RADIO NEWS

1927

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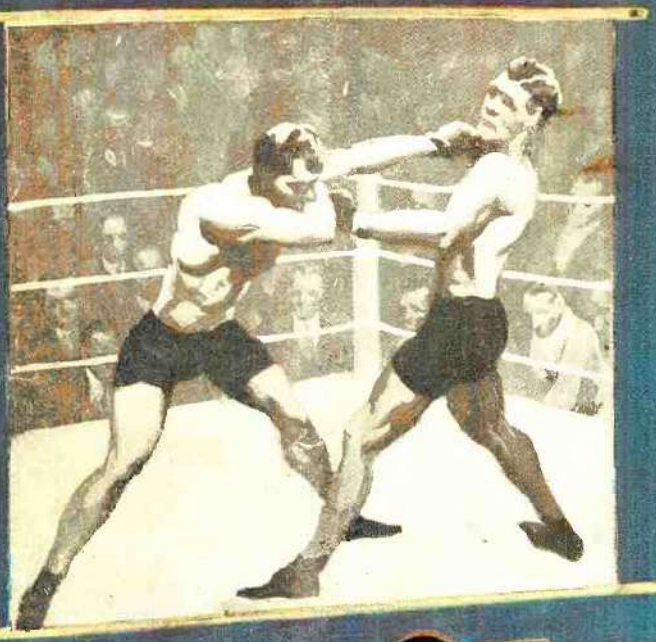


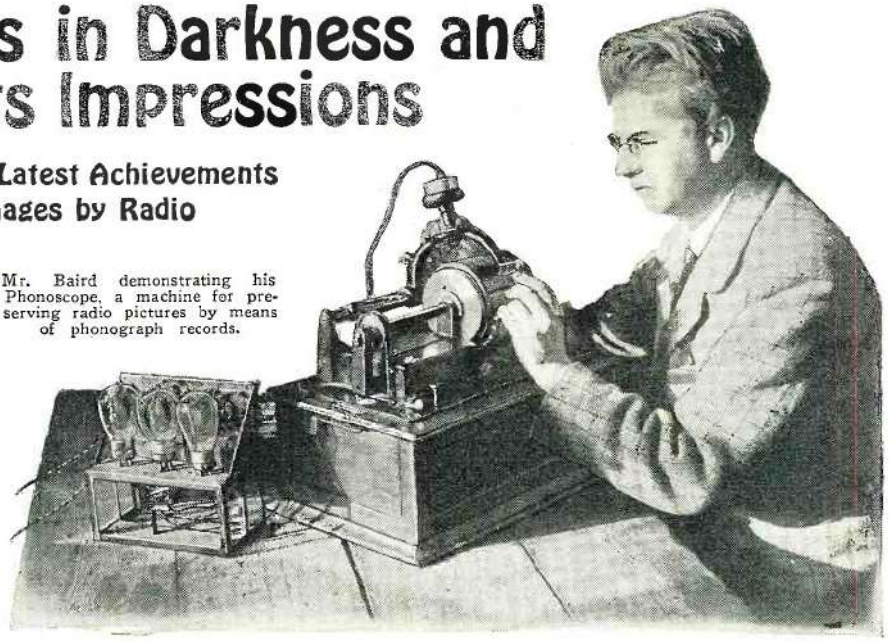
TELEVISION
ON
PHONOGRAPH
RECORD
SEE PAGE 1422

EXPERIMENTER PUBLISHING COMPANY, NEW YORK, PUBLISHERS OF
SCIENCE & INVENTION - RADIO LISTENERS' GUIDE - AMAZING STORIES - MONEY MAKING - RADIO INTERNACIONAL

Television Sees in Darkness and Records Its Impressions

An Account of John L. Baird's Latest Achievements Transmission of Moving Images by Radio

By A. DINSDALE



Mr. Baird demonstrating his Phonoscope, a machine for preserving radio pictures by means of phonograph records.

