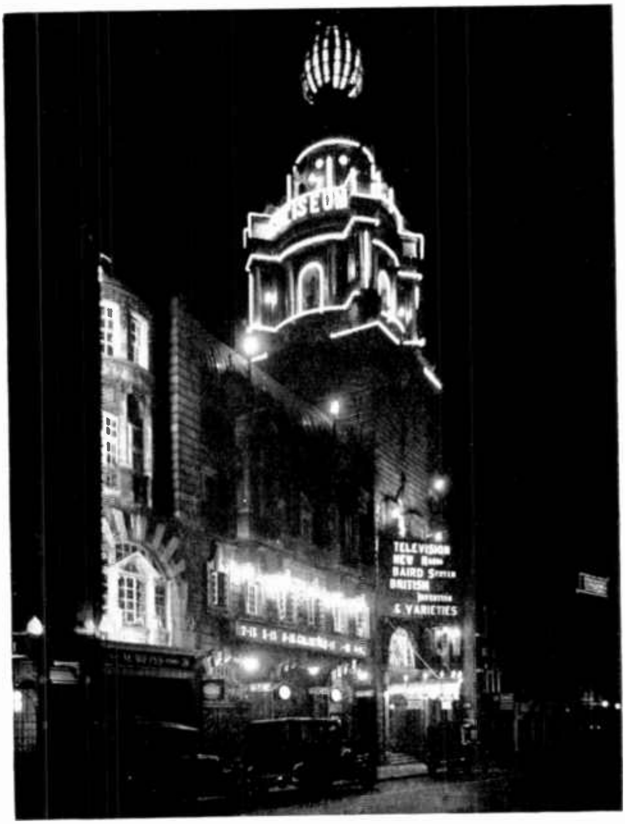


FIG. 46. A PICTORIAL SKETCH REPRESENTING THE THREE-ZONE TELEVISION SCHEME DEMONSTRATED BY THE BAIRD COMPANY



THE COLISEUM BY NIGHT ON THE OCCASION OF THE DEMONSTRATION OF BAIRD SCREEN TELEVISION

His movements and those of the wicket-keeper could be clearly seen.

In this latest apparatus the scene to be transmitted is not scanned by a rapidly moving spot of light, but is illuminated by ordinary floodlighting, such as is used in theatres, and ordinary daylight is equally suitable. The picture shown was made up of three sections, transmitted side by side. The transmitter consisted of a large mirror drum with 30 mirrors, which, revolving rapidly, caused a succession of images to be moved over three different apertures admitting light to three photo-electric cells. These cells controlled the light emitted by three neon lamps, which produced the final image on a ground glass screen.

There was also demonstrated a variation of this scheme in which for the neon lamp and its accessories was substituted a powerful arc lamp, the illumination from which was controlled by the simple process of injecting the television signals into the arc supply circuit. This scheme produced a picture of great brilliancy.

The cinema trade paper, *To-Day's Cinema*, of 3rd January, 1931, referred to—

An amazing new development in the Baird television process, which makes it possible to project pictures on to an ordinary, full-sized cinema screen; televised people and objects, illuminated only by arc lighting or daylight instead of an intensive "exploring beam," show an unlimited amount of detail in the picture.

In a special editorial note, the technical editor wrote—

It is my firm belief that Baird has at last hit on the very method which will bring television into the cinemas. It is a bold statement, but I make it in all seriousness, and when I saw yesterday's demonstration, I could see, beyond the tiny screen shown to a visitor, a new revolution in our industry.

The *Daily Express*, of 3rd January, 1931, wrote—

Hitherto not more than one stationary figure has been flashed through space, but at yesterday's demonstration eight moving figures were seen on a screen. A group of people, in a room in the laboratory of the Baird Television Company in

London, saw the full-size figure of Strudwick, the England and Surrey cricketer, appear on a screen. He stood in front of a wicket and made imaginary strokes with his bat, which the audience in another room could see quite clearly. Then eight figures appeared on the screen.

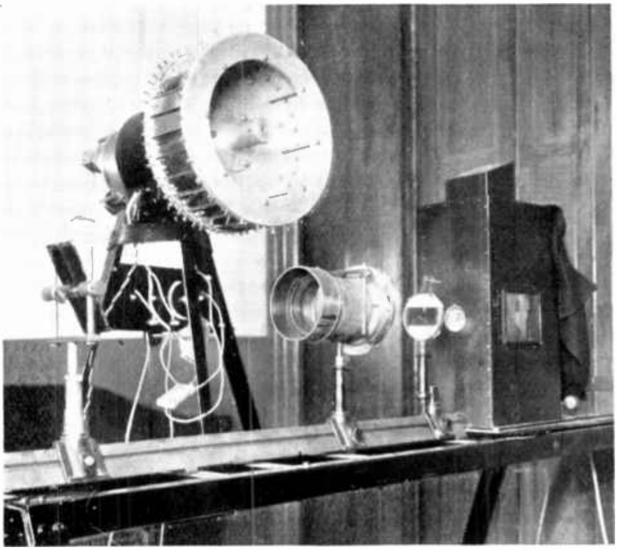
Direct Arc Modulation

On 2nd January, 1931, another remarkable development was disclosed for the first time. This consisted in *modulating an arc itself*, current from a television signal being applied directly to the arc without the use of any subsidiary modulating apparatus. Wonderful success was achieved. The demonstration was given before representatives of the scientific Press, including *Nature* and the technical representative of *The Times*. Television signals from the Baird transmitter as previously used in the B.B.C. broadcasts were applied to a specially adapted arc, and light from this arc was focussed by means of a condenser upon an aperture in a diaphragm, an image of the aperture being made to traverse a screen by means of a mirror drum with 30 mirrors.

The image produced was of intense brilliancy, and the detail and definition excellent. It is truly remarkable that the arc can be made to respond to the very high frequencies involved in television, but none the less this has been done, and marks another milestone in television progress.

Commenting on this demonstration, *Nature*, of 10th January, 1931, says—

> The detail and definition of the received image was comparable to that received on the standard commercial "Televisor" receiver, and the brilliance of illumination was remarkable. This demonstration of the successful modulation of the arc with television signals appears to open up considerable possibilities, and the television arc would appear to have a useful future.



Part of the Receiving Equipment Used in Connection with the Demonstration of Direct Arc Modulation for Television Reception with a Large Screen

A B.A. Demonstration

This same modulated arc was not demonstrated publicly until the meeting of the British Association in September, 1931, it being installed in the section devoted to Mechanical Aids to Learning. The audience was seated several feet away from the screen, which was set in a black background. First of all, a large image, in this case a man's head and shoulders, addressed the audience from the screen, the voice being heard from a loud speaker accommodated in the foreground. Having explained briefly the principles involved, and pointed out how this invention in its present form opened up a new field in education, since a lecturer complete with demonstrable apparatus could be located in one central studio, and his image seen and his voice heard at various remote points linked by wire or wireless, the announcer disappeared from the screen, his place being taken by a lady singer.

Apparatus Used

The public were at liberty to examine both receiving and transmitting apparatus, the latter taking the form of a standard light-spot transmitter, to which reference has been made earlier in this book. At the transmitting end, behind the screen, was seen the mirror-drum, with each of its 30 mirrors set at a slightly different angle from the preceding one. Before this drum was a lens concentrating the light from the Baird modulated arc on to the mirrors (see Fig. 47), and, as the drum revolved, the light-spot was made to traverse a screen in a succession of 30 parallel lines, the light from the arc lamp flickering in and out, corresponding to the light and shade of the image, being bright at the high lights and dim at the shadows, the

