Mar.—Apr.

TELEVISION News

HUGO GERNSBACK Editor

ARTICLES BY

Dr. E. F. W. Alexanderson
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Laurence M. Cockaday
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D. E. Replogle
Philo T. Farnsworth
Dr. Fritz Noack
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50¢

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Vol. I

TELEVISION News

No. 1

HUGO GERNSBACK, Editor

H. WINFIELD SECOR, Managing Editor

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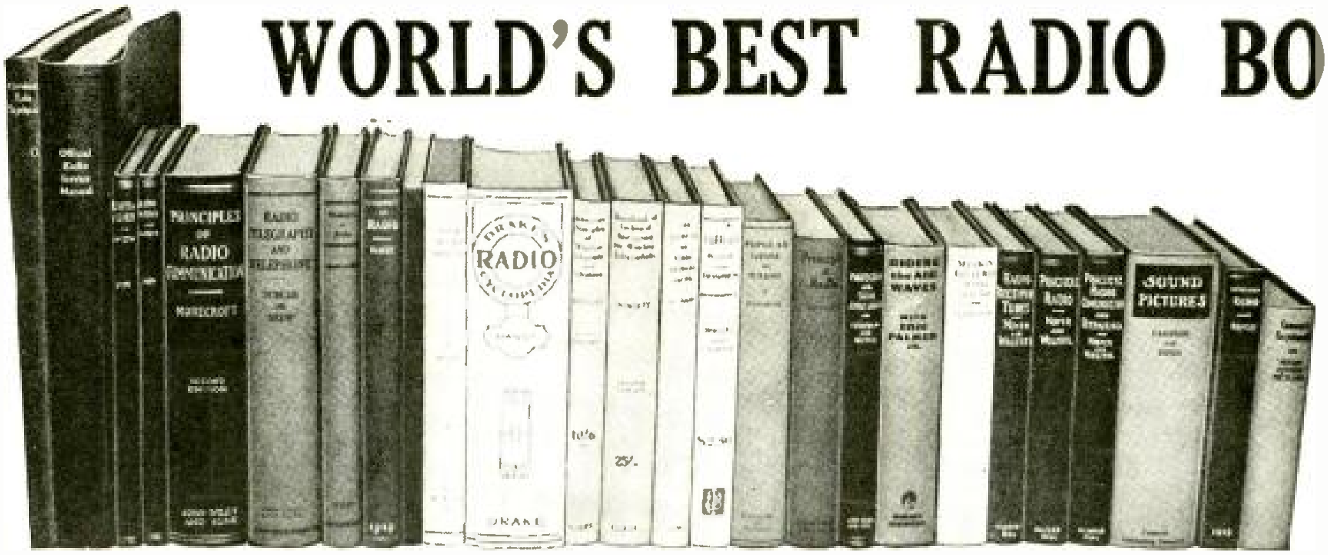

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PRINCIPLES OF RADIO COMMUNICATION, by J. H. Morecroft, Prof. of Electrical Engineering, Columbia University. Cloth covers, size 9½x6", 988 pages. Profusely illustrated. Price **$7.50**

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RADIO TRAFFIC MANUAL AND OPERATING REGULATIONS, by R. L. Duncan and C. E. Drew. Flexible covers, size 9x6", 186 pages. Price **$2.00**

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This is a well illustrated and intensely practical handbook for all radio service men and operators, as well as set builders and testers. Some of the practical problems illustrated and discussed are, interference and noise problems—how to locate and remedy them; antenna circuit troubles and their effect on radio; batteries, chargers and eliminators.

DRAKE'S RADIO CYCLOPEDIA, by H. P. Manly. Cloth covers, size 6x9", 1035 pages, profusely illustrated.
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This massive cyclopedia covers radio apparatus—its operation and maintenance, the various subjects being alphabetically arranged. There are 1735 subjects in alphabetical order ranging from A-battery to zero-beat. This volume contains 1110 illustrations, diagrams, etc. There are 411 illustrations and articles on the building and designing of radio sets, alone; 110 articles with 383 illustrations on the methods of repair, service and adjustment of radio sets.

S. GERNSBACK'S RADIO ENCYCLOPEDIA, by S. Gernsback. Stiff leatherette covers, size 9x12", 168 pages, profusely illustrated.
Price **$1.45**

Radio apparatus, inventors and terms are all illustrated and described in this remarkable book which required the efforts of several engineers in its compilation. The subjects are alphabetically arranged and the illustrations are especially fine and clear.

TELEVISION TO-DAY AND TO-MORROW, by S. A. Moseley and H. J. B. Chapple. Cloth covers, size 8x5½", 130 pages, profusely illustrated.
Price, prepaid **$2.50**

This up-to-the-minute work on television describes in detail the apparatus used by Baird. The student will learn all about scanning discs; the best type of motor; reverse defects and how to overcome them; isochronism and synchronism; various ways of synchronizing the receiving discs; photocells and neon tubes; radio receivers for television signals; noctovision.

SOUND PICTURES AND TROUBLE SHOOTER'S MANUAL, by Cameron and Rider. Cloth covers, size 8x5½", 1120 pages, profusely illustrated. Price **$7.50**

This useful volume will appeal to all radio as well as "talkie" trouble-shooters. The first chapters deal with fundamentals of electrical circuits, including Ohm's law, A.C. and D.C. circuits, rectifiers, amplifiers, mixers and faders; various types of loud speakers and how to arrange them; photocells; electric motors; various types of talkie projectors; also commercial amplifiers with diagrams are given.

RIDING THE AIR WAVES, WITH ERIC PALMER, JR., by himself. Cloth covers, size 7½x5½", 328 pages.
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Short wave fans cannot miss reading this highly entertaining and informative book which tells the story of youthful Mr. Palmer and his remarkable achievements in amateur radio. "Around the World with 5 Watts" and many other interesting subjects appear between the covers of this book.

A POPULAR GUIDE TO RADIO by B. Francis Dashiell. Cloth covers, size 5½x8½", 286 pages, profusely illustrated.
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The author starts off with an excellent section on electricity and magnetism; the use of radio aerials and grounds; the fundamental principles of radio the electron tube and crystal rectifiers—how they work; the principle of radio amplification; radio inductance coils and condensers; fundamental radio receiving circuits; electrical reproduction of sound; the atmosphere and radio phenomena, etc.

RADIO VISION, by C. Francis Jenkins. Cloth covers, size 9½x6", 111 pages, profusely illustrated.
Price, prepaid **$1.25**

A beautifully printed and interesting illustrated history of transmission of images by radio; particularly covering the apparatus and successful demonstrations of the Jenkins system. Other apparatus illustrated and discussed are the Braun tube receiver; the R.C.A. Photo-radio apparatus; the A. T. & T. Company system; and the Belin machine.

RADIO MOVIES, by C. Francis Jenkins. Cloth covers, size 9½x6", 111 pages, profusely illustrated.
Price, prepaid **$1.25**

An absorbing history, handsomely illustrated, of the Jenkins system of transmitting and receiving movies "via radio." One of the chapters gives constructional details and drawings for building your own Radiovisor or machine for making the radio movies visible in your home. Diagrams of amplifiers are given, with some other very valuable information.

RADIO PUBLICATIONS

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TELEVISION News

VOLUME I NUMBER 1

HUGO GERNSBACK, EDITOR
H. WINFIELD SECOR, MANAGING EDITOR

The Television Art

By HUGO GERNSBACK

DESPITE the many advances made in television during recent years, it is felt in many quarters that the art of television has been, so far, somewhat of a disappointment to the industry. The chief reason for this is, probably, to be found in the impatience of the radio industry, which has been accustomed to sudden advances in its own technique, and because the general public has not jumped immediately with both feet into television.

In the radio industry, when broadcasting finally came along, we had a somewhat different situation. Here the radio art was ready, and it had advanced sufficiently so that, when the public finally stampeded into radio, the industry, new though it was, was more or less prepared. All a man needed to do was to get a cheap crystal set; and he could listen in to his heart's content and receive radio programs galore. In television this is not the case and, although there are now over twenty-seven television stations in the United States broadcasting regularly, it is not quite such a simple matter to "look in" as it was in 1921 to "listen in". Up to now, it has been necessary to have a motor-and-disc arrangement; and the matter of synchronizing the disc, in order to enjoy a television program, is not so simple.

However, I am most confident that this situation will be remedied very shortly. The fact remains that there is such a thing as television; that there are a number of stations broadcasting television now daily; and that we have some excellent means of receiving these programs!

A complicated art, such as television, does not grow by leaps and bounds overnight, and it takes time to accomplish real results. Yet, crude as the present state of the art is, fair results have actually been achieved. During the latter part of January, for instance, I was sitting in an apartment on Riverside Drive, where a well-known television firm has installed three television receivers, all of which were running simultaneously from a single aerial. During that evening I witnessed excellent images from the following stations:

The Jenkins Television Station W2XCR at Passaic, N. J., broadcasting motion pictures which came over remarkably clear, if you except some heavy static discharges that, once in a while, marred the pictures.

Second, but with quality not as good, was W2XR, the Hogan station, broadcasting silhouettes from Long Island City.

The third was the N. B. C. Television Station W2XBS, in Manhattan, which broadcast a card on which were shown the initials of the corporation, as well as the call letters of the station. Results, just fair.

This result can be obtained by anyone any night, not only in New York City, but in many sections of the country. The equipment necessary, of course, is a good short-wave receiver and a television receiver (televisor), such as are now offered commercially.

It is admitted that we have as yet quite a stretch to cover before we will be enabled to push a button and "look in" on any program that is on the air. Yet an excellent start has been made; and the fact that there are now over twenty-seven stations broadcasting regularly should be indication enough that the new art is being taken more seriously, and that it is only a matter of time before the public will demand complete radio sets embracing the "visible" as well as the audible programs.

Until that time, however, I am quite certain that television will be mainly for the experimenter. I predict that, even during this year, an increasing number of firms will put out television parts of all sorts, making it more and more easy for the experimenter to get good results. Nor will the millions of radio receivers which are now in the homes of radio owners be scrapped for a long time to come. In the meanwhile television promises to be a real paradise for the experimenter who will "make his own," just as he built his radio sets between 1921 and 1927. History in this case is sure to repeat itself. At the present time, even the synchronization bugaboo is no longer taken seriously; because several companies have already solved the problem in such a way that it is no longer necessary to correct the speed of the disc manually, in order to keep the received images from "drifting".

As I have said many times before, in published articles, I do not believe that the rotating disc will finally prevail. Even as this is written, a number of firms are working on electronic tubes, in which the image will be automatically reproduced on one end of the tube, where it can be seen or otherwise projected upon a screen. And, though these tubes in the beginning will no doubt be rather expensive, the time will come when they will sell for little more than a few radio tubes cost today. It should be remembered that, when the first vacuum tubes came out, they sold as high as $12.00 apiece; while the same tubes can be had today for 30 cents apiece. Of course, once electronic television tubes have been perfected, immense strides will be made in television. At the present time, it is true, these electronic tubes produce only a rather small image; but, as the art progresses, there is no doubt that pictures a foot square or more will be readily obtained.

It has also been charged, in many quarters, that some of our great radio corporations are deliberately holding back television, and are jealously guarding whatever improvements are made, because these large firms naturally wish to come out with a complete set that can be sold ready-made to the public. Some of these charges are probably true.

I believe this to be a most short-sighted policy, because it is leaving the radio experimenter out of the picture. Yet everyone knows that, the more people who are working on an art, the more rapid the progress will be in the end. Many improvements in radio have been due to experimenters who started in in a small way and, later on, became outstanding figures in radio. We need only mention DeForest and Armstrong among those who have contributed tremendously to the radio art.

And this is one of the reasons for bringing into life TELEVISION NEWS which, I hope, will be a factor in the new art as it progresses. Up to the present time, there has been no regular periodical in this country to describe accurately from month to month the advances in television. It will be the mission of the new magazine to portray television from each and every angle and to show the reader what work has been done, not only in this country, but the world over. And I sincerely believe that the time is ripe to launch a magazine on television at the present time. The next two years may possibly prove to be the most important in the life of the new art; and, the more experimenters and the more television fans who become interested in the art, the quicker it will advance and the sooner it will be put on the stable basis which it deserves.

To this purpose I am dedicating this new publication, and the future will demonstrate the correctness of the assumption.

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THE NEXT ISSUE COMES OUT APRIL 15TH

And What of Television?

One of America's foremost radio engineers, Dr. Alfred Goldsmith, here tells us what he thinks about the future of Television. He discusses the three principal methods used for receiving television images and some of the interesting problems yet to be overcome, before the new art emerges from the laboratory to commercial practicability

Alfred Norton Goldsmith has, since his freshman days at the College of the City of New York—where he graduated in 1907, been keenly interested in radio. He has done much original research work and is the author of many books on the theory and practice of radio. During the World War, both the Army and Navy found his instruction invaluable. From 1915 to 1917, he cooperated with Dr. Alexanderson, of the General Electric Company, developing vacuum tube radio telephone equipment. Since the advent of broadcasting, his success, due to his brilliant mind and keen analysis of the problems of radio, has been meteoric. He has served as President of the Institute of Radio Engineers. Now as Vice-President and General Engineer of the Radio Corporation of America, as well as one of the recognized outstanding authorities of radio in the country, he is particularly well qualified to give some sound comments on the nearness, commercially, of television.

By Dr. Alfred N. Goldsmith
Vice-President and General Engineer,
Radio Corporation of America

IN every discussion between radio men nowadays, someone in the group comes out with the inevitable question: "And what of television?" Usually, the questioner wants to know what has been accomplished so far, and what are the prospects for acceptable television in the future.

Television of today is a purely experimental art. It is in the laboratory, and that is a good place for it at present. The television egg needs an incubator like the research development laboratory for another year or two before it can be expected to hatch out a healthy fledgling.

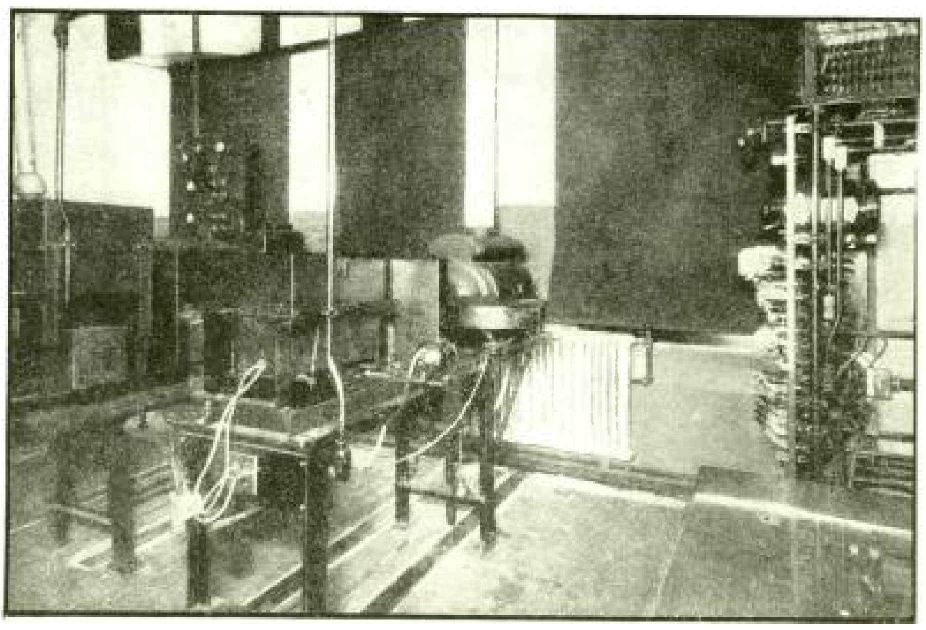
Three Groups of Receivers

Television receivers which have been demonstrated up to the present fall into three main groups. One group is arranged so that the looker (who is the equivalent of the broadcast listener) sees a picture a few inches square through an enlarging lens. The picture is dim, has pink highlights and fairly black shadows, has a certain amount of flicker, and is produced by a receiver containing a motor and scanning disc. The scanning disc is generally a circular sheet in which a spiral series of holes has been punched; a neon or gas-filled lamp of the plate type is used in this case. These plate type lamps have a uniform glow over a surface an inch or more square. The scanning disc enables only a small section of this plate to be viewed at any time, although permitting all parts of the plate to be viewed in such rapid succession that the looker gets the impression that he is viewing the entire plate. The magnified image produces the television image provided the neon lamp is turned on and off in just the right way by the incoming television signals.

In the second type of equipment, the projected picture is a fraction of an inch in area. Here, too, a neon lamp is used, but in this case, it is of the so-called crater type. That is, a small intensely bright and glowing spot of light is produced in one of the electrodes through special internal arrangement and design of the tube. Lens discs or perforated hole discs are used in this case as well for "scanning" the picture.

Television Images Six by Seven Feet Produced

The third type of equipment, which has been used primarily for theatre demonstrations, has produced a black and white picture as large as six feet by seven feet. The illuminating source here is an arc lamp, the light from which is modulated or controlled



Television studio of the Westinghouse Electric & Mfg. Co., at Pittsburgh, Pa., showing the switchboard, movie transmitter and stereopticon slide machine.

TELEVISION?

by a so-called Karolus cell. A lens disc or a mirror drum or other equivalent draws out the light spot into the television image.

In all these cases, it is significant that there is a considerable amount of rotating machinery. It is also a fact that the detail which pictures of this sort can present is very limited in the present state of the art. In fact, the head and shoulders of a single person in a close-up view is about the limit of their capabilities, which thus fall far behind those of home motion pictures, not to mention the still more elaborate motion pictures shown in the theatre.

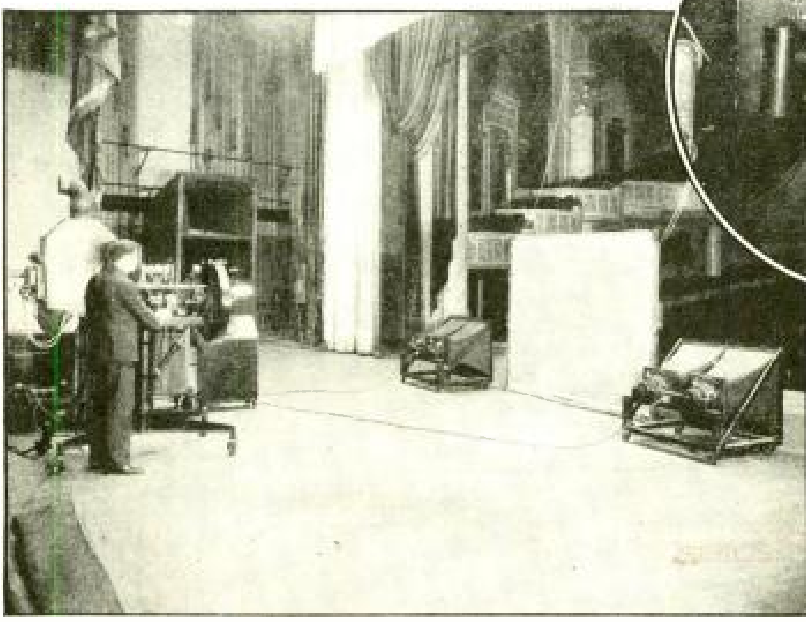
The equipment is not of a type which would be generally acceptable for use in the home. The pictures produced are not sufficiently bright nor detailed, nor yet steady enough in position and sufficiently free from flicker. They do not show enough subject matter to have continuing entertainment value. Unfortunately, the difficulties of the situation increase very rapidly as the detail of the picture is increased.

The laboratory engineers are working along a number of different lines. Some of them involve painstaking improvement of existing methods in various ingenious ways. Others involve more radical and novel methods of attacking the problem and these, too, show considerable promise.

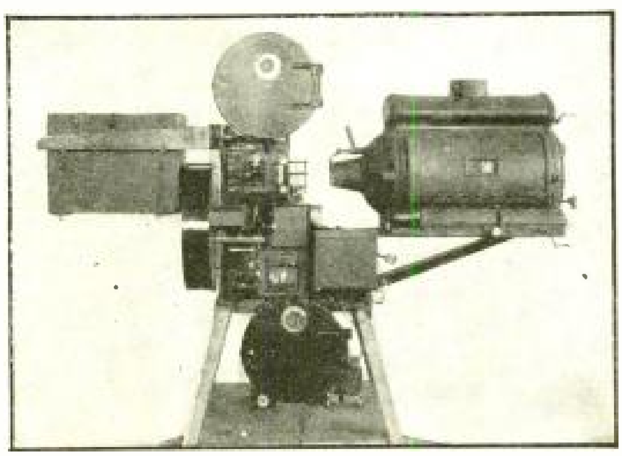
After the receiving equipment has been produced in satisfactory model form, there will still be many steps to take before commercial television is with us on a nation-wide scale. Studios must be established; actors and actresses who are capable of facing the televisor must be found. Studio backgrounds and stage sets must be designed, methods of syndicating the programs all over the United States must be contrived, and transmitting stations, strategically located in all parts of the United States, must be built—and paid for. The question of engineering design the economics involved in all this is serious, and it is doubtful whether we may hope for television on a nation-wide scale, and of acceptably high quality, within the next few years.

There are two optimistic features about all this. In the first place, radio distributors and dealers need not worry about the effect of television on their business in the next few months, nor need the public concern itself with this matter. In the second place, it is possible to assure the public that the engineers are hard at work ingeniously contriving new devices and methods which, in the course of a few years, may be expected to place a marvelous new service at the disposal of the public. When that day comes, the previous limitations of our human senses will in large part have been removed by radio. With the human eye, one can see a face distinctly only over short distances, and one can hear a voice only in its immediate neighborhood. By means of radio television and telephony, men will be able to see and hear each other even though they are at the antipodes and the great bulk of the earth itself lies between.

The television and transmitter pick-up arrangement used by the General Electric Company.



Theatre television projector developed by Dr. Alexanderson of the General Electric Company.



A movie machine equipped for transmitting talking movies at the Westinghouse Electric & Mfg. Co.

New Field for Tubes

The advent of commercial television will open new fields of interest for the public and extend the radio merchants scope. The apparatus will, in all probability, be separate from the present radio set which will mean a new radio tube market.

(*Continued on page* 77)

The Radio-Controlled TELEVISION PLANE

Tomorrow we shall find a new order of things if a war should occur. Pilot-less Radio-controlled planes fitted with "Television" eyes will flash back what they see to headquarters.

By HUGO GERNSBACK
Member of American Physical Society

ON a recent trip to Washington the writer visited the laboratories of C. Francis Jenkins, the well-known experimenter of international reputation. It was Mr. Jenkins who perfected the shutter that made our present-day motion pictures possible. He was paid over $1,000,000 for this invention.

Of late he has been experimenting with television and has already obtained astonishing results. At the time of the writer's visit Mr. Jenkins demonstrated his television machine before a number of Government representatives, including the Chief of the Signal Corps. At that time the writer actually saw his own waving hand, projected by radio over a distance of some thirty feet, the shadow of the waving hand being transmitted to a screen at that distance. Every motion made by the writer's hand was faithfully reproduced on the distant screen. Opaque substances, such as a cross, knife, pencil, etc., were also successfully transmitted and projected by the Jenkins Television machine.

It is the writer's opinion that, within two or three years, it will be possible for a man in New York to listen over his radio to a ball game 500 miles away and see the players on a screen before him at the same time. Whether it will be the Jenkins machine or some other machine that will achieve this result is of little consequence. The main thing is that experimenters all over the world are working frantically on television and sooner or later the problem will be solved.

An entirely new age will then be opened up and it is not necessary for the writer to expatiate at length on this phase; as it has been exploited by him in his past writings and by others for some time.

In this article, we shall concern ourselves with the radio-controlled television plane, which will come into being immediately the minute the television problem is put on a practical basis. It should not be construed that the radio television plane is merely a monstrous war machine, but it also has its uses during peace time, as will be explained. At the present time it costs great effort, time and aviators' lives in order to train our perfect flyers.

A radio-controlled airplane has already been demonstrated by the French and American Governments, and it flew for a lengthy period without anyone on board. The entire control was from the ground while the machine was aloft. The plane arose, cut figure eights, volplaned, ascended, descended and went through all the ordinary evolutions; the control being effected entirely and solely by radio. The same kind of a machine is also being experimented with successfully by our own and several other Governments, and it may be said therefore that the radio-controlled airplane has passed the experimental stages and has become practical and feasible for military use.

THE accompanying article appeared in the November, 1924, issue of THE EXPERIMENTER.

While at that time the ideas set forth therein might have appeared more or less fantastic, they are no longer considered so today. As a matter of fact, the radio-controlled airplane is with us today. Several of the leading governments have already in their possession airplanes that can now fly and stay aloft for any length of time, within reason, without a pilot or any human being on board.

The television adjunct will follow as a matter of course.

Most of those who read this article will live to see a television-controlled airplane a reality during the coming years.

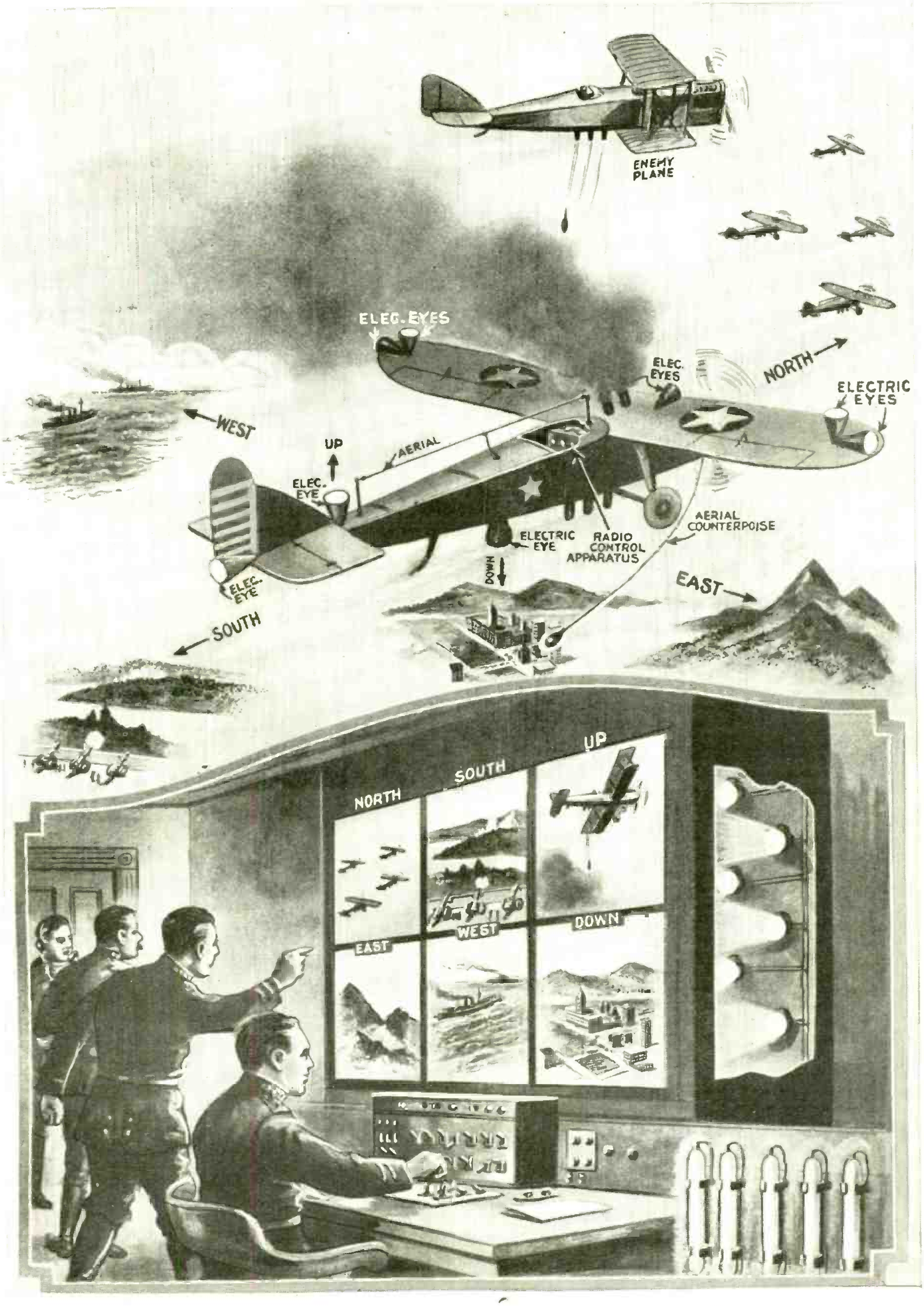
But the great trouble with radio-controlled airplanes is that the operator must see the plane. If his machine were to make a landing at a great distance he might land the airplane on top of a building or in a river, or it might collide with a mountain.

A Pilot-less Plane Which "Sees"

Imagine now a radio-controlled pilot-less airplane which is also equipped with electrical eyes, which eyes transmit the impulses—or rather what these eyes "see," by radio—to the distant-control operator on the ground. Our illustration on the opposite page, which shows a war machine, depicts this phase. Here we have a radio-controlled airplane equipped with a number of lenses which gather in the light from six different directions, namely, north, south, east, west, up and down. The impulses are sent to the operator on the ground, who has in front of him six television screens labeled "North," "South," "East," "West," "Up" and "Down." Each screen corresponds to one of the electric eyes attached firmly to the body of the airplane, as shown in the illustration.

Let us now see what happens. The airplane is started from the ground and is sent over the enemy territory. During every second of its flight the control operator, although 50, 100 or possibly 500 miles away, will see exactly what goes on around the plane, just the same as if he himself were seated in the cockpit; with the further advantage that, sitting before a screen, he can scan six directions all at once, which no human aviator can do. If, for instance, an enemy airplane suddenly comes out of a cloud and starts dropping bombs on our machine below, the control operator sees this enemy machine quicker 500 miles away, than if an aviator sat in the cockpit one-quarter of a mile away from or below the enemy bomber. The control operator will send a radio signal that will immediately discharge a smoke screen from his radio television plane, hiding his craft in smoke. He can also make it turn

(Continued on page 75)



The Pilot-less radio television plane, directed by radio; the plane's "eyes" radio back what they see.

The television cameraman at work, focusing his picture by means of the "monitor" view-finder, while checking on his signals by means of head-phones.

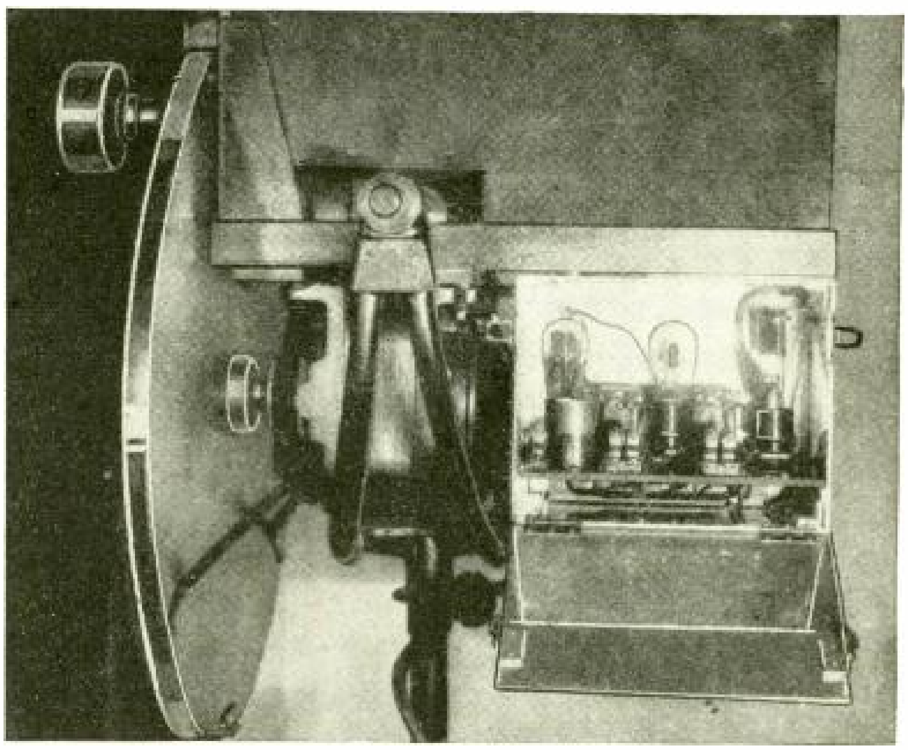
TELEVISI
A New Nut

The author of the present article is exceptionally well qualified, in the opinion of the editors, to tell us about the possibilities and desirabilities of TELEVISION. Mr. Lescarboura has a long acquaintance with the radio industry in its many phases and he has studied hundreds of new inventions and has written articles about them describing their details and merits. The author feels confident that we are on the very threshold of the TELEVISION era. Mr. Lescarboura is co-author with Dr. Alfred N. Goldsmith of the newest popular radio book, "This Thing Called Broadcasting."

As radio television or radiovision steps out of the laboratory and offers its wares to the public at large, the question of programs comes up for discussion. Heretofore, radiovision schedules have been purely of an experimental nature, or little more than an extension of laboratory practice for purposes of demonstration or checking up engineering progress. While some attempt has been made to sell *home radiovision* equipment, it must be admitted that the public has received no assurance of a satisfactory return on its investment by way of regular programs, fashioned to suit its tastes.

Just as the radio telephone became a commercial success only with the advent of organized broadcasting, which laid the foundation for the huge radio industry, so radio television must replace "haywire" transmission with regular and entertaining programs before it can begin its commercial career. Radiovision, heretofore engrossed in technical problems, must now turn to showmanship. This means the enlisting of more and a different type of personnel.

Engineers should not undertake to be showmen, any more than showmen should undertake to solve the technical problems confronting television. Showmanship requires a peculiar ability and training leading to the determination of just what audience should be reached, and how best to entertain all of them all the time. Unlike the subsidized opera, with its simple task of entertaining a few people bound together by similar tastes in entertainment, television, like radio, must cater to the widest known audience in the world—men, women and children in all parts of the country, all walks of life, rich and poor, rural and urban, cultured and ignorant. Television showmanship resolves itself in finding the common entertainment denominator, of this vast potential audience, and emotionally and intellectually stimulating, through the facilities at the command of television, the latent sensibilities of this audience; so that *lookers-in* will for the duration of the program leave their hum-drum existence and visit



Jenkins television camera opened, showing the self-contained amplifier.

ON PROGRAMS—

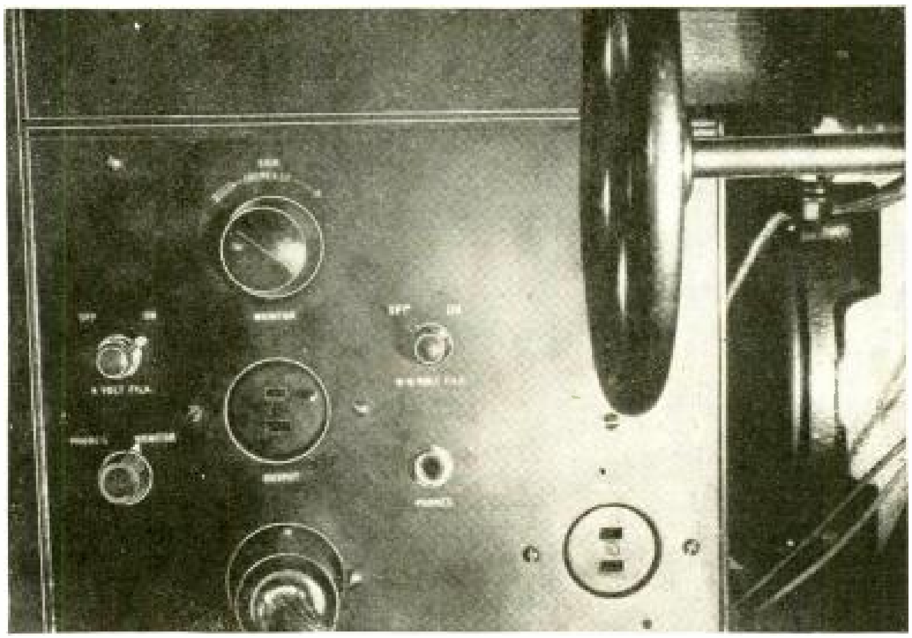
To Crack —

By AUSTIN C. LESCARBOURA
Mem. I. R. E., Mem. A. I. E. E.

the make-believe world of the television program, to awaken at the end with a start and the exclamation—"There was a show!"

The very difficult technique of television, whereby an animated image must be broken down into a limited number of pictorial elements for transmission, and these pictorial elements then reassembled and woven into a replica of the original image for proper reception, has advanced to the point where fair entertainment possibilities are in order. Radiovision broadcasters now have sufficient facilities at their disposal. The next step is one of masterly showmanship, whereby the utmost entertainment can be fashioned with the available tools.

