A. Dinsdale

De-Bunking

Many conflicting reports concerning the time have left most of us in a fog. Several fairly There are many reasons for progress in for the serious experimenter is here today. being made here and abroad we present the latest

By A.

IN January, 1926, the Scottish inventor John L. Baird gave his first public demonstration of the transmission and reproduction by electrical means at a distant point of the image of a living human being. I have thus described the process, known as television, in order to differentiate it from experiments which have been made, both before and since, in the transmission of the shadowgraph images of inanimate bodies, or the reproduction by similar methods of moving picture films.

Shortly after Baird gave this now classic demonstration, the Editor of RADIO NEWS specially commissioned me to investigate and report on the Baird system, and as a result there appeared in the September, 1926, issue of this journal the first detailed account of Baird's methods to be published in the United States. That article terminated with the following words:

"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."

At that time Baird unquestionably led the world, and it gave me pleasure to be able to report as quoted above. Today, four and a half years later, it is with regret that I am compelled to report that Baird has lost his leadership, and shows no signs of being able to regain it. The apparatus he uses today is identical in principle with that which he used in 1926. That this fact is not evidence of great wisdom and foresight is obvious to all who are intimately familiar with the problems of television. On the contrary, as I propose to show in this article, television cries aloud to heaven for the discovery of some entirely new principle which will free the infant art from its present limitations and permit of its normal and healthy growth.

OLDER readers of RADIO NEWS will remember Mr. Dinsdale as a frequent contributor to our columns. Until recently he has been Editor of the British monthly magazine, *Television*. In England, where he is regarded as one of the leading authorities on television and is widely known as a public lecturer, Mr. Dinsdale, now Managing Editor of our sister publication, *Science and Invention*, has been a close student of the subject for over five years. He already has two books on the subject to his credit, and is engaged upon a third, and in order to make it authentic and up-to-date he has come to the United States to investigate personally the work which is being done here. In the following closely reasoned article he presents an unbiased commonsense review of the subject. THE EDITORS

Television, as we know it today, is capable of giving only a head-and-shoulder view of the person seated before the transmitter, and that more or less imperfectly. True, somewhat wider fields of view have been demonstrated from time to time, but with a most unsatisfactory amount of detail; the more of the individual one attempts to show, the less the detail. Television in natural colors has been demonstrated, and also television in stereoscopic relief, but any departure from the stereotyped head-and-shoulders view, in monochrome, is in the nature of a stunt designed for publicity purposes.

As to size, the received images, unmagnified, are limited to an inch or two square. It is customary to enlarge the apparent size of these tiny images by means of magnifying lenses which, besides enlarging the size of the image, also serve to show up any defects which would otherwise pass unnoticed. In many instances, also, overmagnification is resorted to, which distorts the sides of the image.

The above remarks apply to the small receiving screens of the so-called "home televisors." Various attempts have been made to enlarge the size of the received image so that an audience of several hundred, or several thousand people may watch it with ease.

Anyone who has followed television developments with an intelligent, but not necessarily technical interest, must have been struck by the deadly lack of originality displayed by one so-called "new" system after another, by the similarity in the size, scope and degree of perfection (or imperfection!) of the received images, and by the utter lack of any real progress towards the long-promised goal—the day when he can watch, in the comfort of his own home, the Army and Navy football Game or the World's Heavyweight Championship at Madison Square Garden.

We are just as far from that goal today as we were from modern sound broadcasting in, say, 1902, when wireless telegraph communication was conducted clumsily and precariously by the aid of spark coils and coherers.

I do not mean by the above statement that it will take us *as long* to reach our goal in television. Far from it. One has only to make a cursory examination of the record of scientific achievement to realize that as each new scientific discovery is perfected it shortens the period of incubation required by the next. Lessons learned in one science are becoming increasingly applicable to succeeding sciences, or new scientific applications.

Apart from technical difficulties, one of the troubles of television, which is doing it a great deal of harm, is that no one so far has attempted to visualize the thing in its true perspective. It is actually being handicapped by the very fact that it has made a tremendous appeal to the public imagination. And this appeal is by no means of recent growth.

The history of television dates back to 1873, when an obscure telegraph operator at the transatlantic cable terminal station at Valentia, in the south of Ireland, accidently discovered the light-sensitive properties of selenium. Contemporary scientists immediately seized upon the discovery as providing a possible means of supplying an electric eye to supplement the electric ear (telephone) then recently discovered by Bell. And from then on the story of the futuristic possibilities of television came to be built up, largely by imaginative authors.