SINCE developing his apparatus till a crude image was reproduced, as described in RADIO NEWS for September, 1926, Mr. Baird has greatly improved the quality of his results by the use of rays invisible to the human eye. He has also utilized a phonograph to record the transmissions in permanent form for future repetition. It has been lately announced that experiments in transatlantic transmission are being initiated to demonstrate Mr. Baird's system in America.

—EDITOR.

IT was, I think, Sam Weller who explained to the Judge that he was unable to follow the accused's movements, "not being provided with million-magnifying double-barrelled opera glasses to see through a brick wall and a flight of stone stairs."

It is now over a year ago since I first had the opportunity of looking through just such a magic pair of opera glasses and saw what was going on through not one but several brick walls, and also, by a rather curious coincidence, a flight of stone stairs. I sat in a large room and saw on a little screen the face of a friend who was in a different part of the building, separated from me by two flights of stone stairs and many brick walls.

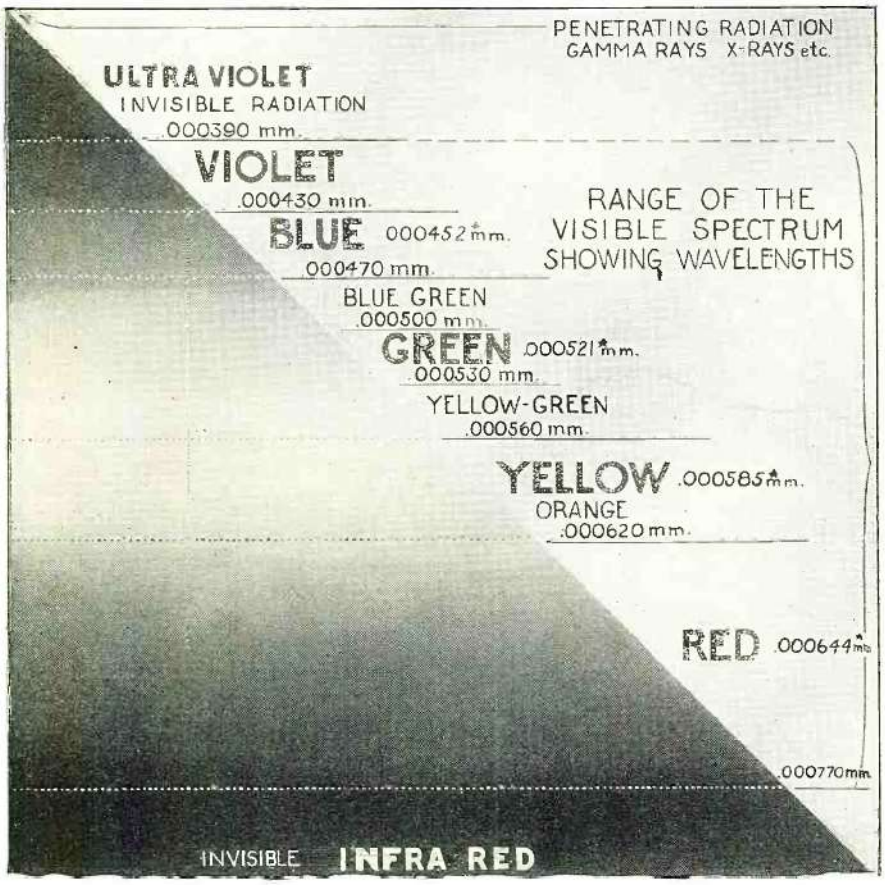
His voice came to me from a loud speaker: "Can you see me?" he asked, and see him I did, at least a small sepia-tinted replica of him about six inches square. I saw him turn his head, open his mouth, wink his eye. I even saw the curling wreaths of smoke from his cigarette. It was indeed Sam Weller's opera glasses come to reality.

The magic opera glass is called a Televisor, and is the result of years of patient research into the problem of Television by the Scottish inventor, John L. Baird, whose apparatus has been described in this journal. (See RADIO NEWS for September, 1926). The Televisor far transcends in power anything imagined by the witty Sam, for brick walls and flights of stone stairs are mere trifles to it. Its range is only limited by the distance over which we can converse by telephony, either wire or radio.