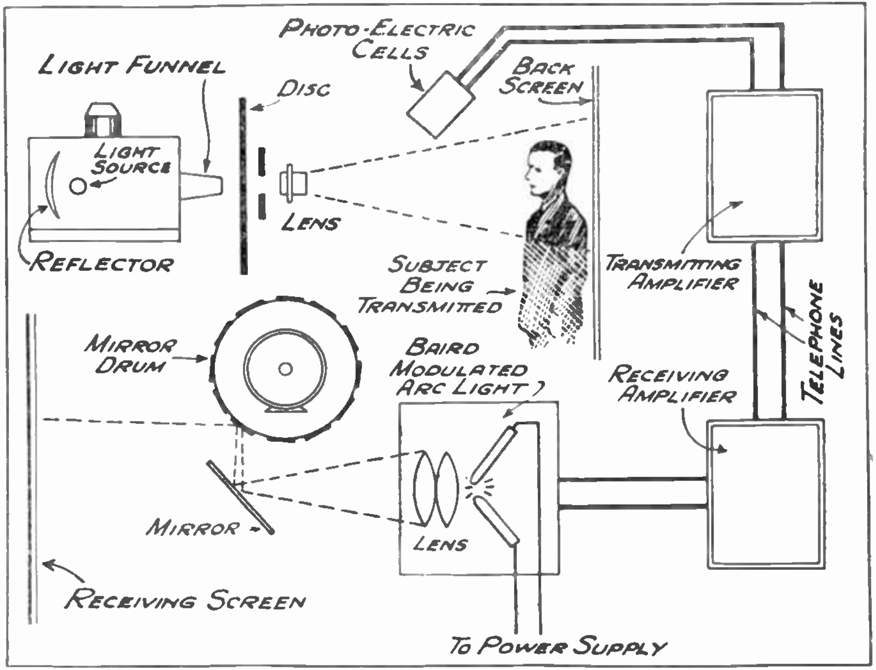
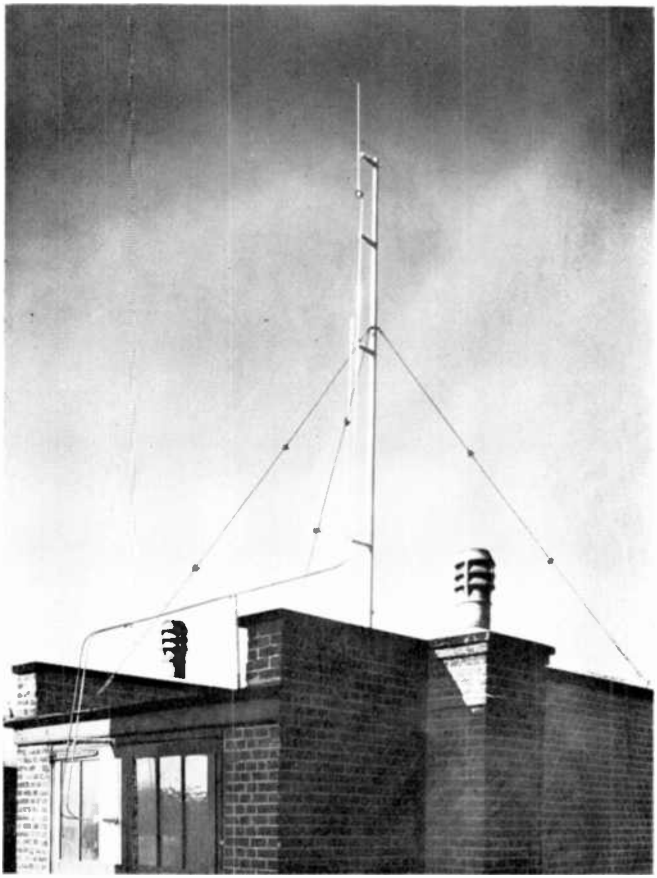


FIG. 47. A SCHEMATIC DIAGRAM DRAWN TO ILLUSTRATE THE METHOD EMPLOYED FOR DIRECT ARC MODULATION



THE SPECIAL AERIAL ERECTED FOR ULTRA-SHORT WAVE TELEVISION TRANSMISSIONS

168

whole process being really, in principle, very similar to that of the ordinary Baird "Televisor."

Since the arc equipment was arranged parallel to the screen, it was necessary to include a large mirror to turn the light beam through an angle of 90 degrees.

Ultra Short Waves

The next stage in the development of television to be recorded in these pages concerns the *ultra* short waves. As has been pointed out earlier in this book, the limitations in sideband spread (9 kc.) which are imposed when working on the medium wave broadcast band in Europe restrict rather the extent of the scene which can be televised, as well as keeping down the number of complete images transmitted per second.

On the *ultra* short waves, however, that is those below a length of 10 metres, a much wider sideband can be employed; and by successfully exploiting this, flickerless images, having a considerable amount of fine detail, can be transmitted. Unfortunately, as far as present knowledge exists, the radius over which the signals can be received successfully is restricted somewhat, roughly to the "optical" path of the waves. That is to say, the receiving station should be in sight of the transmitting aerial, but this is not a hard-and-fast rule. However, for a local television service within a densely populated area, the *ultra* shorts are admirable, and it is well known that the B.B.C. is investigating this new side of broadcasting.

A Step Forward

The Baird Company are also pursuing a broad policy by examining the use of *ultra* short waves for television, and the first public demonstration on these lines was given on 29th April, 1932. The transmission took place between the Baird Company's premises in Long

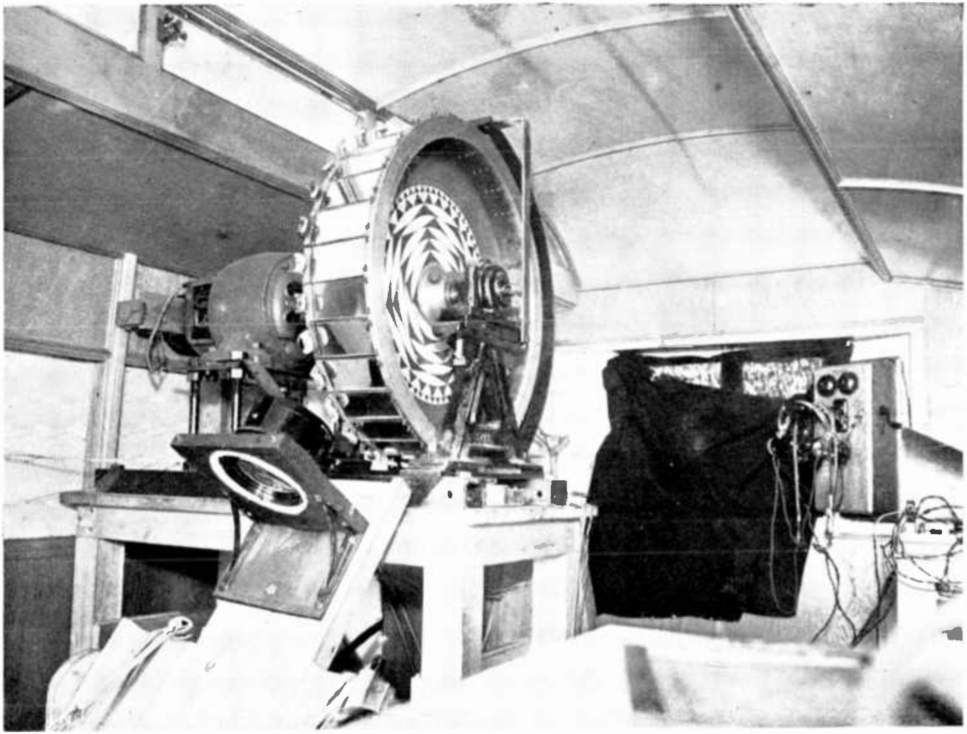
Acre, where the *ultra* short wave transmitting apparatus had been installed, and a wireless receiver on the roof of Selfridges.

The demonstration not only represented an important development at the transmitting end, but an advance was marked by the entirely new experimental receiver upon which the images were seen. The image was shown on a screen instead of in a lens, as in the disc "Televisor." The size of the image was considerably larger, and in this way a number of people were able to see the image simultaneously.

In the experiment a wavelength of 6·1 metres was used, and the original aerial consisted of two copper rods, with a meter registering aerial current in the centre, the total length of the rods being one-half of a wavelength. This was supported by a well-stayed wooden pole, mounted on the roof of a small brick hut erected on the flat roof at Long Acre.

Standard Vision Signals

The transmission lines from the aerial made separate connections to the copper rods in such a way that it was split into three divisions. The parallel wires then passed through insulators, and were joined to the extremities of a coil inductively coupled to the main oscillator drive. For the purpose of the demonstration, the vision signals were supplied from the standard Baird transmitters, then in daily use for the morning transmissions sent out by the B.B.C. station at Brookman's Park; that is to say, 30 scanning strips were used and 12½ pictures were transmitted per second. At this juncture no attempt had been made to exploit fully the advantages offered by *ultra* short wave working, namely, an image of much greater detail which can be displayed with an absence of flicker.