Today, television is faced with two major problems which are classified under the heads (1) terminal equipment and (2) channels of communication. The first is essentially a problem for those engaged upon television research. The second is outside of their province, and must be solved by those skilled in electrical communication, both by wire and by radio. It is, however, desirable that both groups work in close co-opera-

TELEVISION

when we may have television in our homes satisfactory systems are in operation at present. television being comparatively slow. Television In this comprehensive review of the progress available information on this absorbing subject.

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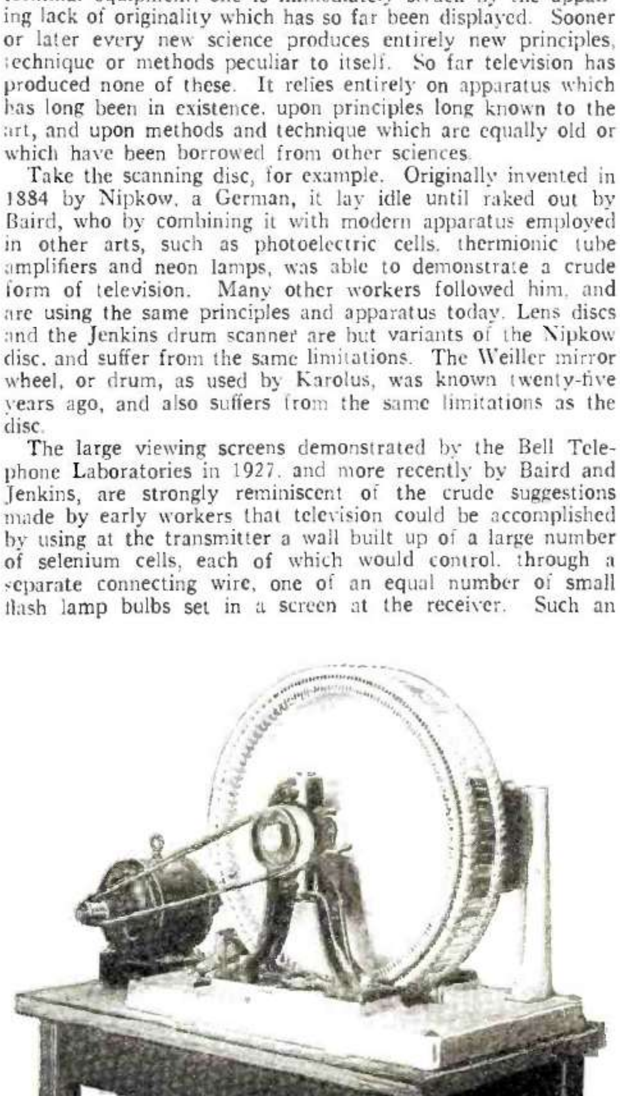
Dr. Vladimir Zworykin, of the R. C. A. Victor Company, with the new cathode ray tube which he has developed for television reception purposes

tion, for television is but another branch of electrical communication, and must ultimately come under that general heading.

As soon as one comes to examine closely the problem of terminal equipment, one is immediately struck by the appalling lack of originality which has so far been displayed. Sooner or later every new science produces entirely new principles, technique or methods peculiar to itself. So far television has produced none of these. It relies entirely on apparatus which has long been in existence, upon principles long known to the art, and upon methods and technique which are equally old or which have been borrowed from other sciences.

Take the scanning disc, for example. Originally invented in 1884 by Nipkow, a German, it lay idle until raked out by Baird, who by combining it with modern apparatus employed in other arts, such as photoelectric cells, thermionic tube amplifiers and neon lamps, was able to demonstrate a crude form of television. Many other workers followed him, and are using the same principles and apparatus today. Lens discs and the Jenkins drum scanner are but variants of the Nipkow disc, and suffer from the same limitations. The Weiller mirror wheel, or drum, as used by Karolus, was known twenty-five years ago, and also suffers from the same limitations as the disc.

The large viewing screens demonstrated by the Bell Telephone Laboratories in 1927, and more recently by Baird and Jenkins, are strongly reminiscent of the crude suggestions made by early workers that television could be accomplished by using at the transmitter a wall built up of a large number of selenium cells, each of which would control, through a separate connecting wire, one of an equal number of small flash lamp bulbs set in a screen at the receiver. Such an apparatus was actually built and experimented with by Rignoux and Fournier in 1906.