Just as Ruth Draper presents an entire play with no scenery whatever and but a shawl or apron for costume, herself acting many characters, so too must our radiovision broadcasters develop a stagecraft that will provide real entertainment through the scanning disc. Of course, Ruth Draper's act is the culmination, the peak of perfection. But television can use the accumulated wisdom of the ages in making its programs.



Some of the details which the television cameraman must care for: a close-up of the control board of the latest Jenkins television camera.

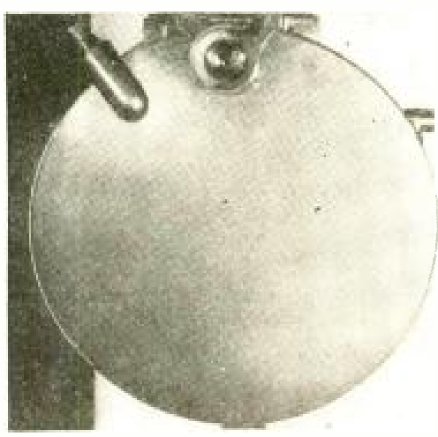
What Television Has On Hand

What does our television inventory disclose. Well, we have: (1) the film pick-up, which is extensively employed today; (2) the "flying spot," which is popular in televising close-ups in the studio; (3) the television camera, the possibilities of which remain to be proved; and (4) the sound accompaniment for any of the foregoing. Let us analyze these in due turn.

The *film pick-up* has met with widest favor among television broadcasters because it reduces the program problem to its simplest terms. With the film pick-up, any standard film becomes television program material. However, some of our television broadcasters have employed the same reels over and over again for several years past; thereby negating all the advantages inherent in this method of pick-up.

Just as the phonograph and the automatic piano were the backbone of early sound-broadcast programs, so must the film pick-up be the mainstay of the television program for some time to come. It may serve to keep the transmitter on the air during the daytime, filling in many hours; for at present there is little money with which to buy television talent. But films cannot be used indiscriminately.

Until now, television broadcasters have failed to display any showmanship with regard to films; rather, they have employed films purely for technical purposes, with the result that certain features have appeared over and over again until the lookers-in have tuned out in sheer disgust. Also, television broadcasters have not selected film features with any thought of entertainment value. Thus film presentations have been, on the one hand, too simple to offer any entertainment beyond primitive curiosity which, once appeased, is no more; or they have been too intricate to be satisfactorily reproduced with the average equipment available. Excellent film stories have been broadcast without any editing; resulting in the attempted transmission of moonlight scenes, which appear as a perfect mess on the home screen.



What it looks like to be televised: the Jenkins television camera as seen head on, showing lens at top of scanning disc casing, and monitoring neon lamp casing at left.

Obviously, television broadcasters must select their films with great care, both as regards their pictorial and their entertainment possibilities. Every foot of film should be "previewed" under typical television conditions, before being placed on the air for the lookers-in at large. If this rule is observed, there is no objection to the film pick-up method; especially since many films made especially for television may come into extensive use.

Recently, television broadcasters have been handling standard 35-mm. motion-picture film with real success.

Scenes including half a dozen actors, with typical backgrounds, are being handled with fair detail. It is truly amazing what can be done even with the 48-line, 15-pictures-per-second scanning system, as well as the 60-line, 20-pictures-per-second system, when refinements and improvements are incorporated throughout the pick-up, transmitter and receiving functions.

Sound Accompaniments Help Greatly

At this point, it is well to point out that the sound accompaniment is highly desirable, although not absolutely essential, in attaining the necessary degree of entertainment value for public acceptance. Whatever television presentations lack, by way of detail or understandability, may be more than made up by the sound accompaniment. In fact, the sound accompaniment may be the real basis of the program, with the pictorial feature as an incidental detail.

For instance, many of the present-day sound-broadcast features, now presented for the "blind" audience, may without change be admirably supplemented by television broadcasts for those who wish to "see" as well as "hear". The pictorial supplement may be a close-up of a speaker or artist, or again a living tableau or cartoon carrying out the theme of the musical selection. Indeed, such organizations as Publix-Paramount, in their stage presentations which play the motion-picture theatres, have done no more than stage a visual representation of the music, so that by either dance or pantomime the music is visually augmented.

The television presentation supplementing an already scheduled radio program would do the same thing, minus the element of color, and be either photographed for transmission or staged in a small studio. The clever publicist may yet work out ingenious commercial "credits" or sponsorship announcements in pictorial form, without serious objections on the part of the lookers-in.

In the case of the film pick-up, the sound accompaniment is frequently included by the use of synchronized discs. The sound values are amplified and sent over a wire line to the radio-telephone transmitter, usually operating on a broadcast wavelength. At the receiving end, the usual broadcast receiver tuned to the sound channel receives the sound accompaniment; while a short-wave receiver and televisor picks up the pictorial counterpart.

Methods in the Studio

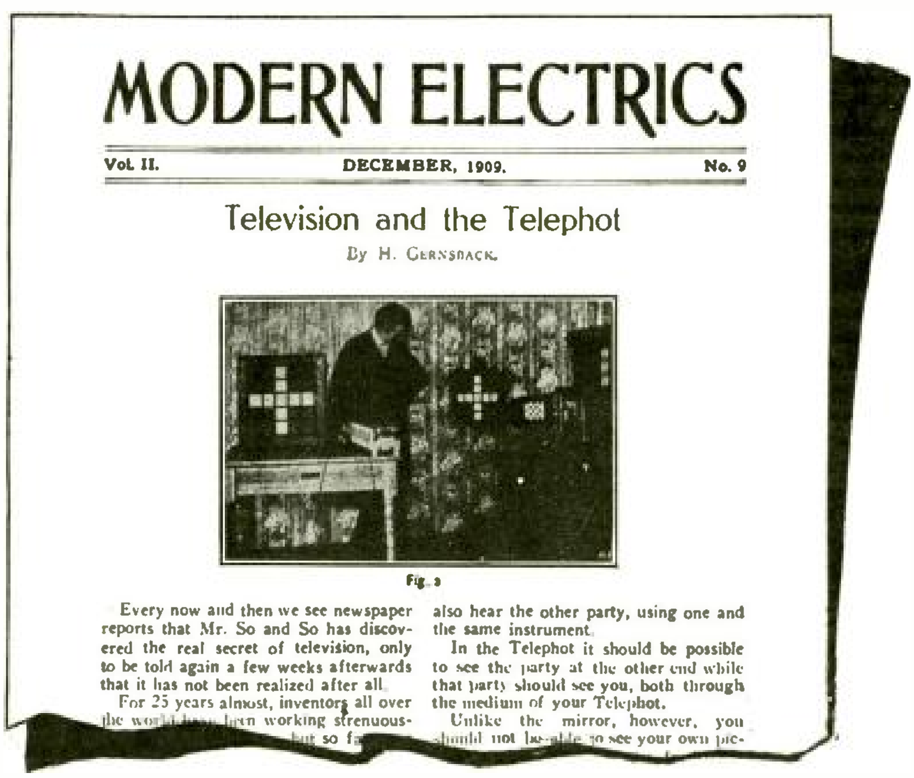
The "flying-spot" technique covers scanning by means of a spot of light, which sweeps the subject in horizontal lines. The original arrangement consisted of a frame carrying a number of photoelectric cells, against which pressed the subject to be scanned by the beam of light projected by a scanning system back of the frame. The inflexible arrangement of the photo-cells did much to make for uninteresting pictorial effects; just as flat lighting makes for dull photographs. More recently, the "flying-spot" technique has been materially enhanced by the use of adjustable photoelectric cell units which may be placed at any height, distance or angle with respect to the subject; thereby making it possible to pick up the reflected light in a more artistic manner, similar to trick lighting in photography. Also, the subject has greater freedom of action, no longer being obliged to press up against a small frame carrying the photoelectric cells. A group of persons, and even a simple background, may be picked up by the latest "flying-spot" technique. The scanning beam may be adjusted by means of the mirrors, which reflect it in any desired direction.

For televising personalities, such as speakers and artists, the flying-spot technique is rich in possibilities. The subject can be brought to the studio to face the flying-spot. If a sound accompaniment is permissible, the microphone may be placed nearby, to pick up voice or music. The flying-spot technique also permits televising such close-up studies as cooking recipes, simple sewing, household hints and so on; provided the necessary detail requirements are modest and within the scope of the 48-line or 60-line scanning systems now available.

Improvement of the Television Camera

The third method available to radio-vision broadcasters is the *camera pick-up* which, while relatively new, has made rapid strides during the past three months. Instead of actuating photoelectric cells by means of reflected light, as in the flying-spot, the camera method makes use of direct light focused by means of a lens upon a scanning disc, behind which is placed a photoelectric cell in a light-proof cabinet. The camera technique permits of televising subjects in broad daylight or in a well-illuminated studio, and therefore presents a greater field of action than that permitted by the flying spot.

Elaborate television cameras have been developed, although the theoretical possibilities of this method are not yet even remotely approached. The latest models make use of an ultra-fast anastigmat lens, a large scanning disc, a single photoelectric cell, a suitable "head" amplifier contained within the camera itself, a view-finder for monitoring the pick-up (a television lamp and the common scanning disc are employed), a battery box containing the necessary batteries and a control board. The camera is adjustably mounted so that it may be swung horizontally and vertically, as well as raised and lowered, to take in any desired scene. The operator



MODERN ELECTRICS

Vol. II. DECEMBER, 1909. No. 9

Television and the Telephot

By H. Gernsback

Fig. 2

Every now and then we see newspaper reports that Mr. So and So has discovered the real secret of television, only to be told again a few weeks afterwards that it has not been realized after all.

For 25 years almost, inventors all over the world have been working strenuous- ... but so fa...

also hear the other party, using one and the same instrument.

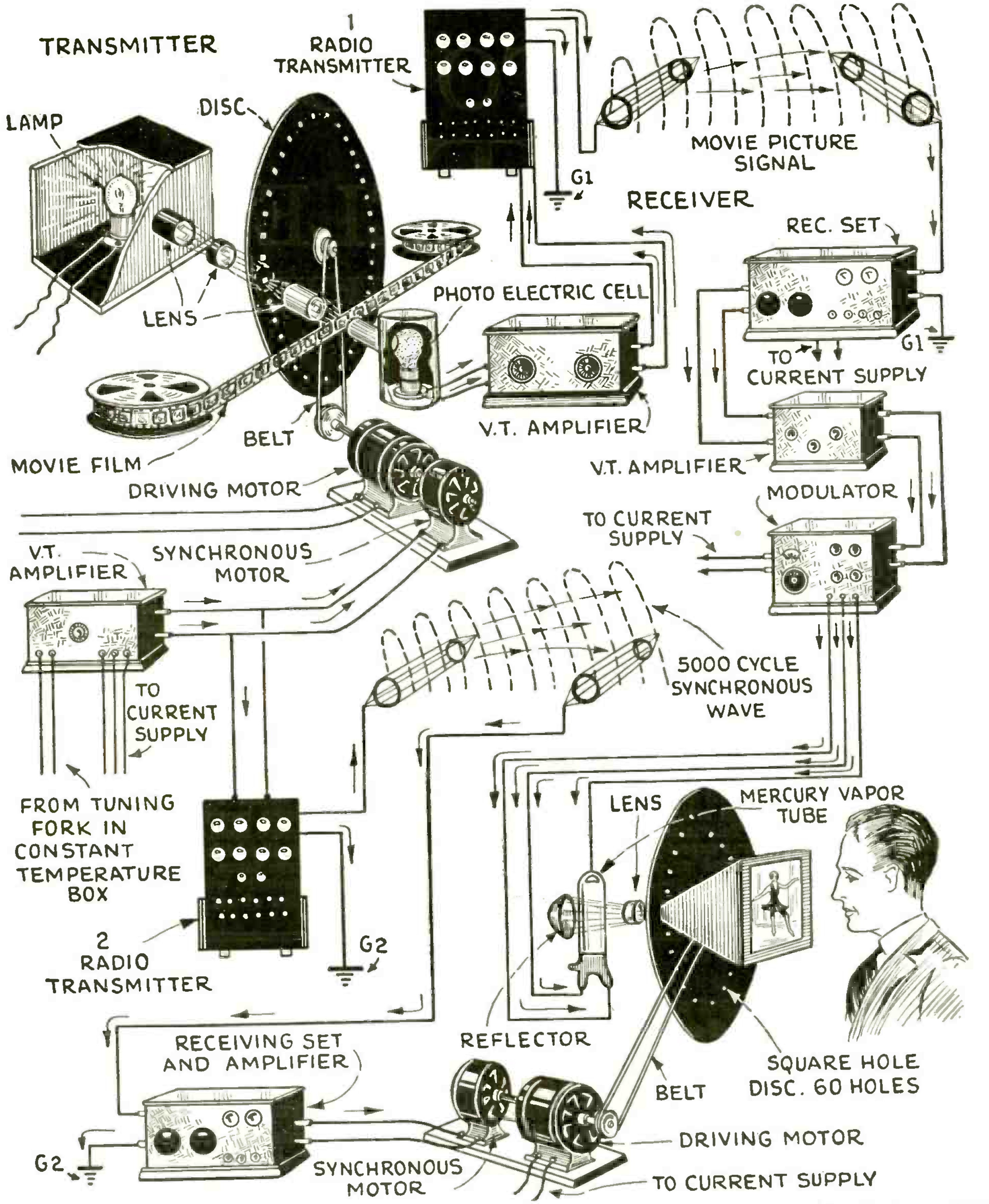
In the Telephot it should be possible to see the party at the other end while that party should see you, both through the medium of your Telephot.

Unlike the mirror, however, you should not be able to see your own pic-

"TELEVISION" COINED IN 1909

By Hugo Gernsback

Nearly a quarter century ago, 22 years to be exact, Hugo Gernsback, editor of TELEVISION NEWS, coined and first used the word "Television," as the page from "Modern Electrics" magazine here reproduced proves. At that early day, "Modern Electrics," of which Mr. Gernsback was editor and publisher, frequently contained articles on "Television." The astonishing thing is that the early writers and experimenters invented nearly everything we use today, except the fast-working photo-cells and neon tubes, which handicapped them and held back real working television at least twenty years. Nipkow could have demonstrated television 35 years ago, if he had had photo-cells and glow tubes which would respond fast enough. But they used the slow-acting selenium and that "wrecked the works," metaphorically speaking.



The Westinghouse television "movie" pick-up is shown at top of Diagram, while method of reproducing the movies is shown in lower right-hand corner of diagram. The transmitting and receiving scanning disc motors are "locked" by synchronizing signals transmitted from the No. 2 radio transmitter. The transmitter disc has a circle of holes and the receiver disc a spiral of holes.

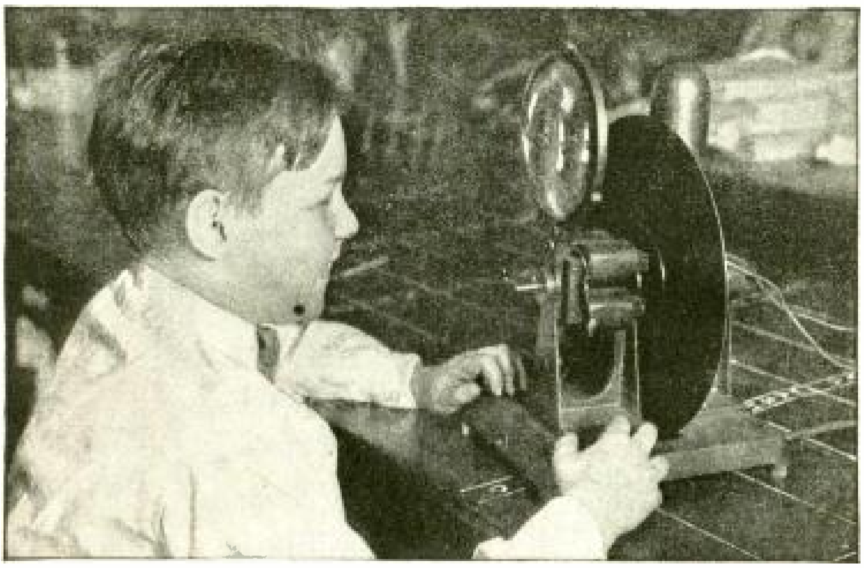
wears phones while operating the camera, to be sure that the camera is functioning properly, by listening to the characteristic television signal.

The camera pick-up offers no end of program possibilities for the television broadcaster. Not only is it more flexible for studio purposes, because of the general illumination and a larger available field of action, but it permits going out after suitable sub-

(*Continued on page* 70)

How to Build a Home Televisor

A BRAND NEW THRILL



Radiovision—pictures via radio—is simple with a properly engineered radiovisor and associated receiver and amplifier.

Especially prepared for TELEVISION NEWS
By H. G. CISIN, M.E.

SEVERAL months ago, the editor of TELEVISION NEWS sent for me and requested an article on "How to Build a Television Receiver". Since my previous experience had been largely confined primarily to ordinary radio work, it required some persuasion before I finally agreed to investigate the present possibilities of television from the standpoint of the home experimenter and set builder.

Television Now Practical

My preliminary researches revealed some extremely interesting facts. I found that television, in its present state of development, is indeed practical and very much worth while. Furthermore, I ascertained that there is really nothing complicated about it; since even a novice can construct a television outfit, which will be a source of immense pride, instruction and entertainment to him.

This does not mean that television has reached its final stage of perfection. We have been hearing about television for a number of years and, during all this time, tireless research workers have been devising cumulative improvements. While these developments have advanced the art rapidly, it is my personal opinion that the home experimenters are destined to play a most important part in bringing this fascinating form of entertainment to its ultimate perfection.

When I built my first cigar-box radio receiver in 1921 and tuned in music from station WJZ, I received a thrill which I shall never forget. This experience, however, was duplicated recently, when I finished the construction of my first television outfit and

EDITOR'S NOTE

The Editors of TELEVISION NEWS have frequently been urged to supply practical constructional articles on television apparatus. In order to meet this unprecedented demand, the editor commissioned Mr. Cisin to investigate the possibilities of home television and to prepare a series of articles containing complete working data on the construction of television equipment. Mr. Cisin, who is known to radio enthusiasts throughout the country, is the designer of over fifty different radio circuits. His interesting articles on home set-building have appeared in nearly every radio magazine and also in newspapers from coast to coast. The article presented here is the result of careful research. It contains just the information needed to assemble an excellent television receiver at a surprisingly low cost.

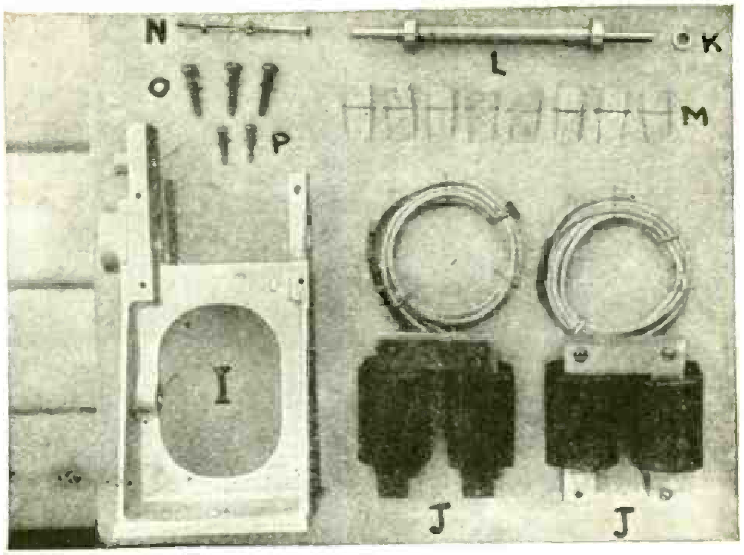
tuned in an interesting radio movie which was being transmitted over station W2XCR.

There are two essential elements for television reception, or radiovision, as it is sometimes called. These are a suitable short-wave receiver (used because television radio impulses are transmitted, in the United States, on certain allotted short wavebands) and a properly designed scanning mechanism or "radiovisor" capable of translating the amplified audio signals into pictorial form.

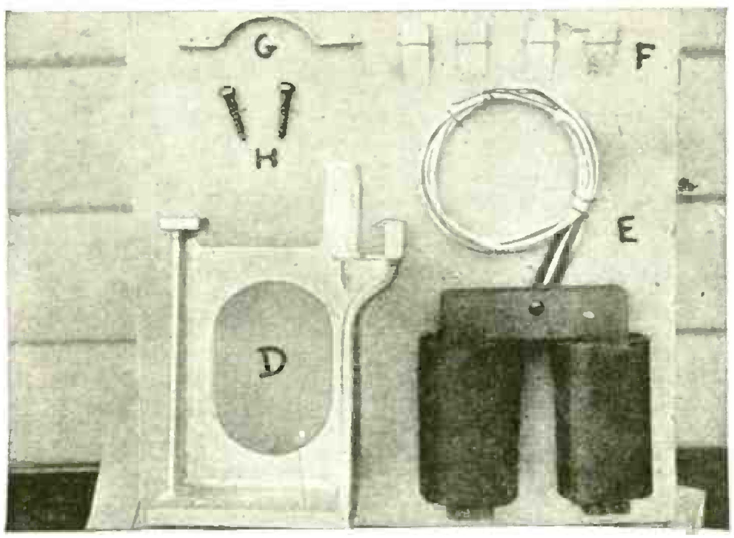
As regards the short-wave receiver, there is nothing startling in its design or construction. This is apparent to anyone who cares to study the diagram of a typical television short-wave receiver, as here presented. Most readers of this journal will experience no difficulty whatsoever in constructing such a receiver. For those who like to work from detailed instructions, I will present complete assembly and wiring data on an efficient television short-wave (tuner) receiver, in an early issue.

Of course, it is possible to purchase such a set completely assembled, if desired. The standard television short-wave receiver differs from the ordinary short-wave job in several important particulars. For one thing, the television receiver does not employ regeneration; as this would tend to produce excessive selectivity. Instead, it uses an extra stage of radio frequency to provide the additional sensitivity required. The television short-wave receiver must tune to 100 kc., instead of to the conventional 10 kc. waveband; a special band-pass filter is therefore necessary. It is obvious that shielding must be adequate and complete.

With respect to the audio amplifier, resistance coupling is essential; since it is necessary to pass a band of frequencies of from 15 to 30,000 cycles. A schematic diagram of such an amplifier is shown here.



Front bracket components, including ball-bearing shaft for scanning disc.



Rear bracket components, including rotor guard and bracket mounting screws.

Constructing the Scanning System

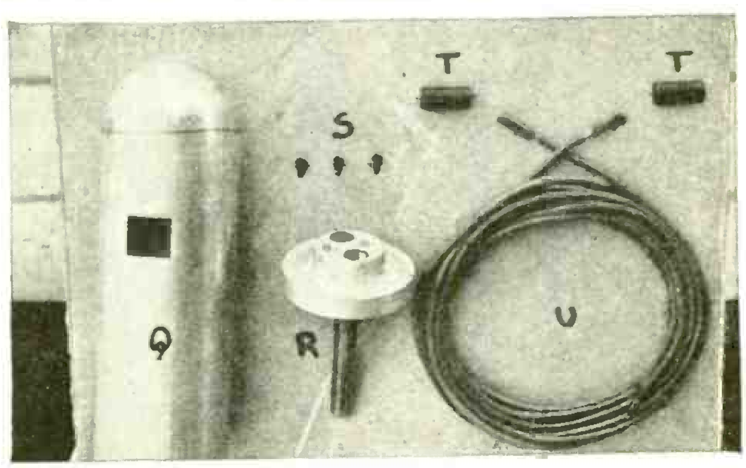
We now come to the construction of the all-important scanning system. Through the progressiveness and initiative of the Jenkins Television Corporation of Passaic, N. J., a complete home radiovisor kit is now available, which removes the last vestige of uncertainty, as far as the home constructor is concerned.

This kit can be assembled and wired by the average beginner in a few hours time. The kit contains all necessary parts, with the exception of the wood and bakelite for the platform or base. All parts are drilled and tapped, so that the work is merely a matter of simple assembly and wiring. The various components are shown in the accompanying illustrations; the details of assembly are also clearly illustrated but, for those who prefer to work from written instructions, complete directions are given.

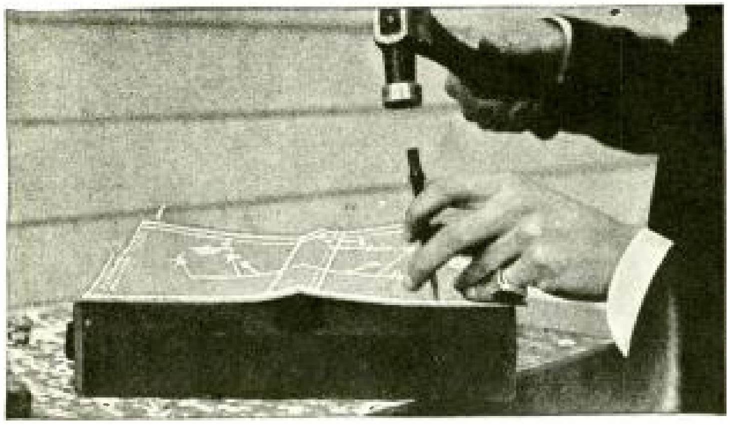
The first step is to cut two pieces of white pine measuring ¾x5x9 inches, as shown at "A", in the base drawing. The pieces should be carefully planed and perfectly square. Two additional pieces, measuring ¾x1¾x11⅛ inches, should also be cut, as shown at "B". Next, cut a bakelite strip measuring 2½x9x3/16 inches, and drill the necessary holes in the strip, as indicated in the layout drawing; thus obtaining the part shown at "C".

Assemble the platform by placing strips "B" on edge, parallel to each other; and laying across them the "A" pieces, allowing 1½-inch spaces between the latter. The pieces should be neatly and accurately fitted, followed by nailing in place. The bakelite piece is then placed across one end and screwed to the ends of the "B" strip; forming the control panel, as shown in the completed assembly view of the radiovisor.

The template, shown in another drawing, is placed on top of the platform, face-side up, making sure that the edge marked "front" faces the control-panel end of the platform. The edges of the platform should match the edges of the template, for accurate location of the holes. Next, prick-punch the points indicated on the template, remove the template, and



Lamp house components, including shield, socket, prong clips and conductors.



Using the template to indicate screw mounting holes and wiring holes to be drilled in platform.

drill the various holes as indicated. The platform is now ready for the subsequent mounting of parts and for wiring. A coat of shellac or varnish, at this time, provides an attractive finish and also serves as a protection against moisture.

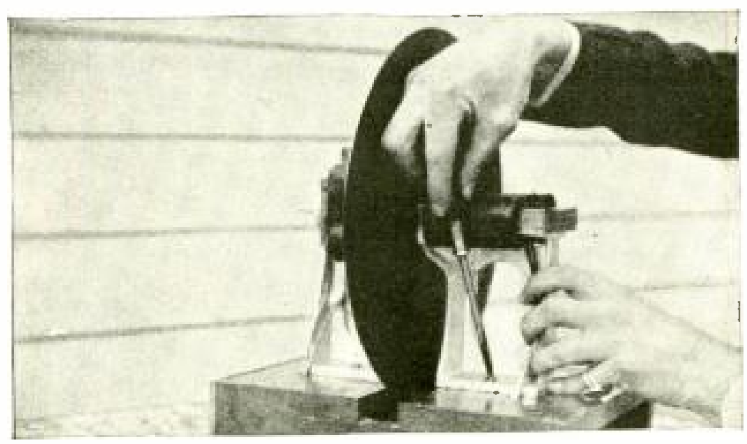
The rear bracket assembly is started next. The first step is to place the bracket upright on a table. The rear electromagnet is placed on top of the bracket, as shown in one of the illustrations, with the open end of magnet straddling center post of bracket. Next, place the rotor guard "G" on top and across the open end of the electromagnet core and align its holes with those in the pole pieces and bracket; slip through and tighten the screws. Secure the remaining magnet screw in place. Ascertain which two of the four wires of both coils lead out from the outside of each coil, and mark them "Outside"; while the wires leading from the inside of the coils are marked "Inside". This is to simplify subsequent wiring. Each coil should be pushed as far back as possible, snugly against the back or crosspiece of the core. Insert one wooden wedge between the inside of each coil, to hold the coils firmly in place. If necessary, drive the wedges home with a piece of metal and a hammer, *taking care not to damage the coils,* which must be wedged firmly to prevent noise when set is operating. This completes the rear-bracket assembly.

Front-Bracket Assembly

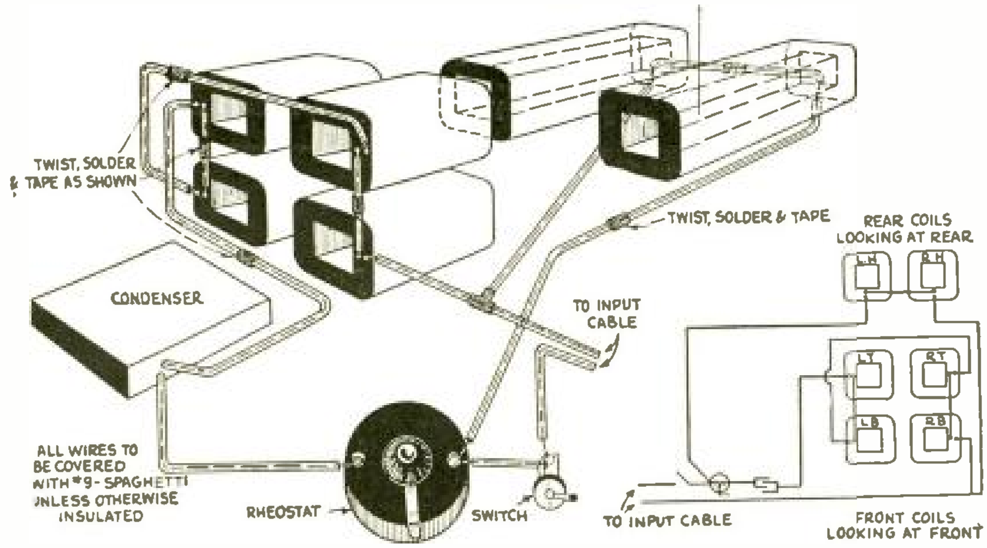
The parts for the front bracket assembly are shown in one of the illustrations. To begin the assembly, place the front bracket on its base, upright on the table as illustrated, and place one electromagnet against one side; noting that the open end straddles the rounded bearing-holder of the bracket. Keep wires or leads outside. Drive home three screws to hold the magnet in position, and do the same with the other magnet. It will be noted that the fourth hole in each electromagnet is without a magnet screw and, subsequently, takes the bearing clamping screw "N". The coils should be pushed as far back as possible, with wedges driven in to hold them, as explained for the rear-bracket assembly.

Now take the shaft assembly "L" in your right hand, holding it horizontal, with the *rounded end* of shaft to your left. Insert the rounded end of shaft and bearing through that end of front bracket which is slotted through to the bearing hole. Push the shaft assembly as far back as it will go; so that the ball bearing nearest rounded end fits snugly into the boss at the far side of the bracket. The boss is so formed that the bearing cannot be pushed clear through, except by sheer force, which must be avoided. Be careful not to hit against the coils while inserting the shaft assembly. If preferred, the shaft assembly may be inserted in place before inserting the coils on the front bracket.

The ball bearing should now be flush at both ends of the bracket. If the ball bearings fail to clear the first or slotted hole, insert a screw driver in slot and open it slightly to allow enough space in the hole. Now insert the bearing, tightening the screw "N" through the empty holes in the cores which are aligned with holes in slotted bracket arm. Apply the lock washer and nut on the screw, and draw them up tightly to hold the bearing in place. However, be sure to twirl the shaft while tightening up on the bearing, to avoid binding the bearing. It is very important that the shaft be free enough so that it can be spun with the thumb and the first finger. The front-bracket assembly is now complete.



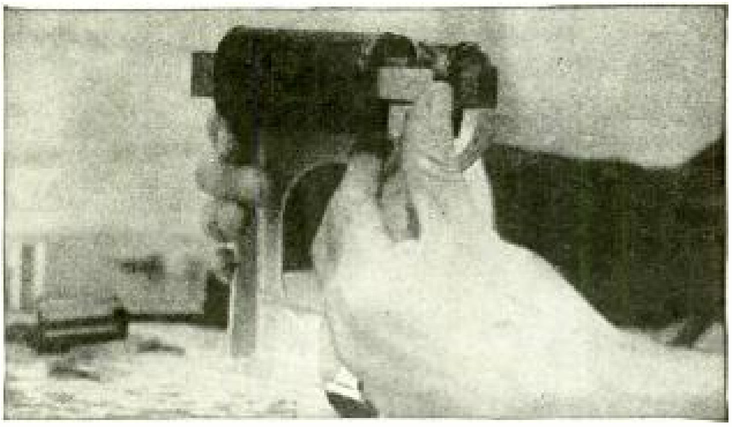
Mounting brackets on wooden platform, after scanning disc has been set in place.



This shows wiring diagram for Jenkins Television scanning disc motor.

The Neon Lamp-House

The lamp-house is assembled next. The components are: "Q", the lamp-shield; "R", the base for the lamp-shield; "S", the tube-shield screws; "T", the prong jack sleeves, for establishing contact with the television lamp's prongs; and "U", the rubber-covered leads. The prong-jack sleeves come already assembled in the tube socket, thus simplifying the assembly. The three felt cushions supplied



After pushing magnet windings as far back as possible, the wooden wedges are driven in between core and winding.

should be cemented to the inside of the lamp-house at three points equally spaced, just above the rectangular opening; DuPont's household cement is recommended for this purpose. To assemble the lamp-house, simply place the television or neon lamp in the socket, with the smooth surface of the tube's plate facing the constructor. Place the tube shield over the lamp, with its window or opening aligned with plate of lamp. Align the screw holes in shield with those of the tube-socket member, insert screws and tighten. The lamp-house is then complete.

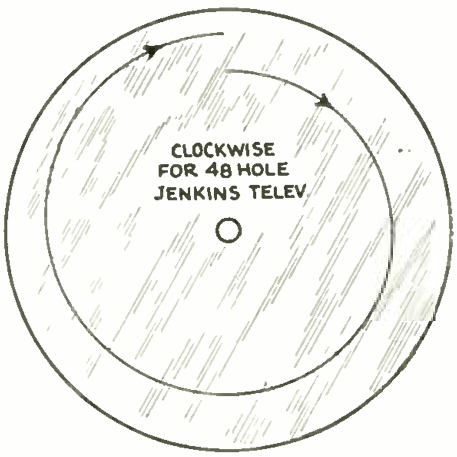
The Scanning Disc

One of the pictures shows the components of the scanning disc. To assemble, take the black disc "V" and hold it in your left hand, while the side that shows the spiral of tiny holes running *clockwise towards the center* is facing you. Place the copper hub-flange "Y" at the back of the disc, aligning its holes with those in the scanning disc. Drive home the screws from the front face to engage with threaded holes in rear copper disc.

Now place the rotor in center on side facing you, align the holes with those about center of disc, and insert flat-head screws in the rotor, through the disc, and the copper hub-flange; slipping nuts on rear side and drawing up tightly. The disc assembly is now complete.

The parts required to start and regulate the motor driving the scanning disc are the rheostat, the fixed condensers and the holding screws for the condenser; these components are mounted on the underside of the platform. A toggle switch may be used for starting and stopping the motor. The condenser should be mounted under the board adjacent to the bakelite panel, being screwed to the left-hand upright board. The rheostat is mounted on the panel in the right-hand hole, facing the panel front. The switch, if used, is mounted in the panel's center hole.

The brackets are now ready to be mounted on the platform. First, the front bracket is mounted with the rounded end of the scanning-disc shaft facing the front or panel end of the platform. Next, the scanning disc is mounted on the shaft protruding from the rear of the front bracket. The rotor spacer "K" is first slipped over the square end of the shaft, and then pushed back until it is up against the ball bearing. Then the scanning disc is slipped over the shaft and pushed back against the spacer, with the rotor facing rear of platform; after which the set-screw in the rotor is tightened.



Direction of rotation of disc necessary to receive the images broadcasted by the Jenkins Television transmitting station.