A Section of the Daylight Television Transmitting Equipment Inside the "Caravan" at Epsom

At the receiving end a simple super-regenerative wireless receiver was connected to a short length of aerial wire. The set consisted of a back-coupled detector valve, linked to a resistance-capacity coupled low-frequency amplifier fed from the mains. The signals then passed to the vision apparatus, where they were reconstituted from electrical currents into the resultant image. This appeared on the screen as black and white, instead of the more familiar glowing neon colour.

Programme Transmitted

From 11.45 a.m. until 12.15 p.m., Press reporters and technical experts were given a programme which was divided into two separate sections. The first section was identical with the latter half of the normal television morning programme, which was being transmitted from the Brookman's Park station on a wavelength of 356 metres.

At noon Mr. Sydney A. Moseley appeared in front of the transmitter, and his image was seen at the receiving end. After he had closed the morning programme in the usual way, his image remained instead of disappearing, thus showing that the signals were being transmitted by means of the *ultra* short waves. For the first quarter of an hour also the sound section of the dual television programme was received through the medium of a pair of portable wireless receivers, and as soon as the sound from these ceased, direct telephonic communication was established between the transmitting and receiving ends.

The speaker conducted a short conversation from the transmitting end, his movements and the telephone used being seen clearly on the screen. The images throughout were distinct and steady, the synchronizing system functioning perfectly without "image hunting."

After this the company was entertained by artists located in the Baird studios.

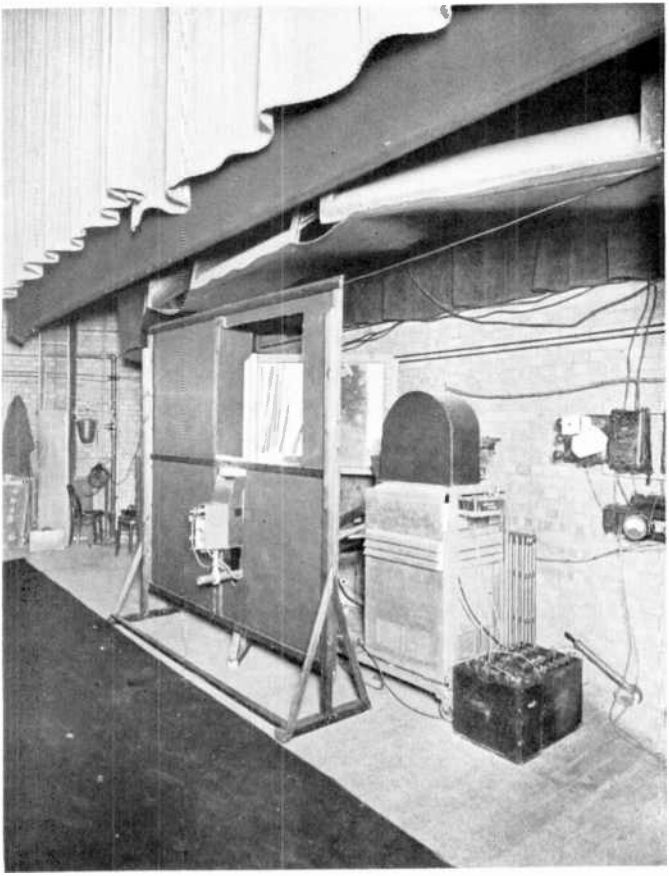
New Aerial Employed

Bearing in mind that an absolutely steady signal maintained at the exact wavelength is one of the criterions at the transmitting end, it is interesting to note that steps have been taken by the Baird Company, subsequent to this demonstration, to ensure this. A new aerial arrangement can now be seen on the Long Acre roof, and is illustrated in an accompanying photograph. The prime difference is in the method of feeding the signals to the aerial. A pair of burnished half-inch diameter copper tubes, maintained at approximately 4 in. apart by insulators, pass through the unit to the rods of the half-wave aerial. One of these tubes makes metallic contact with the bottom end of the aerial, while the other is free, and serves to neutralize any tendency to radiation which may occur in the main tubular feed.

This scheme is known as the "Zepp" aerial, and lends itself admirably to the prime objects of rigidity in construction and simplicity in erection, as well as a steady transmission. It is adaptable particularly to situations where the aerial is positioned on the top roof of the transmitting hut. If preferred, the same idea can be carried into effect by having two concentric tubes, the inner one being half an inch in diameter and serving as the main feed, while the outer tube of about 2 in. diameter neutralizes the radiation tendencies.

An Outstanding Feat

We now come to what may be well looked upon as the outstanding television feat of 1932, and it is as well to introduce this by describing vividly the day in question.



THE NEW TELEVISION SCREEN RECEIVING APPARATUS IN COURSE OF INSTALLATION ON THE STAGE AT THE METROPOLE CINEMA

Note the position of the large deflecting mirror

"Look!—there are the horses." This exclamation, to the accompaniment of rounds of applause, released the pent-up feelings of an overflowing audience at the Metropole Cinema, Victoria, on 1st June. The day will become historic in the annals of Baird television—nay, in the whole science of television, for the demonstration which was staged was unique in that nothing of a similar character had ever been attempted in any part of the world.

Scenes from the Derby were shown on a large screen approximately 10 ft. wide and 8 ft. high at the same instant as they were being watched by the enormous crowds on Epsom Downs.

The experiment was an ambitious one, for the transmission by television of an outdoor scene of this character was bristling with almost insuperable difficulties. This did not daunt Mr. Baird and his engineers, and the whole of the audience seemed fully alive to the privilege which was theirs to enjoy, namely, being in at the start of a new era of television.

Introducing the Experiment

First of all, Mr. Sowden addressed the cinema patrons from the stage, drawing an analogy between the development of cinema films and television, and emphasizing that while it was about thirty-five years ago that Lumiére first showed his flickering pictures, it was only six years ago that Mr. Baird gave his first demonstration of real television. The image was then about the size of a postage stamp, but to-day it was large and bright enough to be seen in a large cinema.

Asking the audience to, metaphorically speaking, come with him to Epsom Downs, first of all was heard the remarks of Mr. John Thorne, who kept up a lively running commentary throughout the whole of the transmission. When the horses came within the range of the television transmitter at Epsom, the curtains parted and everyone could see the horses parading in front of the Grand Stand. This was the crucial moment mentioned in the opening sentence, and it might be added that Mr. Baird himself was just as excited as anyone else when he saw his untiring efforts crowned with the success they richly deserved.

True the images on the screen were somewhat blurred and flickered, but the horses and jockeys, as they trotted past slowly in succession, could be seen, and then they all turned round and cantered by, this time closer to the transmitter, preparatory to going to the starting post.

The Horses Seen

The curtains came together again, it being stated that the screen would be exposed again as soon as the horses were "off." Meantime the commentator stuck manfully to his task and described all that was happening within the range of his vision. As the murmurs of the crowd in the background of the "mike" turned to a great shout of "They're off!" the screen came to life again, and in about two minutes the winning horse and jockey flashed by with the remainder of the field close at their heels. Another short pause and Mr. Tom Walls was seen to lead in his winning horse.

No one will gainsay that this transmission was a historic achievement, and when Mr. Baird was persuaded to show himself on the stage he was greeted with a truly British expression of feeling by handclapping. He did not say a word; he had scored a triumph and left it at that.