This Weiller Mirror Wheel, as used by Dr. Karolus, has 100 mirrors mounted in staggered formation around its periphery

The underlying principle of the large screen used by Karolus in Germany, and more recently by Dr. Alexanderson in this country, is the Kerr cell (sometimes called the Karolus cell) which controls the intensity of the scanning beam at the receiver in accordance with the fluctuations of the incoming picture impulses. This cell, based on the Kerr effect, well known to physicists for many years, was originally developed by Karolus for use with his still picture transmission system, and is still being used for this purpose, with highly successful results.

In 1911 the English scientist, Campbell Swinton, declared that television would never be accomplished by mechanical methods, and described an intricate system for the achievement of television by the use of cathode ray tubes at both the transmitting and receiving ends of the system. This idea was experimented with soon afterwards by Boris Rosing in Russia and Belin in France, and is still being experimented with by several workers in this country.

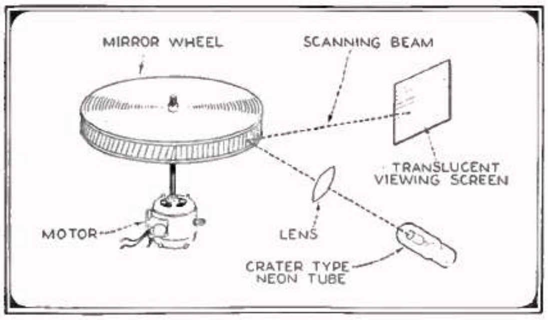
This exhausts all the known apparatus which has proved capable of producing any tangible results. Let us now examine the limitations of these various devices.

Television is at present faced with two imperative demands: (1) to increase the detail of the received image, and (2) to increase the size of the image. Both of these requirements mean that the total number of picture elements must be increased and, where a scanning disc is being employed, this means increasing the number of holes in the disc. And here we encounter a vicious circle.

In order to provide increased accommodation for a larger number of holes it is necessary to increase the diameter of the disc, unless the diameter of the holes, and the circumferential distance between them is made smaller, in which case the resultant image is made smaller, not larger, as is wanted. But smaller holes, and more of them, will provide greater detail and permit of the televising of a field of view greater than the head and shoulders of a human being. The smaller the diameter of the holes, also, the more of them we can get on a disc of given diameter. Furthermore, the phenomenon known as aperture distortion becomes less apparent as the diameter of the holes is reduced.

The ideal, therefore, would appear to be the use of holes infinitely small in diameter. But, apart altogether from the impossibility of drilling an infinitely small hole, the smaller the hole the less the amount of light which will pass through it and light values are so small in television work already that we cannot afford to lose efficiency on this score. There is, therefore, a practical limit to the diameter of the holes, below which we cannot go. This limit must, of necessity, be a compromise wherein detail is sacrificed to satisfy the limited efficiencies of the photoelectric cells at the transmitter and the light source at the receiver.

We are therefore face to face with the necessity for increasing the diameter of the disc, and at the speed of rotation demanded (20 pictures per second, or 1200 R.P.M.), it would not be mechanically safe to build a disc more than ten feet in diameter. If such a disc were drilled with 60 holes, each 1/10″ in diameter, the received image, a 60 line image, would be six inches square, unmagnified. This is a reasonable size of image for home use, but the size of the disc is most decidedly not! Also, the amount of detail in such an image would be very poor.



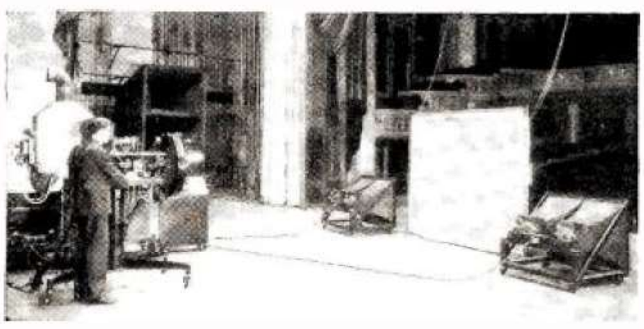
A schematic outline of the mirror wheel type television receiver developed by Dr. Karolus, by means of which he projects an image on to a ground glass screen measuring approximately four inches square

Alternatively, such a disc would give smaller images with better detail, down to, say, a one inch square image built up of 360 lines, or holes, each 1/360″ in diameter. The detail obtainable would then be excellent, but the idea of using a ten-foot disc to obtain a one-inch picture is absurd.