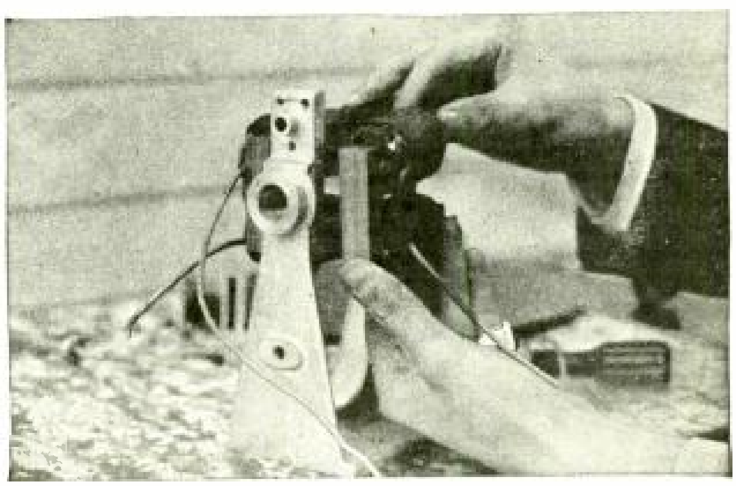
The rear bracket is now placed on the wooden platform, and so adjusted that its holes align with the small holes already drilled in the platform. The pole-pieces and the rotor guard should now surround the rotor. The screws are driven home through the bracket base and into the wooden platform as shown. The scanning disc should be twirled, to make certain that it turns freely and that the rotor does not rub against the coils or core of rear magnet. It is best to tighten the rear bracket's wood-screws only lightly; so that, after the set is wired and the power turned on, the rotor can be made to rotate under its own power. The proper setting between the rotor and the rear magnet's core may then be found by tapping lightly on the rear bracket at the bottom until the set runs quietly. The proper distance between the front of the scanning-disc assembly and the ends of front magnet core is 3/16-inch. The rear magnet's core and the back of the scanning disc should also be 3/16-inch apart.

Wiring Diagram Instructions

A pictured wiring diagram, furnished with the radiovisor kit, makes this part of the job exceedingly easy. All leads coming from the outside of the coils, as shown on the diagram, are lacquered red. The splices should be taped with adhesive tape. From this diagram it can be seen that the motive power is furnished by an "eddy current" motor, made up of six electromagnets. These operate in conjunction with the toothed rotor and the copper disc. The "eddy current" motor functions as a synchronous motor for automatic synchronization, when used on the same A.C. power system as the transmitter. The speed-control rheostat allows for manual synchronization; although the automatic synchronizer described below makes this use of the rheostat unnecessary.

The lamp-house is mounted on the rear bracket, by inserting the long pin of the lamp socket in the hole in the center post. The pin permits raising or lowering the lamp, or turning it from side to side, to "frame" the pictures properly. There is a special type of radiovision lamp, known as "Model 601-B", which has been found best adapted for use with this kit. A magnifying lens and holder may be obtained, separately, for the purpose

Mounting the electromagnet assembly on the front bracket, with wires outside.



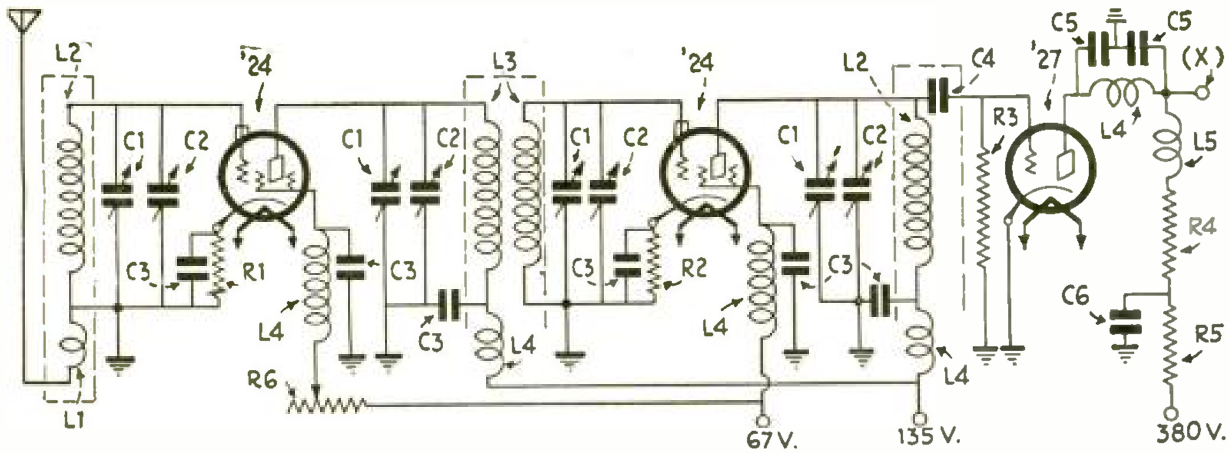


Diagram herewith shows the connections of the Jenkins Television receiver or "tuner", utilizing screen grid tubes in two radio frequency stages, and a '27 tube in the detector stage. The output terminal "X" joins with the input terminal "X" of the amplifier shown below.

of magnifying the radiovision images, instead of viewing them in their original small dimensions. To assemble the lens, place the lens in frame, with its rounded side facing the front. Then slip in the screws (with the large or lower washers next to the glass, and the small or upper washers next to the screw heads), into the holes at rear of the lens frame. Drive home the screws, completing the assembly. It will be noted that the lens frame fits on the front of the front bracket, fastening in place with three flat-head machine-screws.

Operating Instructions

The first step, in using the completed radiovisor, is to provide the necessary input for the radiovision lamp. This input is supplied by a resistance-coupled amplifier, as outlined above, with a '45 or a '50 power tube; the amplifier in turn being supplied by the detector output of a short-wave (100-150 meter) receiver. As in sound-broadcast reception, it is necessary first to tune in the desired signal. Before doing this, it is best to ascertain the schedules of regular and experimental radiovision broadcasters. A complete list of these stations is given elsewhere. When radiovision signals are on the air. they may be found quite readily by tuning the receiver in the conventional manner until the characteristic "buzz-saw" note, of rising and falling pitch, is at maximum volume and clarity; at which time the radiovisor is substituted for the loud speaker by means of a simple switching arrangement.

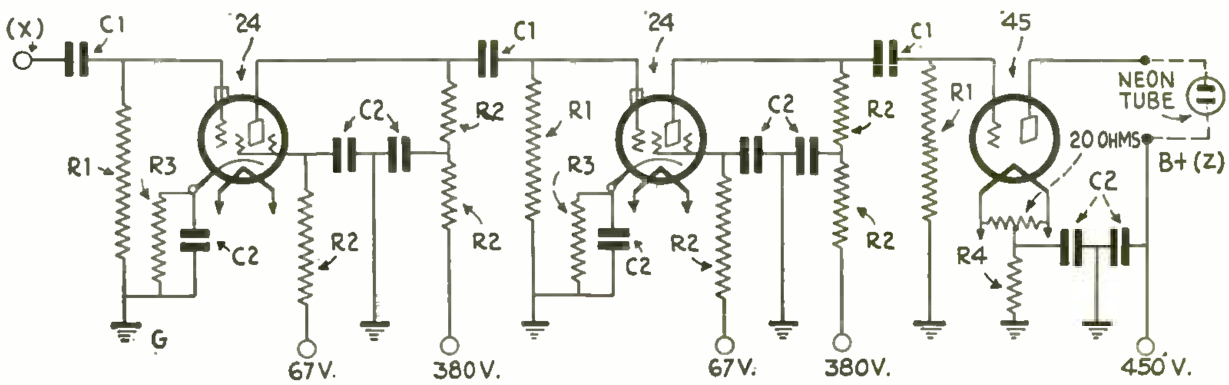
The radiovision lamp should glow when connected with the amplifier output. If the plate does not appear to glow, as seen through the aperture, and yet there is a faint sign of light, the rubber-covered leads from the amplifier or set output should be reversed.

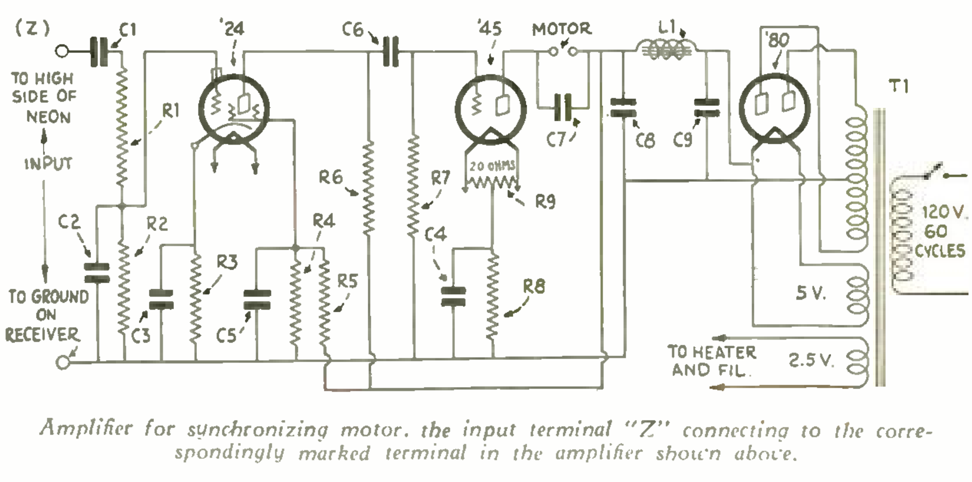
The voltage impressed on the television lamp should be not less than 230 volts for proper operation; the usual '71-type power tube has insufficient power to operate the television lamp satisfactorily. When the motor is turned on, it may be necessary to give the scanning disc a slight twirl, clockwise (as seen from the front) for 48- and 60-line pictures, and counter-clockwise for 45-line pictures. When the scanning disc gets up to speed, a luminous pattern made up of the 48, 45 or 60 lines should appear. Under the influence of the radiovision signals, these running lines blend into lights and shadows forming pictures.

The figures as viewed may float towards the right or left, depending on the scanning disc's gaining on the transmitted images, or falling behind. To get the disc in synchronism, or perfect step, with the transmitted images, the speed-control or rheostat knob on the front panel should be turned, left and right, as necessary until the desired effect is obtained. It is possible to hasten synchronism by pressing lightly on the protruding scanning-disc shaft, at just the right time.

When the motor is synchronized with the current supply, a slight uniform purr is heard. With a little practice, one soon becomes an adept at synchronizing. If the radiovisor is employed on the same A.C. power system as the transmitter, the disc

Jenkins Television amplifier for boosting the television image signal before it is passed into the neon tube. The input terminal "X" joins to the similarly marked terminal of the output receiving circuit shown above.



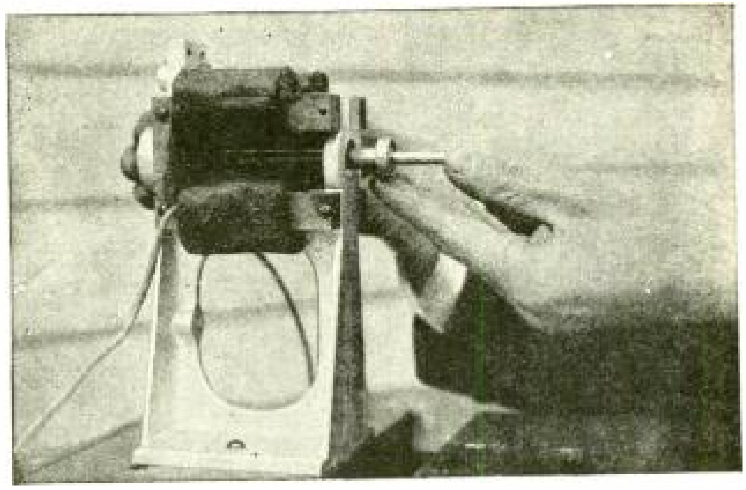


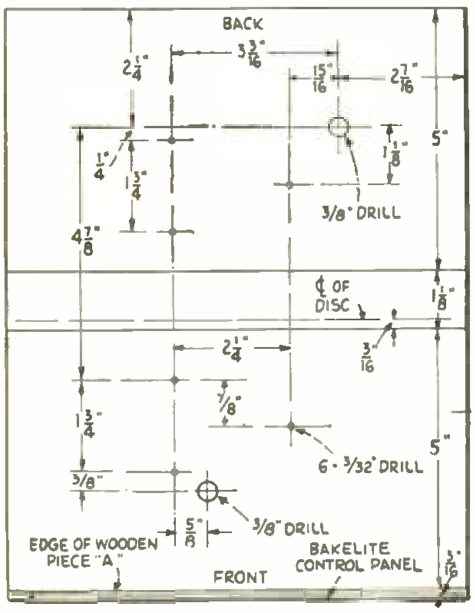
Amplifier for synchronizing motor, the input terminal "Z" connecting to the correspondingly marked terminal in the amplifier shown above.

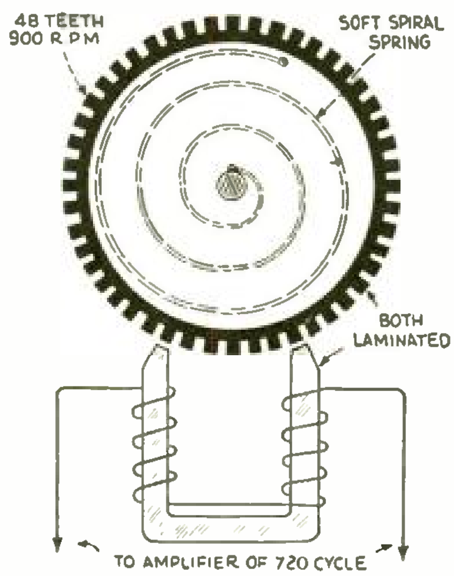
will remain in perfect step with the transmitted images, once it is in synchronism; if the radiovisor is used on a different power system from that supplying the transmitter, it is desirable to add one of the new self-synchronizing devices, recently developed by the research laboratories of the Jenkins Television Corporation.

This new device is a "phonic motor," consisting of a toothed rotor on the drive shaft of the radiovisor, together with a 2-pole electromagnet or field coil furnished with a 720-cycle energy component inherent in the 48-line, 15-frame television signals. This signal component is filtered out by a special circuit, and amplified sufficiently to definitely "lock" the radiovisor disc in synchronism. The motor is attached to the front bracket; but first it is necessary to remove the slotted rotor from the scanning disc and replace this with a blank rotor. With the new motor attached, the radiovisor is ready to pick up any television signal; since in this case the signal itself synchronizes the picture. It should be understood that the motive power of the radiovisor is furnished by the eddy current motor; whereas the phonic-motor attachment merely serves to keep the motor in synchronism with the incoming signals.

Checking the end-play in the motor shaft.







Drawing above shows layout of holes on motor base at left, while diagram at right shows arrangement of synchronizing motor of Jenkins Radiovisor.

The self-synchronizing device, although it constitutes a decisive advance in television reception, is exceedingly simple in construction and is readily attached, either to an outfit already constructed, or to a radiovisor in the process of assembly.

If portions of two pictures show simultaneously, this indicates that the picture is improperly framed. To frame, or center, the picture horizontally, the lamp shield should be turned slightly to the right or left, as the case may be. To frame vertically, the lamp shield should be slightly raised or lowered. The pictures will then remain framed for considerable periods.

If the radiovisor is to be employed for reproducing 60-line pictures, a 60-line scanning disc with the necessary rotor for the proper operating speed is available. Changing disc with attachments is accomplished readily in a few minutes.

An ever-increasing variety of television programs are being broadcast; and, during the present season, these will include, not only moving pictures via radio but also synchronized sight and sound broadcasting.

For those whose interest is centered more in the *actual reception* of television, rather than in experimenting and construction, a completely-assembled radiovisor is obtainable; this is so designed that changes and additional equipment may be added, as advances are made in the art. It is known as "Model 100."

A completely-assembled and wired radiovision receiver, developed by the Jenkins research engineers, is also available for use in connection with the radiovisor; this is of the non-regenerative type, completely A.C. operated, and includes the necessary power amplifier.

IN OUR NEXT ISSUE

LATEST TELEVISION RECEPTION RESULTS WITH THE BRAUN TUBE, by Baron Manfred Von Ardenne—Illustrated With Photos by the Author

FULL SIZE TEMPLATE FOR LAYING OUT TELEVISION SCANNING DISC

LATEST GLOW - DISCHARGE LAMPS FOR TELEVISION SYSTEMS

PRACTICAL CONSTRUCTION AND OPERATION HINTS FOR TELEVISION SET BUILDERS, by H. Winfield Secor

A SHORT COURSE IN TELEVISION —Part Two—by C. H. W. Nason, Television and Short Wave Specialist

A NEW MULTI-CHANNEL TELEVISION SCANNING SYSTEM

TELEVISION PROJECTED IN THREE DIMENSIONS

HOW SHALL WE AMPLIFY TELEVISION SIGNALS?

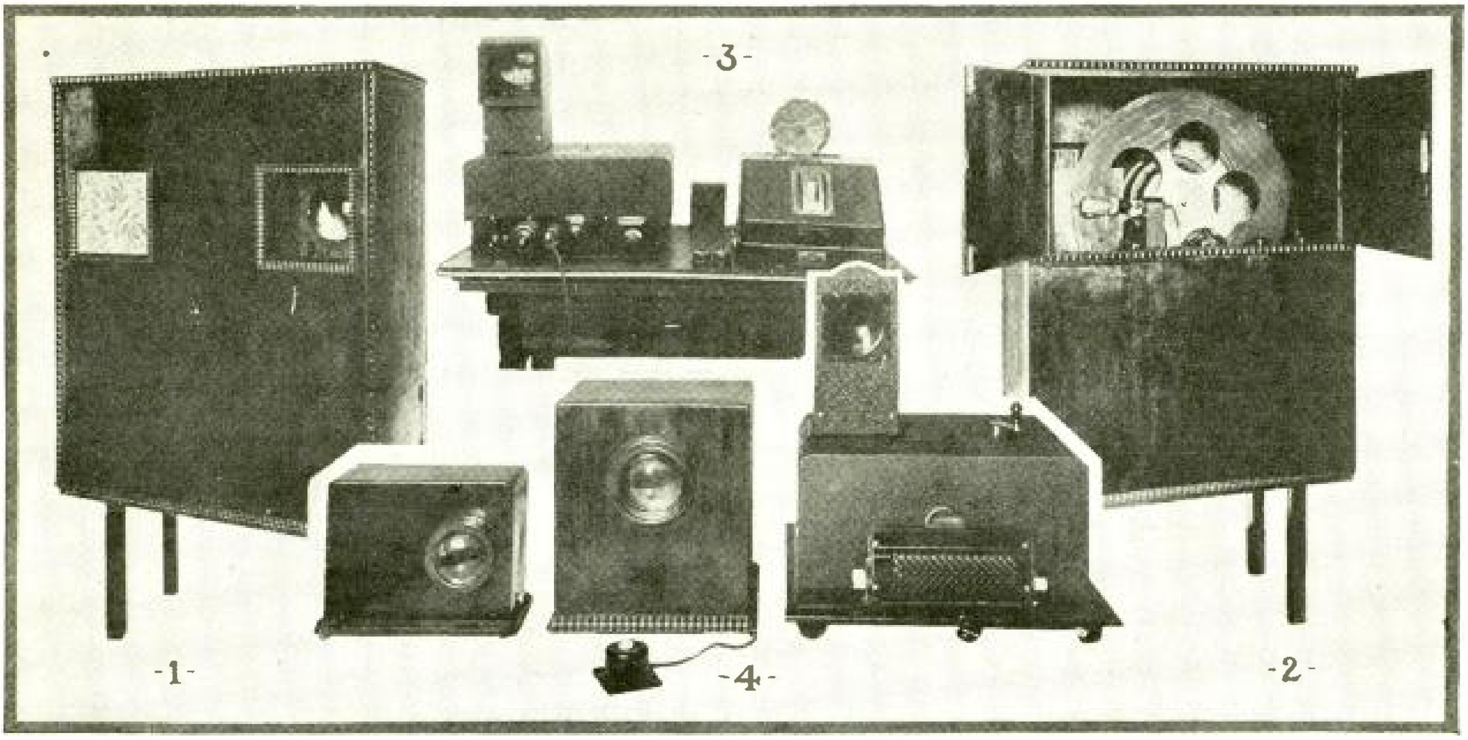
HOW THE GERMANS TELEVISE, by Dr. Fritz Noack

SOME OF THE PROBLEMS OF TELEVISION, by D. E. Replogle

The MIHALY TELEVISION SYSTEM

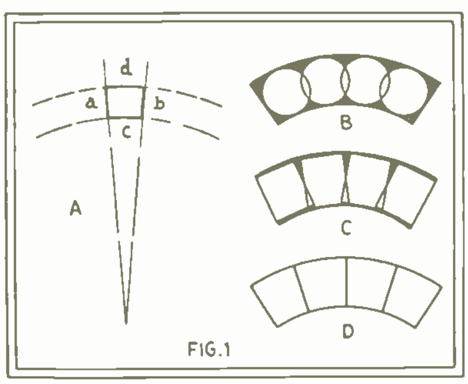
The latest Mihaly television apparatus is claimed to produce exceptionally clear images at the receiver, free from the shifting dark lines caused by scanning disc holes and so characteristic of the usual television image.

By Dr. Albert Neuburger
(Berlin)



A group of televisors produced by the Telehor Company, of Berlin, which is developing the inventions of D. von Mihaly. The large sight-and-sound receiver shown at 1 is viewed from the rear at 2: it has a large disc, reproducing the image at the side in the window. At 3, a layout including a modern German broadcast receiver, with a televisor at its left: here the image is reflected upward into a "window". In the foreground at 4 are small televisors, one in the center with a speed control.

THE difficulty of obtaining freedom from the flickering which is familiar to all who have seen television images, has been completely overcome by D. von Mihaly. In his latest apparatus, the images are perfectly motionless in the "window," and they do not show the customary shifting dark lines, which are due to the holes in the scanning disc. The image is evenly illuminated and clear.

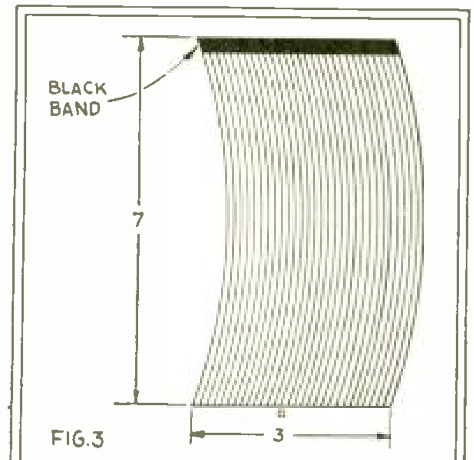


The Mihaly disc has holes (A) bounded by arcs and radii. This overcomes the unevenness of light received through circular (B) or square (C) holes: and gives perfect illumination, as at D.

Part of this is due to the increased speed of the scanning disc. This, which has thirty holes, revolves so fast that an area 12 x 16 inches is covered at the rate of 15,000 scanning points a second; and this figure may be increased to 18,000 points. (*The former corresponds to a speed of 750 revolutions per minute, and the latter to 900, which is standard with American 48-hole scanning. German television, however, is permitted the use of the broadcast band, and this limits the modulating frequency.*)

Furthermore, the holes in the scanning disc have been given the special shape shown in Fig. 1A. The sides of the hole slant toward each other at a very acute angle; while the top and bottom are concentric arcs.

From Fig. 1B, it will be seen that equality of illumination cannot be obtained with circular holes; in 1C, it will be seen that square holes, while an improvement, still cause lines; but the shape of opening just described, with its slanting sides, gives exactly even illumination and freedom from lines, as illustrated at 1D.

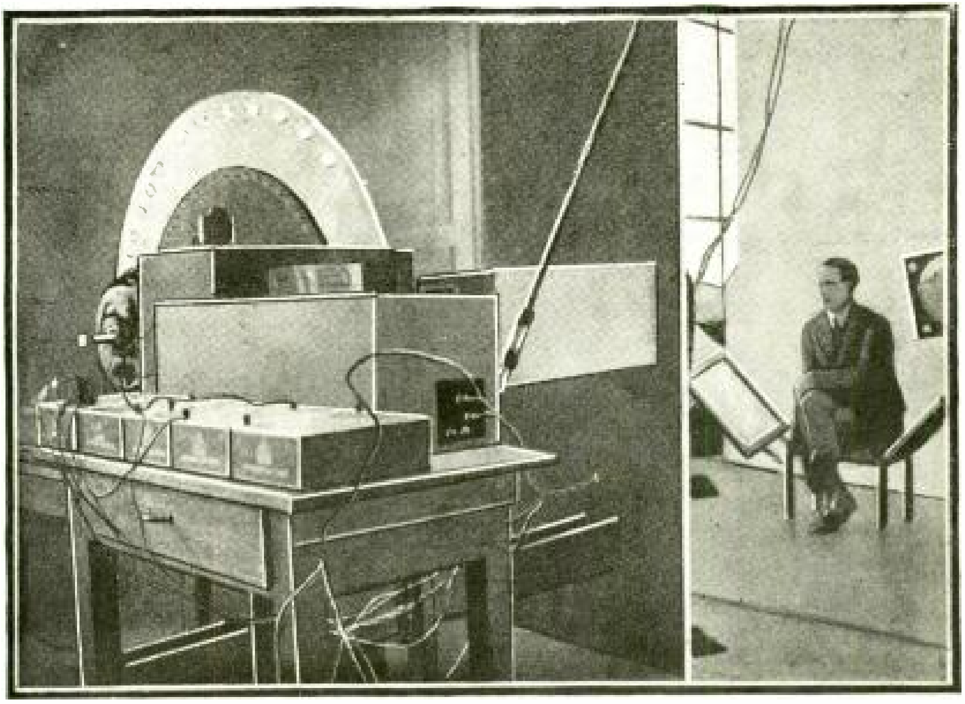


In the Baird system, which scans the image vertically, a part of the line is cut off at the upper end; this serves to create a synchronizing signal.

Mihaly Synchronizing Method

The "window" used to frame the image on the scanning disc is narrower than the distance between successive holes. For this reason, there is always at the end of each line an instant when no light can pass into the photo-cell at the transmitter (Fig. 2A), and the cell therefore gives out no current. To emphasize this effect, a rotating collector, which shorts the cell at this instant, is employed.

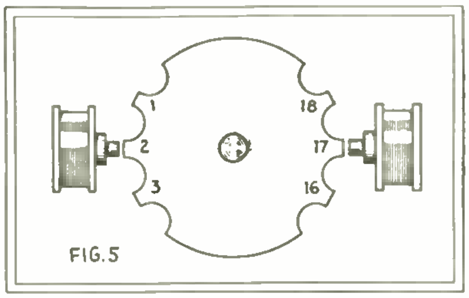
The result is that, at the receiver, a black line is formed after every passage of a hole across the window; that is to say, 375 times a second. This frequency of 375 a second acts upon a "phonic wheel," or cylinder, which is made of an insulating drum covered with thirty strips of soft iron, one for each hole in the disc. Opposite the wheel is an electromagnet, through which the synchronizing current impulses are directed. The wheel, therefore, turns in synchronism with the scanning disc at the transmitter; as its strips (corresponding electrically to the teeth of a gear) are attracted and released 375 times a second. This disc is mounted on the shaft of the receiver's scanning disc, which is thereby driven in synchronism with the transmitter (Fig. 2B).



The set-up of the Mihaly televisor for scanning subjects by natural daylight. Mirrors help to illuminate the subject properly; and a powerful lens concentrates the image upon the large scanning disc, which is placed in a dark room.

BRITISH SYNCHRONIZING SYSTEM

IN the transmission of images, and their reception, by the Baird system, now in use in England, a somewhat similar principle is employed. In following this description, it must be remembered that, on the Baird televisors, the image is framed at the side of the disc, and scanned from bottom to top; it is narrow and high (Fig. 3).

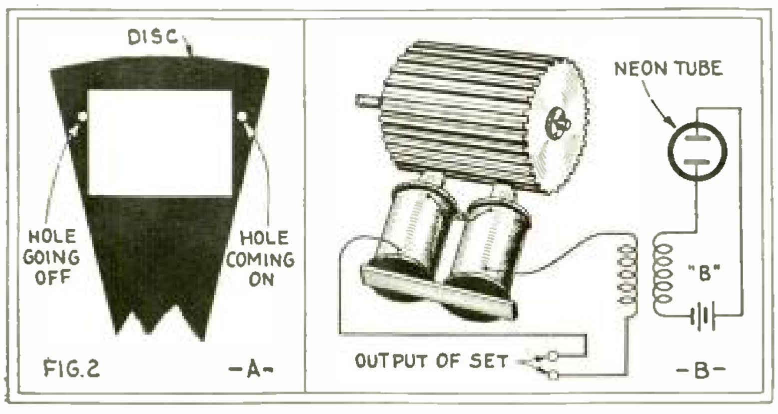


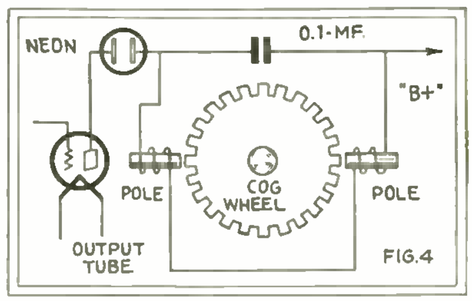
A close-up of the Baird speed controller, shown in circuit in Fig. 4. The adjustment is very close. (From Wireless Magazine.)

scanning disc is just half covered by the frame of the window (that is, half of it is in the black band of Fig. 3) two opposite teeth of the cogwheel are exactly facing the magnet poles.

When the scanning pole is completely within the shadow, and no current is emitted by the photoelectric cell, the accelerating force exerted on the wheel by the magnet poles has reached its maximum; and their pull will tend to retard it, while the next hole is passing into the illuminated area of the scanner. If the disc runs in exact step with the received impulses, these opposite pulls will balance.

The fundamental principle of synchronization by a signal, transmitted with the television image, is based upon the creation of a signal by the scanning disc itself. This done by making the mask narrow enough so that a complete darkening of the scanning hole is caused after every line. This causes a frequency component which is applied to a "phonic wheel" as at B.





Here we have the synchronizing regulator at the receiver, which is placed in series with the glow lamp, and responds to the strongest component of the signal.

The Baird method, it is explained, differs in the use of the synchronizing impulse to actuate, not a phonic wheel (which is a true synchronous motor) but a speed controller which regulates the actual driving motor. This controller is a "cogwheel," built up of thin laminations of mild steel in later models, and cut with thirty equally-spaced teeth, one for each hole in the disc. This cogwheel is connected in series with the output of the television amplifier and the neon tube, as shown in Fig. 4.

On each side is mounted an electromagnet, so connected that poles of opposite polarity are always presented to the cogwheel. The surface of each magnet pole is exactly equal in size to the outer face of each cog, and the clearance is very small—about 1/500-inch. The cogwheel, which is keyed to the driving shaft of the scanning disc, is so set that, whenever a hole on the

A Message *from* Dr. E. F. W. Alexanderson

Famous Inventor of "Theatre Size" Television Projector

Above: Dr. E. F. W. Alexanderson, consulting engineer of the General Electric Company and the Radio Corporation of America, is shown standing alongside of his latest "brain child," the theatre television projector. Below, at left, note size of image: at right, how one of the performers appears in front of Alexanderson television pick-up. Note microphone at left. The photo-cells are electrically shielded by the screens.

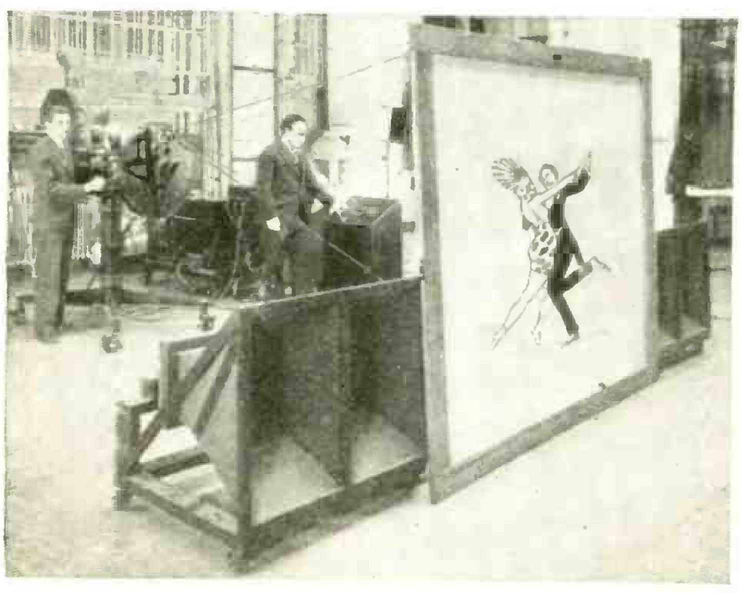
GENERAL ELECTRIC COMPANY

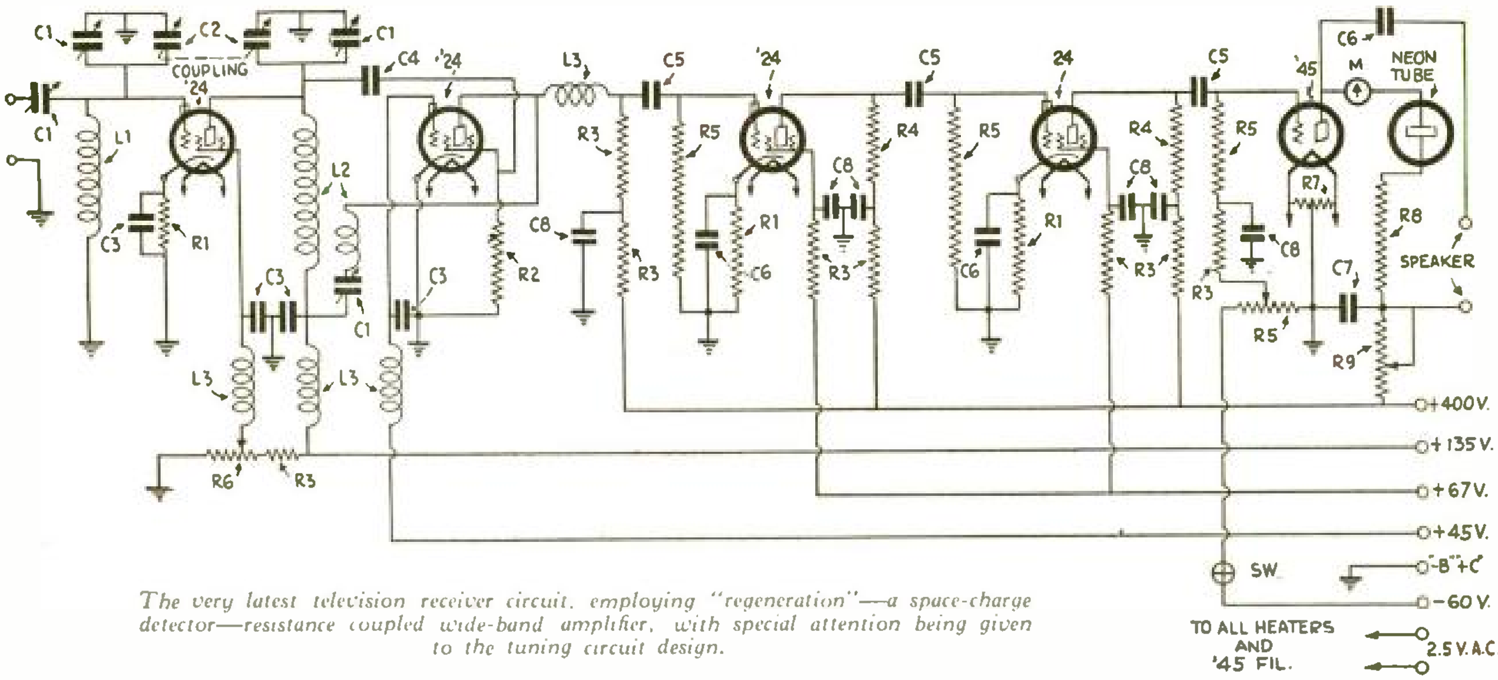
Dear Mr. Gernsback: *Schenectady, N. Y.*

Many thanks for your telegram. I am much interested in your undertaking of launching a new Television magazine. This is one of the many indications of the great interest the public takes in this subject. I shall be glad to contribute an article as soon as we are in position to demonstrate some new progress.

I do not believe that television will either compare or compete with the film (movies), but may take some unexpected turn. Perhaps visual broadcasting combined with sound will furnish a mode of self-expression of local talent for local consumption. What standard of performance will be demanded or tolerated under such circumstances is hard to predict. We have to feel our way.

(Signed) E. F. W. ALEXANDERSON.





The very latest television receiver circuit, employing "regeneration"—a space-charge detector—resistance coupled wide-band amplifier, with special attention being given to the tuning circuit design.

A GOOD A. C. RECEIVER *for* TELEVISION

By C. H. W. Nason

The author, well-known as a television expert, tells us all about his idea of the very latest television receiving set. It employs "regeneration" — yes — and a lot of other features such as a space-charge detector, employing a '24 screen grid tube, etc.

THE theory of Radio is so full of meaningless platitudes that the novice is hard pressed to discover just what constitutes the "best". We are told that "bias" or plate-circuit detection is the best where quality is concerned. We are are told that regeneration is destructive of this same quality, and that in television regeneration must under no circumstances be employed.