Following on this, connection was effected to the Baird studios at Long Acre, and Mr. Sydney A. Moseley spoke to the audience as a televised image, emphasizing

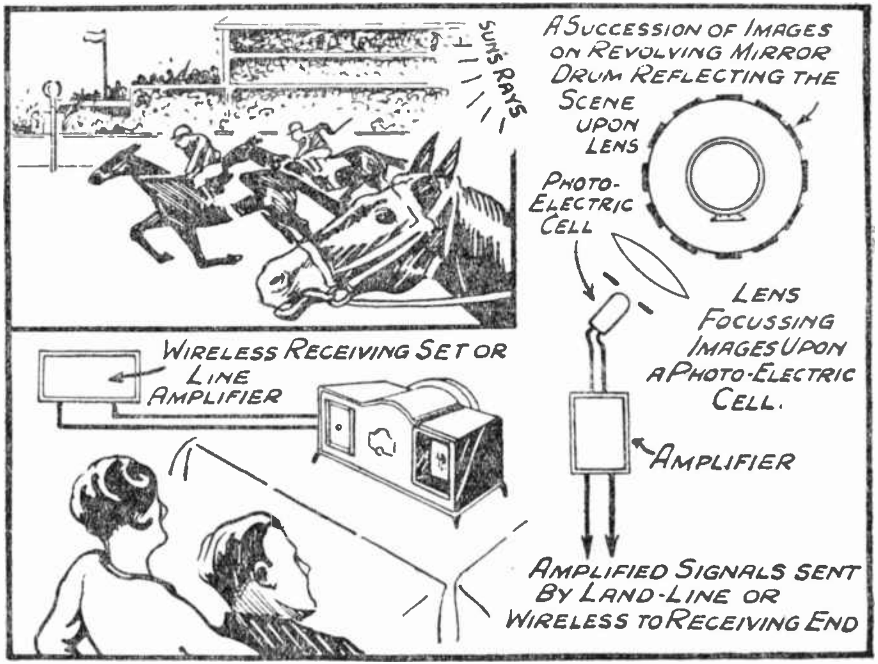


FIG. 48. SCENES FROM THE DERBY BEING REPRODUCED BY THREE-ZONE TELEVISION (DAYLIGHT) IN A DISTANT CINEMA

in a few well-chosen words the marvel that had just transpired.

So much then for the experiment, and now let it be explained how the work was really carried out. The accompanying pictorial diagram of Fig. 48 and photographs will enable the reader to visualize the scheme.

Describing the Apparatus

The Baird daylight television apparatus was housed in an ordinary-looking trailer caravan situated opposite to the Grand Stand at Epsom and adjacent to the winning post. Inside could be seen a large drum, with 30 mirrors arranged round its periphery. This was revolved at a speed of 750 r.p.m., and since each mirror was set at a slightly different angle to the preceding one, the whole scene was in effect split up into thirty strips. A succession of images of the scene thrown on to the drum was thereby made to move over three apertures, admitting the different degrees of light and shade comprising the scene to three separate photo-electric cells.

Each of the cells in its turn converted these light and shade effects into electrical variations of equivalent intensity. In this way the scene was split up into three adjacent zones and the separate signals passed to amplifiers, from whence they passed to telephone lines laid under the course for transmission to the Baird Company's control room at Long Acre. From here they were relayed to the stage at the Metropole Cinema, Victoria, and, after being further amplified, passed to the receiver.

The receiving apparatus was most ingeniously designed, and a reference to the photographs should make this side of the scheme quite clear.

A "Dress" Rehearsal Early on Derby Day Morning (1932), Prior to the Ambitious Three-zone Experiment

At the Receiving End

Three arc lamps were set at the three points of a compass, each being responsible for one zone of the resultant picture. Three Baird grid cells modulated the beams from the arcs, and the resultant modulated light was thrown on to a single mirror drum geometrically identical to that at the transmitting end and automatically synchronized. One of the light beams, namely the centre zone, passed direct to the drum; but the other two, since they were situated at right angles, were bent in their path by means of small mirrors. The three beams of light were then reflected from the revolving mirror drum to a large plate-glass mirror set at an angle of 45 degrees, and in this way the beams were once more turned through an angle of 90 degrees to be projected on to the translucent screen situated on the Metropole Cinema stage.

It was necessary to include this large mirror owing to the absence of adequate depth in the back of the stage; and in consequence the mirror drum, instead of being at right angles to the screen, revolved in a plane parallel to the screen.

Centre Zone Broadcast

It may be asked why the picture ratio of each zone was maintained at the Baird standard of 7 vertical to 3 horizontal, together with the speed of 12½ pictures per second, with only a 30-line picture. This was done so that the centre zone of the picture could be broadcast on Derby Day by the B.B.C., and this wireless transmission was effected through the medium of the National transmitter on a wavelength of 261 metres. In this way it was possible for anyone in possession of a "Televisor" and a suitable wireless receiver to be able to watch the Derby in comfort in their own home;

and, according to the many reports received, this side of the transmission was a great success.

Reverting to the cinema, the three adjacent zones were carefully phased so that they would build themselves into a composite picture, and it was by this means that it was possible to make the screen so large. The simultaneous effect of sound and vision made a vivid impression, and indicated the enormous progress recently made in television transmissions by wire and wireless. The experiment was repeated with the Oaks Race on 3rd June and, although the visibility was not so good as that on Derby Day, it was attended with equal success. The finish of the race was not so close, with the result that the horses were seen to better advantage as each passed the winning-post.

Studio Transmissions

In support of these two outdoor events, transmissions were effected from the studios in Long Acre to the Metropole Cinema three times a day throughout Derby week. In addition to ordinary artists, many celebrities appeared before the transmitter and addressed the audience from the screen.

These transmissions were introduced from the stage by Mr. Sowden, and then the Baird Company's announcer appeared on the screen, speaking from Long Acre. After saying a few words, he was asked by Mr. Sowden from the stage, through the medium of a telephone line to the studio, to perform one or two simple things in order to convince any sceptics in the audience who may have felt that the television image was a projected film.

For the purpose of these transmissions both the standard disc and mirror-drum transmitters then employed for the daily broadcasts of television were

Mr. Baird with a Screen Model "Televisor," being Filmed in the Gaumont British Studios at Shepherd's Bush brought into service, and it is interesting to record that not a single hitch occurred during the whole week.

A New Model "Televisor"

At the end of this same month, on 30th June to be exact, another very important development took place, taking the form, on this occasion, of a new model Baird "Televisor." This machine was shown to a party of engineers and Press representatives, and had several distinctive features. Instead of being seen in a lens, which limited the view to three or four persons at a time, the image was thrown upon a screen 4 in. wide by 9 in. high, and could be seen all over a large room. It was sufficiently bright to be visible even in a normally lit room, and could therefore be viewed without the necessity of putting the room in total darkness.

The quality and brilliance of the image was greatly in advance of anything hitherto put before the public. The red colour of the neon tube has also been eliminated, giving instead a brilliant image in black and white. Compared with previous results, the image is remarkably free from the line effect which has hitherto been one of the drawbacks in television.

The machine shown was extremely compact, as it measured, when closed, 18 in. long, 8 in. wide, and 13 in. high. In operation the screen is pulled out, as in a camera, and its appearance can be gathered by an examination of an accompanying photograph. The construction differs from the disc model, described earlier in these pages, in that a mirror drum replaces the disc, and the neon lamp is replaced by a special form of light valve. One of the great difficulties in utilizing the original type of Kerr cell has been that very high voltages were required, such voltages making it impossible to turn out a model suitable for home use. By using a special patented construction, this difficulty has at length been overcome. The new Baird grid cell acts as a light valve, and modulates the light from a small filament lamp.

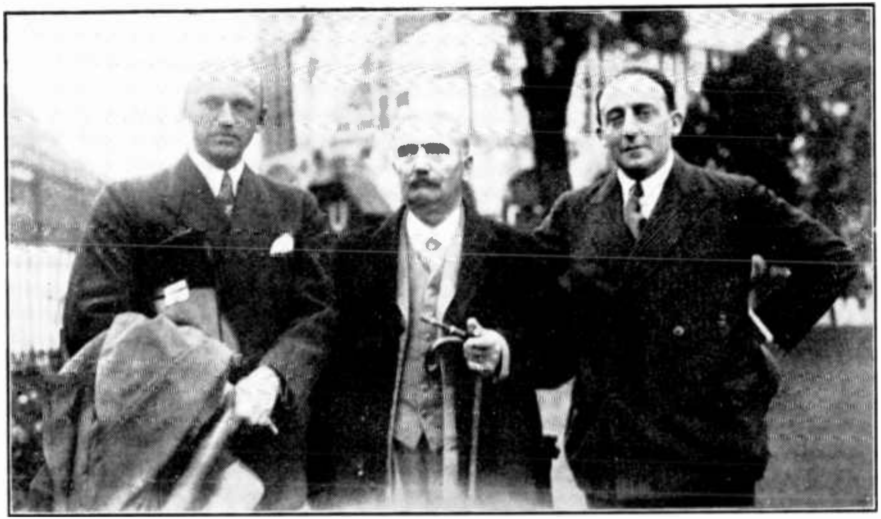
An Ingenious Arrangement

The scheme is most ingenious, and it is felt necessary therefore to give a full description of the form of model shown on that date.

The beam of light from a metal filament projection lamp (located at the back of the instrument and on the base) is passed through a lens and then concentrated on a pair of Nicol prisms, between which is placed a Baird grid cell. This is one of the most important parts of the instrument.