It would be logical and reasonable on the part of the public if it demanded, for home use, a screen one foot square, capable of depicting any scene coverable by means of a home movie, and with as much detail. To get the detail we should have to analyze (scan) the scene into at least 100 lines per inch. To get an image measuring 12″ x 12″ we should therefore need 1200 holes, and each hole would require to be separated from its neighbor circumferentially by a distance of 12″, so that the diameter of a disc to meet these requirements would have to be no less than 400 feet!

The crude absurdity of the disc, and the impossibility of making any further material progress with it is, I hope, now quite clear. Other mechanical methods of scanning, such as the Jenkins drum scanner and the Weiller mirror drum, do not offer any solution either; sooner or later the mechanical limitation of size will be reached.

The limitations of the Bell Telephone Laboratories' large screen obviously lie in the enormous number of picture elements which must be provided, entailing thousands of commutator segments and connecting wires. The same remarks apply to Baird's large screen. The limiting factors in the Karolus-Alexanderson large screen are (1) a scanning disc or mirror wheel is used and (2) the amount of light lost in the optical system, especially in the Kerr cell, is enormous; Alexanderson had to use a 150 ampere arc to obtain sufficient illumination for his six-foot screen.



The apparatus used by Dr. E. F. W. Alexanderson, of the G. E. C. to project television images on to a six-foot screen. A 150 amp. projector lamp is used, in conjunction with an improved Karolus cell and nicol prism combination

Everything points to the conclusion that we must ultimately scrap all mechanical means of achieving television and look for some entirely new principle. Radio communication blundered along cumbrously by brute force methods, the scope of which was decidedly limited, until the invention of the thermionic tube revolutionized the science, and permitted us to develop the intricate, all-embracing and marvelous system of radio communication which we have today. All the indications point inexorably towards the development of some means whereby we can achieve television by purely electronic methods.

The cathode ray tube appears to offer the desired solution. Electrons are weightless, and therefore inertialess. They travel with the speed of light, and speed is the all-important factor in television, where we have to find a means of increasing the number of picture elements (representing increased detail) transmitted per second so that they run into millions. An electron stream, such as is produced by a cathode ray tube, can be moved about, or caused to scan, instantaneously by the external application of either electrostatic or electromagnetic forces.

But the disadvantages of the cathode ray tube, as at present manufactured, are that its first cost is high, its life is short, it requires expensive auxiliary equipment which involves rather heavy upkeep and running expense, it is difficult to focus the pencil or stream of rays to a sufficiently fine point, and make it "stay put" at that during scanning, and the degree of illumination produced on the fluorescent screen is low.

However, I feel confident that the ultimate solution of the television problem will be found through the medium of the cathode ray tube, but I am equally confident that by the time a complete solution is reached the cathode ray tube, as we know it today, will have been altered out of all recognition.

So much for terminal equipment. There remains now the problem of channels of communication, and that problem resolves itself into the discovery of ways and means of transmitting the enormously high frequencies which will be involved when the problem of terminal equipment has been solved.

Take, for example, the above-defined suppostitious requirement of a home image measuring a foot square, giving detail equivalent to 100 lines per linear inch. The total number of picture elements in such a picture is $1200 \times 1200 = 1{,}440{,}000$, and if the picture is scanned 20 times per second, the A.C. signal frequency which we must transmit will be

$$\frac{1{,}440{,}000 \times 20}{2} = 14{,}400{,}000 \text{ cycles, or } 14{,}400 \text{ kilocycles per}$$

second. Using present technical methods, such a frequency could not possibly be transmitted by radio except, perhaps, on a wave-length of 1 metre, or less.

However, a ray of hope has already dawned on this problem, in the form of the Stenode Radiostat invented by the British scientist, Dr. James Robinson. Briefly, this invention accomplishes perfect reception of broadcast stations on such razor-sharp tuning that, in the case of one receiver which I have handled myself, any interfering station tuned to within not less than 100 cycles of the assigned frequency of the desired station can be cut out completely. And Dr. Robinson's ultimate aim is to produce a receiver with an acceptance band *a few cycles* only in width. This will permit of the erection of hundreds more broadcasting stations without creating mutual interference, or, alternatively, a vastly wider frequency band could be radiated by existing stations. That is the germ of the idea; it is not yet commercial as far as broadcasting is concerned.