The same designers who perpetrated the above platitudes will then offer us a television receiver with an untuned input to the first '24 R.F. stage, and wonder why the broadcast harmonics swamp out the television signal. Without going too far into the theory of the thing, the writer intends to give one idea a firm foundation in his readers' minds. An untuned antenna of the type as employed in the first single-control broadcast receivers, is the worst thing that can happen to any young receiver, whether it be for broadcast reception or for television. It not only allows cross-modulation of the desired signal by a strong local, in such a manner that no amount of selectivity in the succeeding circuits will reduce the interference, but makes it possible for a powerful carrier to produce a strong second harmonic in the plate circuit of the first tube. This is particularly annoying in television, where the harmonics of the broadcasters are within the required band.

Choice of Detector Circuit

It is easily shown that a grid-circuit detector—that is a "grid-leak" detector—produces less harmonic distortion than a "bias" detector, of the type for many years held to be ideal. In order that the superiority shall become evident, however, the plate voltage must be high and care must be taken in choosing the type of tube for use in the detector circuit. Distortion of the frequency-response characteristic of the receiver is also less with the grid-circuit detector, provided the grid-leak and condenser values are chosen with the desired high-frequency response in mind.

The grid-circuit detector has one disadvantage in comparison with the plate circuit system—that the damping or resistance interposed across the tuned circuit is quite high. It is with this fact in mind that the writer includes regeneration in his circuit, in open defiance of all that has been said before. The purpose of introducing regeneration is not that of producing oscillation by neutralizing the resistance of the tuned circuit, but that of decreasing the effective damping across the tuned circuit; by neutralizing the effect of the grid leak and the low impedance of the detector input circuit. If the degree of regeneration is held within reasonable limits, no tendency toward oscillation or cutting of side-bands will be encountered.

The Television Tuning Problem

As far as the tuned circuits themselves are concerned, the problem is not great. It is the most elementary theory, that the response characteristic of a tuned circuit is widest when the ratio of capacity to inductance at resonance is large. Therefore we will place a large fixed capacity across our tuning coils. Although a band-pass arrangement would be better, because of the possibility of "peaking" at the higher frequencies, we will do well not to complicate this—our first television receiver.

Let us investigate the characteristics of some particular signal—for example that of W2XBS of the National Broadcasting Company in New York. This station transmits a 60-line picture which is 72 elements wide. That is to say, the picture has an "aspect ratio" of 1.2 to 1; taking something of the shape of the frame of a motion-picture film. The scanning disc rotates at 1200 r.p.m., giving twenty complete images per second—enough to avoid any evidence of flicker. The maximum frequency present may be determined by multiplying the number of picture elements by the number of pictures per second and dividing by two. That is

$$\frac{60 \times 2}{2} \times 20$$

or 43,200 cycles per second, as compared with 5000 cycles for a broadcast signal. This means that extreme care must be taken in the design, if all the detail present in the transmitted image is to be achieved. I have chosen this sixty-line signal as representing the greatest difficulty; since a 48-line image at fifteen pictures per second requires a correspondingly lower upper-response limit.

Proper Number of Amplifier Stages

In passing through a vacuum tube, the signal is reversed in phase by a full 180 degrees; so that a *positive* image applied to the grid (positive in the sense that maximum light intensity corresponds to maximum signal amplitude) will become reversed in passing through the tube. Thus it may be seen that an even number of such reversals is necessary, if a positive picture is to result.

In grid-circuit detection the low-frequency component of the signal is reversed in phase and we must employ an odd number of A.F. stages following the detector. If we were to employ plate circuit or "bias" detection, an even number of stages would be used because the signal suffers no reversal of phase in the process of detection.

We must therefore employ either one or three stages of amplification with our grid-circuit detector. Since the signal will hardly be large enough to warrant the use of a single A.F. stage we will have to assume the necessity for a multi-stage A.F. amplifier.

Standing alone, the A.F. amplifier shown in connection with the receiver is flat, to slightly beyond thirty thousand cycles, and has fair transmission characteristics of detectors to beyond forty thousand. A rigid inspection of the characteristics of detectors (both personally conducted and including data gathered by many others) shows that the detector suffering least from losses at the higher frequencies of modulation is the '24 operated as a "space-charge"-grid tube. In this connection the functions of the two grids are reversed; the control-grid connection from the juncture of the leak and condenser being made to the grid terminal on the socket. The potential for the space-charge or upper-grid terminal is taken from the power supply in the manner shown. The values for the grid condenser and leak have been carefully worked out, and they should not be made a subject for further experiment. The potential of the space-charge grid is relatively unimportant; as it may be shifted over a wide range without disturbing the detector sensitivity.

Distortion Caused by Detector

Regardless of all that has been said before, the primary cause of distortion in all receivers—television or broadcast—lies in the detector. The design of a tuned circuit to pass a given band of frequencies without attenuating the higher modulation frequencies is a relatively simple matter. In the case of detector response, the design problems are not so simple. The ultimate response of the receiver is dictated by factors outside the knowledge of many designers. Not so long ago, there was an agitation for the use of the '10 tube as a detector, in certain "kit" receivers, to avoid distortion; and yet it is a perfectly-established fact that the '10, operating as a detector, will not pass frequencies over about 3,500 cycles within seventy per cent of the response at lower frequencies.

Full Size
TEMPLATES
for
Laying Out
Scanning Disc Holes
In Next Issue

One of the major requirements which the writer has borne in mind, in the design of this receiver, is that of availablity of materials. This, coupled with simplicity in operation, is of the highest importance in the design of a receiver for amateur use. Today the television transmitters lie within a band between 2000 and 3000 kc., or between 100 and 150 meters. In order to cover this band with a high ratio of "C" to "L" in the tuned circuits, we will employ the standard Hammarlund coils designed for the 80-meter band. Across the inductances we will employ 100 mmf. midget variable condensers which will give a high minimum capacitance and a high-frequency limit slightly above 3000 kc. Minor adjustments of these condensers will allow ganging of the tuning condensers, which must be .00025 mf. units in order to cover the required range with so small an initial inductance in the circuit. This last specification is due to raise a lusty howl from many circles. It is, nevertheless, just what the writer is striving for and, in the event that the excessively large capacitance is still in doubt, let us repeat: the tuned circuits consist of Hammarlund coils for the 80-meter band, shunted by 100-mmf. midgets and tuned by variable condensers having a maximum capacitance of 250 mmf. These coils have an inductance of about 20 microhenries.

The resistance-coupled amplifier stages are of quite standard, but for the fact that rather stringent measures have been taken to avoid feedback or "motorboating". No liberties should be taken with this filtering system, or trouble will be encountered. In the event that motorboating does take place it can be suppressed by the use of additional capacity in the filter circuits.

The Neon Tube Circuit

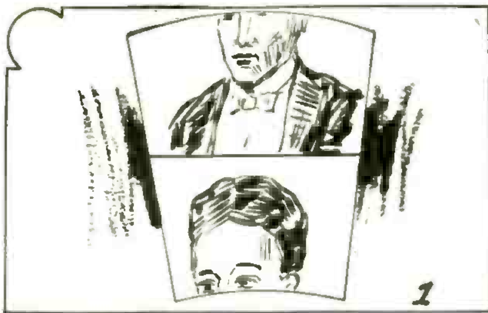
In order to reproduce the television image in a satisfactory manner, it is essential that some means be provided for varying the current through the neon tube. Although a satisfactory constant-current arrangement, which would allow this to be done without changing the D.C. plate current of the output tube, could probably be devised it would complicate the arrangement of the output circuit. In consequence we must rely on a simple method of reducing the plate voltage by means of series resistance. This means that we must also vary the grid bias, so that the relationship between the plate voltage and the grid bias of the output tube will always be favorable.

If a meter is included in the plate circuit of the output tube, the value of the plate current will at all times be known. This same meter will indictate the optimum operating point for the bias control, by showing the point at which the signal causes the least variation in the plate current of the output tube. A switch has been provided for disconnecting the "C" battery when the set is not in use. *It is essential that this switch be closed before the receiver is turned on; since both the output tube and the neon lamp will be destroyed if plate voltage is applied to the '45 while its grid is unbiased.*

The heaters of the '24 tubes and the '45 filament are supplied from a single 2.5-volt winding; either on a separate filament transformer or included in the power transformer's windings. In the latter case, it is probable that more than one 2.5-volt winding will be available—in which case the R.F. and detector tubes may be operated from another source than that for the A.F. tubes. The writer hesitates to recommend the use of this receiver on batteries; as the current drain from the "A" battery and the high plate voltage required represent a large financial investment in batteries. Where it is necessary, the heaters may be arranged in a series—parallel connection which the writer will be pleased to communicate privately to those interested. The plate supply may be taken from any well-filtered source capable of supplying the required voltage; power packs designed for use with the '10 type of

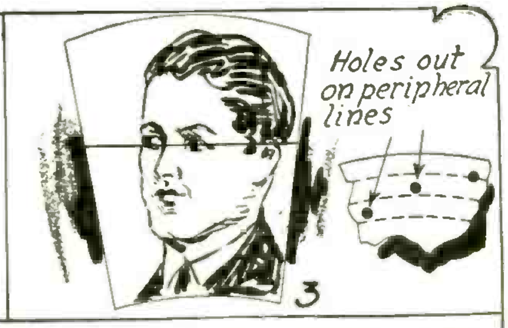
(Continued on page 74)

When Your Television Image Goes Blooey!



1. OUT-OF-FRAME VERTICALLY—Cause: Receiving scanning mechanism out of phase with transmitting scanner. **Remedy:** If using a synchronous motor stop and start motor until phase relation is same, as evidenced by the vertical centering of the picture. If using a double spiral disc shift lamp until image is centered.

2. OUT-OF-FRAME HORIZONTALLY—Cause: Receiving scanning mechanism in step but slightly out of phase with transmitter. **Remedy:** If using a synchronous motor rotate field slightly until image is centered or move television lamp around the periphery of the disc until image is centered.

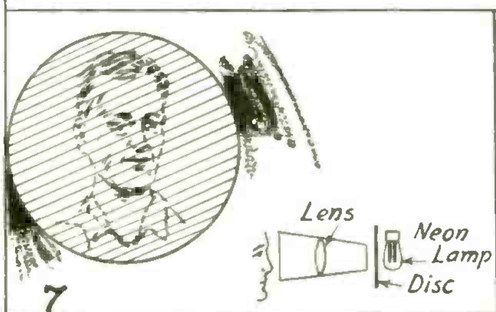


3. BLACK LINES ACROSS IMAGE—Cause: (a) Dirt in the holes of disc. (b) Hole in disc radially "off center," due to inaccurate punching. **Remedy:** (a) Clean disc. (b) Obtain new disc. Sometimes possible to relocate hole sufficiently to eliminate difficulty by punch and small file.

4. REVERSED OR "NEGATIVE" IMAGE—Cause: Output signal 180 electrical degrees out of phase, namely, positive impulse causes "decrease" of output plate current, instead of "increase". **Remedy:** Best to add or subtract one audio stage of resistance coupling. Another method is to change the type of detection from condenser grid-leak to grid bias type, or vice versa.

5. "GHOST" IMAGES—Cause: (a) Usually interference of the horizontal component of the transmitted wave being reflected by the Heaviside layer and interfering with the ground or vertical component. (b) Sometimes caused by reflected voltages in the radio receiver due to improperly placed impedances. **Remedy:** (a) For the first cause, move to different location. (b) Find the offending circuit by process of elimination.

6. SHIFTING IMAGE FROM SIDE TO SIDE—Cause: Receiving and transmitting scanning mechanisms out of step. Often caused by use of synchronous motors at transmitter and receiver being connected to different power systems, whose frequencies slightly differ. **Remedy:** Impossible to correct with synchronous motor equipment. Can be eliminated by using self-synchronizing devices.

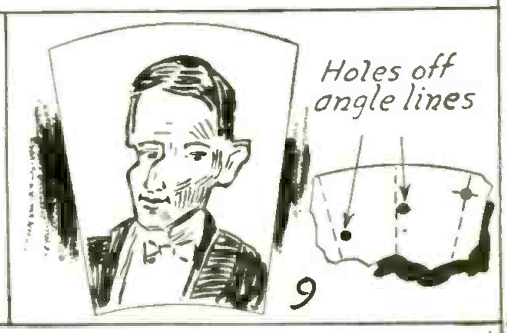


7. DIM IMAGE—Cause: (a) Insufficient signal strength. (b) Too much current through television lamp. (c) Too much outside light. **Remedy:** (a) Television signals should be uncomfortably loud on loudspeaker to properly operate television lamp. Use more powerful amplifier. (b) If television lamp is in series with output tube cut down current by increasing grid bias or reducing plate voltage, or inserting resistance in plate circuit. (c) Darken room.

8. INVERTED IMAGE.

Cause: Disc or scanning mechanism running backwards.

Remedy: Change direction of rotation of scanning mechanism.

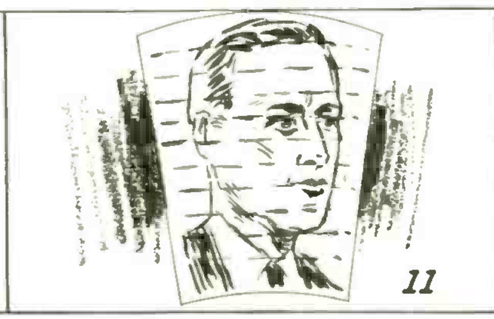


9. IMAGE DISTORTED AT ONE POINT BY OFF-SET STRIP.

Cause: Hole in scanning disc out of position angularly.

Remedy: New disc or repositioning of hole by use of punches and file.

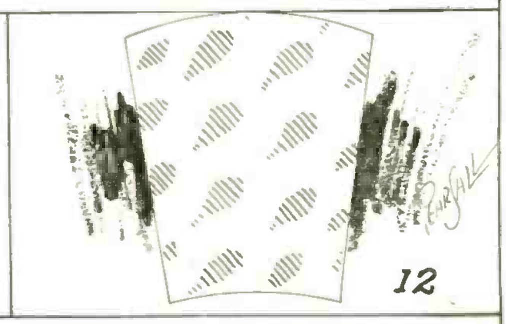
10. NO DETAIL—PICTURE TOO CONTRASTING—Cause: Lack of high frequencies in receiver. (a) Improper bias on audio tubes. (b) Improper detector circuit. (c) Regeneration. (d) Radio circuits too sharply tuned. **Remedy:** Find cause and correct. (a) Proper grid bias. (b) Proper detector circuit. (c) Eliminate regeneration. (d) Broaden radio circuits.



11. LIGHT SPLOTCHES OVER IMAGE.

Cause: Static or noise from receiver, bad tube, etc.

Remedy: If static no remedy. If in receiver test and eliminate.



12. IRREGULAR PATTERNS ACROSS PICTURE OR SHIFTING PATTERNS WITHOUT PICTURE—Cause: (a) Interference from broadcast stations; (b) television station announcing by voice; (c) television signal being transmitted on different scanning standard than receiver uses. **Remedy:** (a) Eliminate interference. (b) If announcement by voice shift over to loudspeaker and hear announcement. Shift back again for picture. (c) Listen for voice announcement and secure receiver scanning equipment to match transmitting standard.

TELEVISION in the THEATRE

No name in America is more prominently known in the realm of television development than that of Mr. Jenkins. It is vital therefore to read his message.

By C. Francis Jenkins

FROM the results of experiments, recently made by the Jenkins staff, it is confidently expected that a demonstration of television and radiomovies will be made in a Washington theatre during 1931.

The pictures will be the full size of the theatre screen, and the lighting will equal in brightness the present lighting of the screen from film projection.

It is well understood that such a result is not possible by the present method of scanning a latent (inactive) picture surface with a single spot of light. The impression on the eye by this scheme, is less than one-six millionth part of the light available in the usual neon cathode-plate lamp.

By using an arc lamp and a light-valve to control the flying light spot, there is a gain over the cathode-light source, but the loss is still terrific, and the picture still depends on the "persistence" of the human eye.

The scheme, from which theatre projection is now confidently predicted, depends on the substitution of persistence of each elementary area of the latent picture surface itself, for the persistence of vision of the eye.

A light baffle (a lantern slide, for example) is interposed between a constant - intensity light source and the theatre screen; and the picture elements on this lantern slide are changed to change the picture.

The lantern slide, in effect, is divided into dot elements (like the dot elements of a newspaper illustration—"halftone"—block) to make up a picture.

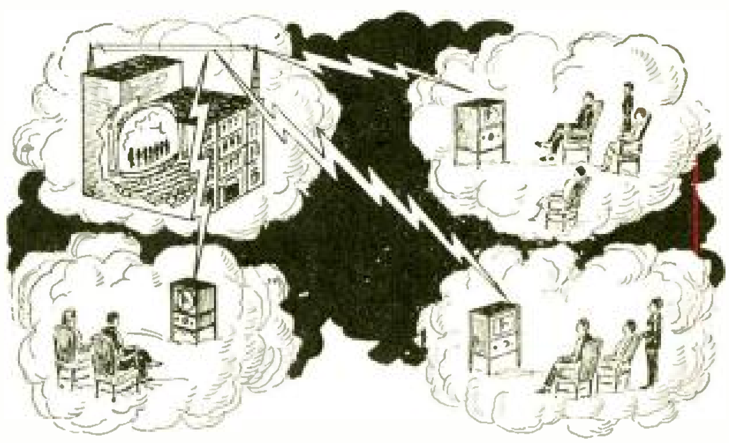
The incoming radio signals, amplified, are applied to the picture dots of the lantern slide to change the picture every fifteenth of a second.

Such a lantern slide constitutes a new form of motion picture, controlled in its changes by radio signals which represent an object or scene at the distant broadcast transmitter.

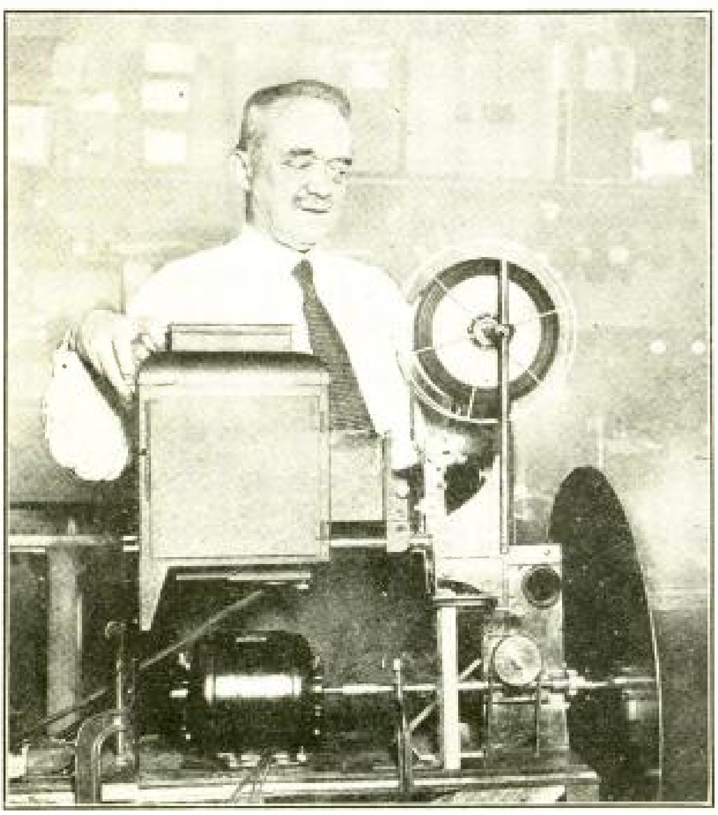
When this is perfected, every theatre may then exhibit motion-picture stories distributed from Hollywood by radio instead of by film; and events may be seen on the theatre screen, and on a small screen in the home, at the instant of their happening.

Mr. Jenkins and one of his staff, Mrs. Sybil Windridge, who is shown seated before one of the inventor's television receivers. The dials tune in the signal—the image appears at the large lens at the top of the cabinet.

We have all enjoyed the music and speech broadcast from the theatres, but there has always been the visual element lacking. This is about to be supplied by the "home televisor".



Tomorrow, we shall, if we feel so disposed, sit in our homes and enjoy the theatre, via television.



Mr. C. Francis Jenkins beside one of his television (motion picture) transmitter pick-ups.

HAROLD A. LAFOUNT

Uncle Sam's View of Television

Here's the latest official news from Uncle Sam, stipulating just what bands in the ether the television transmitters can occupy, along with a table of wave lengths and frequencies, as well as lines per frame or number of disc holes required to receive image.

By Harold A. Lafount
Member of the Federal Radio Commission,
Washington, D. C.

THE last general International Radio Conference, held in Washington, did not make specific frequency assignments to visual broadcasting; but later, at a North American Conference held at Ottawa, Canada, the following frequencies were set aside for television assignments:

2000 to 2100 kilocycles
2100 to 2200 "
2750 to 2850 "
2850 to 2950 "

with the additional frequency band 2200-2300 kilocycles, available for assignment in the United States, in such geographical regions as the South and Southwest, where such assignments would not interfere with the use of the same frequencies for other purposes in Canada or any other nation on the North American Continent, or in the West Indies. It will thus be seen that there are only four frequency bands, each 100 kilocycles wide, for general allocation in the United States.

The Federal Radio Commission has encouraged legitimate experimental research work in television. The present frequency assignments to television stations are made upon a purely experimental basis. All such stations are subject to the provisions of General Order 64, which requires the filing of regular quarterly reports showing the technical progress made by the station during the previous quarter.

The following list shows the television stations now licensed on an experimental basis by the Federal Radio Commission, together with the call letters, frequencies and power used. As will be seen, there are at present eighteen companies engaged in television research work, operating twenty-two stations:

Television Time Table

Call Letters	Lines per Frame	Power in Watts	Company	Location
			2000-2100 kc.	
W3XK	48	5000	Jenkins Laboratories	Wheaton, Maryland
W2XCR	48	5000	Jenkins Television Corp.	Jersey City, N. J.
W2XAP	48	250	Jenkins Television Corp.	Portable
W2XCD	48	5000	DeForest Radio Company	Passaic, N. J.
W9XAO	45	500	Western Television Corp.	Chicago, Ill.
W2XBU	48	100	**Harold E. Smith	Nr. Beacon, N. Y.
			2100-2200 ks.	
W3XAK	60	5000	National Broadcasting Co.	Bound Brook, N. J.
W3XAD	60	500	R C A Victor Company	Camden, N. J.
W2XBS	60	5000	National Broadcasting Co.	New York, N. Y.
W2XCW	—	20000	General Electric Co.	South Schenectady, N. Y.
W8XAV	60	20000	Westinghouse Elec. & Manufacturing Co.	East Pittsburgh, Pa.
W9XAP	45	1000	Chicago Daily News	Chicago, Ill.
*W2XR	48	500	Radio Pictures, Inc.	Long Island City, N. Y.
			2750-2850 kc.	
W2XBO	—	500	United Research Corp.	Long Island City, N. Y.
W9XAA	48	1000	Chicago Fed. of Labor	Chicago, Ill.
W9XG	—	1500	Purdue University	West Lafayette, Ind.
W2XDK	—	500	Atlantic Broadcasting Co.	New York, N. Y.
			2850-2950 kc.	
W1XAV	48	500	Shortwave & Television Lab., Inc.	Boston, Mass.
W2XR	48	500	Radio Pictures, Inc.	Long Island City, N. Y.
W9XR	24	5000	Great Lakes Broadcasting Company	Downers Grove, Ill.

** 1 hour daily (1 to 2 P. M.)
* Subject to operation between 5 and 7 P. M.
Subject to shared operation after 10:00 P. M. and before 2:00 P. M. by agreement with other licensees within 150 miles of W2XR.

Because of the very few channels available in the medium-high frequency band (1500 to 6000 kilocycles), some thought has been given to the development of television in the very high-frequency part of the spectrum; *i.e.*, in the bands from 30.000 to 400,000 kilocycles. Should these very high frequencies prove useful for television, a considerable step forward in the development of the art will have been made; as the wide band used in television can be more easily accommodated on these frequencies.

The main purpose of the regulations, which are promulgated from time to time by the Commission, is to encourage and foster technical progress in television in order that the public may be better served thereby.

A SHORT COURSE in

The editors feel sure that the reader will greatly appreciate this short course in Television, which has been specially prepared by Mr. Nason, an electrical engineer who has been closely associated with the growth of American television. This first lesson covers the action of photo-cells, neon tubes and scanning.

LESSON 1.

SINCE the first successful attempts of man to communicate by electric means, the dream of scientists has been television—seeing at a distance. It is an unfortunate fact that the majority of these

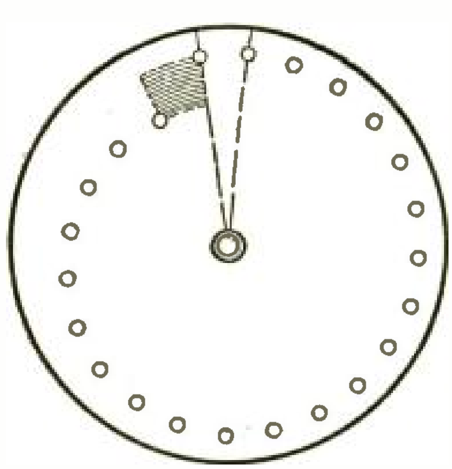


Fig. 1. The Nipkow scanning disc—each hole scans one progressive path as indicated.

dreamers have tried to take too much at a stride—have been unwilling to work out the basic principles of an art before attempting its perfection. It is true, we all know, that modern science approaches apace the dream of the ancient alchemist—but the transmutations which have been performed have come, not because some greedy individual wished to change a pound of lead into a pound of gold, but because some learned scientist labored long and proudly far from the world of men in the realm of the Electron. So it comes that, with a basic understanding of the elementary constitution of this universe, the dreams of centuries are about to be fulfilled.

Our Scanning System 47 Years Old

We have in a measure succeeded in the search for distant vision; but it has come only with an increased knowledge of the properties of electric circuits, of the electron and of the nature of light. Forty-seven years ago Nipkow invented a system for analyzing a scene in such a way that it might be translated with the aid of a photo-sensitive device into an electric current. Undoubtedly, had science been as far advanced in electron theory, as it is today, television would have become an established fact at that time.

By means of the Nipkow disc—a simple version of which appears as Fig. 1—the scene is so analyzed that it appears to the photo-electric device as a single strip, varying in light values along its length. If an intensely-illuminated scene is concentrated upon the disc by means of a camera lens this image will be scanned in such a manner as to produce a continuous but varying light upon the photo-electric cell or photo-tube (Fig. 2). The current produced by this light may be amplified to any desired degree, by means of vacuum-tube circuits, such as are employed in radio telephony. As we shall see later, the electric current produced does not differ greatly from those used in radio and, with certain minor changes, the technique of radio engineering serves in the design of television equipment.

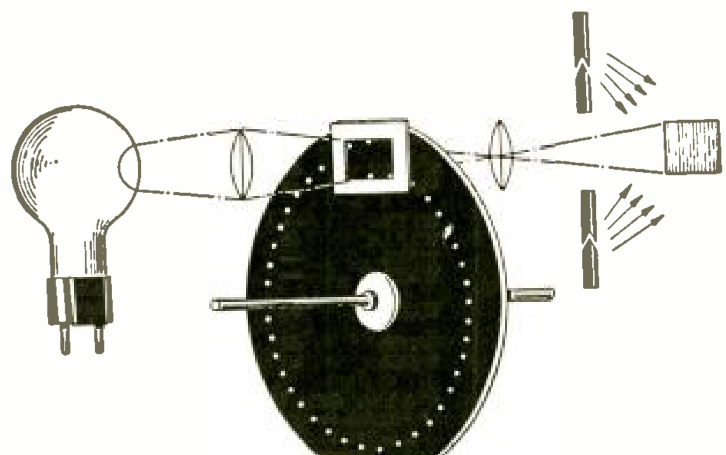


Fig. 2, at left, illustrates how the object to be televised (transmitted) is illuminated by light from say two sources; the reflected light beams are transmitted through the lens, scanning disc, diaphragm, second lens and on to photo-cell at extreme left. This cell converts the light pulsations into electric current variations.

The Photo-Cell—How It Works

Before we enter into the study of television we must become acquainted with certain apparatus and certain effects peculiar to the art. The phototube, in particular, is of interest because of its remarkable possibilities and because of its romantic past. Heinrich Rudolph Hertz (who gave his name to the waves which later became known as Radio) was one of the first physicists to note the effect which light had upon certain substances and phenomena. Hertz, although his name is not connected with the subsequent development of the photo-tube, discovered the fact that certain substances when subjected to the influence of light rays gave off electricity. The degree of this electron emission is proportional to the intensity of the light falling upon the surface, and also upon the character of that light. That is to say, certain substances are more sensitive to one color range of light than another—light being defined as to wavelength in much the same manner as radio waves, except for the fact that the light waves are much shorter.

The meter would be an unwieldy unit in this case and we measure the wavelength of light in "Angstroms". The Angstrom is a unit one ten-bil-

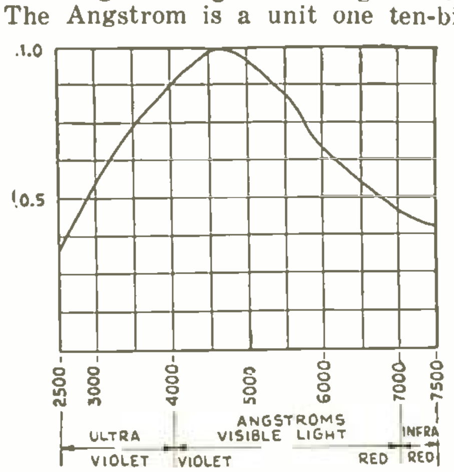


Fig. 3. Curve showing relative sensitivity of a certain photo-cell to different colors.

Television

By C. H. W. NASON

Television and Short Wave Expert.

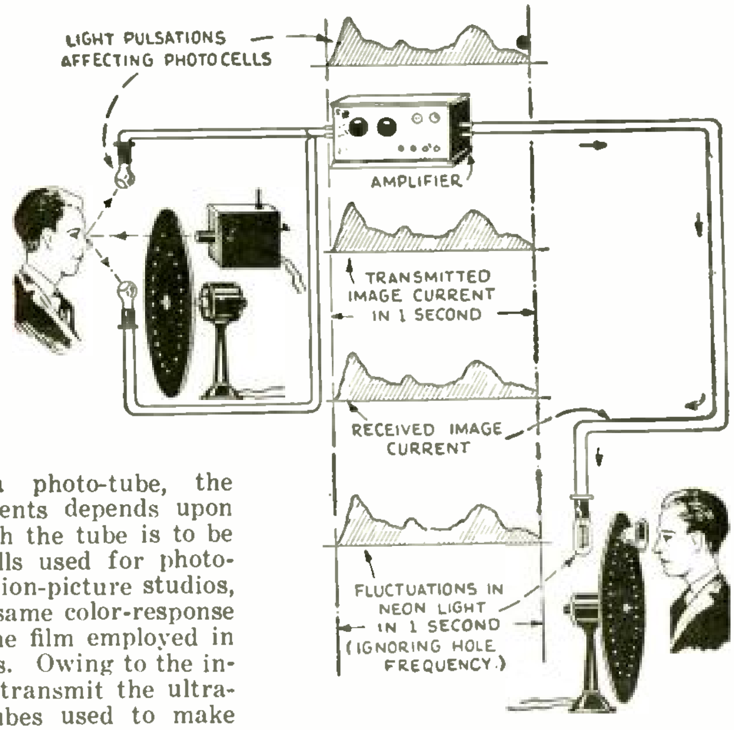


Fig. 6. Approximate representations (in graphic form) of what goes on in a complete television system.

lionth of a meter in length (taking "billion" in the American sense of one thousand million, and not one million million as it is defined in Europe).

The color-sensitivity curves of photo-tubes are not unlike the curves of audio-frequency transformers, as you may see from Fig. 3, where the relative sensitivity of a particular photo-tube is plotted against wave-length of light. In constructing photo-tubes, a thin layer of potassium hydride is deposited on the wall of a glass bulb. This layer constitutes the cathode or electron emitting element. The other electrode—the anode—is usually a wire loop mounted in the center of the tube, directly between the sensitive wall or cathode and a transparent window in the coating of the bulb.

When light is caused to fall upon the cathode, a stream of electrons is given off; this is accelerated toward the anode because of the fact that the latter is maintained at a high positive voltage with respect to the cathode. (The electrons are accelerated toward a positively-biased point in all electronic devices.) The path between the two electrodes becomes conductive, in a degree depending upon the number of electrons leaving the cathode; this factor is, in turn, dependent upon the intensity of the light flux incident upon the sensitive surface. This light flux is measured in "lumens"; the lumen is—simply stated—the amount of light falling upon a surface of one square foot from a one-candle power source at a distance of one foot.

In designing a photo-tube, the choice of the elements depends upon the service in which the tube is to be used. In those cells used for photometric work in motion-picture studios, the cells have the same color-response characteristic as the film employed in making the pictures. Owing to the inability of glass to transmit the ultra-violet rays, the tubes used to make

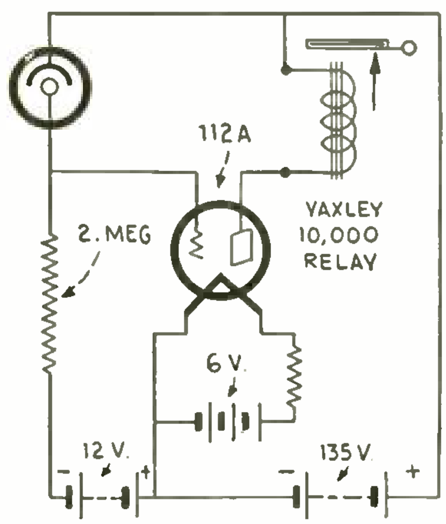


Fig. 4. How a photo-cell may be connected to operate a relay.

measurements in this range are constructed from fused quartz.

Use of Rare Gases In Cells

After the sensitive surface has been formed on the wall of the tube it must be "pumped" or exhausted to a high degree of vacuum. Cells requiring a high output are filled with some inert gas such as argon, neon, or helium. A secondary effect, due to the ionization of the gas during the electron flow, gives rise to a high current through the tube. It is an unfortunate fact that, although the electron emission is instantaneous, the ionization of the gas is subject to some lag. For this reason, high-sensitivity gaseous tubes cannot be used in services where great rapidity of action is required. Some gas-filled cells will operate at the frequencies required in talking motion-picture work, but so far none have been developed for television.

There are three methods of operation in which we may utilize a photo-tube. In the first, the photo-tube is utilized to close or open electrical circuits by means of relays. The amateur constructor can find many uses for the tube in this method of operation—daylight alarms—light switches which operate at dusk—garage-door openers which operate by the head-light glare of the car—these are but a few of the things that the photo tube can do when connected in the manner shown in Fig. 4.

The cell can be used in conjunction with D.C. amplifiers—(the Loftin-White circuit will amplify direct-current changes) to record daylight intensity, in conjunction with a recording milliammeter. These daylight recorders are a part of the equipment in every Weather Bureau observatory, and are used to keep a record of the sun's rays throughout the day.

Amplifying the Photo-Cell Current

The use of the photo-tube which is most interesting to us is as a generator of alternating current; this is the mode in which the tube is operated in

(*Continued on page 71*)

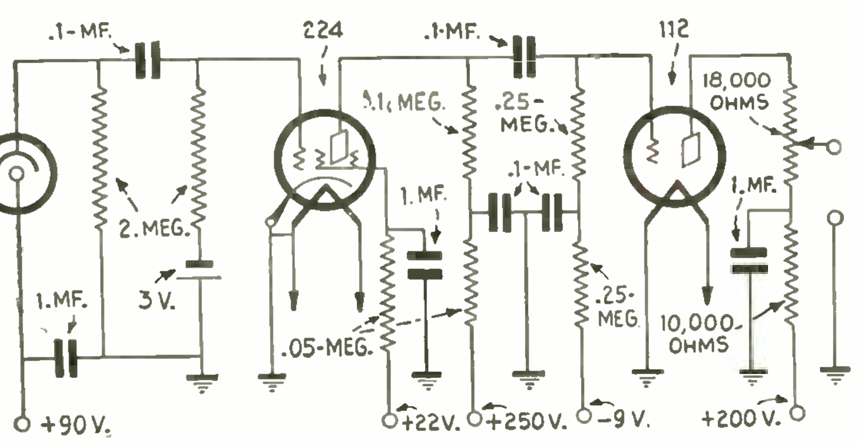


Fig. 5. Typical television amplifier for use with photo-cell.