As is well known, a beam of light consists of transverse vibrations, in all directions at right angles to the direction of propagation. The action of a Nicol prism is to select the component of all these vibrations lying in the direction of a given line, fixed with respect to the prism. If no cell was interposed and the second prism was set to pass only components in a direction at right angles to that of the components passed by the first, the net result would be that no light would get through the combination.

The new Baird grid cell, consisting principally of a set of thin interleaved electrodes immersed in a liquid called nitro benzene, has the effect of distorting the line of vibration passing through the first prism into an ellipse, of eccentricity progressively changing as the voltage between alternate leaves is increased, passing through a circle and eventually becoming a line of vibration at right angles to the initial direction.



Nipkow's Name will be Always Associated with Tevevision, for to Him must be credited the First Scanning Disc. He is here seen in Berlin with Dr. P. Goerz (left) and Mr. Moseley (right)

Accordingly, a progressively increasing component is available for passage through the other prism.

This particular cell has minute inertia, and the variations of light passing through the combination are practically proportional over a definite range to the corresponding voltage variations, due to an applied signal.

Furthermore, it has the enormous advantage that it will work at voltages such as are available in any good wireless set.

By applying the received television signals to this cell, therefore, the amount of light passing out of the second Nicol prism is proportional to the magnitude of the signal strength, and in this way we secure a light variation which is proportional to the reflected light picked up at the transmitting end when exploring the subject.

Using a Mirror Drum

On passing from the Nicol-prism grid-cell combination, the light reaches an inclined mirror, is then turned through an angle, and finally passes through another lens to be focussed on to a revolving mirror drum.

The mirror drum merely replaces the perforated disc employed in the simple models of television apparatus. The drum is made from aluminium and purposely lightened by having sections cut away, and 30 mirrors are positioned round the edge. Each mirror is inclined at a slightly different angle from its immediate neighbour, with the result that as the drum revolves the light projected on to each mirror is thrown as a spot on to any screen placed in its path, and this spot is made to move vertically from the bottom of the screen to the top. As each mirror takes charge of the spot of light, it is made to create a strip of light, these individual strips joining together to produce a total light area of approximately 9 in. high by 4 in. wide.

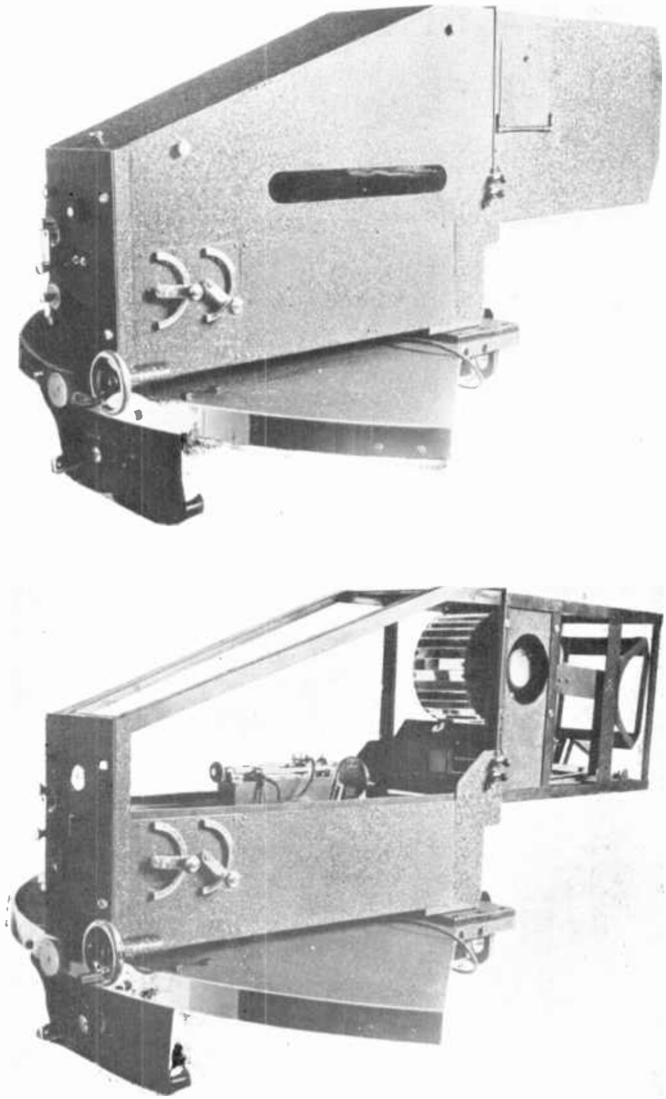
Operation

On the case of the new "Televisor" are two switches which control respectively the mains feed to the motor and the mains feed to the filament lamp, while a knob just above is linked to a rheostat for adjusting the motor speed.

When the motor is switched on, the drum is run up to its normal speed of 750 r.p.m. and, since the familiar Baird automatic synchronizer is incorporated, this pulls the drum into step with the transmitter motor. For framing and phasing the image, a large knob is provided at the side of the instrument near the back. This rotates the carcass of the motor and will move the image up or down; by turning it through the requisite number of degrees, the image can be moved to right or to left according to the number of light strips that it may be out of phase. The resultant images are quite brilliant, and are black and white.

The B.B.C.'s Attitude

The progress which has been recorded in this chapter had a marked effect on the attitude of the B.B.C. towards television as typified by the Baird process. They eventually came to the conclusion that sufficient headway had been made to make it possible to grant an extension of facilities and introduce television into proper programme hours. A new transmitter and amplifiers were therefore built by the Baird Company and installed in Studio BB of Broadcasting House. When tests had been completed, the B.B.C. took over entirely the whole of the programme and transmitting



Two Views of the Ingenious Television Transmitter Supplied by the Baird Co. and Installed at Broadcasting House for the Regular Television Broadcasts now Sent Out by the B.B.C.

side, and the first official programme was sent out on 22nd August.

At the time of writing the vision signals are broadcast by the London National station on a wavelength of 261 metres, and the accompanying sound is broadcast by the Midland Regional station on a wavelength of 399 metres. These transmissions take place on Monday, Tuesday, Wednesday, and Friday of each week, starting at 11 p.m., each programme being of half an hour's duration. It is conceded on all sides that the type of programme featured by the B.B.C. is of a very high standard and of a novel and interesting character, with the result that interest in the science has been very greatly stimulated.

Television Apparatus at Broadcasting House

Undoubtedly readers will be glad to learn a little of the actual apparatus that has been installed. First of all, then, the television projector is of the mirror drum type, and one or two accompanying photographs will show the details. There is an arc light source which can be moved backwards and forwards on channelling in a metal casing by moving one of the levers seen in the photograph. Just in front of the arc lamp is a circular metal shield with four correctly-sized apertures, which can be used in turn, and thus allow a square beam of light to pass through to be focussed on an inclined mirror. The mirror reflects this beam on to a drum having 30 mirrors positioned round its periphery. This drum is built on similar geometrical lines to those mentioned earlier in this chapter, and as the drum revolves the light projected on to it is reflected on to any screen placed in its path. Scanning follows the usual Baird standard of spot movement from bottom to top and strip movement from right to left, but the resultant light area is rectangular in shape and not sector-shaped, as is the case with a disc transmitter.

Following Artiste's Movement

With this mirror-drum spot-light machine, focussing and adjusting the spot for "long shots" (extended scenes) and close-ups can be carried out rapidly, and the ingenious mechanism used in this connection is seen clearly in the photographs. Furthermore, it is possible to move the transmitter bodily on rails and also swing it, and in this way follow any movement of the artist being televised.

As in the Long Acre Studio, four groups of photo-electric cells are used. Each of these groups is connected to separate amplifiers, the outputs of which are taken to the "mixer." The mixer panel consists of three controls through which, by judicious adjustment, and with the co-operation of the studio staff in arranging the groups of cells round the object being televised, various lighting effects can be produced.

Special Amplifiers

Altogether nine amplifiers are installed: four "A" type, two "B" type, and three "C" type. Though the notation of A, B, C for amplifiers is common practice, some explanation of each type may be interesting. "A" amplifiers are of the two-stage type, and have to be located as near the photo-electric cells as possible, to which they are connected by a very special type of cable. The output signal from these amplifiers is only just audible on 'phones and, after passing to the mixing panel and master control panel, it is fed into a "B" amplifier. This amplifier is a three-stage type with double outputs, the signal of which is fed in its turn to a "C" amplifier of three stages.