It gives to the eye what broadcasting has already given to the ear, and enables us to *see* by radio.

At that demonstration a year ago (one of Baird's first after overcoming at last the difficulties which have baffled the leading scientists of the world for so long) tremendously powerful lights were necessary to illuminate the sitter whose image was to be transmitted to distant points. So powerful were these lights, in fact, that the "victim" was well-nigh blinded and burned by their intensity.

Obviously, the first necessity was to increase the sensitivity of the light-sensitive cell, in order that the intensity of the light required might be decreased. Within a few months this was successfully accomplished so that the lighting required was no more brilliant than that used in a photographic studio.



The electromagnetic rays of the "visible spectrum," one billionth as long as those used in broadcasting, produce on the eye the effect of color (the stars indicate the wavelengths of the primary colors). Beyond its limits, at either end, no sensation of sight is caused. However, photo-electric cells register the impact of both ultra-violet and infra-red rays. The latter are used for "lighting" at the receiver of the Baird Televisor; and at the transmitter are reproduced as visible light, giving a normal effect.

CONCERNING THE SPECTRUM

Not entirely satisfied with these results, however, Baird began experimenting to see if he could not make use of invisible rays, and these experiments led to most important results. In order to understand clearly exactly what has been done, let us consider briefly the spectrum.

Beneath the range of the shortest wireless waves are other wavelengths extending in length down to infinitesimally small fractions of an inch. The frequency of these waves is enormously high, and the entire range of known frequencies, from the lowest to the highest, is known as the spectrum.

An illustration of these appears at the left, showing the wavelengths to which we assign colors, and the range of normal sight.

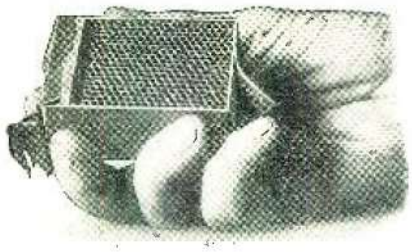
The composition of the spectrum may be outlined as follows: Starting at the highest known frequencies, the spectrum is divided up into sections in which fall first the gamma rays given off by radium, X-rays,

ultra-violet rays, the visible spectrum (light), infra-red rays, and finally, radio waves. (A description of its exploration will be found on page 218 of the September issue of RADIO NEWS, previously mentioned.)

The most familiar of these sections is the visible spectrum, which contains the colors extending from violet to red. It is more familiar to us because it is the only band of frequencies within the entire spectrum to which the unaided human senses are capable of responding. To detect the other frequencies special instruments are necessary; such as, for example, a radio receiver, when it is desired to detect radio waves.

Light-sensitive cells, such as are used in a television transmitter, are capable of responding to not only visible light, but also a narrow range of frequencies beyond the upper and lower limits of the visible spectrum; and it is this fact which has made possible one of the latest developments in television.

In his first attempt to make use of invisible rays, Baird used ultra-violet rays; but these proved to be far too dangerous, for they had a bad effect upon the eyes of sitters.



The cellular structure of the image-projection tubes used in Baird's television apparatus.

Turning to the other end of the visible spectrum, Baird next tried infra-red rays, and immediately discovered that his light-sensitive cell was capable of responding equally well to these rays, which are invisible to the human eye.

SEEING IN TOTAL DARKNESS!

Within a short space of time the inventor was able to dispense entirely with visible light, with the very startling result that it was possible to *see in total darkness!*

This is, perhaps, the most spectacular development of all in connection with television, and it has an uncanny and impressive effect upon visitors to a demonstration; as I discovered for myself recently when I was privileged to witness a demonstration of "seeing by dark light."

First of all, I was shown into the transmitting studio, the windows and doors of which were heavily draped to exclude all daylight. The place was in complete darkness. Even after having become accustomed to the stygian gloom it was literally impossible to see my hand in front of my face; and yet those watching the receiving screen were able to see me put my hand up in an effort to see it!

Leaving a friend of mine there I wended my way down stairs to the receiving theatre, where I conversed with my friend over the telephone and simultaneously watched his face on the televisor screen. He assured me that he was *still in total darkness*, and yet there was his image on the screen before me, an image which, incidentally, showed considerable improvement over that which I first saw over a year ago!