"Large Image" Received by Virtue

New BRITISH TELEVISION

A new television "movie" transmission and reception scheme has been perfected and demonstrated by engineers of the Victor Phonograph Company (His Master's Voice, "H. M. V.") of England. The picture is

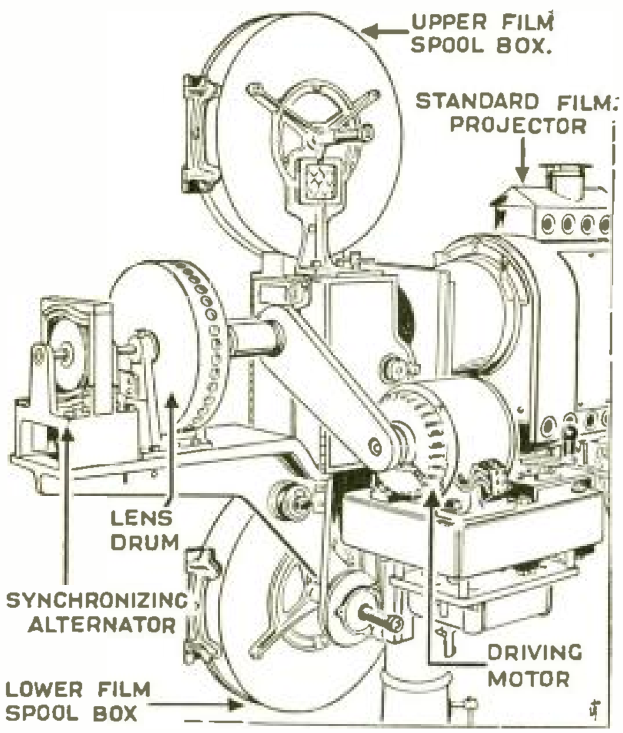


Fig. 1. The "H-M-V" movie film transmitter for television, which scans each image or frame in five sections.

THE principles which have been employed in attempting television up to the present moment are well-known to many; but, in order to indicate the lines upon which the H. M. V.* Research Laboratory experts have made a new scientific attack on this absorbing problem, a brief recapitulation is considered necessary.

A close examination of any printed "halftone" illustration discloses the fact that the picture is actually made up of an enormous number of small dots which vary both in size and blackness. If there are a very large number of these dots to a given area, the texture of the picture is finer, and detail is more easily achieved. If, on the other hand, these dots are very much fewer, the picture is found to be lacking in detail and graduation.

The principle on which the motion-picture projector and the camera operate, and the principle which must be considered in dealing with the transmission of moving objects, are based upon the fact that the eye tends to retain an image after the original object has been, as it were, extinguished. Without this "persistence of vision," no moving-picture technique would be possible; and, to give the illusion of a continuous moving picture, at least twelve pictures per second must be passed before the eye or an objectionable flicker will be noticeable.

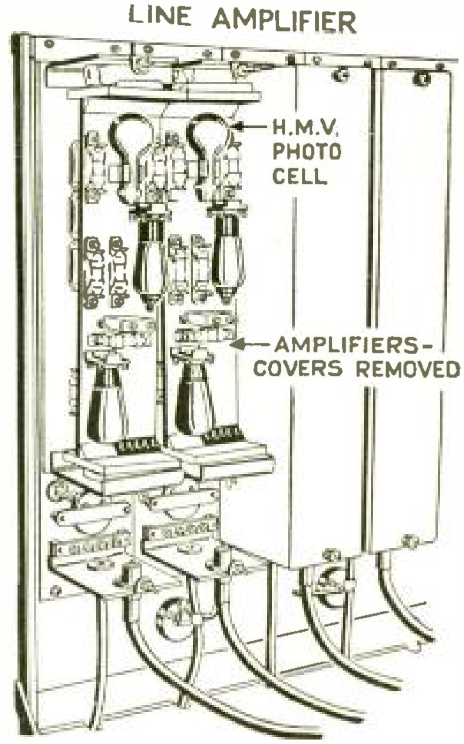
It follows, therefore, that in a picture in which there may be as many as 10,000 of the small dots mentioned above, each of those small dots must be reproduced 12 times a second in order to give the transmitting image the illusion of moving, and yet to make use of the optical effect of "persistence of vision."

This means that 120,000 individual signals will have to be transmitted per second; although, in point of fact, a picture transmitted with as few as 120,000 signals per second must be lacking in definition.

There has been a tendency in the television system which have been developed up to the present, to concentrate on reducing the number of signals per second required for television; with the object of reducing the maximum number of signals per second (or modulation-frequency), so that the system can be conveniently operated under the present broadcasting conditions.

This policy has had the effect of restricting the scientific development of the perfection of a picture, without regard to the number of points which it might be necessary to transmit per second.

The advance development section, of the "His Master's Voice" research department, decided to concentrate their efforts on producing as perfect a picture as possible, in order to ascertain how much real entertainment value can be secured. Hitherto, the all-important question of entertainment value has been forced into a position of secondary importance by scientific considerations. Without entertainment value, television must fail as a popular commercial proposition. It is felt that, when this has been achieved, steps may then be taken by a process of careful scientific elimination to develop, on commercial lines, what has already been perfected scientifically.



REAR OF PHOTO CELL AMPLIFIERS

Fig. 2.

The "H. M. V." System

The general arrangement of the system will be gathered from the diagrams of the apparatus. The two principal points which have been concentrated upon to develop this system are:

(1) In order to get definition, a large number of picture-elements per unit-area of the picture are required.

(2) In order to get sufficient illumination for an image which could be said to possess entertainment value, some means of modulating the powerful light had to be found. The comparatively feeble

* "His Master's Voice"—The Gramophone Company, Ltd., England.

of Multiple Light Valve and Arc

"H-M-V" SYSTEM

scanned separately in five sections, the image currents are caused to operate five light valves, which modulate the light from an arc, yielding a large and brilliant reproduced image 20 by 24 inches on the screen.

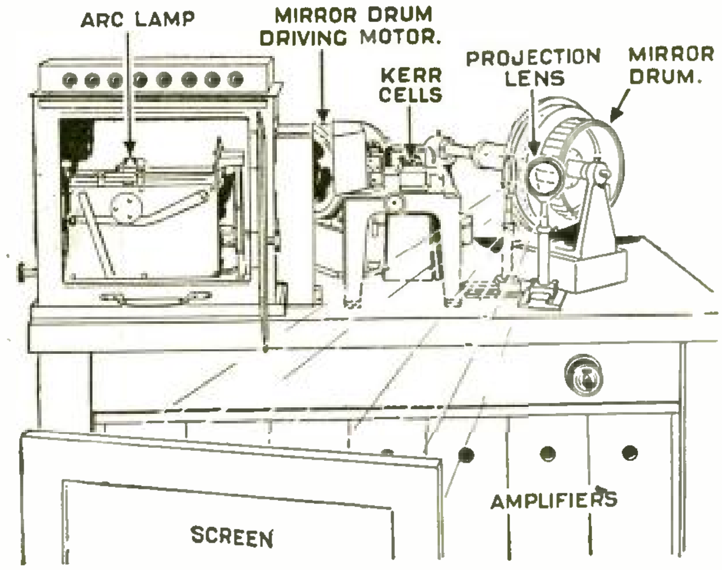


Fig. 4. The "H-M-V" television reproducer, which utilizes five light valves to modulate the arc beam and yield a 20 by 24 inch brilliant picture.

illumination from the glow-discharge lamps, which have up to now been used, have not proved themselves sufficient; in spite of the fact that some special devices of glow-lamps have been developed.

The "H. M. V." engineers set themselves the problem of employing the light from a powerful arc lamp, and designing apparatus which would actually control so powerful a source of illumination—no easy task. This has made it possible to view the "H. M. V." televisor screen from a far greater distance, and over a far wider angle, than has ever been possible before.

In order to get definition, a very much greater number of spots or points of scanning light are employed in this system. In order to reduce the total number of spots per second, the picture is divided into five sections, each section being scanned separately, and the signals from each are transmitted along a separate channel; the total scanning of the five sections being then re-assembled on the receiver screen.

There are, therefore, two advantages which arise from the use of a multiplicity of picture-transmission scanning channels, which can be set against the disadvantages of a rather more cumbersome system.

(1) If five channels, each transmitting a fifth of the picture, are used to transmit a picture having in it 15,000 points, each of which must be transmitted 12½ times per second, a modulation frequency of 23,750 per channel is required. The design of low-frequency amplifiers, capable of handling with a straight-line relationship such a high frequency, is in itself a very considerable scientific achievement.

(2) The use of five transmission channels means that there will be much more light available to illuminate the receiver screen than if only one channel were used to produce the same definition.

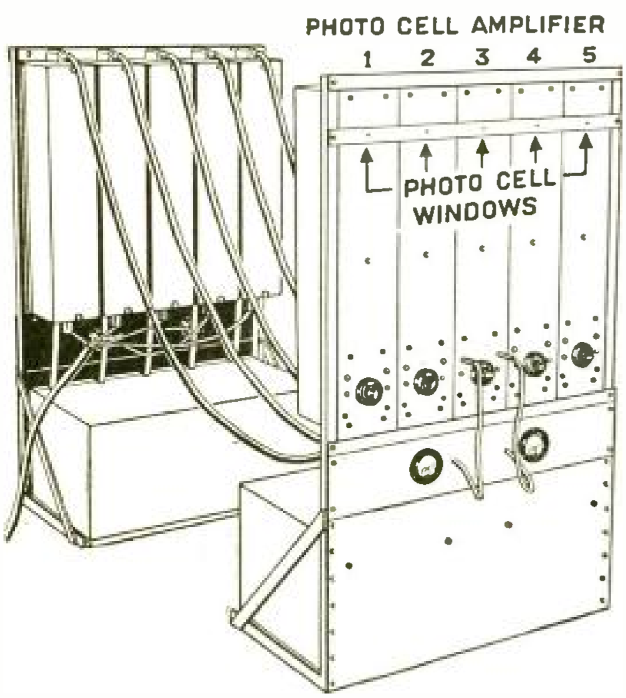


Fig. 3. Appearance of the five-section, photo-cell amplifier, each photo-cell having its own amplifier, thus reducing the frequencies to be carried by each amplifier.

General Arrangement of Transmitter

As will be seen from Fig. 1, the film is passed through an intermittent motion-picture projector of the standard type; and the light from it is reflected through a series of lenses mounted on a revolving drum which, for every revolution it makes, completely scans the picture in five sections.

The light reflected through the revolving lenses is thrown, in turn, upon five photoelectric cells, each taking care of a strip of the picture, having a width of one-fifth of the total. This arrangement enables the output of five photoelectric cells, instead of the single cell normally used, to be utilized for controlling a brilliant light source at the receiver end.

The output from each photoelectric cell is amplified by two tubes in the photo-cell rack shown in Fig. 2; these signals are in turn amplified by five further amplifiers, having two tubes each, in order that the output from the photoelectric cells may have sufficient strength to pass down the necessary intervening channels. Fig. 3 is the complete view of these photo-cell and amplifier racks.

General Arrangement of Receiver

Fig. 4 shows a general view of the receiving end of the system. The signals received from the transmitting station are here further amplified by specially-designed amplifiers having a far wider frequency-characteristic than would be possible with one channel only. By this arrangement, an amplification of nearly a million is secured.

The intensity of the transmitted spots of light will vary, according to whether each spot relates to a light or a dark portion of the picture. The light from the arc lamp, therefore, is modulated, or graduated in sympathy,

(*Continued on page 71*)

E. E. SHUMAKER, *President, R. C. A. Victor Company, Inc.*

TELEVISION—ITS FUTURE

What is the viewpoint of the large radio set manufacturers toward Television? This question was propounded to Mr. Shumaker, head of the famous concern which makes thousands of sets daily—and here's his answer.

By E. E. Shumaker
President R. C. A. Victor Company, Inc.

THE American public, accustomed as it is to prodigies of scientific and technical achievement, seldom realizes that the engineering marvel that is heralded today has been preceded by years of research and experiment. Television is a case in point. The almost fantastic possibilities of this wonderful, new radio development have caught the fancy of the public, like nothing that has been produced during the past few years; and the public, according to its habit, has jumped at the conclusion that, because television is a laboratory success, tomorrow may see its introduction to the home. Unfortunately such is not the case.

How Soon Shall We Have "Home" Television?

The RCA Victor engineers have been working on *television* for a number of years, and have made truly phenomenal strides towards its practical use. We have overcome many of the technical barriers, and already have made successful demonstrations; but the apparatus necessary to carry out successful television today is totally unfitted, both by its character and by its bulk, to installation in homes. In a word, television is a laboratory success, but appears to be a long way from practical and general use. It is impossible to say how many months or years may intervene between the present stage of television development and its ultimate availability for home use.

Quite apart from the development of television receivers, is the problem of equipment for broadcasting television. It will take time and a great deal of money to parallel the present transmitting equipment of the broadcast networks with equipment for broadcasting visual impressions; and this would be true, and would be another element of delay in the coming of television, even if the home television receiver were now ready for presentation—which it decidedly is not.

The erection and cost of a multitude of expensive transmitting stations, the proper (and complicated) choice of wavelengths for distortion-free transmission, the building of compact, attractive, simple, and reasonably-priced receivers which will operate automatically and give a picture of satisfactory size, color, brilliancy, and detail—these are vital factors in the problem television presents. The problem is literally one hundred times harder than that of radio-telephone broadcast transmission and reception; and it is taxing to the utmost even the long experience and high intelligence of the profound research and development workers who devote their days and nights to the solution of this fascinating problem, whereby the world may see as well as hear through radio broadcasting.

The possibilities of Television seem almost magical.* —*E. E. Shumaker.

The "Television" Program Problem

There remains also the problem of the program for television. What sort of a program shall it be, how shall it be coordinated with the musical or speech program and, above all, who will pay for it? Must actors and actresses be handsome, as well as mellow-voiced? Must elaborate costumes and complicated backgrounds and sets be provided? Are we inheriting all the problems of the motion-picture producing industry? Apparently we are, and these things are not to be solved in the next few months. It will be fortunate, indeed, if they are solved in any measure in the next few years. However, the public may be assured that television is coming, and that RCA Victor will not only bring it to its highest development, but will present it when satisfied that it is in practicable form.

Meanwhile, radio is providing entertainment that has reached the final stages of perfection. Radio receivers of today bring broadcast entertainment into the home with a beauty and realism of performance that are practically indifferent to distance and the congestion of the air channels. Tone quality, sensitivity and selectivity of these ultra-modern receivers have been brought to a degree beyond which radical improvement is not possible.

Probable Effect of Television on Present-Day Receivers

We have noticed a certain amount of public curiosity, as to what effect television, when it does come, will

(*Continued on page* 76)

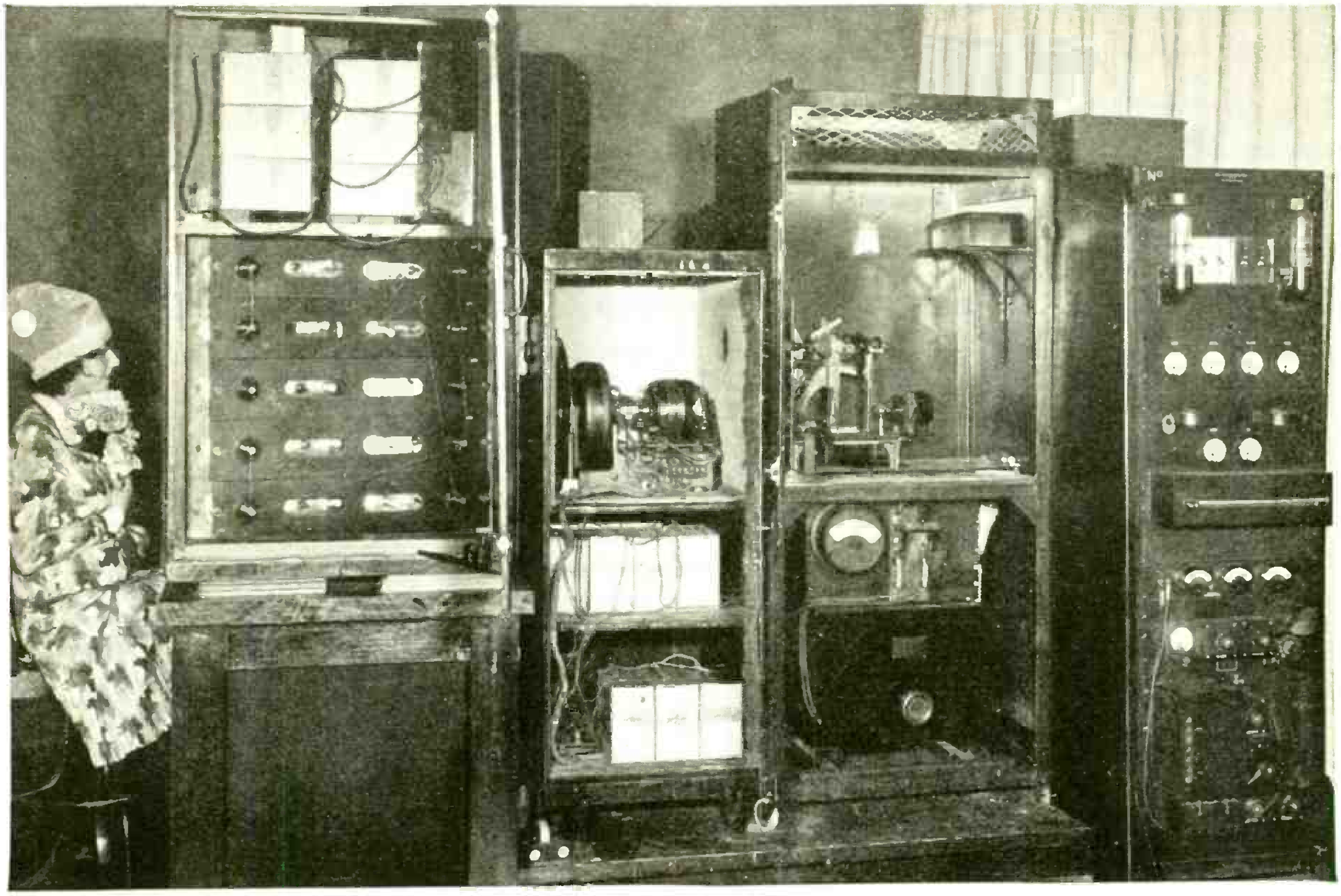


Fig. D

Side view of transmitting scanning disc, its motor, synchronizing motor-generator, power amplifiers, motor and amplifier controls, direct-current supplies, lenses, translucent glass, filters, and photoelectric cells with doors of cabinets opened. All but the cells and the box containing the diffusing glass and filters are the same as in the transmitting units used in the original demonstration of monochromatic television. The girl subject wears apparel of gay colors.

TELEVISION in NATURAL COLORS

A description of the use of sodium photoelectric cells and argon-neon lamps for the demonstration of three-color television over wires in the Bell Telephone Laboratories.

By Dr. Herbert E. Ives
Research Department, Bell Telephone Laboratories

THERE are two methods of television transmission in general use; one by radio and the other by wire. The laboratory usually develops its equipment "on wire" and transfers it to a radio circuit after the initial difficulties have been ironed out. This was the plan followed in the development of natural-color television, the demonstrations to the representatives of the press being given over a wire.

Reproduction in the monochrome of the orange-red neon lamp is an old accomplishment. The new feature, combined blue, green and red response, is obtained by the use of the

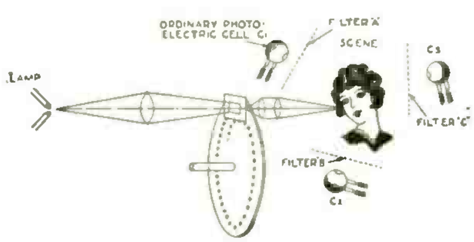


Fig. A

In this is seen the ordinary potassium light-sensitive cell, C1, to which has been added filter "A." Special sodium photoelectric cells C2 and C3, in conjunction with filters "B" and "C," are required to obtain additional color selection.

old machine (driving motors, scanning discs, synchronizing systems, and the same amplification circuits) plus a special design and arrangement of photoelectric cells and "noble gas" (neon and argon) lamps.

The Olpin-Stilwell Cell

Through the work of A. R. Olpin and G. R. Stilwell there has been developed a new kind of photoelectric cell (Fig. B) *which uses sodium in place of potassium.* Its active surface is sensitized by a complicated process using sulphur vapor and oxygen, instead of by a glow discharge of hydrogen as with the former type of cell.

The response of the new cell to color, instead of stopping in the blue-green region, continues all the way to the deep red. Because the former potassium cells were responsive only to the blue end of the spectrum, objects of a yellowish color appeared darker than they should, and the tone of the reproduced scene was not quite correct. (This disadvantage applied particularly to persons of dark or tanned complexion.) When the new cells are used in the original television apparatus but with yellow filters—similar to those used in photographing landscapes in order to make the blue sky appear properly dark—this defect is corrected and the images assume their correct values of light and shade, no matter what the color of the object or the complexion of the sitter.

The development of color television has been greatly simplified by the fact that, so far as the eye is concerned, any color may be represented by the proper mixture of just three fundamental colors—red, green, and blue (this fact was utilized in the development of color photography).

The method of "beam scanning" used in regular television has been employed.

Color Filters

To apply this method to *color* television, three sets of photoelectric cells, C1, C2 and C3, in Fig. A, are used in place of the one set used before. Each of these sets is provided with color filters ("A," "B," and "C") made up of sheets of colored gelatine. One set has filters of an orange-red color which make the cells "see" things as the hypothetical red-sensitive nerves of the retina see them; another has yellow-green filters to give the green signal; while the third has greenish-blue filters which perform a corresponding function for the blue constituent of vision.

The photoelectric-cell container, or "cage," has been built into a new form. (Fig. C.)

Balancing the Color Pick-Up

In the new photo-cell cage twenty-four cells are employed; two with "blue" filters, eight with "green" filters, and fourteen with "red" filters. These numbers are so chosen, with respect to the relative sensitiveness of the cells to different colors, that the photo-electric signals are of about equal value for the three colors. The cells are placed in three banks; one bank in front of and above the position of the scanned object, one bank diagonally to the right, and another diagonally to the left; so that the cells receive light from both sides of the object and above. In placing the cells they are so distributed by color as to give no predominance in any direction to any color. In addition, sheets of rough pressed glass are set up at some distance, in front of the cell containers; so that the light *reflected from the object* to the cells is well diffused. (Fig. F.)

The television signals produced in the color-sensitive photoelectric cells through the color filters are not different electrically from those used in monochromatic television. *Three sets of amplifiers are required, one for each color, and three transmission channels in place of one;* but the transmission channels are exactly similar to those which were used with *the same scanning disc before.* (Fig. D.)

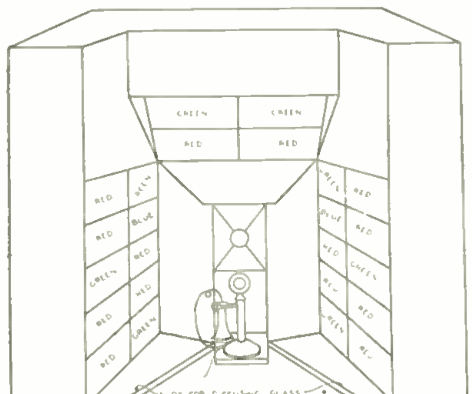


Fig. C

The grouping of the color filters, in front of the color-sensitive photoelectric cells, is shown in this perspective sketch of the television transmitter.

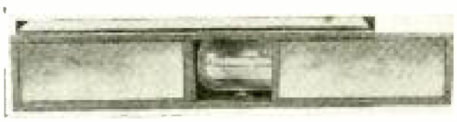


Fig. B

Light-sensitive cell with filter drawn partly out. Banks of these are used. (See Fig. C.)

Fig. E

Dr. Ives adjusting the "volume and quality" of the visual output of the receiver. The largest amplifier tubes are at the right.

Comparison Between Scanning Methods

It may be well to point out that there are two fundamental systems in use for the process of picture "pick-up"; one is just the reverse of the other. In one method, the scanning disc breaks into lines, the light reflected from the subject; in the other (Fig. A) the disc projects, as lines, the illumination from the light source. In the former method the subject is exposed to a continuous light of high intensity which results in what is equivalent to a sunburn. In the latter method, the subject is rapidly *scanned by a pencil of light* and "sunburn" does not result. This is the scheme adopted by the Bell Laboratories, as most satisfactory.

Fig. F

"Symphony in Blue"—green, red, and all the other colors of the rainbow.

It will be noted that the location and relation of the photoelectric cell and the light source are reversed in the two methods; the *photoelectric cell* is back of the scanning disk in the former, and the *light source* replaces it in the latter.

As each "color" (frequency) has its own amplifier, the "color gain" may be controlled and the colors "mixed" in much the same manner in which voice frequencies are controlled; that is, by manipulation of "gain" and "fader" circuits (Fig. E).

For color television, the three images must be received in their appropriate colors, and viewed simultaneously and in superposition. The first problem was to find light sources which, like the neon lamp previously used, would respond with the requisite fidelity to the high-frequency signal of television, and at the same time give red, green, and blue light. With such lamps available, a decision would have to be made as to how the three colors could best be combined to form a single image.

Several methods of reception are possible. For displaying the transmitted image to a large audience a big, zig-zag grid could be employed; but it would consist of three parallel tubes, instead of a single one used in earlier television demonstrations in one color.

Thus far the television images have been received in a manner similar essentially to the method for monochromatic television. The surface of a disc similar to that used at the sending end is viewed, and the light from

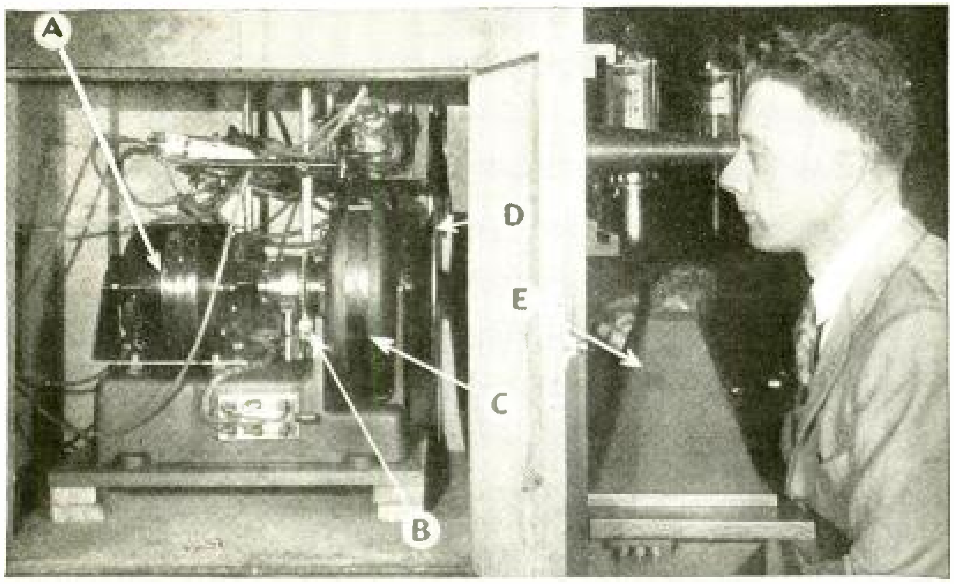


Fig. H

View of the receiver equipment: A, driving motor; B, gears for framing the image; C, synchronizing motor-generator (which connects to a similar part in the transmitter, variation in the speed of either causing a reaction which tends to equalize the speed); D, 50-hole, 1080-r.p.m. disc; E, light shade. The lamps and special (encased) mirrors are at upper right.

the receiving lamp is focused on the pupil of the observers' eye by suitable lenses.

To combine the light of the three lamps, they are placed at some distance behind the scanning disc and two semi-transparent mirrors are set up, at right angles to each other, but at 45 deg. to the line of sight (as shown in the upper right of cabinet, Fig. H). One lamp can be viewed *directly through* both mirrors, and one lamp is seen *by reflection* from each, as illustrated by the schematic diagram (Fig. G).

Obtaining Blue and Green

The matter of suitable lamps to provide the red, green, and blue light has required a great deal of study. There is no difficulty about the red light; because the neon glow-lamp which has been used previously in television can be transformed into a suitable red light by interposing a red filter. For the sources of green and blue light, however, nothing approaching the efficiency of the neon lamp was available. The decision finally made was to use another one of the "noble gases"—*argon*—which has a very considerable number of emission lines in the blue and green region of the spectrum. Two argon lamps are employed; one with a *blue filter* to transmit the blue lines, and one with a *green filter* transparent to the green lines of its spectrum.

These argon lamps, unfortunately, are not nearly so bright as neon lamps and it was, therefore, necessary to use various expedients to increase their effective brilliancy. To work at high current intensities, special lamps were constructed with long narrow cathodes, made hollow so that streams of cold water could cool them. The *cathode is viewed end-on;* this greatly foreshortens the thin layer of glowing gas and thus increases its apparent brightness. Even so, it is necessary to operate these lamps from a special output amplifier to obtain currents as high as 200 *milliamperes.*

The Receiver

The receiving apparatus, at present, consists of one of the 16-inch television discs used in earlier experimental work. Behind it are the three special lamps and a lens system which focuses the light into a small aperture in front of the disc. The observer, looking into this aperture, receives (through each hole of the disc as it passes by) light from the three lamps—each controlled by its appropriate signal from the sending end. When the intensities of the three images are properly adjusted, he sees a combined image in its true colors, and with the general appearance of a small colored motion picture.

Technical Difficulties

Satisfactory television in colors is a far more difficult task than monochromatic television. Errors of quality which would pass unnoticed in an image of only one color may be fatal to true color reproduction, where three such images are superimposed and viewed simultaneously. In three-color television, any deviations from correct tone rendering destroy the balance of the colors; so that, while the three images might be adjusted to give certain colors properly, others would suffer from an excess or deficiency of certain of the constituents. A further source of erroneous color exists at the scanning end; *if the light from the object is not distributed equally to all the cells, the object will appear as though illuminated by lights of different colors shining on it from different directions.*

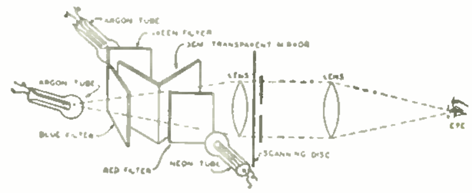


Fig. G

The lens picks up at once red light from the neon tube, reflected from one mirror; green from one argon tube, also reflected; and blue, from the other argon tube, which shines through both mirrors.

Color television constitutes a definite further step in the solution of the many problems presented in the electrical communication of images. It is, however, obviously more expensive, as well as more difficult, than the earlier monochromatic form; for it involves the use of extra communication channels as well as additional apparatus.

$50.00 For a New Word—Why "Lookers-in"?

HERE'S your chance to earn fifty dollars very easily by using your wits for a few moments and write the editors what word you would suggest to substitute for the clumsy term "LOOKERS-IN". For example in radio broadcast reception we have the "Listeners-In" or "B. C. L's." as they are sometimes called. A number of names are easily called to mind, such as: SEERS-IN—TELEVISORS — RADIO-EYES — RADIOVISORS — RADIOVISIONIST — RADVISON —VIS-RADS—VIS-TELS.

These names have already been suggested so do not send in any of these. However, we are sure that among our many thousands of readers, some one will suggest the perfect word, which will serve as a good substitute for "LOOKERS-IN".

Here are the rules:

The word should be euphonious, sound well and be short rather than long. This contest closes Noon—May 1st, 1931. All letters containing entries to this contest must be postmarked not later than the time specified. In the event that two or more persons should submit the name selected as the best, each of those persons will be awarded the full amount of the prize offered.

All letters must be addressed to: "New Word" Editor, TELEVISION NEWS, 98 Park Place, New York City, N. Y.

The LATEST In Transmitting

By D. E. Replogle
Assistant to the President, Jenkins Television Corporation.

Are you familiar with the latest technique in picking up the television image in the studio? Do you know what the "flying spot" and "direct-vision camera" are? If not, read Mr. Replogle's enlightening and timely article. The author is one of a group of men who are bringing television broadcasting rapidly to the front in this country.

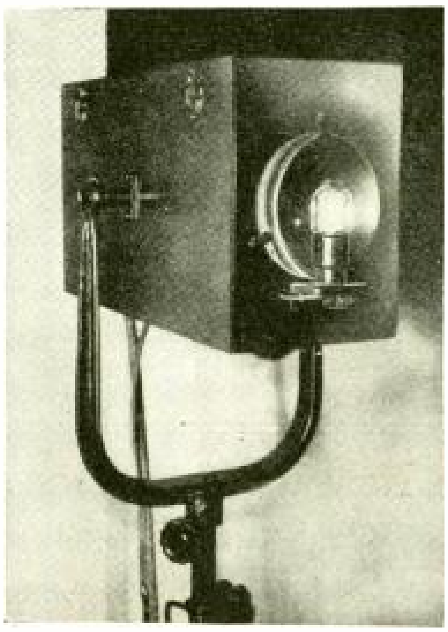
D. E. Replogle, Assistant to the President, Jenkins Television Corp.

AS detailed in the opening chapter of a new book on broadcasting, published by Dr. A. N. Goldsmith and Austin Lescarboura, the reader is struck with the early struggles of radio broadcasting to achieve a place in the sun. Technical difficulties, financial difficulties, public skepticism were thoroughly effective stumbling blocks in the way of those early pioneers. On the other hand, television to date has had a comparatively easy birth.

Although handicapped by many of the same problems, it has been possible within the last two years to build *television broadcast* stations which are capable of quality sight broadcasting. Comparable with the 1921 and 1922 days of sound broadcasting, the problems confronting a television broadcaster are as interesting as those offered by its twin, sound broadcasting.

In sound broadcasting, the quality of program could not be built up until the number of listeners increased; and it was difficult to increase the number of listeners until the quality of broadcasting had been raised to a real entertaining stage. The broadcasters said, "Show us the listeners and we will put on the features"; and the listeners said, "When there are good programs on the air, we will listen in." The courageous efforts of the early radio broadcasters are certainly to be commended; for it was their foresight in going ahead with the programs that eventually built up the gigantic listening audiences of today.

Television, right now, is in the position of needing more *lookers-in;* but these cannot be interested until better broadcasting is on the air, and so the old circle has again to repeat itself in this new art. There are some courageous interests in television who are broadcasting, and steadily improving their programs, at tremendous effort and expense. To these, much praise is due and some day books will be written of their struggles.



Adjustable photo-electric cell unit, with cell mounted in parabolic reflector and "head" amplifier contained in case, for greater artistry in "flying spot" pick-up work.

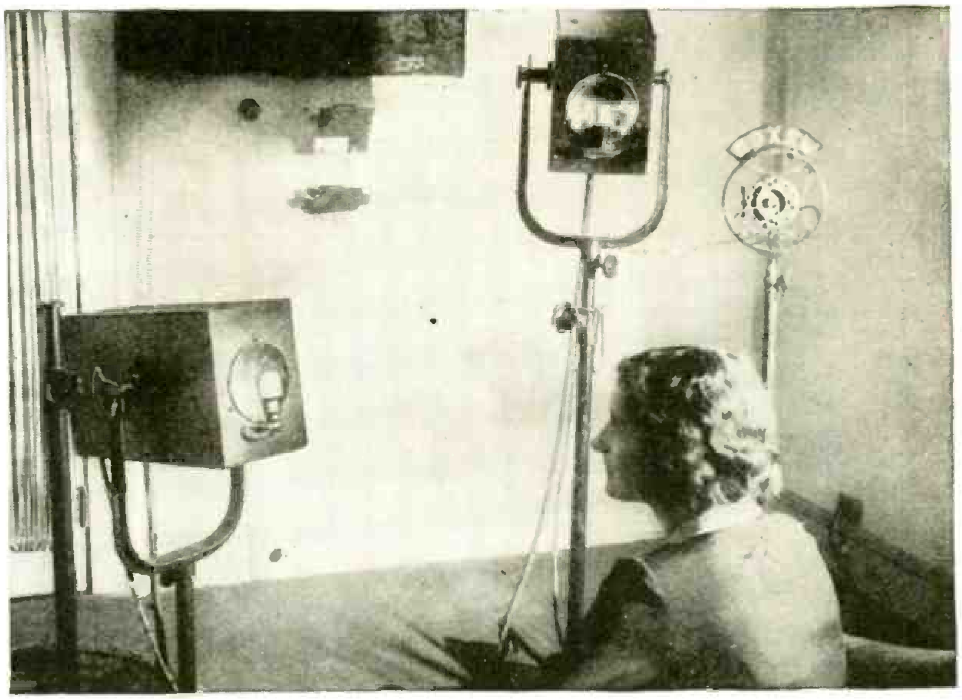
Where, a year ago, only silhouettes and letters were visible to the *lookers-in*, today motion-picture scenarios and direct vision of artists singing can be seen on the air in and around New York City, where the *looker-in* has his choice of receiving pictures from six different stations. In Chicago, regular schedules, including artists from broadcasting studios, are being run daily. The same is true of Boston.