In the input circuit of the "C" is a corrector network, which is suitably adjusted to compensate for all high-frequency attenuation, including the scanning aperture factor. All the inputs and outputs of the amplifiers are brought to a control panel, which, with the mixer and master control, is on a desk-like frame quite separate from any amplifiers, as a precaution against valve microphony due to the handling of different controls.

An interesting point in the inter-connection of the amplifiers is that no transformers are used except those which feed the lines to the main control room.

The vision monitors are of the new type (similar to that described on page 179), the image being projected from behind on to a ground-glass screen some 7 in. by 3 in., and is black and white in colour.

London to Copenhagen

In bringing this chapter to a conclusion, it is necessary to mention that a single zone large screen, similar to that used at the Metropole Cinema, was shown at Messrs. Selfridges in August, and was then taken to Copenhagen.

The transmitting studio was in the offices of the Danish newspaper, *Politiken*, under whose auspices the demonstrations had been arranged, and the screen images were seen in the Arena Theatre. Towards the end of the demonstrations, however, on 8th November, to be exact, a most important event took place—another television milestone, in fact.

The audience sitting in the Arena Theatre in Copenhagen watched scenes taking place in the B.B.C.'s Studios in London. The scenes formed part of the regular nightly transmissions which are sent out by the B.B.C., but on this occasion a special programme had been arranged for the experiment. Carl Brisson, the famous Danish actor, although he had hitherto refused absolutely to broadcast, consented to take part in the demonstration. The distance between London and Copenhagen is approximately 700 miles, and, in spite of the fact that an atmospheric storm was raging over the North Sea, the show was a complete success.

Public Demonstration

The Arena Theatre in which the demonstration was given was packed to overflowing with a public audience. It was a great event for Copenhagen—and, in fact, for the world—for it was the first time that any such thing had ever been attempted, and the demonstration was made doubly interesting in that one of the performers was a Dane who was going to appear for the first time as a star in his native country, and strangely enough his first appearance in his home country was to be made on the television screen.

First of all those present witnessed part of the English programme, then suddenly appeared a large placard which filled the whole of the screen: "LONDON GREETS COPENHAGEN." The B.B.C. announcer was then heard informing British listeners that Carl Brisson had promised to perform and take part in an interesting experiment. The announcer turned and said: "Come on, Carl."

Carl Brisson then came into the picture. Applause broke out among the audience, but was immediately stopped by loud calls of "hush." He asked to be allowed to introduce the inventor of television, and Mr. Baird entered the picture and said: "I am glad to appear before you, and I hope you are able to see me clearly in Copenhagen."

Carl Brisson then appeared again on the screen, and was clearly seen and heard to say: "Good evening, ladies and gentlemen. It is a great experience for me to be the first Dane standing in London and being seen at the same time in Copenhagen. It is a curious fact that I am at this moment standing in my old home. I used to live at this very spot, but was compelled to move when the British Broadcasting Corporation erected this magnificent building.

"Another curious coincidence is that I am being shown by television in the very theatre where I made my *début*." Mr. Brisson then sang one of his popular songs, and the programme concluded with Mr. Einar Christiansen thanking Mr. Brisson on behalf of the Danish audience. The first demonstration of television to a theatre audience from one country to another was over.

The importance of this landmark and its meaning can scarcely be over-estimated. It marks the beginning of a time when public speakers and entertainers in any country will be seen and heard throughout the world.

Outstanding Developments

The developments outlined here are the straightforward advances anticipated from past results, but it may well be that the art will not develop along any of these channels, but along some quite different path. For example, as suggested in the Foreword of this book, a screen, built up either of elements or of a phosphorescent substance possessing luminous inertia, might be traversed by a recording point preceded by an obliterating point; thus a semi-permanent image would be continually present on the screen at every instant, the eye being continuously presented with a complete picture—unlike present devices where at any given instant all that the eye is presented with is a single spot of light.

CHAPTER XIII

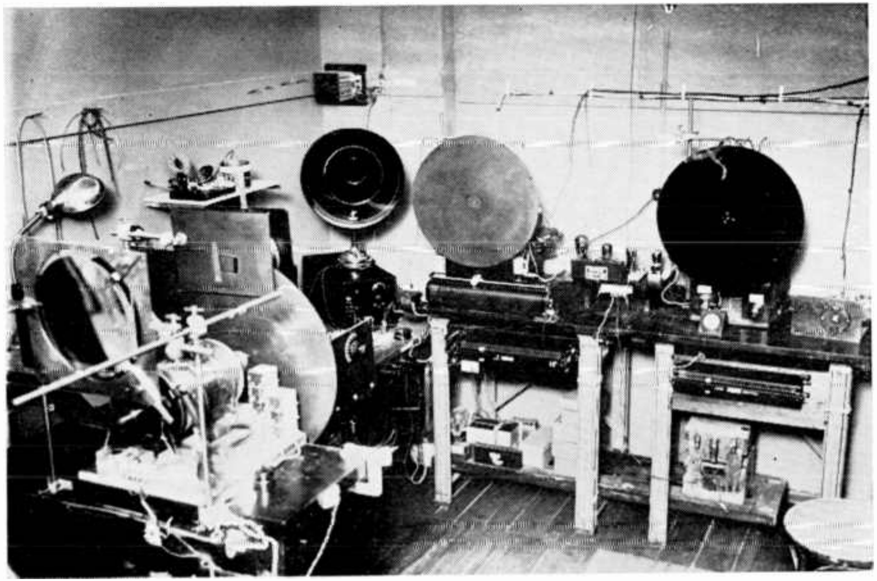
TELEVISION IN OTHER COUNTRIES

WE have so far confined ourselves more or less to the achievements of television in Great Britain. As explained in the Introduction to this work, this has been done in order to correct certain views expressed in books emanating from abroad. Besides giving credit where credit is due, that is, to the Scottish inventor who first demonstrated television, we have at the same time included in this work the latest developments in all branches of the science.

At the same time, we are in no mind to ignore the claims of those foreign investigators who have been working in friendly rivalry with Mr. Baird. Indeed, in many ways it has become an international race in the perfection of television. There is no doubt that the success achieved by the British inventor served to stimulate the efforts of his rivals abroad.

Early Pioneer Efforts

Let us see what these other inventors have achieved. The early efforts of television pioneers seemed to be focussed on methods for constructing a duplicate of Nature's television system—the eye—by substituting selenium for visual purple and building an artificial retina out of a mosaic of selenium cells, each of these cells being connected by wires to a shutter. This shutter opened when light fell on the cell connected with it, and allowed a spot of light to fall on a screen. In this way each cell controlled a spot of light, the image being reproduced by a mosaic formed of these spots. Models



Some of the Transmitting and Receiving Apparatus Employed in the Experimental Laboratories of the German Post Office on these lines were actually made, prominent amongst them being those constructed by Rignoux, Fournier, and Ernest Rhumer.

A Mirror and Cathode Ray Combination

Jan Van Szopanik suggested vibrating mirrors, as did also Boris Rosniz, but in the case of the latter he introduced an original scheme, dispensing with mechanical parts and using cathode rays instead.

Then, again, in France we have two noteworthy workers in Belin and Holwick. Their transmitter consisted of two mirrors vibrating at right angles to one another, thus causing the image to traverse a potassium photo-electric cell. The current from this cell controlled the intensity of the cathode ray at the receiver, the ray being caused to traverse a fluorescent screen by magnets energized from an alternating current transmitted from the motor which moved the mirrors at the transmitter.

In France the Baird Television Company have now formed a combination with the powerful Pathé-Natan group, which controls the Pathé cinematograph interests in France. This French Company—Télévision Baird-Natan—is developing the Baird system in France and already tests have been conducted through the Radio-Vitus station in Paris, on a wave-length of 315 metres. Arrangements are also being made to commence broadcasting on a large scale from other stations.

A further new Company—Société Française de Vision-Téléphonie—has been formed to use the Baird system in France for two-way television telephony, and demonstrations have already been given.