Thus have the Powers of Darkness been dispelled—those mythical powers which, right down through the ages of Man's history, have struck terror into the hearts of the ignorant and the superstitious.

It is difficult to estimate the full extent of the importance of this achievement in warfare, for it renders it possible to follow the movements of the enemy when he believes himself to be under cover of darkness.

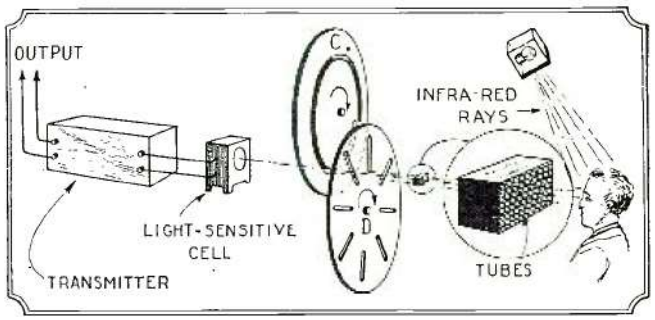


FIG. 1.

The infra-red rays are reflected from the object, through the tubes, and the revolving slotted discs C and D, where they are broken up, as explained in the text. They are then transformed into electrical energy by the cell, and are fed to the transmitter. At the receiving station they may be recorded on a phonograph, and reproduced at any future time.

Attacking aircraft, approaching under cover of the night, will be disclosed to the defending headquarters by the electric eye of a television apparatus. They will be followed by searchlights emitting not visible light but infra-red rays, and as these rays will be invisible to them they will continue to approach until, without warning, they are brought down by the guns of the defense.

Darkness, the great cloak for military operations, will no longer give security. The attacking party, creeping forward for a surprise attack on a pitch-black night, will be swept by an invisible searchlight and watched on the television receiving screen of the defenders. They will be permitted to come well within range and then find themselves, in spite of the apparent protection of darkness and the absence of visible searchlights, overwhelmed and decimated by well-directed gunfire.

It is to be hoped, however, that other uses may be found in peace time for this latest development of television. The fact that infra-red rays possess great fog-penetrating powers opens up possibilities in connection with the navigation of ships during foggy weather.

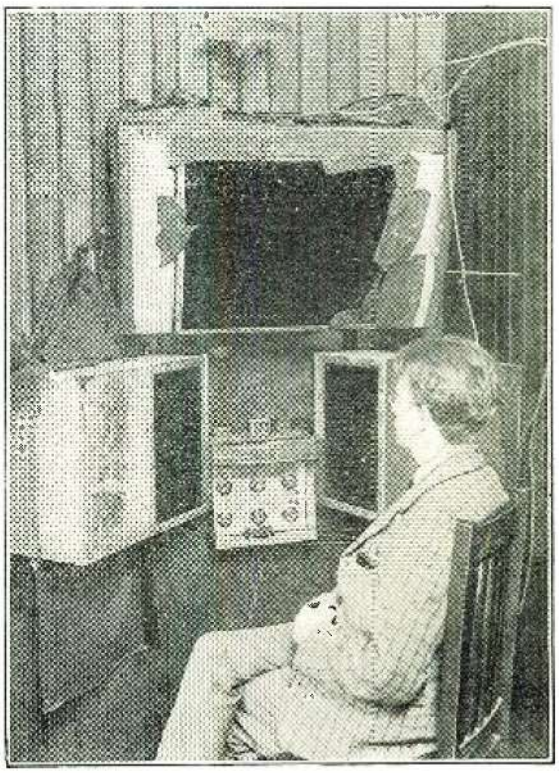
SEEING THROUGH FOG

To understand the possibilities in this direction it is only necessary to consider the behavior of ordinary visible light during foggy weather. The most intense white lights, it will be noticed, show through fog as a dull red color. The thicker the fog the duller the red which shines through.