The year 1931 will undoubtedly see a considerable expansion of these broadcasting facilities and the steady improvement of entertainment in the programs, as well as in the technique of transmitting. With the advent of better signals on the air, 1931 reception technique will be given a new impetus; with the result that much better receivers and much better television receiving equipment will be available.

Simultaneous Sight and Sound

In the New York area, plans for a tie-up between *sound* and *sight* broadcasting stations are under way. Artists who are now appearing regularly before the microphone will also appear before the television camera's eye. With this arrangement, those who have their regular broadcast sets will receive only the sound, as usual. But, for those who have television apparatus, the sight of the artist performing will also be possible; for from the regular sound broadcasters undoubtedly will come the material for television broadcasting and the twins, sight and sound, will join hands in supplying home entertainment.

IDEAS Television Images

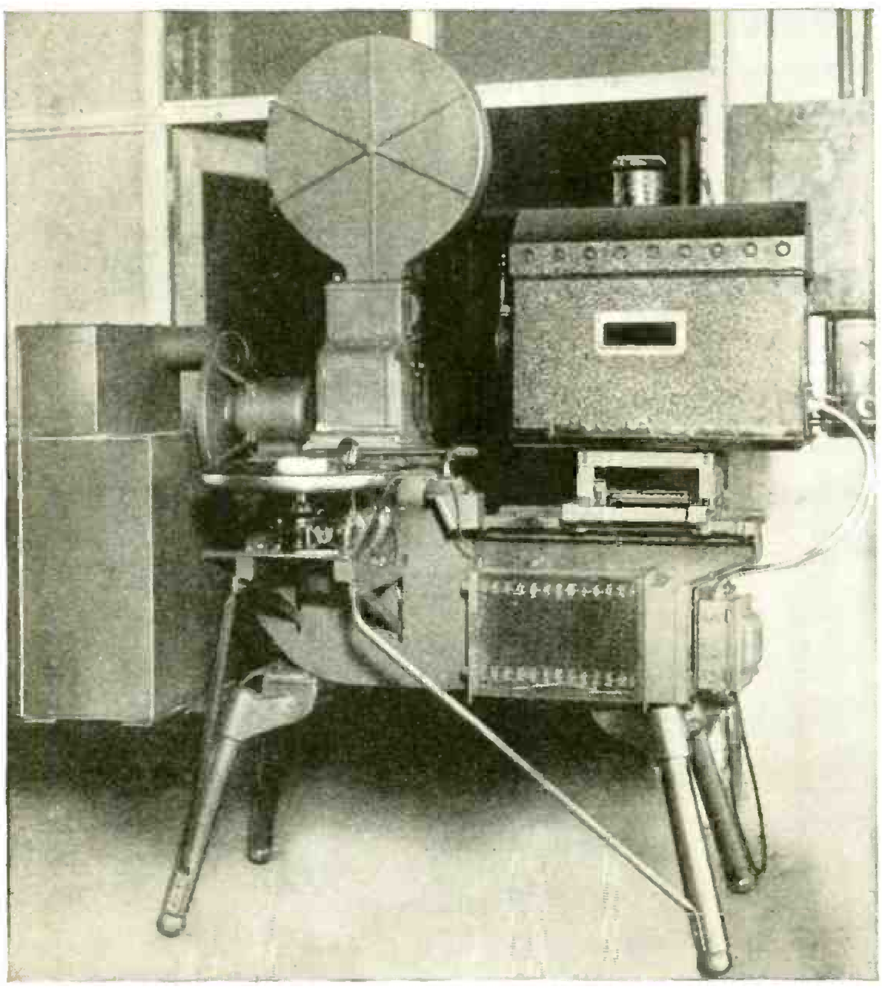


Direct pick-up equipment in Studio of Station W2XCR. This equipment is to be installed in a more favorable location to serve metropolitan New York. Note photo tube pick-up stands. These are made portable for maximum pick-up adjustment.

During 1930, which has been a year of intensive television work, along with purely electrical circuit development work, much work has been accomplished in the design of usable and practical studio equipment. In the pictures accompanying this article, there are photographs of two types of equipment, which at present are vieing with each other.

Use of the "Flying Spot"

The first and most used type is the "*flying spot*," which has been used in most of the recent demonstrations. In this system, a spot of light is made to traverse the object. The reflection from the spot of light is picked up by photoelectric amplifiers, and broadcast through a transmitter. The light used in the flying spot has been the subject of a lot of experiment; and the color used has varied, from the blue end of the spectrum, clear down to the infra-red, or invisible light rays. It has been possible to televise people in absolute darkness by use of these rays, or to scan them with any desired color of light. This equipment, however, lends itself best to stationary set-ups and requires additional equipment to be used in daylight or out-of-door televising.



Film projector used at Station W2XCR for projecting both "sound and sight" in television broadcasting. Note synchronized disc for sound records.

The Direct-Vision Camera

Another type of studio equipment, which has been named the *direct-vision camera*, is modeled after the present motion-picture camera and is able to televise in a lighted studio or in daylight. This new camera employs a lens of very high speed, which projects the image upon the scanning mechanism and photoelectric pick-up. The methods used in this device are not new, but have been abandoned by most experimenters as being too difficult. With the advent, however, of more sensitive photo-cells and better amplifier technique, results secured from this highly advantageous system have been fully as good as those secured by the more popular "flying-spot" type of equipment. This development has greatly hastened the day when it will be possible to go out and televise a fight or the arrival of some notable from Europe; for this camera can be just as portable as the present sound-motion-picture cameras.

Whatever one may think, and whatever is said, of the present status of television, to those who follow advances in science, these applications are most interesting.

TELEVISION IN THE

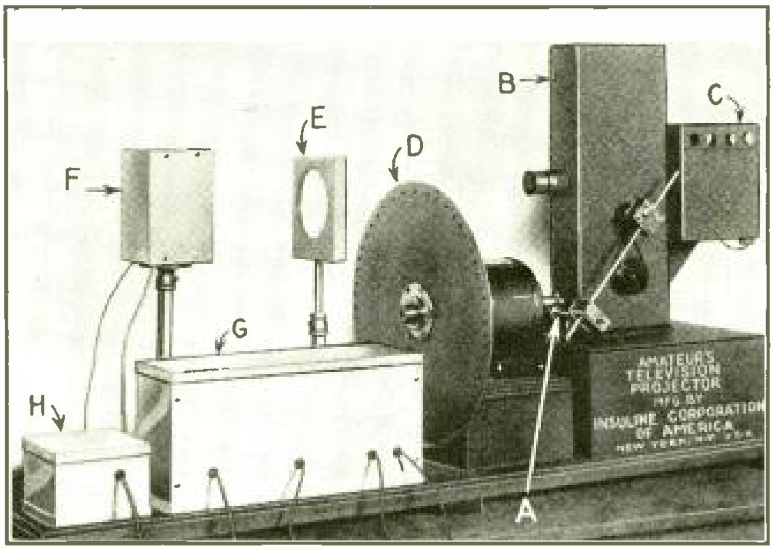
By ALEXANDER GORDON HELLER
Chief Engineer, Insuline Corp. of America

Mr. Heller tells the dyed-in-the wool experimenter that some of the most important research is yet to be conducted in television "transmission" and he reveals how this work can be carried on in the Home "Lab."

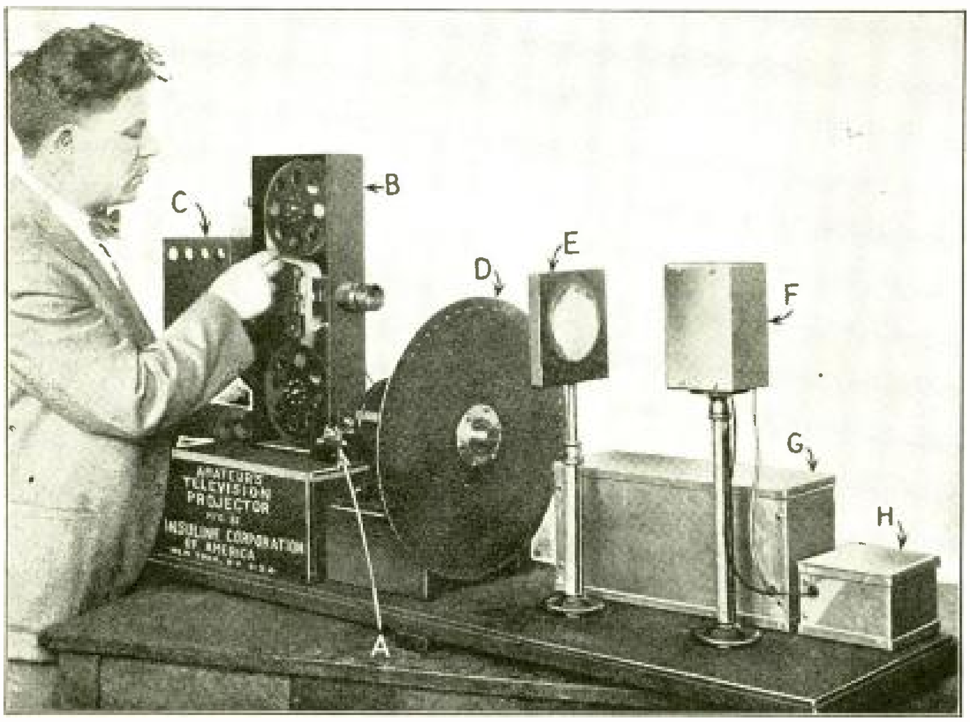
FOR some reason or other, many workers in the television field seem to look upon this nascent art as a secret ritual. In other words, they insist on working behind sealed laboratory doors, taking their own time with the development of this promising art, and keeping the public in more or less total ignorance as to the actual progress and prospects. One would assume that they could hold back the progress of the world at large, deciding when, where, and how television shall be introduced. Evidently, such secretive workers forget their radio history. They no longer remember that the radio telephone existed for full fifteen years, before it became the practical radio broadcast service. They forget that there were early broadcasters, such as Lee de Forest, who transmitted the artistry of such outstanding persons as Enrico Caruso and Madam Mazarin as early as 1909, to a mere handful of wireless amateurs provided with the equipment and the skill to listen in. It was only when the wireless amateurs of the entire country took keen interest in the possibilities of the "wireless" or radio telephone that the art of broadcasting came into existence.

Likewise with television: history must repeat itself. Television is not going to be the monopoly of any one person or organization. Rather, it will be the problem of the world at large; and the radio amateur is going to take a keen, active, and withal effective part in its commercial development. If the art has progressed so slowly until now, it is mainly because the amateurs and experimenters have not had the opportunity to study the basic principles at first hand.

Under the present arrangement, the experimenter interested in television can buy or build equipment for the purpose of tuning in on the several stations now transmitting experimental programs. During the past few months, notable progress has been made by way of providing satisfactory equipment for the experimenter, but at a considerable cost; in fact, much of the equipment now offered is beyond reach of many experimenters who would otherwise engage in this art. Even if the experimenter can engage in the television art, he is admitted only to the receiving end, which is frankly less than half the story. In other words, the greatest improvement in radio television can come from the transmitting end, where the greatest opportunities are open for original research and development. The situation here is quite different from that which existed in the early days of radio telephony, where the transmitting end was far ahead of the receiving end; and therefore the greatest improvements could come from the receiving end in which experimenters and amateurs took active part.



Transmitter, rear view: A, reduction gear; B, film reels; C, exciter lamp; D, scanner; E, lens; F, "PEC"; G, amplifier; H, "phaser".



Front view of transmitter: A, reduction gear driven from rear end of motor shaft; B, reel housing; C, exciter lamp; D, circle-scanner; E, lens (without mask); F, photo-electric cell; G, television-frequency amplifier; H, phase reverser.

Work In the Home Laboratory

Fortunately, it is possible for the experimenter to study the television art from the transmitting end. The principles are quite the same, whether the signals are transmitted over the air or over wires. Therefore the experimenter can work with a trans-

Experimenter's *Laboratory*

mitter handling signals over a pair of wires to a nearby receiver; thereby studying the art from one end to the other. Much of the television receiving equipment developed by the average experimenter can best be tested by having his own transmitter; so that he knows precisely the quality of the signals he is employing in testing his equipment. Too often, the signals over the air from the usual transmitters are quite uncertain and hardly suitable standards whereby to gauge the quality of receiving equipment and amplifiers.

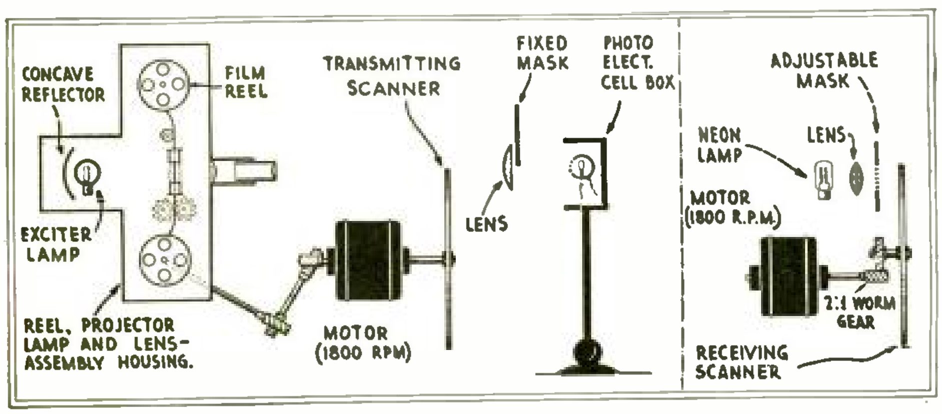
To overcome this situation, the writer has designed a simple transmitter which, while incorporating no new principles of operation, permits amateurs to investigate television between two points connected by wire, as transmitted by a simple adaptation of a motion-picture projector making use of standard 35-mm. motion picture film. The equipment is available at a low initial cost, while its upkeep is negligible.

The laboratory television equipment in this case comprises a complete transmitting assembly and, if desired, a complete receiving assembly; the two units being connected by a pair of wires.

The transmitter comprises a modified motion-picture projector, with the necessary reels, gate, lamp-house, and lens. The lamp-house contains a powerful exciter lamp, the rays of which pass through that section of film framed in the gate. The transparent image is then projected by the lens upon a scanning disc which breaks the image into a series of moving dots; the moving dots, forming horizontal lines, are focused by a lens upon a photoelectric cell. The varying output of the photoelectric cell, passed on the light which reaches it from the scanning disc, is amplified by the television-frequency amplifier, and sent over the wires to the remote receiver.

If preferred, the picture-modulated energy output of this television projector may be employed to modulate the carrier of an amateur transmitter, in place of the usual microphone. A phase-reverser is also included in the television projector layout, in order that either positive or negative film may be employed. The projector and scanning discs are driven by a 1/10-horsepower synchronous motor, which operates at 1800 revolutions per minute and in perfect step with the motor of the television receiver on the same electric power circuit. This is the simplest means of maintaining synchronism, inasmuch as the transmitter and receiver are virtually geared together by the common A.C. frequency.

Mr. Heller, author of present article.



Arrangement of "movie" television projector at left; receiver at right.

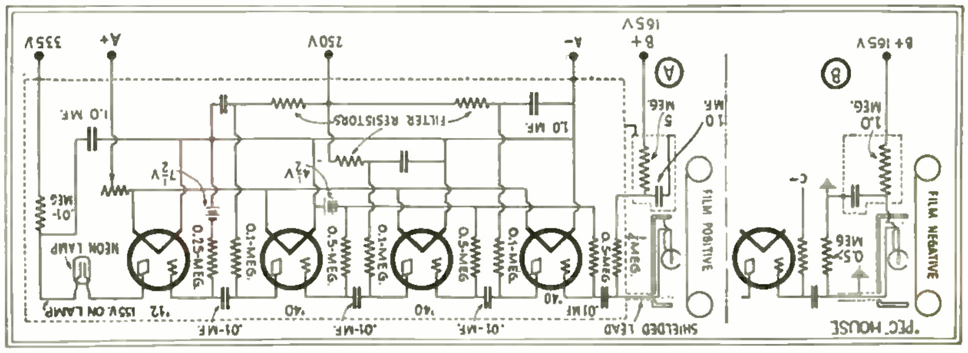
Special Film-Scanning Methods

The method of scanning employed with this transmitter projector makes use of a 16-inch aluminum disc, with the holes arranged in a circle for film picture projection. The scanning is horizontal, from left to right, while the vertical scanning is obtained by the continuous motion of the film in the projector. Therefore, the speed of the film downward through the projector must bear a definite relation to the speed of the scanning disc. Each "frame" must be scanned from left to right 48 times. Instead of having 48 holes in a disc revolving once for each frame, we have a 24-hole disc and revolve it twice as fast. For a given size of projected picture, this permits the use of a much smaller disc than would be necessary if 48 holes were employed.

If the experimenter desires to project still pictures, it is necessary to adapt spiral scanning, and for this purpose spiral scanning holes are provided in another type of disc.

Because of the limitations of the amplifier, the best results are obtained with silhouette or plain black-and-white shadow pictures. However, standard motion pictures of the halftone variety may be employed; especially if the experimenter is anxious to work on the television-amplifier problem, with a view to handling the very wide range of frequencies called for by good halftone transmission and reception.

(*Continued on page* 73)



The electrical circuit of the home television projector and receiver described here; the phase-shifter is connected as shown at the left (B) for use with negative films: as at the right (A) with positives. It is the resistor and condenser shown in the grounded shield (dotted lines).

The Latest Developments in Television

By LAURENCE M. COCKADAY

MR. COCKADAY, well known to all our readers as a designer of famous circuits, and former editor of *Popular Radio.*

SINCE the days of Greek mythology, when the common mirror came into being, there has been something fascinating about an image or reflection. This fascination led to the invention of the camera in 1558 A.D., and finally to the perfection of the motion-picture camera in the early part of the twentieth century. All of these discoveries and inventions are the forerunners of a new means of reflecting images, which is virtually upon us. This new science is *television;* the transmission of visible images by wire and radio.

Television is now a successful laboratory device. The past year has seen many outstanding improvements and practical laboratory perfection of the transmission of moving images by both wire and radio circuits. With some hesitancy (because some experts will disagree, who are strongly opposed to the inception of television) I venture to predict that, within the next two or three years, home television will assume the same status with the public that broadcasting did when it first gained a foothold in 1922.

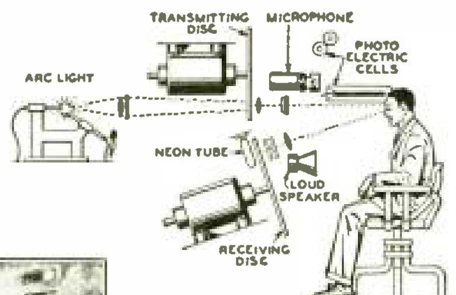


Fig. 1

Above, a diagram showing the arrangement of the acoustical and visual equipment used in the two-way television-and-phone system. The photoelectric cells are banked around the subject scanned, as in the illustration to the right. A 40-kilocycle band is required for the 74-line image transmissions.

Fig. A

The two-way televisor with its screen removed to show the microphone (above) and loud speaker (below).

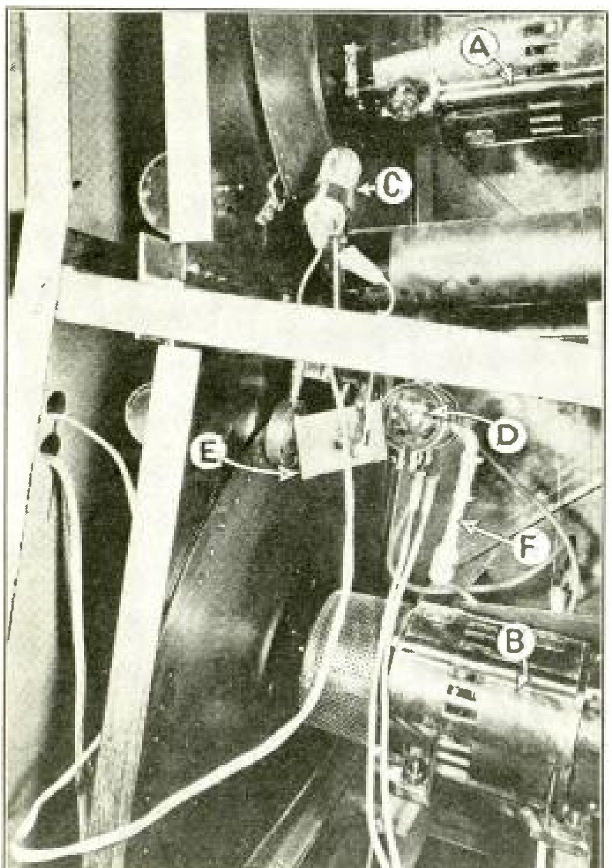


Fig. B

At the left, a view behind the scenes of the "Ikonophone"; the works of the television pick-up (upper) and reproducer (lower) scanning discs. At A, the housing of the motor which drives the scanning disc of the transmitter; this causes a spot of concentrated light from the arc lamp at the back of the cabinet to sweep the features of the subject before the apparatus. The neon lamp C, is a "monitor," to enable the operator to see the outgoing image, as it is picked up by the photoelectric cells, after being scanned by the light pencil passed by another part of the disc; note the mask at lower portion of upper disc, and the lenses at left of C and E. By the aid of the mirror E, the incoming image also is made visible (monitored) at the side. B is the driving motor of the scanning disc of the receiver. Observe the tubes leading from the water-cooled neon tube D, and its hydrogen valve F. (Photos and diagram courtesy Bell Telephone Laboratories.)

Television Service Men Soon

Obviously, there is bound to be a demand for experienced technicians to service commercial television receivers the instant the public becomes sold on television. This will create an entirely new branch of radio servicing. Fundamentally, television involves basic radio principles, employing to a large extent identically the same apparatus, such as tubes, resistances, batteries, etc. Logically enough, those who will be qualified to service television are the radio experts who

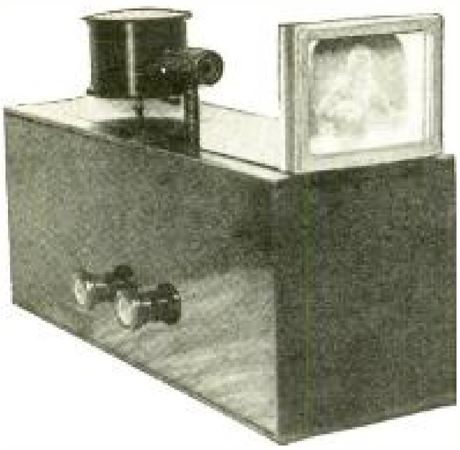


Fig. C (above)

One of the models of the Gould spiral-tube television receiver. The tube is housed within the vertical drum projecting above the cabinet.

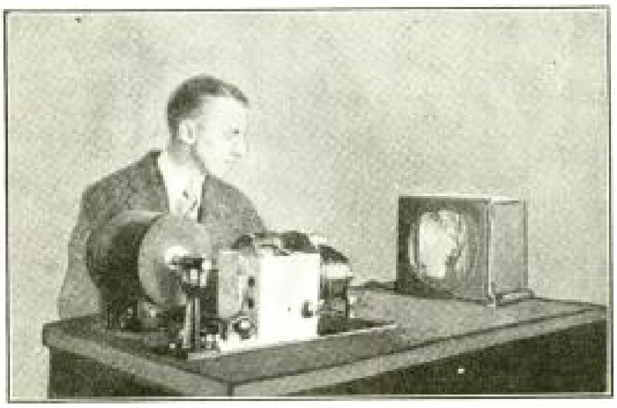


Fig. D (right)

Leslie Gould reproducing a television image in colors on the screen at the right, with one of his latest experimental models. The successive red and green impulses are reflected by an optical system through the scanner in the center.

have already basic experience in radio and who, with past technical training, may apply it to the new science.

The enterprising municipality of Jersey City, N. J., inaugurated early in April the first television "theater" in the United States. Less than a week after this event, the Bell Laboratories announced demonstrable two-way television.

These two developments, while not marking an entire departure from the laboratory stages, will have the effect of accelerating the practical application of this new art.

Perhaps the greatest number of technical contributions are to be found in the apparatus for two-way television demonstrated by the Bell Laboratories. Two duplicate sets of apparatus were set up for this experiment —one in the Bell Laboratories building at 55 Bethune Street, New York City, and the other, about two miles away at 195 Broadway. While transmission was effected by wire, the same fundamental principles are involved as those of radio television.

Two-Way Television

Apparatus at each end of the circuit was housed in a sound-proof room slightly larger than a standard telephone booth. This writer was among the first to have the privilege of entering the "television booth" and to converse with a friend at the other end of the circuit. The effect of seeing the other "party" and at the same time knowing he was several miles away, was decidedly uncanny.

Upon my entering the room which contained the television booth, an operator gave full instructions. She told the name of the party who would be at the other end. In the booth was a chair. In a small aperture was a sign reading: "Ikonophone.* Watch this space for television image." Presently the sign was removed by an operator behind the booth, and the image of the person to whom I spoke appeared. Talking was simplified by the use of a concealed microphone which recorded the voice, and a loud speaker which brought the synchronized words of the speaker "on the other end." It appeared almost as if the animated pink-and-orange image in the aperture were actually talking.

The use of pure blue light for scanning, rather than the bright white illumination which has been employed in past experiments, contributed largely to the success of the affair. Had the bright light been used, it would have been impossible to see the neon-colored received image. Blue light is soft to the eyes, but reacts on the sensitive element of the special photoelectric cells equally as well as white lights (see page 577 of *Radio-Craft* for May). This blue light is obtained by employing a filter in front of the arc scanning light.

A new type of water-cooled neon tube was used for reproducing the received image. The new tube has a hydrogen valve, and is much faster in action than previous types used, giving a much clearer image on the receiving end. This lamp reproduces the image satisfactorily when the effective value of the alternating current is of the order of 100 milliamperes. In order to operate such neon lamps at such low levels, it is necessary to shield them against electrical, mechanical and acoustical interference.

More Detailed Images

The reason for the excellent image in the two-way experiment is traced to the use of a seventy-four hole scanning disc, which gives almost double the number of scanning lines. (Forty-eight holes is the number most commonly used.) When reproduced in the aperture of a receiver, the 74-line image is comparable to the reproduction of a halftone cut in a newspaper.

There are two general systems of actuating photoelectric cells. (See Fig. A, page 317, January, 1930, issue of *Radio-Craft.*) One is to use a single cell operating behind the scanning disc, and flooding the subject with powerful lights. The other is to scan the subject with a light beam in a darkened room, and to use three or four banks of photoelectric cells in appropriate locations to record the reflected light.

For outdoor television transmission, obviously, it would be impossible to use the bank system applied so successfully in the "booth" set-up. To scan the image with natural light, it is also necessary that extremely sensitive photoelectric cells be used. These cells have been perfected so that the light reflected, through the tiny holes of the scanning disc, into the sensitive element, gives rise to an alternating current whose value is of the order of one ten-thousand-billionth of an ampere.

The Jersey City television "theater" already referred to utilizes Dr. C. Francis Jenkins' system. In transmission, the so-called "camera eye" system, with a single photoelectric cell behind the scanning disc, is employed; while a total light of 4,000 candlepower is flooded on the subject. Simultaneous sound transmission is accomplished through another station, which, incidentally, was first used in 1928 by the editor of this magazine, Mr. Hugo Gernsback, for the earliest New York television broadcasts.

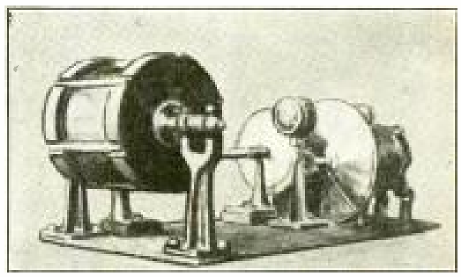


Fig. E

A close-up of the neon-tube drum and scanner of Fig. D (and Fig. 3); red and green tubes alternate on the drum.

These Jenkins receiving units employ a standard neon glow-lamp, connected directly with the "picture-frequency" output of the radio television receiver. The disc has forty-eight holes, and is driven by a synchronous motor, as described previously in *Radio-Craft.*

A point of particular interest in the Jenkins television receiver, as so far developed for home use, is the motor unit, shown in schematic form in these columns (Fig. 2). The scanning disc, of thin aluminum, carries a heavier central copper disc and a small, toothed iron wheel. "Eddy currents"

* From the Greek words "Eikon," an image and "Phonein," to speak. Hence, "the speaking image."

are created in the copper disc by the four "eddy current coils." This construction serves four purposes: a starting torque is available to move the toothed iron wheel out of dead center relation to the motor coils; a field current is produced, which strengthens the field current of the motor coils; an electrical load, controlled by the 1350-ohm resistor, which tends to maintain even speed, is given to the spinning disc and, by varying the resistance and snapping the switch, proper speed and framing are obtained. The motor action is that usually found in induction motors; the teeth of the iron wheel being attracted by the motor coils when the current through the coils reaches a maximum value.

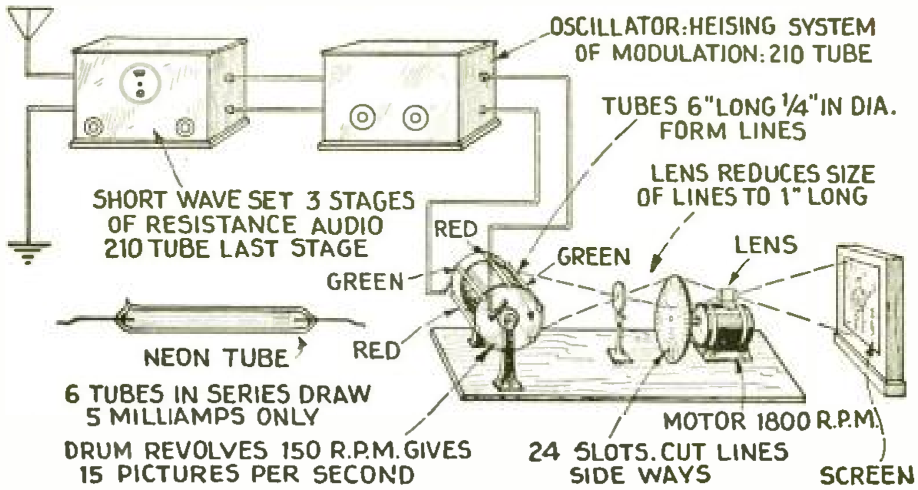


Fig. 3
Schematic arrangement of the Gould system of colored television reproduction.

The Gould System

That the square-plate neon tube has certain limitations is recognized in engineering circles. A departure from this design of tube is seen in the work of a Bridgeport, Conn., experimenter, Leslie Gould, who has been working

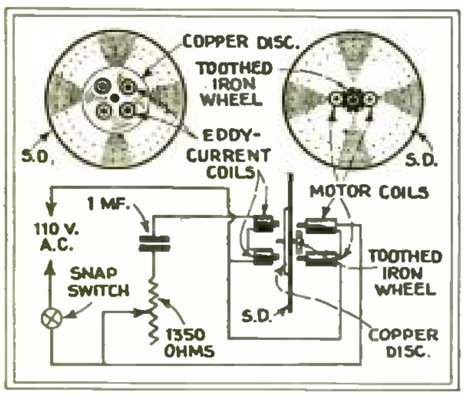


Fig. 2
The ingenious driving and synchronizing system of the latest Jenkins radiovisor.

with spiral neon tubes, and has obtained some interesting results. He is also studying color television, by using different-colored neon tubes to obtain different degrees of tone.

In his television receiver he makes use of a revolving neon tube and a drum, which replace the usual circular disc and stationary square-plate neon tube. The Gould neon tube is in the shape of a helix and has two complete turns; resembling the tubular type now employed in advertising signs. This tube is surrounded by a circular drum perforated with holes which correspond to those in the usual disc. Both the neon tube and the drum are fastened to the hub of a motor, which revolves in synchronism with the transmitting disc.

Gould employs a small power oscillator to excite the neon tube. His method of obtaining variations in the light, in order to reproduce an image, consists of modulating the oscillator with a 7½ watt vacuum tube through a Heising circuit.

This causes a variation in the oscillatory impulses, which in turn increases and decreases the brilliancy of the neon tube. As the signals are received, the speed of the revolving drum is synchronized with that of the transmitting disc; so that the holes correspond to the parts of the image which are being transmitted. The light is projected through a camera lens, which enlarges the images and reflects them on a ground-glass screen about five inches square.

One of the unusual features of this receiver is the spiral neon lamp. Each of the two turns of this lamp operates *separately;* that is, when the drum makes one revolution it automatically, by means of a commutator, disconnects the other portion.

Engineers are now developing gas tubes for Gould which contain a white glowing gas, and will permit reproduction of images like photographs in actual black and white, instead of the usual orange and black of the neon tubes.

Color Television

Gould's television receiver for reception of images in color is fundamentally the same as the regular television receiver, from which it differs in that special gas tubes are employed instead of the usual orange-colored lamps.

These are mounted on a six-inch drum, which revolves in synchronism with the disc. Three red and three green neon tubes are mounted on the drum, and are excited from an oscillator, which in turn is modulated from the received signal. As the drum and disc revolve, the colors are blended together; giving the effect of reproducing the image in true color tones.

The results obtained with any of the foregoing described systems of television are such that anyone would be glad to have a permanent installation for his amusement. Although these are laboratory set-ups, they are far enough developed to be used for home demonstrations, with satisfactory clearness of reproduction to place them rather farther along than aural radio broadcasting was in 1922. The time is fast drawing near when receiving sets for television will be in vogue, if the recent improvement in results is to be taken into account; and Service Men will do well to follow the developments with a more alert eye, in keeping up with improvements and new methods of transmission and reception of moving pictures at a distance.

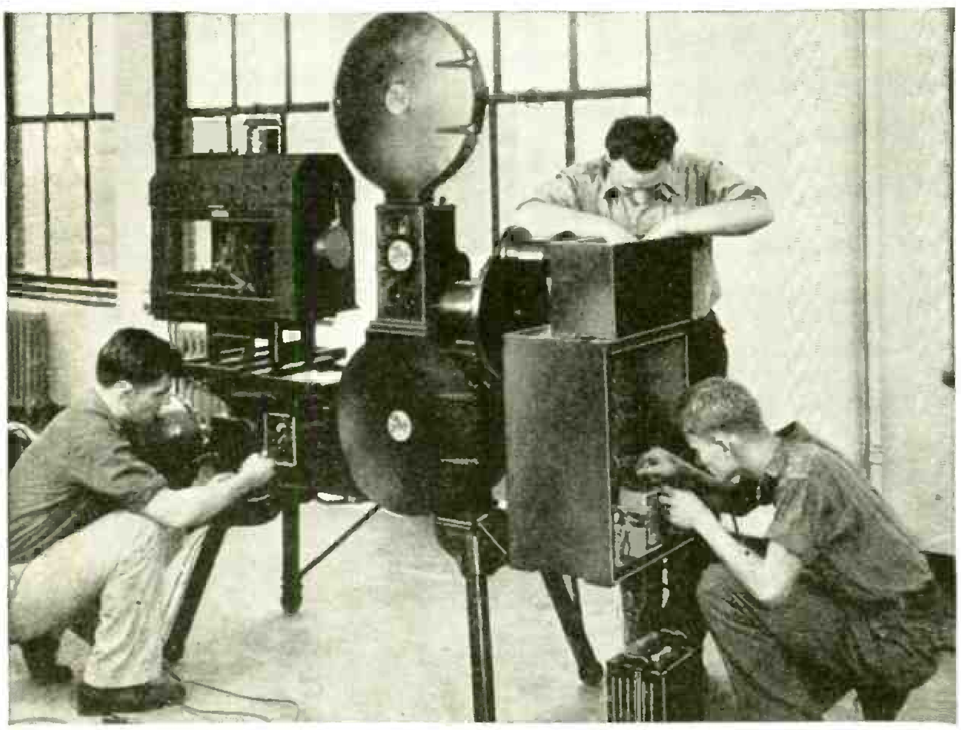
The Service Man who is interested in undertaking the study of television must have a thorough knowledge of the principles of reception. In addition to radio, he must gain a knowledge of synchronous motors, neon tubes, photoelectric cells and how they are connected in the circuit. He must know how to adjust the machine to synchronization, in order to keep the image in the aperture, without "drifting." Such things are gleaned only from careful study of developments and advances in the art.