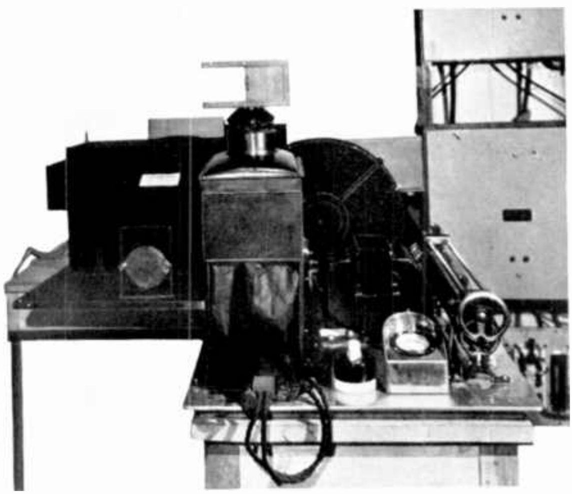
Two-way Vision and Telephony

The inauguration took place in Paris on 19th May, 1932, being staged between the offices of the French newspaper, *Le Matin*, and a studio at the Galeries Lafayette, M. Louis Rollin, Minister of Commerce and P.T.T., being present.

The image was projected on to a small screen 10 in. high by 5 in. wide, on which the head and shoulders of the speaker were clearly shown. It is interesting to note that at this transmission, Noctovision was for the first time applied to two-way television. There was no question of a flickering light playing on the sitter's face, and it is largely due to this innovation that the new system was rendered practicable. For conversation an ordinary telephone was used.

Commenting on the occasion, the Paris correspondent of *The Times*, in the issue dated 20th April, paid an independent tribute to the success of the transmission. "Although the image was fairly coarse," he said, "the features of the sitter were clearly recognizable, while the movements of the lips could easily be followed. The whole play of expression on the face of the speaker at the other end was remarkably clear, and when he obeyed a request to put out his tongue, the organ in question duly popped out from the face on the screen. It required a considerable effort to remember that one's own face was appearing on the screen at the other end, since the screening light from the transmitter had been deprived of all but the *infra* red rays, which are invisible to the human eye."

Remarking that one-way television transmission with sound is, of course, already in operation over the B.B.C. system to-day, *The Times* added that "ultimately two-way television, subject to the limitations governing ordinary wireless telephony, will become commercially possible."



In the Top Illustration is seen a Person Holding a Two-way Television and Telephony Conversation, while below is the Combined Television Transmitter and Receiver Seen from the Rear

The Apparatus Used

Between the two dual receiving and transmitting stations were four pairs of ordinary telephone lines, two pairs of which handled the telephonic signals and the remaining two pairs the television signals. The speaker sat at a table facing an aperture in a wall (see photograph). On the right, behind this aperture, was situated the translucent screen about 10 in. high and 5 in. wide, on which appeared the head and shoulders of the individual at the other end of the line. On the left of the aperture could be noticed the end of a telescopic lens, and this formed part of the television transmitter used in scanning the seated individual. As soon as the telephone receiver was lifted and connection established between the two studios, the head and shoulders of the person seated at the other end appeared on the screen, and not only were the features quite clear and distinct, but the image remained steady throughout. This was made possible by employing the Baird automatic system of synchronizing.

"Invisible Scanning"

The transmitter consisted of the Baird spot-light transmitter complete with a heavy metal disc having a spiral of 24 holes arranged near its periphery. This disc rotated at a speed of 750 r.p.m., thus giving 12½ complete exposures in 1 second. Situated behind the revolving disc was a powerful source of light, and the resultant light beam passed down the telescopic lens; but instead of the visible spot of light playing on the sitter's features, a thin disc of ebonite placed at the end of the lens effectively filtered out all the visible and invisible rays except the *infra* red.

The photo-electric cells (mounted in two banks of four cells on stands) were particularly sensitive to the *infra* red end of the spectrum and, in consequence, the "light" reflected from the rapidly moving *infra* red spot passing over the sitter was picked up by these cells, and translated faithfully into electrical variations which were transmitted to the other end of the line, after passing through the usual amplifiers. This apparatus is shown in the photograph taken from the rear of the control room; the source of light and dust case surrounding the scanning disc are seen mounted on the transmitting table.

Just to the left of this is the television receiver, which had been designed specially by the Baird Company for use in conjunction with this system, and consisted of a revolving mirror drum complete with 24 mirrors mounted round the drum edge. Each of these was set at a slightly different angle from its immediate predecessor, and a light beam from the spot-light neon, pulsating in accordance with the television signals passed from the far end, was focussed on to the mirror drum and, in turn, reflected back on to the translucent screen. The drum revolved in perfect synchronism with the transmitting end, and in this way the light and shade of the living subject transmitted was built up from the 24 light strips lying side by side.

The apparatus is now being worked between Paris and Lyon.

Jenkins's Work in the U.S.A.

In the United States of America television workers have been extremely active, and foremost amongst them we have C. F. Jenkins, whose name is, like that of Monsieur Belin, known in connection with phototelegraphy. He has contributed to the science a most ingenious device known as the disc prism. This consists of a circular glass disc, the edge of which is ground into a prismatic section, the section varying continuously round the circumference. Light passing through the disc is, therefore, bent backwards and forwards as the section changes, and by passing the image through revolving discs of this nature it is made to traverse a photo-electric cell. The current from this cell is transmitted to the receiving station, where it controls the light from a lamp invented by Mr. Moore. This lamp changes in intensity instantaneously in proportion to the current, and its varying light is caused to traverse a screen by a similar device to that of the transmitter.

Of late, however, Mr. Jenkins has abandoned his lens prism and is now conducting work on a 48-hole spiral disc.

Jenkins' work is meritorious in the highest degree, although it has been rather overshadowed by the spectacular demonstrations of the American Telephone and Telegraph Co., which, in April, 1927, gave a series of television demonstrations, both by land line and by wireless, between Washington and New York, and then showed colour television after Mr. Baird.

Mihaly and His "Telehor"

In Germany a very prominent worker has been the Hungarian, Denes von Mihaly, who made striking claims as far back as 1923 for a device which he termed the "telehor." This consisted of little mirrors, suspended upon two thin wires, vibrating in front of a powerful electric magnet. The "telehor" appears to have been incapable of achieving demonstrable results. In any case, in 1928 Mihaly abandoned his "telehor," and, following the lead of Baird, adopted the rotating Nipkow disc, neon tube, and synchronous motor.

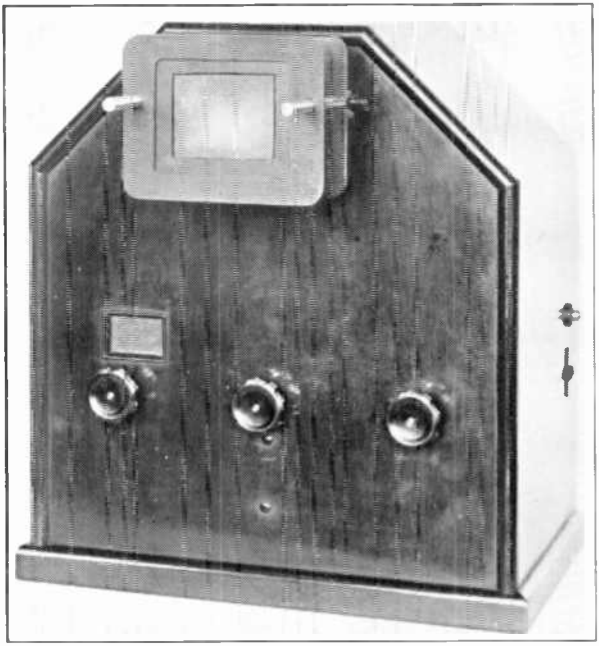
At the 1929 German Wireless Exhibition, held in Berlin, actual television was not demonstrated by this inventor, but he had two transmitters of his own in operation, one sending a lantern slide, and the other a film. Mihaly has not so far publicly demonstrated any form of automatic synchronizing; he has used the same A.C. mains to drive transmitter and receiver motors.