This phenomenon is not due to any change in the characteristics of the original source of light. The fact is that any given light-source emits not one single color of light, but several, which combine to give the effect of a single color. By means of filters which will allow only certain component colors to pass, all other colors can be eliminated. Fog acts as a filter which will pass only red light.

The penetrating power of light varies as the fourth power of the wavelength; so that red light penetrates some 16 times more effectively than blue light, and infra-red light 200 to 300 times.

Red light has already come widely into use in aerodromes and for other purposes where fog-penetrating properties are of importance. This new application of television renders possible the use of infra-red rays with their still greater penetrative powers.



Mr. Baird seated before his television transmitter. The three black-faced boxes are the sources of the infra-red rays.

They will not, of course, be visible to the naked eye, even through fog. It will be necessary at the receiving end (*e.g.*, a ship at sea) to make use of a television apparatus in order actually to *see* through fog.

In order to generate infra-red rays any form of lamp may be used which will provide the necessary intensity of illumination, although certain types of lamps are richer in infra-red rays than others. Having selected a suitable light-source all that is required to obtain infra-red rays from it is a filter which will cut off all the frequencies but those belonging to the invisible rays. Several substances may be used as filters, such as, for example, hard rubber.

Thus, in order to transform an ordinary searchlight (which is already very rich in infra-red rays) into an infra-red ray searchlight, it is necessary only to cover the front of it with a suitable filter substance.

The infra-red rays are used by Baird in exactly the same way as ordinary visible light. That is to say, the rays are directed upon the sitter, and the "dark light" reflected from his face is passed on to the television transmitter.

IMPROVEMENTS IN IMAGE-EXPLORING MECHANISM

Since his apparatus was last described in these pages, Baird has made some improvements in his image-exploring mechanism. He has discarded his rotating disc of lenses, retaining only the two rotating slotted discs. To understand his reasons for doing this,

(*Continued on page* 1490)

Television In Darkness

(Continued from page 1423)

let us consider briefly the rotating lens disc and its function in the apparatus.

The lens-disc, it may be remembered, consisted of a large disc upon which were mounted 16 lenses, in two groups of 8, each lens in each group being set a little nearer the center of the disc, or staggered. As the disc revolved each lens took a small portion, or narrow strip of the image and swept it across the light-sensitive cell, so that the entire image was so swept across once for every revolution.

The image was thus divided into 16 vertical strips. They were further sub-divided into minute horizontal portions, or flashes, by the two other rotating discs, and each flash was, in turn, thrown upon the light-sensitive cell and signalled to the distant receiver.

From the foregoing it will be obvious that the fineness of the "grain" of the image as seen on the televisor screen was limited to sixteen vertical strips, or lines. This is all right for a small reproduced image; but when it is desired to enlarge the size of the televisor screen it becomes necessary to retain the fineness of grain during the magnification process. Sixteen image strips are scarcely discernible as such, on a screen only about six inches square; but on a screen six *feet* square the effect can well be imagined.

The obvious solution to the problem seems to lie in an increase in the number of lenses mounted upon the rotating lens-disc, but when an attempt was made to do this, mechanical difficulties were immediately encountered. In the first place, in order to accommodate the desired number of lenses, the diameter of the disc had to be increased to such an extent that it became unwieldy. Secondly, the weight of the lenses increased the centrifugal force of the rotating disc to such a great extent that it burst.

Baird therefore cast about for some other means of projecting an image in small sections across his light-sensitive cell. Besides lenses, prisms and vibrating mirrors can be,

A HOWLING RECEIVER

and have been used for this purpose; but they have their own peculiar disadvantages. Finally the idea of the pin-hole camera occurred to Baird one day, and he devised an apparatus based on this principle.

PROJECTION TUBES A SOLUTION

This apparatus is illustrated in Fig. 1. It consists of a block, or cellular structure, of tubes of tiny diameter which is arranged between the sitter and the two rotating slotted discs. The cellular structure can be seen in the illustration of this block.

Each tube in the block casts an image of a small part of the scene before it, so that the total effect of the block is to split up the entire image into scores of tiny round sections, or dots, and it only remains to impress the light values represented by each individual dot upon the light-sensitive cell in proper sequence.