TELEVISION PRACTICE Now Taught in School

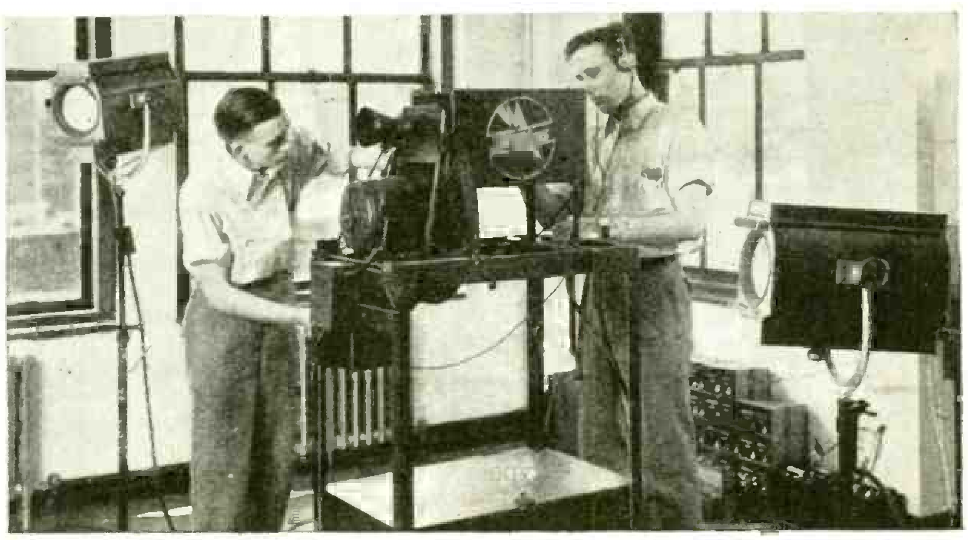
A Practical Radio Education Must Now Include Instruction in the Technically Most Important New Development of the Art.

By HAROLD C. LEWIS*

(Above) Learning how to assemble Jenkins Radiovisors.



(Above) Another transmitter in the Coyne television department. This scans and televises motion-picture film for the well-known "radio movies."



(Right) Students setting up the scanning apparatus of a television transmitter. The model shown televises the features of a direct-lighted human subject.

I AM fully aware of the fact that there are in the radio industry today many people who maintain that television is so far in the future that it is of no practical account at the present time.

I have had sufficient confidence in the future of television to expend a sum in excess of $25,000 to provide actual television apparatus in my school, where students are actually taught the principles of television.

When students have satisfactorily completed the preliminary theoretical courses, they become qualified to continue in the new department for those who want to be equipped with a practical knowledge of television. They are instructed in the assembly and operation of televisors for reproduction of television images, and they also receive instruction on the types of short-wave receivers now in use for the reception of television impulses, or energy used to operate these televisors. The operating principles of the latest types of television transmitters and receivers are thoroughly covered, and students receive also actual operating instructions on television transmitting equipment of the type used for programs, with live subjects or artists, and also on film-scanning machines for sending out motion-picture entertainments by television.

* President, Coyne Electrical School.

Solving *TELEVISION'S* Problems

By Clyde J. Fitch

THE progress of television seems to be taking place step by step; each step in advance giving us new courage, new hope, and a deeper insight into the intricacies involved. While some say that practical television is a thing of the future, and that present methods, even though working 100% perfect, would still be entirely too crude and lacking in detail to be considered worthy of the name, yet all must admit that only by improving present methods can we arrive at future perfection.

The Bunsen photometer is familiar in every physical laboratory; it operates by balancing the respective intensities of light falling from either side on a translucent spot S.

In this, the first of a projected series of articles, I will point out one problem in present television methods, and show, or attempt to show, how it may be solved. This discussion deals with the receiving end and the intensity of the illumination of the reconstructed image, which we all know, at present, is considerably below par.

Imagine, for the sake of illumination, a 48-hole scanning disc spinning in front of a neon lamp at the receiver, and let us see what happens. In the first place, we see, at any given instant, only the amount of light that passes through *one hole*. Therefore, if the picture is square, for every unit of light that passes through the hole, 2303 *equal units hit the back of the scanning disc!* What an enormous waste of precious energy for people who call themselves conservative electrical engineers! The old street lighters put up a better showing than this. Of course, the new Jenkins drum-type radiovisor is a considerable improvement in this direction (as those who read the article on page 60 know) but we are at present interested only in the more simple, yet inefficient, disc type.

To solve this problem of increasing the lighting efficiency of the disc type radiovisor, I turned to optical principles employed in photometry; the photometer, according to my reasoning, serves the same purpose optically that the Wheatstone bridge serves electrically. To illustrate more clearly, I will first describe the basic principles of the photometer.

The Photometer

A simple form of photometer, used for comparing the intensity of two light sources, is illustrated in Fig. 1, and consists of a "Bunsen screen" S mounted on a carriage between the two lights being compared, with its surface at right angles to a line passing through the light sources. It is usually arranged with prisms or mirrors, (these being omitted from the illustration for the sake of clearness), so that both sides of the screen may be viewed at once. The "Bunsen screen" is simply a piece of paper with a circular part of the center made translucent by treatment with paraffin. If the light falling on one side of the screen is stronger, the translucent spot will appear *dark* from that side of the screen, and *light* from the opposite side. When the light falling on the two sides of the screen is equal, the translucent spot disappears. The values of the two light sources are then directly proportional to the squares of their respective distances from the screen.

As an example, suppose the candle C (Fig. 1) is a "standard candle" of one "candle-power," and L is the lamp being compared. If the distance from C to L is 15 inches and the translucent spot disappears when the screen S is placed 3 inches from C, we then have the simple proportion $x : 1 = 144 : 9 = 16 : 1$; which shows that the lamp is of 16 candle-power.

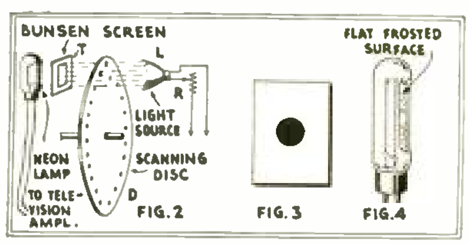
The above rule is known as the Law of Inverse Squares, and holds true only when the dimensions of the light sources are small in comparison with the distance between them, and when there are no reflecting surfaces present, as when readings are taken in a dark room.

It is interesting to note here that this principle of the Bunsen screen is largely employed in stage settings to produce "disappearing" optical effects. We have all probably witnessed stage effects in which groups of actors or scenes slowly appear and disappear by a gradual manipulation of the stage lighting. This is done by the use of a translucent screen which divides the back portion of the stage from the front. When the light behind the screen is stronger, everything behind the screen can be seen by the audience; when the light in front is stronger everything behind disappears.

The "Bunsen Screen" In Television

The manner in which I propose the use of the Bunsen screen in television is illustrated in Fig. 2, which shows the principle diagramatically only. Instead of "scanning" the light from the neon lamp, as done now with such excessive waste, I scan the light from a powerful light source, L, which should be some 2500 times as powerful as that of the neon lamp. In other words, the light from L which passes through one scanning hole, in the disc, should have about the same intensity as that of the entire neon lamp. The Bunsen screen T is placed between the neon lamp and the disc, as shown, and is so adjusted that its translucent portion (which should be equal in size to the image being reproduced) disappears when the neon lamp is lit to its average intensity. Therefore, when the neon lamp glows brighter, the translucent spot shows bright on the side of the screen facing the disc and, when the neon lamp becomes dimmer, the spot appears darker on that side.

Suppose we are receiving a simple silhouette figure (such as the black disc shown in Fig. 3). It is evident that the neon lamp apparently goes

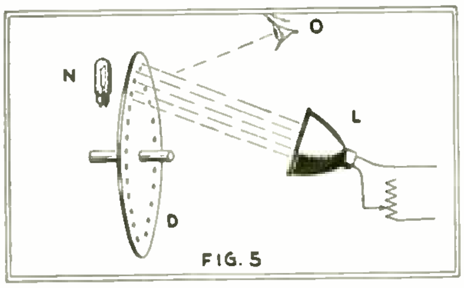


In Fig. 2, the arrangement of Mr. Fitch's proposed televisor in which stronger light may be used than at present; the expected effect is shown at Fig. 3. A tube like that in Fig. 4 will simplify matters.

out every time that a scanning hole in the disc allows light from L to pass through and strike the screen on that portion outlined by the silhouette. Thus, only the area of the screen marked off by the silhouette will have much greater light intensity on the side facing the disc; and only that area will appear dark. The contrast between the dark silhouette and the light background in this case will be greater. It may be enhanced by experimenting with screens of different material and lights of different colors. In the old method of scanning with a 48-hole disc the contrast is equal only to the difference between light of zero intensity and the light that comes through one hole of the disc, or about 1/2304 of the total intensity of the neon light.

It appears, therefore, that the contrast and the amount of light available are much greater, whether we are reproducing silhouette or halftone images. The light source L should be very powerful and its rays should be projected in a parallel path; its intensity should be variable by means of a resistor R. The screen should be placed as near to the disc as possible, and mirrors suitably arranged for viewing the image. The closer the neon lamp also is to the screen, the less light is wasted. The whole apparatus should be housed in a light-proof enclosure, for best results.

One method of obtaining greater efficiency is shown in Fig. 4. Here the neon lamp has one flattened side, which is frosted to serve as the screen, to which the luminous electrode of the lamp may be placed very close with little loss of light. The pink-orange coloring of the neon lamp is more or less compensated for by balancing it against the white light, (L, Fig. 2). Balancing the light values on either side of the screen is like balancing the electrical currents of a Wheatstone bridge; the slightest un-balancing is easily detected and, since this un-balancing is produced solely by the moving image it appears only on the portions of the screen occupied by the moving image.



A further extension of the same principle, in which a transparent disc D with black spots would scan the image.

Alternative Method

Now, for a simpler method, I suggest a radical departure from all known scanning devices—the use of a *transparent* scanning disc with opaque disc with transparent spots, or holes. This disc, rotating in synchronism with the scanning disc at the transmitter, serves the purpose of the Bunsen screen, and is placed between the neon lamp (N, Fig. 5) and a light source L. When the light from N balances that from L, the disc disappears from view from the observer O. Any unbalancing of the light values, such as would be caused by dark portions of the image which weaken the intensity of the neon lamp N, would cause that portion of the picture, where the unbalancing occurs, to appear dark to the observer; and vice versa. Of course in this case also the apparatus should be inclosed in a light-proof housing with a viewing window for the observer. The disc may be of glass.

To explain more fully, when the light from L which is reflected by the opaque spots to the observer is of the same intensity as the light from N which is transmitted through the disc, the opaque spots disappear. Where light from N does not balance the reflected light (as where a dark portion of an image disappears) the opaque spots become visible to the observer; but only on the unbalanced portions of the picture where the image appears. For example, if the neon lamp flickered continuously at a certain fixed frequency, the observer would see a checkerboard formed by the opaque spots, the opaque spots appearing stationary. If the disc is viewed from the side adjacent to the neon lamp, the lamp L may be dispensed with, but this is mentioned as a matter of interest only, as the observer would only see the amount of light reflected from the neon lamp by one dark spot at a time, and the results would be similar to those obtained with present opaque scanning discs. This does not apply when using the scheme of Fig. 5. in which the lamp L is used. This lamp should be very powerful, similar to that of Fig. 2. so that the light reflected from one opaque spot is equivalent to the total light from the neon lamp. The rest of the light passes through the glass disc and is lost, or absorbed by the black walls of the housing.

These methods of radiovising will probably enable the image to be enlarged to a much larger size than has been heretofore possible; as the amount of light available is much greater. At least they offer a field of experimenting for the television enthusiast which may lead to valuable improvements.

Use of the Television Signal in Measuring the
Effective Height of Kennelly-Heaviside Layer

By C. H. W. Nason

THE mechanics of wave transmission are rather obscure to the average radio enthusiast. Although almost all of us have at one time or another heard of the "Heaviside layer" as one of the causes of fading and as the fundamental cause of "skip distance" in short-wave transmission, there has been little of a popular nature said in connection with these phenomena. In pursuing the elusive television signal certain facts have become apparent which, the writer believes, will lead to a simpler understanding of fading, and of other things contributing to the engineer's difficulties.

Very often, in receiving an image from a not too distant transmitter, double or "ghost" images evidence themselves. Fig. 1 shows an image of a simple geometic figure as it would appear on the television scanning disc. The image proper is dark. Superposed on this is another image, displaced by one-half the width of the field of vision.

Now, radio waves travel at a substantially constant velocity, and a wave traveling from point to point along the earth's surface naturally takes a shorter time to traverse the distance than a wave which has been directed upward and then reflected back from a medium impervious to the wave. This medium which reflected our wave (as shown in Fig. 2) is known variously as the Heaviside layer -or (more properly, the Kennelly-Heaviside layer) and is taken to be a heavily *ionized* stratum in the earth's outer "stratosphere." If the portion traveling along the earth is taken as the main component of the signal, we may consider that a wave traveling from the transmiter upward to the reflecting layer and back to the receiving antenna will travel a greater distance than the first or "ground wave" and will arrive at the receiving antenna slightly late. Just how late

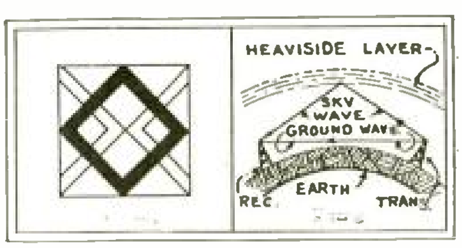


Fig. 1 Fig. 2
The double television image at the left is caused by the two paths of the signal, at the left.

(*Continued on page 68*)

SCANNING WITH AN ELECTRIC PENCIL

By Philo T. Farnsworth*

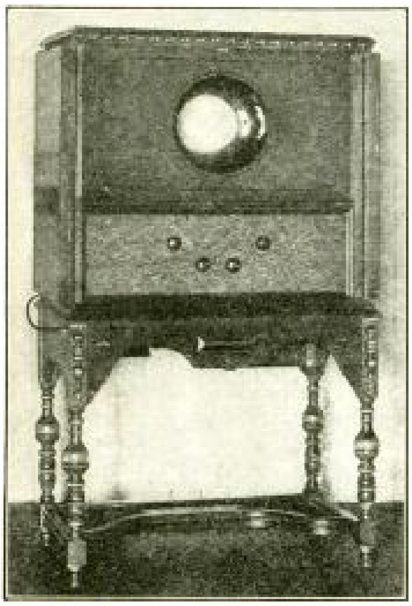


Fig. C
A television receiver, using the "oscillite."

IT has long been apparent that the full development of television requires a scanning device free from the mechanical limitations which are inherent in the motor-driven disc or drum. With the latter, four or five thousand points are all that we can expect in an image; and these can show clearly little more than a single person in a limited field.

The electron tube, with its "*weightless beam*," has been an obvious solution; but the task of making it effective is one requiring no small degree of ingenuity and application to detail. Mr. Farnsworth, in his laboratory in San Francisco, has been working for some years along this line; and it has been known for some time that he has obtained striking results. Until now, however, no detailed statement of his methods has been available.

In this article he explains for the first time the operation of his "dissector" tube, a photoelectric device used for scanning at the transmitter; as well as his experiences with the "oscillite," an oscillograph which he has improved for the purpose of reproduction. He has constructed also a special amplifier, having a favorable characteristic over a frequency band 600 kilocycles wide, details of which he encourages us to expect soon.

Mr. Farnsworth sets the maximum television image required at 200,000 points—eighty-seven times as extensive in detail as present standard-disc scanning—and for this work he states that a 1200-kilocycle channel will be required. He has already transmitted 300-kilocycle signals by wire and by radio on a wavelength of four meters.

We know that all television enthusiasts will hail this substantial contribution to the perfection of the art.

PERHAPS the most significant element in human vision is that the amount of detail which we can see in a picture is limited by the structure of the retina. Although the image focused on the retina by the lens of the eye may be perfectly continuous, the retina will give to the image seen a finite structure, depending principally on the number of "cones" which lie in the central spot. It appears possible for the human eye to see separately at one time about 100,000 elements; this is, probably, not more than one-tenth of the number of cones in the retina. This range, however, is greatly extended by the facility with which the eyes can move from one point on an object to another; and from these considerations it was suspected that an image of perhaps 200,000 to 400,000 elements would compare favorably with that which the human eye gives us.

It will be seen from a study of standard half-tone pictures that a television image of 200,000 elements will approach near enough to the limit of the eye to make greater detail seem unnecessary.

Let us outline, then, the requirements of a television system which is to handle 200,000 elements, assuming the mode of scanning to be that shown in Fig. 1, and that 12 pictures are to be transmitted per second. We shall have two scanning frequencies; one of them a sawtooth wave having a period of 1/12th-second, and the other a similar wave of 4800 cycles per second. Our highest fundamental picture frequency will be 1200 kilocycles and, with single-sideband transmission, we shall require a wave band 1200 kilocycles wide.

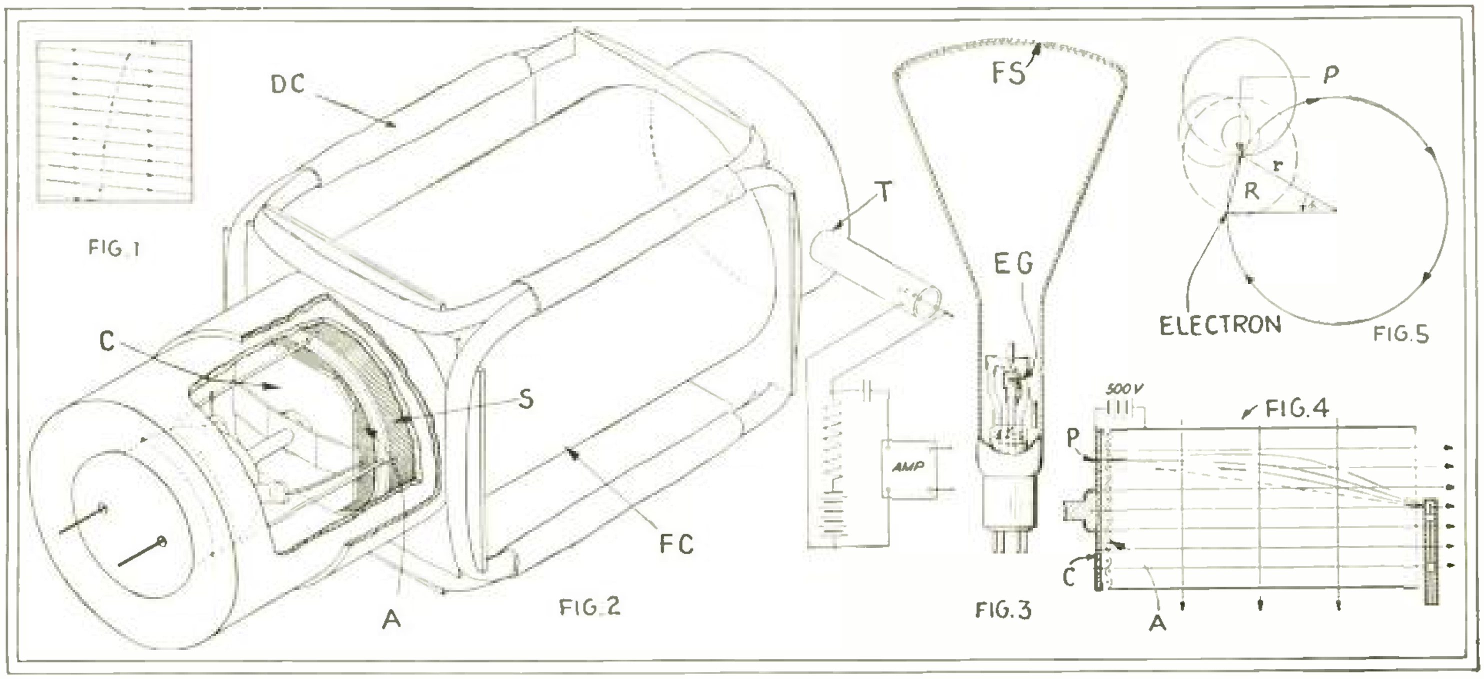
Problem of a Channel

When this work was first undertaken, it seemed quite apparent that three definite problems existed, namely: (1) a suitable scanning system to handle this high speed; (2) an amplifier capable of passing this very wide band of frequencies; (3) the perfection of a suitable wire or short-wave radio link which would take care of the wide waveband required. At the present time it is perhaps allowable to say that the first two problems have been completed.

Considerable work has been done on the development of a four-meter radio link. The progress to date indicates that quite satisfactory television service could be had for distances up to about fifty miles by proper location of the transmitter. Trouble from double images and fading may not, after all, cause particularly serious trouble. Absorption by conductive obstacles will make it

Fig. D
The image of Dr. Lee de Forest (center) though blurred is recognizable: this is a composite of the images reproduced on an "oscillite" for half a minute. The smaller images at either side had shorter exposures.

* *Television Laboratories, Inc.*



The magnetic scanning at the upper left assumes its shape as a resultant of two moving fields. The "dissector" of Fig. A is shown here internally in Fig. 2; and the "oscillite" of Fig. B in cross-section in Fig. 3. Fig. 4 illustrates the path of electrons from an illuminated point on the cathode; and Fig. 5 is an end-on view of their rotating motion. The object is to bring them all to the same point at the target. It is the opinion of several television experts that the Farnsworth system marks a distinct advance.

necessary, however, to locate the transmitter so that it will be almost visible from any part of the area it is to serve.

Considerably more success has been obtained by the use of wired radio as a medium. It has been found quite practical to modulate a 300-kilocycle band upon a 1000 kilocycle carrier, and to transmit this over an ordinary telephone line; the pictures so transmitted are practically equivalent to those seen on a monitoring set located close by the transmitter. The attenuation in voltage has been found to be about 45 decibels per mile for a No. 19 pair cable. It would probably be necessary to relay every few miles with this attenuation; but it is thought that a cable line represents the extreme case and that, when an open wire line is used, television by means of wired radio becomes entirely within the range of possibility.

In our experiments so far, no attempt has been made to correct the line for phase shift and frequency discrimination; this may not be necessary, but it is thought that considerable improvement in the transmitted image might be attained by carefully making these corrections.

Synchronization is accomplished simply by putting the synchronizing frequencies on the same telephone wire; audio frequencies may, of course, be put on the same pair.

The "Dissector" Tube

The first-mentioned requirement, which will be the subject of this article, has been solved by the development of an electrical scanning system. The basis of this is an "image dissector" tube, a practical form of which is shown diagrammatically in Fig. 2 and in cross-section in Fig. 6A. As will be seen, it comprises a cathode (C), coated with photo-sensitive material, which is parallel and closely situated to an anode screen (A). The anode screen is electrically connected to the electrostatic shield (S). At the end of the tube opposite the cathode is placed a target electrode (T) having all but a single small area shielded from the discharge.

This tube, considered broadly, is a photo-electric cell wherein provision is made for forming an "electron image" of an optical image focused on its cathode surface. By "electron image" it is meant that, if a fluorescent screen were placed in the plane of the electron image, the original optical image would be reproduced. The condition necessary for the formation of this electron image is that all the electrons emitted from any single point on the cathode surface shall meet again in a corresponding point in the plane of the electron image.

An image of the object to be transmitted is focused upon the cathode, and the photo-electrons emitted therefrom are accelerated by a potential of the order of 500 volts between the cathode and anode screen. Most of them are projected into the region between the screen and target and, by means to be described later, combine to give an electron image in the plane of the target. This electron image, made up as it is of a prism of moving electrons, can be shifted by a magnetic field at right angles to the tube. By this means, the image is moved over the scanning aperture in the target shield.

In practice, two sets of coils are placed about the dissector tube, as shown in Fig. 2, at right angles to one another. A sawtoothwave alternating current, of about 3000 cycles per second, flows through one set of coils; producing, let us say, a horizontal deflection of the image. A current of similar waveform, but with a period of 1/16-second, flows through the other set of coils, and produces a vertical deflection of the image. The resultant path of the image, relative to the aperture, is similar to that given in Fig. 1; there will be 200 horizontal lines drawn for each traversal of the image, and the time of one line will be 1/3000-second. We shall therefore require an amplifier handling a band width of approximately 300 kilocycles, to amplify the target current.

This problem presented by the amplifier has been one of the most difficult encountered in any of this work. Furthermore, at the higher frequencies, the impedance in series with the dissector target becomes very low, because of the capacitance shunting it; and this causes a corresponding decrease in the amount of voltage delivered to the input of the amplifier. However, the whole problem has been greatly simplified by a system of "admittance neutralization," which is particularly useful in the neutralization of capacity, and which permits input impedance (as well as interstage tube impedance) as high as several megohms to be obtained, up to a million cycles or more. At the present time an amplifier is being used which has a frequency-characteristic approximately flat to 600 kilocycles. The "admittance neutralization" principle, as well as the design in general of these wide-frequency-band amplifiers, will be explained at another time.

"Oscillite" or Receiver Tube

The picture frequencies from the amplifier are re-built into an optical image at the receiver by means of an electron-beam tube, or "oscillite," as shown in Fig. 3. This is simply a modified Braun oscillograph, which makes use of the electron-image principle of the dissector tube, to allow good light intensity to be obtained.

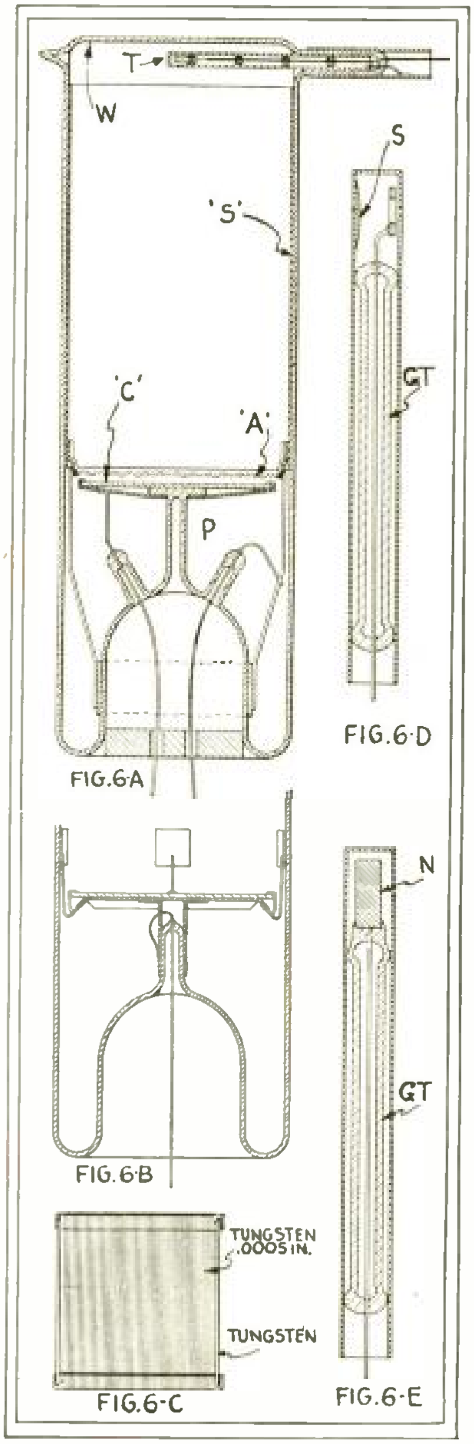
It is required to generate at the receiver, two alternating currents of sawtooth waveform, identical to those used at the transmitter. These currents, of course, have to be synchronized with those at the transmitter; to accomplish this, use is made of the fact that these currents induce a strong voltage pulse in neighboring circuits during the steep part of their slope. This voltage pulse is, accordingly, introduced into the picture frequencies' circuit, and serves at the receiver to hold the scanning generators in step. It serves the further purpose of turning off the oscillite "spot" during the return part of its path; that is, during the very steep part of the sawtooth wave-cycle.

This system of synchronization is very simple and very effective. It does not require any extra transmission medium for the synchronizing impulses, nor even any extra equipment such as filters, etc., to separate the synchronizing impulses from the picture frequencies. Much work has been done in the development of these sawtooth-wave generators, and on this system of synchronization, but space requirements will not allow their being reported here.

"Magnetic Focusing"

Consider the path of the electrons which leave the same point, on the surface of the cathode, at which a point of light in the optical image is focused. If all of them traveled parallel to each other, a perfect image would be formed at any point of the beam. But they are emitted at different velocities, corresponding to potentials from zero to about three volts. The irregularity of the cathode's surface, large in proportion to the electrons, and the ending of electro-static lines of force near the wires of the anode screen (A) cause the electrons to spread out in a conical ray—with an angle at the apex of about five degrees, in our present dissector tubes. Nevertheless, something of an image may be formed at the window by the use of low-frequency (*reddish or infra-red, presumably, to which photoelectric surfaces are less sensitive—*Editor) light, careful construction of the anode screen, and high anode voltage. However, it has been found possible to focus these electrons rays magnetically.

This is done by creating a uniform magnetic field of proper intensity, with lines of force parallel to the axis of the tube. This causes the electrons to follow spiral paths, all *tangent* to the line of magnetic force through the point P where they originate. Each electron, viewed from directly ahead, is describing a circle, large or small, as it travels forward. (See Fig. 5.) However, regardless of the speed of the electron, and the diameter of the circle, it will reach the same point on the circle, from which it started, in the same time; that is, every electron will be in line with P at a given time. This makes it possible to bring the whole beam of electrons to a point on the target, as shown in cross-section in Fig. 4.



Left, cross-sections of two "dissector" tubes, and (at 6-C) the anode. The cathode C throws out from each point a ray of strength proportionate to the light received. The electrons pass the anode A and fall on the target T; as they scan this, it transmits each element of the image to the amplifier. D and E are cross sections of target rods; N is a nickel target, and S a fluorescent substance while GT is the glass tube.

If we change the direction of the field, the point where the electron beam is focused will be shifted; and, by imposing a transverse magnetic beam on the lengthwise field, we will deflect the electrons proportionately. In this manner the deflecting coils, carrying alternating currents, will cause the beam to move from side to side.

The present dissector tube with its carefully-made anode screen produces a stationary electron image which is not inferior to a very good optical image. When the image is deflected for scanning, however, the resulting moving image is slightly blurred at the edges, for the following reasons:

The distance from the cathode is slightly greater than at the center;

The velocity of the electrons toward the aperture is less for the edges than for the center.

The magnetic field, in the direction of the electron's path, increases with the angle from the center.

All these factors are reduced by increasing the deflection distance. In practice, 15 degrees deflection on each side of zero is the value used, when the scanning aperture is not smaller than 15/1000-inch.

The principle of magnetic focusing becomes very useful in the construction of oscillite or receiving tubes. It enables us to focus back, to a point, all electrons from a single emitting point; and thereby to obtain very good light intensity in one of these tubes. In fact, the light intensity so obtainable is limited only by the properties of the fluorescent material. Spot intensities can be obtained which turn fluorescent material black and inactive after only a few seconds' exposure. The element used in this work will be described later on.

The reproduced photographs here were taken from the receiving tube, from transmitted motion-picture film. The large image (of Dr. Lee de Forest) was secured by making the film from a still photograph. The exposure was about half a minute, and the blurring is due principally to the fact that the picture on the receiving tube moves slightly. The effect is quite negligible to the eye, but gives a badly-blurred image when exposed so long to the camera. It is shown merely to represent the inferior limit of quality. (Fig. D.)

The smaller images at the side were made with 60-cycle scanning current, and moving the film at both the receiver and the transmitter at approximately the same rate of speed—about one frame every two seconds. They

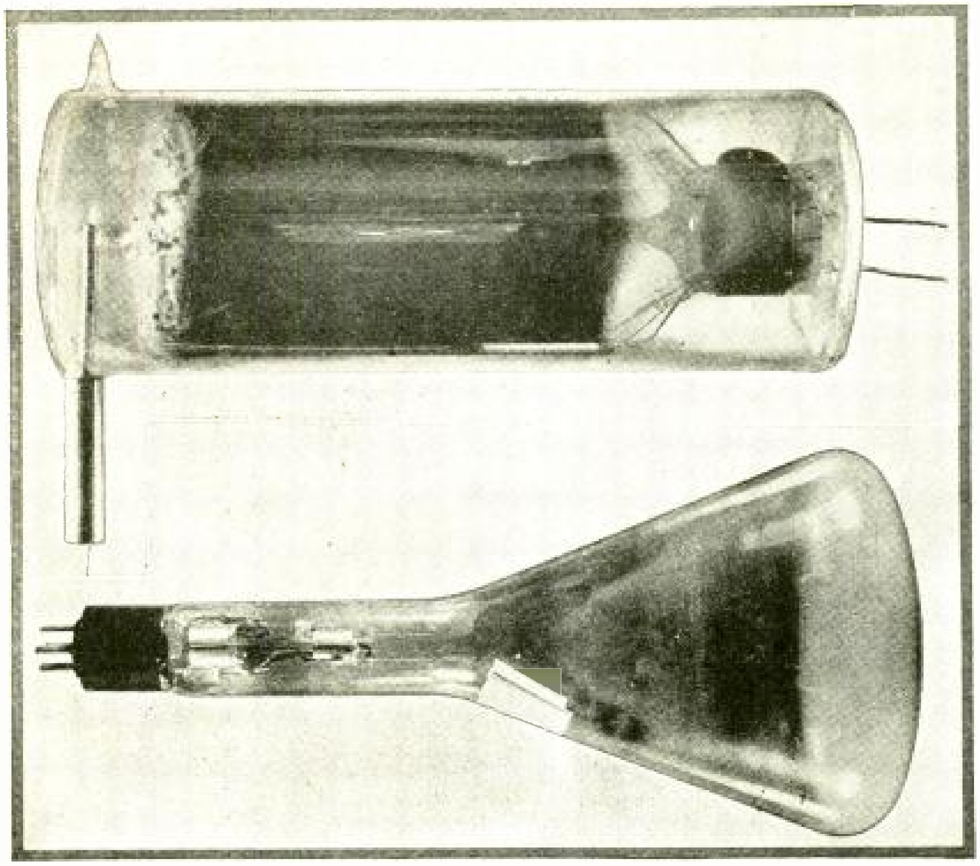


Fig. A (above)

The "dissector tube," with its "target" shown at the left, is used for transmitting.

Fig. B (below)

The "oscillite," or receiving tube; the image appears on the flat surface at the end of the bulb.

therefore indicate the quality of dissection, but not the perfection of the amplifier.

The actual image, as it is seen on the receiving tube, appears much better than any of these reproductions; as those who have seen it will attest.

Types of Dissectors

The high-vacuum-dissector tube (see Fig. 6A) in use at present comprises a cylindrical glass envelope, having at one end a flat window (W) which is polished before sealing in. At the other end is a stem, upon which the elements of a tube are supported and through which the leads pass. The inner end of the stem carries a short glass pillar (P) terminating in a square button; the button supports a silvered mirror on which is deposited a photo-sensitive film. A band clamp is supported from the stem, having welded to it wires which carry the anode structure.

The anode structure itself (see Fig. 6C) is made by winding very fine tungsten wire around a tungsten-nickel frame as shown. This is supported from the collar, so that it is closely parallel to the cathode. Supported separately from the collar is a cylindrical screen, usually of fine nickel mesh, which conforms closely to the inner surface of the glass envelope. (In the latest types of tubes, this screen has been replaced by a platinum coating on the walls of the tube.)

Two general types of targets are in use; that shown in Fig. 6D is designed to make use of secondary emission; while that shown in Fig. 6E is intended only for primary emission.

Photoelectric Substances Used

After the elements of the tube have been sealed in, it is sealed to the pump in much the same manner as an ordinary photoelectric cell, provisions being made to distill into the tube a small amount of potassium. After the tube has been baked for three or four hours on the pump, and the vacuum is as good as can be obtained, a small amount of potassium is distilled into the tube and allowed to condense where it will. Then, by heating the lower portion of the tube, the potassium is deposited upon the cathode; the tube having been designed so that the cathode remains cool, unless the stem is heated.

It is necessary to be very careful in this process, to dry the potassium very slowly. Otherwise there is produced a glazed cathode surface which has been found to be inferior in uniformity to an unglazed surface. Care must also be taken to keep the target of the tube warming during the potassium distillation, to insure that no metal condenses inside the target shield.

After the tube has cooled thoroughly, hydrogen is admitted and the surface colored by the Elster-Geitel process. Care must be taken at this stage to insure the exact pressure of hydrogen which will permit the entire surface to form at one time; otherwise a non-uniform emitting surface will result. The cell is then carefully pumped to rid it of all traces of hydrogen; after which it is sealed off the pump.

The work of A. R. Olpin and L. R. Koller has indicated two general methods for greatly increasing the sensitivity of photoelectric cathodes; the Olpin process particularly has been applied with great success to the construction of dissector tubes. The general technique, as it has been evolved for the preparation of these "sodium-sulphur" dissector cathodes, is closely similar to that employed by Olpin. One rather interesting side light is that if, in the preparation of the sodium-sulphur cathode, it is spoiled for some reason or other, a moderately sensitive dissector is secured simply by admitting hydrogen and passing a glow discharge, as in the Elster-Geitel process. This usually gives a cell with a sensitivity of one microampere per lumen (*unit of illumination*) and the sensitivity seems to be more permanent than with the potassium-hydride cell.