So much for the technical problems of television. Now for a few general comments.

Nobody seems to know yet what standard of perfection will be required of television. I have talked with all the leading workers in Europe and in America, and all are at variance on this point. Baird seems to be satisfied with his present limited achievements. Karolus recognizes the (*Continued on page* 660)

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need for vast improvement. Dr. Alexanderson thinks that a limited form (not necessarily the present limited form) of television will do, while Dr. Ives agrees with me that television will eventually have to be capable of doing all that the home movie can do, both as to scope or field of view, size of image, and comfort in viewing in the image. That we shall ultimately get the latter is certain, but I refuse to attempt to prophesy *when*.

Many people express doubt as to whether the public wants television in the home at all. At present the radio is left on and each member of the family continues to occupy himself or herself by talking, reading, sewing, etc. The music is there simply as a background; nobody gives his full attention to it except when something highly interesting or important is on. Now, if you add television, i.e., sight, to the present sound, it means that those who want to participate in the entertainment must cease all other occupations and concentrate with both eyes and ears. I can't see that state of suspended animation lasting long in the average home.

There is, of course, a definite field for television, projected on to a full size motion picture screen, in the movie theatre, where it could portray spot news events and thus supplant the present news reel. Or the physical distribution of copies of films could be eliminated by running off a film at a central transmitting station and feeding subscribing theatres by television methods.

I am continually being asked when all these things are going to be possible, or even when a real start will be made to give some form of television to the public. Here is my answer.

Looking at the thing in its true perspective we must regard present achievements in television, and the methods by which they are achieved, as merely a preliminary, and very elementary examination of the subject, and of the problems involved. Call them crude laboratory experiments if you like. They have served their purpose. Unfortunately too much publicity has been given to them, and the public has been misled into believing that the ultimate aim has been achieved, and that apparatus for the home can be supplied *now*.

The next phase is exemplified by the fact that the entire television staffs of the General Electric and Westinghouse companies have been transferred to the R.C.A. Victor plant at Camden, N. J., where they are busily and silently engaged behind locked doors. That there is some significance in this move may be adduced from the confident statements made by R.C.A. executives of late, and by the strong emphasis on television in connection with the new $250,000,000 radio city which is being planned by the R.C.A., N.B.C. and Rockefeller interests. Merlin Hall Aylesworth, president of the N.B.C., tells me that the project is being built round television.

We are told that this gigantic new radio city will be ready in three or four years' time, so we may logically assume that by that time television will have been so far advanced by those now working on it that it will be ready for the public. Even then it is not likely to be ready in the perfect form which I have outlined in this article, but at least it will have gone a long way towards it, and it will be presentable in some form acceptable to the public.

That television in its present crude and limited form is not acceptable to the *general public* is evidenced by the fact that attempts which have been made, both in this country and in England, to sell commercial televisors have failed ignominiously. The reason is not far to seek. There is definitely no entertainment value in the present image. For the experimenter the story is a different one. He requires no entertainment value and is quite content to experiment with terminal equipment.

But the day will come when televisors will be as popular in our homes as radio sets are today. A television industry will grow to the proportions of the present radio industry. Meantime, with the aid of a little more moderation in television publicity, we may be enabled to possess ourselves in patience, secure in the knowledge that pioneer work is being done, and that we shall ultimately get what we have been promised.

The Junior Radio Guild

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Thus, in multiplying 95.5 × 3.63 we find that the slide is to the left; the number of digits in the two numbers are respectively 2 and 1; their sum being 3, we have the answer in three places as 346.

2. When the slide is to the right, the number of digits in the answer is one less than the sum of the number of digits of the two numbers. Thus, 255 × 315 = 80,000.

b. For division:

1. When the slide is to the left, the number of digits in the answer is the difference of the number of digits of the two numbers. Thus, in dividing 35.5 by 7.3, the slide is to the left; the difference of the number of digits of the two numbers is 1, we have the answer 4.88.

2. When the slide is to the right, the number of digits in the answer is the difference of the number of digits of the two numbers, plus one. Thus, in dividing 65 by 4.35, the slide is to the right; the difference of the number of digits of the two numbers is 5 plus 1 gives the answer as 15.

(*Continued on page 662*)