Baird does this by retaining two revolving discs of his original system. One of these discs has a long spiral slot in it, while the other has a series of radial slots. These discs revolve immediately behind the cellular structure, as shown in Fig. 1, in such a manner that the discs overlap, the overlapping portions moving past each other in opposite directions as the discs revolve.

The spirally-slotted disc, C, revolving comparatively slowly, exposes layer after layer of the tubes to the light-sensitive cell, shifting in a vertical direction. The slots in disc D, which revolves at a high rate of speed, are so arranged, however, that the light ray of only one tube at a time is exposed to the light-sensitive cell.

Thus, while, say, the lower layer of tubes is open to the cell through the spiral slot, the slots in the disc D swing rapidly along the line and flash the light of each tube in turn upon the cell. Then the next row of tubes is dealt with, and so on, until the entire image has been flashed over the cell.

At the receiving end, apparatus exactly similar is installed, except that the light-sensitive cell is replaced by a source of light which is varied by the incoming electrical impulses, which are strong for high-lights medium for halftones, and zero for dark parts of the picture. Immediately in front of the cellular structure, at the end remote from the spinning discs, there is a ground-glass screen, upon which the picture appears, a faithful reproduction of the original, complete with even gradations of light and shade, and showing the movements of the sitter exactly as would a movie film.

THE NEXT STEP

Whereas the older method used by Baird, employing a spinning disc of lenses to project the image upon the light-sensitive cell, tended to produce at the receiver end a picture made up of closely-fitting narrow strips, the new method gives a picture made up of tiny dots, like a newspaper reproduction.

The grain can be made very much finer by this new method, and the picture enlarged considerably; but, even so, the ultimate degree of fineness obtainable, when enlarging the screen, is limited by mechanical imperfections. Obviously there is a limit to the number and thinness of the tubes which can be employed, as also there is a limit to the speed at which discs can be revolved.

Recognizing this, Baird continued his research until he has now developed what he calls an "Optical Lever" to replace all his present image-exploring mechanism. I am not yet at liberty to describe this latest development, owing to the patent situation, but it can be stated that by means of it any degree of fineness of grain can be optically obtained, and there is no mechanical limit to the speed of operation.

PERMANENT RECORDS OF SCENES

An interesting phenomenon in connection with television is that, if the output currents of the light-sensitive cell are listened to in a telephone receiver, they can be heard as

sounds, and every object or scene has its own peculiar characteristic sound.

For example, the fingers of a hand held in front of the transmitter will give rise to a sound similar to the grating of a very coarse file, while the human face will cause a high-pitched whistle which will vary in pitch as the head is turned or even when the features are moved.

For experimental purposes Mr. Baird had some phonograph records made of the sounds made by different persons' faces, and by listening carefully to the reproductions of these records it is possible to distinguish between one face and another by the sounds they make! With practice, faces may even be recognized by the sounds produced.

A further interesting point of far-reaching importance is that these records can be turned back into images. This is done by replacing the ordinary sound box by an electrical reproducer and causing the output currents from it to vary the intensity of the light source of a televisor. Thus, we can now store a living scene in the form of a phonograph record as well as in the form of a cinematograph film! Baird calls this invention a "Phonoscope."

There is room here for the imaginative to indulge in speculation on the scope for future development along these lines.

There would appear to be no limit to the remarkable inventive genius of John L. Baird, and the enormous possibilities of television stir the imagination, conjuring up visions of marvelous inventions before which even Sam Weller's magic opera glasses pale into insignificance.

STANDARD-FREQUENCY TRANSMISSIONS

THE Bureau of Standards, in announcing its schedule for this summer's standard-frequency signals from its station (WWV, Washington), calls attention to the fact that there are some differences in the frequencies from those previously given.

All signals are C.W., with a slight high-pitch modulation to aid in their identification. At the beginning of each 8-minute period, a general call is given, which continues for about two minutes; it is followed by the signal itself, a series of very long dashes with the call letters intervening, which lasts for four minutes. The announcements of the next frequency are then given,