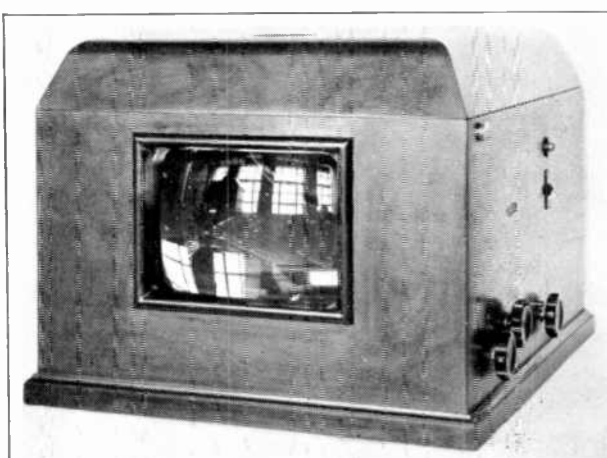
An Obvious Defect

One theory of his was to short-circuit the photo-electric cell six times per revolution of the transmitter scanning disc, through the medium of a commutator mounted on the end of the transmitter motor shaft. While this drastic treatment cannot be said to improve the photo cell, it is likely to cause a flash-over of the wireless transmitter. The maximum signal must always be controlled by the wireless transmitter; therefore the picture signal would have to be unreasonably reduced to allow for this. The signal at the receiving end has its high frequency component by-passed into the neon circuit while the synchronizing pulses are filtered out, amplified, and finally made to drive a phonic wheel, to which is coupled the receiver disc.

More recently, the well-known Telefunken Co., under the direction of Dr. Karolus, have taken up the problem of television in a serious manner, and, using the mirror drum of Weiller, have achieved some excellent results.

Their apparatus was also demonstrated at the 1929 Radio Exhibition in Berlin, and both tele-cinema and television were shown, the results achieved by them in both cases being of good quality, but the apparatus used made no pretensions to being commercial, and was most elaborate and costly. To secure synchronism, electrically driven tuning forks were used, the forks being exactly similar at both receiver and transmitter. Reliance was placed on these operating identically, but





Two Examples of Television Receivers Made and Demonstrated by Fernseh A.G.

their inherent delicacy makes them victims of even slight temperature changes, and this is sufficient to upset synchronism completely. Furthermore, although tuning forks were used, both the transmitter and receiver machines were driven from A.C. mains.

Work of the Fernseh A.G.

The German Post Office, who adopted the 30-hole disc as standard for the Witzleben transmissions, devote a good deal of time to research into the various systems of television, but naturally their efforts in this direction, while extremely praiseworthy from the point of view of results, are self-centred as a Government department. Their broadmindedness on television in general is a matter for congratulation, for witness the long series of daily test transmissions from the Witzleben station, which were conducted by the engineers of the Baird Company, using their own system.

Then, of course, we have the Fernseh A.G., a company formed in Germany in 1929, with Baird Ltd., Television, Zeiss Ikon, Bosch & Loewe Radio as partners. This company is developing the Baird system in Germany and has made rapid progress.

In addition to this, the German Post Office has purchased recently from the Fernseh A.G. a television transmitter working on the Baird " light spot " system, and this transmitter will, it is understood, be used to send out television programmes on the *ultra*-short waves.

INDEX

A.C. mains working, 72
Amateur co-operation, 39
Amplifiers, transmitter, 184
Anode bend rectification, 96
Arc, modulated television, 25, 166

BAIRD grid cell, 177, 180
B.B.C. and television, 12, 19, 24, 29, 182
B.B.C.'s television transmitter, 184

CATHODE ray receiver, 189
Cell, Baird grid, 177, 180
——, Kerr, 180
——, selenium, 49
Cells, photo-electric, 35, 43, 48, 85, 126
——, vacuum, 85
Cogged wheel synchronizing, 79
Colour television, 11, 147

DAYLIGHT caravan, 136, 139, 176
—— television, 10, 22, 135
—— television transmission, 136
Definition of television, 33
Derby, televising the, 23, 27, 138, 173
Detector refinements, 101
—— valve, 94
Disc, double spiral, 150
—— inaccuracies, 47
——, Noctovisor, 131
——, number of holes, 43
——, prism, 192
—— receiver, 59
——, scanning, 1, 3, 35, 41
——, shape of hole, 44
——, television transmitter, 40
——, triple spiral, 147
Distortion, 100
Dot theory, 54
Double spiral disc, 150
Drum, mirror, 1, 136, 162, 181
Dual sound and vision receiver, 110
—— television transmission, 17

EXPLORATION, graduated, 45

FALSE criticism, 52
Faults, television receiver, 62
Fernseh, A. G., 195
Film, talking, 116
Flood light television, 134, 163
Fog penetration, 127
Framing the image, 83
—— mask, 46, 74
Frequency limits, 54
—— loss, 56

GRADUATED exploration, 45
Grid leak rectification, 98

H.F. amplification, 113
Hunting, image, 78

IMAGE detail, 68
——, framing the, 83
—— hunting, 78
——, negative, 113
Improving detail, 53
Infra red rays, 6, 125, 190
Invisible scanning, 191
Isochronism, 70

KAROLUS's system, 194
Kerr cell, 180

L.F. amplifier detail, 105
—— amplification, 105
—— transformers, 104
Light area shape, 45
—— filter, 148
—— spot movement, 46
Luminous inertia, 161

MASK framing, 46, 74
Mercury and helium lamp, 148
Mihaly's telehor, 193
Mirror drum, 1, 136, 162, 181
Modulated television arc, 25, 166
Moore lamp, 193
Motor, receiver, 60

NEGATIVE image, 113
Neon lamp, 36, 89, 162
—— —— circuit connections, 91
—— —— operation suggestions, 92
—— —— working voltage, 90
Nicol prism, 180
Noctovision, 124
Noctovisor discs, 131
—— receiver, 127

Number of disc holes, 43

OPERATING disc "Televisor," 67

PENTODE valves, 109
Persistence of vision, 38
Phonic wheel, 79
Phonovision, 143
—— record, 144
Photo-electric cells, 35, 43, 48, 85, 126
—— cell amplifier, 88
Prism, disc, 192

RAYS, *infra* red, 6, 125, 190
——, *ultra*-violet, 125
R.C. coupled amplifier, 107
Reaction, 100
Receiver, cathode ray, 189
——, disc, 59
——, dual sound and vision, 110
——, motor, 60
——, Noctovisor, 127
—— output, 94
Rectification, anode bend, 96
——, grid leak, 98
Relay synchronizing, 76

SCANNING disc, 1, 3, 35, 41
——, invisible, 191
——, vertical, 56
Screen brilliancy, 161
——, lamp, 154
—— television, 20, 27, 30, 153, 160, 173, 185
Selenium cell, 49
Separate synchronizing valve, 109
Shape of disc hole, 44
Spectrum, visible, 124
Stereoscopic television, 12, 150
Strip sequence, 56
—— synchronizing, 74
Subject movement, 51
Synchronism, 71
Synchronizing, cogged wheel, 79
—— relay, 76
—— shutter, 121
—— strip, 74
—— voice and subject movement, 122

TALKING film, 116
Tele-cinema projector, 117
———— working, 115
Telehor, Mihaly's, 193
Telelogoscopy, 64
Tele-talkie broadcast, 123
Tele-talkie transmission, 155
Televising the Derby, 23, 27, 138, 173
Television analogies, 33
—— and the B.B.C., 12, 19, 24, 29, 182
——, B.B.C.'s transmitter, 184
——, colour, 11, 147
——, daylight, 10, 22, 135
——, definition of, 33
—— disc transmitter, 40
——, first demonstration, 17
——, —— play, 19
——, —— wireless provincial reception, 16
——, flood light, 134, 163
——, Glasgow transmission, 7
——, London to Copenhagen, 185
——, modulated arc, 25, 166
——, original apparatus, 5
—— receiver faults, 62
——, screen, 20, 27, 30, 153, 160, 173, 185
—— signal direction, 113
——, stereoscopic, 12, 150
——, total darkness, 5
——, transatlantic, 9
—— transmission times, 183
——, two-way and telephony, 189
—— wireless receiver, 93
——, zone, 22, 27, 161, 176
"Televisor," new model, 28, 170, 179
—— operating disc, 67
Transatlantic television, 9
Transmitter amplifiers, 184
Triple spiral disc, 150
Two-way television and telephony, 189

Ultra-short waves, 26,169
—— wave aerial, 170, 172
Ultra-violet rays, 125

VACUUM cells, 85
Valve, separate synchronizing, 109
Valves, pentode, 109
Vertical scanning, 56
Visible spectrum, 124
Vision, persistence of, 38

WAVES, *ultra*-short, 26, 169
Wireless receiver, television, 93

ZONE television, 22, 27, 161, 176

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