The sensitivity of such a dissector, like that of the usual potassium-hydride photocell, is best at about one-half microamp./lumen (or one-twentieth that of a gas-filled photo-cell) though this can be nearly doubled by the use of secondary emission from the target. The potassium-hydride cell, is therefore, not sensitive enough to be used with light reflected by an image; the present cells are used with transparencies and a 400-watt tungsten lamp.

The sodium-sulphur cathode dissectors have a sensitivity of 6.5 microamps./lumen; a suitable light intensity may be obtained by illuminating the face, or an object of equal reflecting power, at a distance of one foot with a 1500-watt tungsten lamp. This sensitivity, therefore, approaches the order of that required for direct scanning.

Zworykin (see RADIO-CRAFT for February, 1930) reports sensitivities of 25 microamps./lumen; this sensitivity would permit direct scanning with lamps that are not too bright to be used with animate subjects. Dissectors of this sensitivity, however, have not been built as yet.

Dissector tubes may be built to operate without an anode screen. Fig. 6B shows the construction of such a tube. Its principal advantage is its simplicity; it has the disadvantage of giving a rather poor electron image, and has not thus far been built with

(*Continued on page* 74)

TELEVISION in Twelve Colors

By Dr. Fritz Noack, (Berlin, Germany)

European Television experimenters use ingenious methods, including twelve-color discs and prisms to produce television images in colors.

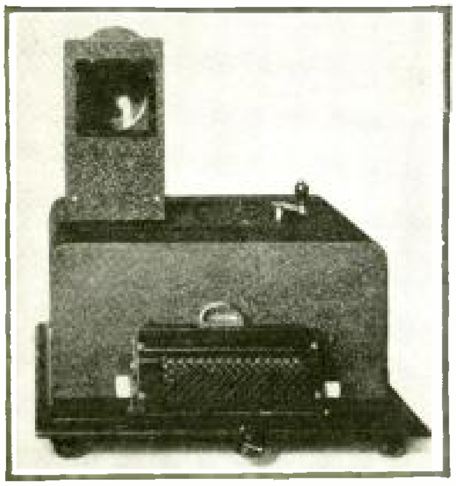


Fig. C
A commercial German televisor, on the Mihaly system, as produced by the Telehor Company.

THE success of colored motion pictures, for which special films are prepared, suggests the application of somewhat similar methods to television. However, colored television necessitates either a special wavelength for each color employed, or else modulating the transmissions at twice or three times the normal image frequency. Either widens the waveband to an extent which is prohibitive.

In addition to this, the superposition of two or three pictures, each in a single color, does not give an absolutely natural effect; because the spectrum of visible light is much more complex.

Then, too, the methods of colored television heretofore published are in principle exactly like those used in black-and-white reproduction. The different image points, varying in illumination, are converted into corresponding electrical impulses at the transmitter; they must be faithfully and exactly reproduced at the receiver, to have a perfect picture. But there are many causes of faulty reception, the most unpleasant of which is fading; not only does this cause interruptions of reception, but it also suppresses parts of the transmission, corresponding to certain frequencies. In a loud speaker, this means that sounds are lost or changed in timbre; in a televisor, that details may disappear entirely.

Equal-Illumination Signals

The effect of fading may be overcome in telegraph work by employing such a modulation that the signal swings back and forth between zero and a fixed value. This, for instance, is done in the transoceanic short-wave work of the Telefunken Co.; a receiver of amplification so high that the signals never disappear entirely is connected to recording apparatus through an automatic volume control. This, of course, is impossible in telephony, where variation of loudness as well as frequency is part of the signal; and it is also unsuited to television, where we must reproduce different light-values. If a process of scanning should be adopted, in which pictorial points of the same intensity are always selected, then fading could readily be overcome.

Dr. Schroeter, of the Telefunken Co., has made the suggestion that the image points be distinguished not by reproducing them at equal intervals with varying intensity, but by giving them the same brilliancy for varying periods of time; just as in telegraphy dots and dashes of the same strength are sent out, instead of dots of varying strength. In order to make this practical, it will of course be necessary to invent a method of converting the image from points of varying brilliancy into dots and dashes representing the same light values in terms of length.

However, a television system has been announced, which overcomes these difficulties and makes color television possible without widening the waveband, without fading and with the greatest fidelity to nature. It is that of a Berlin engineer named Ahronheim, who has lately acquainted me with its details.

Twelve-Color Discs

It is based upon the assumption that the colored image points show, not different intensities of light, but dif-

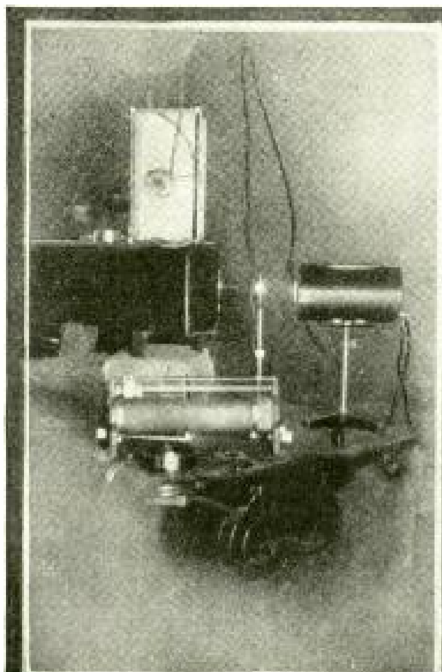


Fig. A

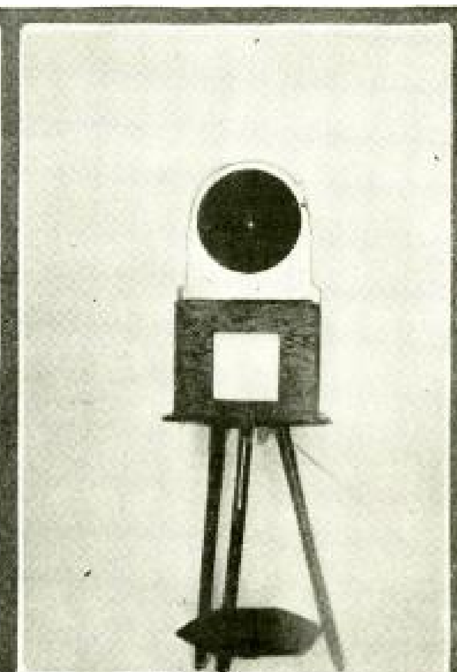


Fig. B

At the left, the experimental transmission set-up of the Ahronheim apparatus, by which it is planned to pick up television images in their natural colors, as determined by the dispersion of white light into its various frequencies. At the right, the receiver of the Ahronheim apparatus, with a loud speaker above and the image-screen below.

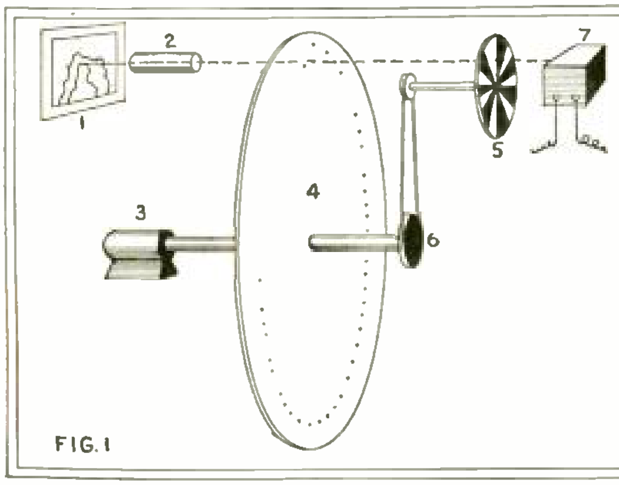


FIG. 1

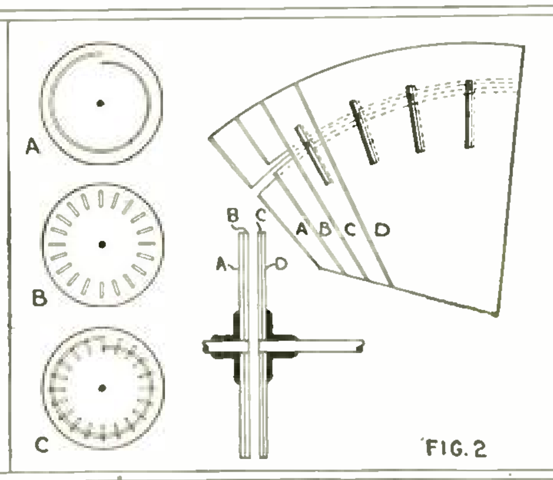


FIG. 2

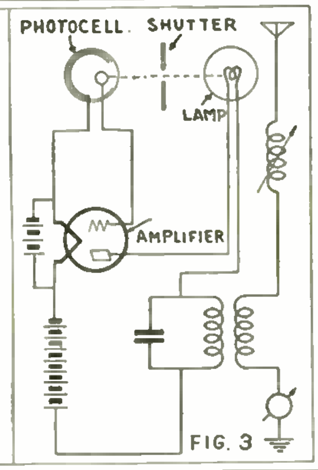


FIG. 3

(Left) Fundamental principle of the Ahronheim system: light from the image 1 is concentrated by lenses 2 on the scanning disc 3; but reaches the photocell 7 only when the proper filter is presented by the disc 5, which is geared (6) to revolve faster than the scanner. (Center) The Fries universal scanner: it will be seen, at the left, that A and B combined as at C give a spiral of square holes. Four discs, two spiral (A-B) and two slotted (C-D), at the right give any desired "grain" to the image; and revolving them on two shafts as shown below gives any desired scanning rate. (Right) Optical regeneration is produced by flashing the impulses of the photo-cell back into it from the lamp. Many other interesting and little-known television wrinkles are described in the text.

ferent color tones; that dark red and light red are not merely reds of different intensity but, actually, different colors. His methods of scanning the image are the same as in previous systems; the novelty lies in filtering the light before it enters the photo-cell, according to its place in the spectrum. The visible spectrum contains many gradations of color, but Ahronheim undertakes to reproduce it with twelve.

Then, if a revolving disc is arranged with colored glass sectors (Fig. 1) through which the light must pass from the scanning apparatus to the photo-cell, the ray of light can penetrate only the filters of appropriate color. The scanning mechanism operates as in other systems; and the filter disc only must revolve at higher speed, to make up for the fact that the light ray penetrates only one of its sectors at each revolution.

At the receiving end, a suitable system of scanning is used to build up the image; but here also a glass filter with twelve sectors is placed between the source of light and the eye of the observer. If the two discs are synchronized, a picture corresponding most exactly to the image at the transmitter will be seen.

Since the photo-cell receives just as many impulses as with black-and-white television, the modulating frequency required is no higher for colored television; and if the transparency of the filter is properly regulated, the image impulses in the input of the transmitter, and the signals it sends out are of uniform intensity.

Use of a Prism

However, Ahronheim proposes, not to build a mechanical filter system of the kind described above, but to utilize a prism which, as we well know, decomposes white light into its constituent colors. The entire spectrum will come out only when light has been directed into the prism; light of a single color will emerge unchanged. Since the light rays are dispersed at different angles, according to their wavelengths, we could arrange twelve photoelectric cells side by side behind a prism; so that one would receive all the dark-red light which entered the prism, another all the light blue, etc. In practice, only one cell will be used, however; and, by the use of a scanning device, only the color corresponding to the image point reproduced at the instant will be conveyed to the cell.

The model at present completed is arranged for but a few color tones; but it demonstrates the fundamental characteristics of the invention. It is especially well adapted for televising colored motion-picture film, and it is possible to transmit simultaneously from the sound track. It is understood that an international moving-picture organization is interested in the invention.

THE editor is anxious to receive letters telling of your experiences in anything pertaining to Television. We want to make TELEVISION NEWS as full as possible of human interest; but we cannot do so without your help and support. Let us have your experiences, so far as they pertain to Television, for the benefit of your co-readers. We will publish all for which space can be found.

Tell us why you are interested in Television—tell us why you like the game—tell us what encourages you—tell us what discourages you—and let us have a general get-together. Only by discussing these things through the columns of TELEVISION NEWS can we make this *your very own magazine.*

Universal Television Receiver

At the present time, the English and German television transmissions are extremely interesting to radio enthusiasts. However, the systems used differ in details; the German transmissions are made at the rate of 750 thirty-line frames per minute, framed at the top of the disc; the image is a third wider than it is high. In the English (Baird) system, while the number of lines and rate of speed are the same, the image is viewed at the side of the disc, and it is higher than it is wide. Since this presents complications to the set owner, a method of adapting a radiovisor to different systems will be valuable.

In America, where several types of transmission are in use, it has been proposed to pierce the scanning disc with several spiral rows of holes, at different distances from the center; this also makes it necessary to shift the glow lamp and "window" for each reception. In addition to this, the images received nearest the center of the disc must be smaller.

The use of separate discs entail unpleasant labor in interchanging them, which would be too much of an annoyance for the set owner who purchases his equipment.

However, the new Fries system overcomes all these difficulties. Radiovisors using this method have already been produced commercially. The simplest, intended for the present transmissions by English and German broadcasters, have two picture windows and two rows of holes in the disc; the regular glow lamp is used. The holes for the English transmissions are on radius midway between those for the German; since there are thirty of each; but the pitch of the spirals is different. Only one glow lamp is required.

To prevent the two sets of holes from causing optical interference, a special disc is used to cover one of them. It has a set of 30 slits, and may be turned on the axis of the main scanning disc to uncover one or the

(*Continued on page* 68)

PHOTO-CELLS and GLOW-LAMPS

Their Role in the Transmission and Reception of Television Images

By A. C. KALBFLEISCH
Television Consultant, National Radio Institute

"Just what does a photo-cell do anyhow?" asks the average man. "And what does a neon tube do toward reproducing a living image at a television receiver?" Read Mr. Kalbfleisch's article and learn just how these two important devices function.

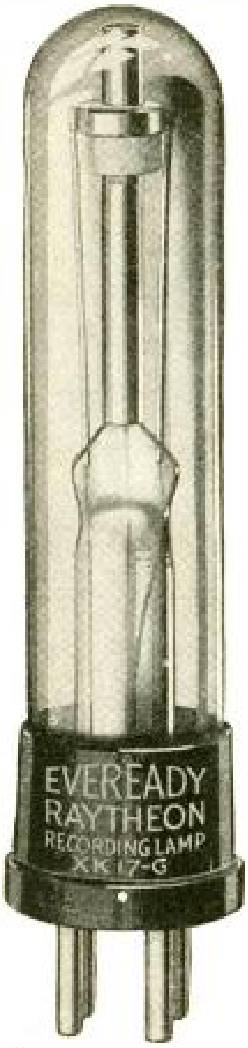


Fig. 4—One commercial form of neon glow lamp.

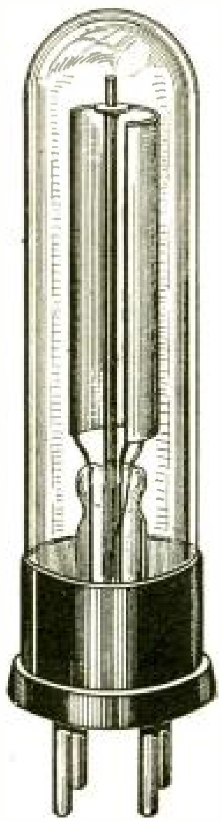


Fig. 1—Typical photo-cell of today.

Fig. 5—The Raytheon "kino" lamp (neon glow tube).

THE first requirement for television transmission is that the variations in light and shade of an object or picture shall be translated into varying electrical impulses. These impulses are then transmitted by telephone wires or by radio waves to their destination. At the receiving end they must be changed from the electrical form back to the original lights and shades. To accomplish this, there are certain fundamental steps which are known to all of us, and which differ only in their method of application. The purpose of this article is to study more or less in detail, the photo-cell and the glow-lamp, which are the prime factors in the conversion of variations in light and shade to electrical impulses and vice versa.

If we are to bring about these changes, we require first of all illumination of the object, in order that the lights and shades used to produce the picture may be present. It is interesting to know that, in early television experiments, the entire object was illuminated; so intense was the light that the heat and glare were more than a human being could stand, and the first objects to be televised were "dummies." As time went on, more sensitive apparatus was developed, with the result that live subjects can be televised without any great discomfort.

How We "Scan" the Object Televised

The method of scanning used in this country is known as the horizontal form. As we know, in most television systems, the entire object is not lighted at once; but a narrow beam is used, which rapidly traverses the object along certain strips. To make this point a little clearer, let us compare a light beam to the words on this page.

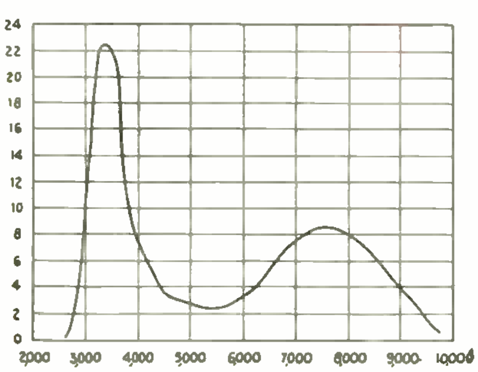


Fig. 2—Curve showing sensitivity of G.E. photo-cell to light of different wave lengths.

We are accustomed to read from left to right, drop down a line and start over again. In exactly the same way, our light beam traverses the object from left to right and from top to bottom.

The lights and shadows cause variations in light which register, as the scanner passes over the object to be televised, and must next be changed into *varying electrical impulses*. The device which has made this conversion possible is known as the *photo-electric cell*.

This peculiar effect of producing variations in electrical impulses for corresponding variations in light and shade, was observed many years ago, with the advent of *selenium* cells. Quite by accident, it was discovered that the resistance of selenium changed with variations in light. Immediately the questions arose, "How can we utilize this phenomenon?" Unfortunately, the selenium cell is too slow in its response for present television requirements, and the problem was unsolved for many years. It remained for the advent of the photo-cell to give us television as we know it today. It might be well to define the meaning of television in this sentence; in this particular instance we mean the reproduction of a scene, a play, or other active scene.

The importance of the photo-cell in the field of television cannot be overestimated. We are justified in calling the photo-cell the very heart of this new science. We shall study in detail the various types of cells, how they are made and their applications.

Design of Standard Photo-Cells

The photo-cell of today looks very much like a vacuum tube, as far as its shape is concerned; its properties, however, are radically different. All photo-cells have two elements: an anode, or positive terminal; and a cathode, or negative terminal. As a general rule, the anode is in the form of a ring or grid in the center of the bulb, while the cathode is formed by a thin coating on the inside surface of the glass bulb. We shall learn what this coating is in our discussion of the actual construction of various types of photoelectric cells.

The photo-cell has what is termed a window or clear spot on the glass, whereby light may enter and fall upon the cathode. The secret of the cell is that, with a voltage of the order of 135 volts across its terminals, it is capable of turning light variations into coresponding electric currents. Since these currents are extremely small in value (that is, only a few microamperes) it is no easy task to design apparatus which would amplify these small currents without distortion. It is not uncommon to find as many as ten stages of resistance coupling, for the purpose of amplifying these extremely minute photo-electric curents.

It might be well to consider for a moment why the photo-cell functions as it does. We spoke a moment ago of the cathode of a photo-cell as consisting of a coating on the inside of the glass bulb. It is due to the light rays, pentrating through the window and striking the cathode, that electrons are given off and flow from cathode to anode. *If a sufficient number of these electrons are given off, we have a flow of current.* These free electrons which are given off at the surface of the metal cathode are called "photo-electrons."

We also know that we must use a substance for the cathode which unites

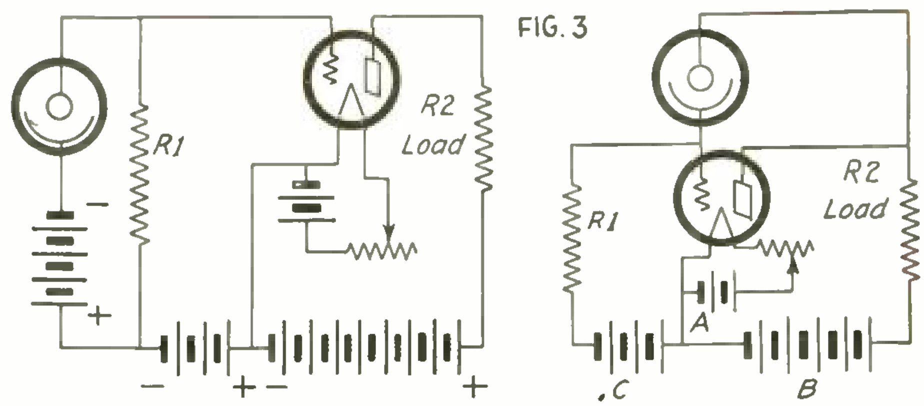


Fig. 3—Above, shows two types of photo-cell coupling circuits.

very readily with other substances. In other words, one very active chemically. The metal sodium is one of the most active substances known; potassium is another, and other elements similar to sodium and potassium which belong to the same "family" group (as it is called in chemistry) are often used in the construction of the photo-electric cell. Another peculiar property of these substances is that, if the light which penetrates through the window of the cell is ultra-violet or short-wavelength light, we have a greater production of photo-electrons, and therefore a larger photoelectric current.

Fig. 1 represents a typical photo-cell of today as developed by the General Electric Company; it is one of the most sensitive that we have. This is called the "caesium-oxide-silver" cell. It might be well to consider its construction and its responses to light intensity.

The process of producing this cell is rather interesting. One method is to release the caesium (an element of the "alkaline" group) which is introduced into the tube as a pellet, by heating the tube after it is sealed. The photo-sensitive substance, condenses on a silver cathode plate which has been oxidized. Baking the cell causes a reaction between the alkaline metal and the oxygen which, ultimately, results in the formation of caesium oxide with a monatomic layer of caesium over all.

High Response of the Photo-Cell

The light sensitivity of this cell is very high, being of the order of 25 microamperes per "lumen," with light from the ordinary Mazda lamp. Fig. 2 illustrates the sensitivity curve for this cell; it is interesting to note the double "hump" of the two maximums as they are called. We find one maximum at 3200 Angstrom units; the other occurs at about 7800 Angstroms. The reason that this cell is so sensitive to ordinary light is explained by the peaks which we find in the deep red portion of the spectrum.

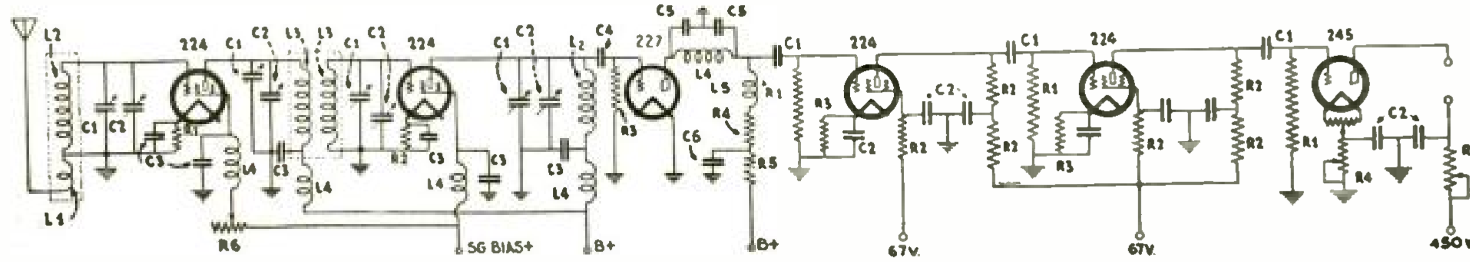
An interesting feature of the photo-cell, and that which makes it valuable to us for television, is that "photo-emission" takes place almost instantaneously. With the countless experiments which have been performed on the photo-cell, none have shown a lag between the incidence of the light and the issuance of the photo-electrons. In the ordinary high-vacuum cell, a fluctuating light causes the number of emitted electrons to vary in exact correspondence to its instantaneous intensity. The alternating component of the current flowing through the cell is called the "dynamic response"; for the sake of definition, it is customary to measure this dynamic response of a cell at a frequency of 1000 cycles per second.

In present-day applications, such as talking pictures and television, in which the alternating component of the photo-cell current is the modulating output, dynamic response is vastly important to us.

Elementary Photo-Cell Circuit

Before leaving the photo-cell, it might be well to consider the elemen-

(*Continued on page* 78)



Radiovision receiver with band-pass filter, and 15 to 30,000 cycle radiovision amplifier—L1, 24 turns No. 32 DCC, 1 in. diameter: L2, 48 turns No. 32 DCC, 1 in. diameter; L3, 48 turns No. 32 DCC, 1 in. diameter (ends together); L4, R. F. choke: L5, 20-100 mh. choke; C1, .00015-mf. gang condenser (shielded); C2, trimmer condensers; C3, .01 mf. radio frequency by pass condenser; C4, .0001 mf. grid condenser; C5, .001-mf. by pass condenser; C6, 1 mf.; R1, 500 ohms.; R2, 500 ohms.; R3, 2 meg.; R4, 30,000 ohms.; R5, 20,000 ohms.; R6, 0-200,000 variable resistor; C1, .2 mf.; C2, 1 mf.; R1, .25 meg.; R2, .05 meg.; R3, 1000 ohms.; R4, 2000 ohms variable; R5, 2500 ohms variable. The neon tube connects in a '45 tube plate circuit.

What I Think of Television

By LOUIS GERARD PACENT

THE author of this article is well-known in radio circles and is, indeed, one of the real old-time radio experimenters. Hence we cannot but respect his views.

While the editor cannot agree with one of his findings—that is, that television is in the distant future—yet we fully agree with Mr. Pacent that the art of television can only be brought to its final perfection if thousands of experimenters get behind it, just as they did when radio was in the coherer-and-spark-gap stage.

That is exactly the mission of TELEVISION NEWS: Namely, to get the large body of experimenters in this country, and elsewhere, interested in the new art.

LOUIS GERARD PACENT

President of the Pacent Electric Company, and one of the foremost radio experts in America. Mr. Pacent was associated with much of the early experimenting carried on with regenerative and super-regenerative circuits. He has had wide experience in the design and manufacture of various classes of radio apparatus and at the present time is particularly interested in the designing and manufacturing of sound motion picture apparatus. Mr. Pacent is an electrical engineer as well as a business man of unusual attainments.

SOME TIME ago, I made a statement to the effect that television as a practical, commercial application in the home would not materialize for at least five years. Today, I still find no reason to change that statement; but, in reiterating it, I do wish it to be understood that I am making this prediction with due acknowledgment of the tremendous efforts that have been expended in developing this art.

Unfortunately, television at one time had been the subject of overenthusiastic publicity; and it was widely advertised in the editorial columns of the press as an accomplished fact, and something that would soon make its appearance on the market for use in the home. Naturally, when the public finally learned that television was still far from the parlor stage, they felt a certain resentment and, for a certain period, public attention to television was very slight. However, it does not follow that television, because of this, will not be eventually perfected.

At the present time, television is in the same state of development that radio was when the crystal detector and coherer were used for radio reception. It seems unlikely, in view of this, that any single revolutionary development will make the televisor an instrument of every day use. Rather, I believe, small improvements made from time to time by amateurs and experimenters (as in radio) will, over a long period of time, bring about those improvements necessary to make television a commercial feasibility.

While I appreciate the work done by commercial laboratories, I do not believe that the really important developments of television will come from large organizations. We have but to scan the progress of radio to learn that this is not likely. Most of the really important inventions and discoveries in radio were made by the individual, and not by the big corporations. Credit for the development of the regenerative receiver and the superheterodyne, the latter regarded as the best receiver in radio today, belongs to Edwin H. Armstrong, who was, at the time, an amateur experimenter; and the tremendous progress made in short-wave transmission has been almost exclusively the result of work by amateurs.

The rapidity with which television will be perfected is regulated, in my opinion, by the number of minds at work on the problem. Organizations interested in television should take cognizance of this fact, and exert every effort to interest the radio amateur in the further development of the art.

When television does arrive, it is very unlikely that it will interfere seriously either with radio, "home talkies," or the corner movie. It will cover a field widely separated from these.

At the present time, many people are ignoring the possibilities of home talkies, which are an accomplished fact, in favor of television which is still in a nebulous state. A few moments' thought on the subject should convince those who have adopted this "watchful waiting" campaign, that television and the home talkie are entirely independent of each other. Obviously, in television the operator must take what is offered; whereas, in home talkies, he will have an enormously greater variety from which to select, and in addition may make talking films of his family and friends.

I repeat again what I said in the opening paragraph: that this forecast I have offered has not been made without due consideration of the developments already effected and the efforts exerted by many great minds throughout the world. But, for all this, the solution to the television problem undoubtedly will come from the brain of an insignificant amateur experimenter who, perhaps, has had no engineering training but who, in his very novel experiments, will *see beyond the rut, and find the road to perfection!*

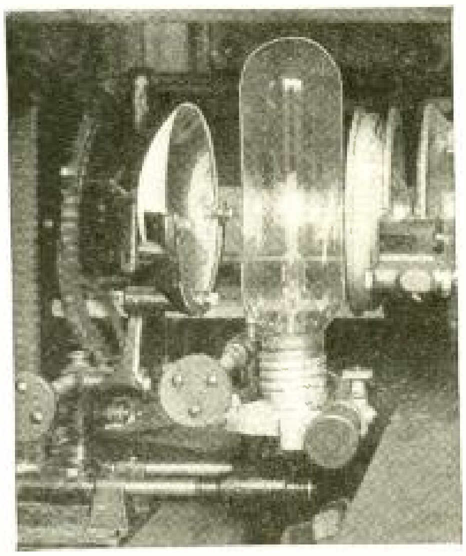
Latest Progress in TWO-WAY Television

By DR. HERBERT E. IVES
Electro-Optical Research Dept., Bell Telephone Laboratories

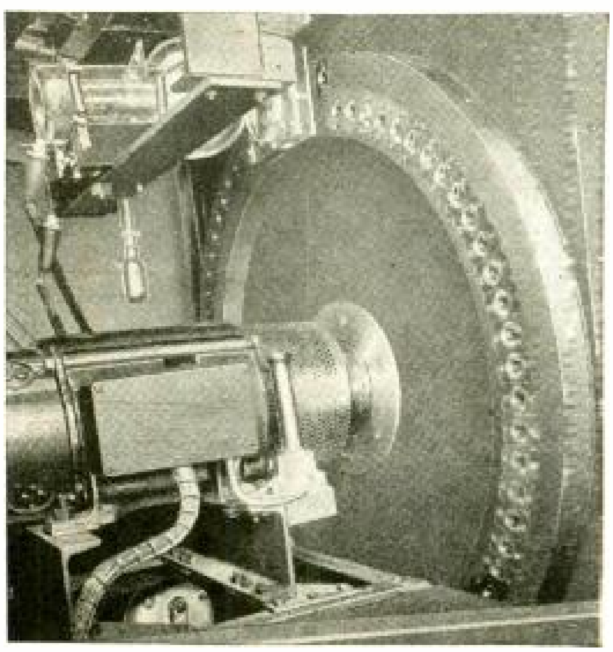
Superior detail in received image is now achieved by use of new transmitter lamp rich in red rays; also by use of red-sensitive caesium-oxygen cells and a neon crater tube of high intensity, placed behind a lens-studded scanning disc.

WHEN two-way television was demonstrated, between the Laboratories and the American Telephone and Telegraph building in April, 1929, certain improvements were incorporated in addition to the changes necessary to convert the earlier one-way into a two-way system. These have already been described in the Record*. Since that time, still further improvements have been made (chiefly in the optical features) which make the received image quite appreciably more life-like than it appeared with any of the earlier apparatus. These changes have, in addition, made the apparatus more compact and have contributed materially toward the ease of operation and upkeep of the system.

* Bell Laboratories Record—May, 1930, p. 399.



New transmitter (incandescent) lamp mounting.



Above: The newest Bell Telephone Lab's., neon tube, having a concentrated or "crater" target, which provides a better image than before.

Left: The latest television receiver, having a "lens" studded scanning disc; note the neon "crater" tube.

The two caesium-oxygen cells are mounted directly in front of the subject; note squares at either side of his head.

Incandescent Lamp Replaces Arc

One of the modifications has been the substitution of an incandescent lamp for the arc formerly used for scanning. The mounting arrangement of the new light-source, which is of the type used with motion-picture projectors, is shown in one of the photos. Several advantages are secured by this change: an incandescent lamp avoids the flickering always present, to some extent, in an arc; and thus there is a gain in the steadiness of the image. Also, the maintenance and adjustment of the incandescent lamp, which is of the ordinary projection type, is much simpler. A still further advantage is that the filament, being at a lower temperature than the arc, radiates more light at the longer wavelengths, which facilitates another improvement made in the scanning system.

At the first two-way demonstration, the scanning beam traversed a filter which passed only blue light, and the photoelectric cells used (which were of the potassium-sulphur-vapor type) were sensitive chiefly to light in the blue part of the spectrum. In the two-way system a person looks at the incoming image formed by the glow of a neon tube, at the same time that his face is being scanned for transmission to the other terminal. The luminous intensity of the neon tube is not high, and its effective brilliancy would be greatly decreased if the eye were exposed to a bright light from some other source. The human eye, however, is very insensitive to blue light, even when of quite high intensity; so that, by making the scanning light blue, it has only a very small effect on a person's ability to see the received

(*Continued on page 72*)

HOW CATHODE-RAY

No Scanning Disc!—That is the slogan of the leading television research experts today and the television receiving apparatus devised by Dr. Vladimir Zworykin, famous engineer, provides the key to "Television Without Scanning Discs." Dr. Zworykin employs the weightless Cathode Ray which can move with incredible velocity.

EXPERIMENTS in television with a new type of receiver, from which the cumbersome scanning disc has been eliminated, were recently described before a district convention of the I. R. E.

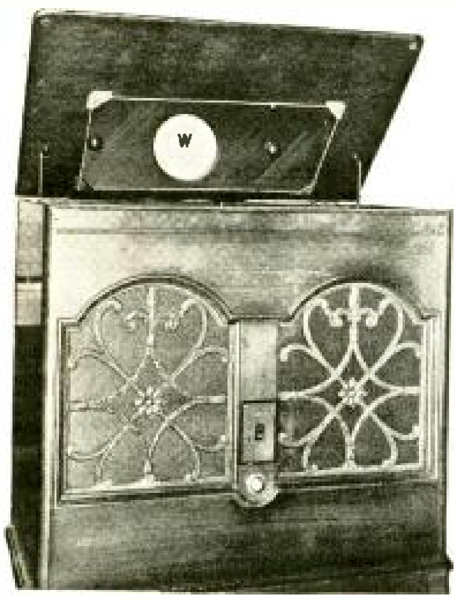


Fig. B
The mirror in the console lid reflects the image on the target of a "kinescope" set below it.

by Dr. Vladimir Zworykin, famous tube expert, who has been testing the utility of the cathode-ray tube for this purpose, in the East Pittsburgh laboratories of the Westinghouse Electric and Mrg. Co., now of the R. C. A. Victor engineering research staff at Camden, N. J.

The theoretical value of the cathode-ray. The cathode ray itself (as with light, moving without mechanical parts, has been evident for many years to those who have considered the problem of television. It was proposed as long ago as 1907 by Boris Rosing, a Russian physicist. However, as with Nipkow, the inventor of the scanning disc, Prof. Rosing was ahead of his time.

Primarily, the cathode-ray tube is a device in which electrons emitted from the cathode (which corresponds to the filament of the earlier, and simpler, radio tubes) are drawn away from it by a high voltage on the other electrode, or anode. The higher the voltage, the greater the speed of the ray. The cathode ray itself(as with the X-ray, which is only one form of cathode ray) is invisible. It may, however, be made visible by contact with *fluorescent* material, which it causes to give off visible light.

The Oscillograph

The beam of cathode rays is composed of moving electrical particles; it is therefore capable of being attracted from side to side in an electrical or magnetic field. In the well-known device of the oscillograph, the beam is subjected to the influence of two varying magnetic fields at right angles to each other; and it is thereby caused to describe curved lines of light on its luminous screen. This same action furnishes the scanning motion required by Dr. Zworykin in his television receiver; while the variations of the intensity of the ray—with the voltage on its controlling element—affect the brilliancy of the light on its screen, and produce the bright and dark contrasts necessary in a television image.

While the apparatus illustrated here is still in the stages of development—with the end in mind of creating a home television receiver which is quiet in operation and has no moving parts to require care from its operator—its inventor states that he is "already in position to discuss the practical possibility of flashing the images on a motion-picture screen, so that large audiences can receive television broadcasts of important events, immediately after a film of these is printed. These visual broadcasts would be synchronized with sound."

The tube, shown in Dr. Zworykin's hand in Fig. A, reproduces its moving images on the larger, or "target," end which is covered with a material known as Willemite (a zinc ore) or a similar fluorescent substance. This end of the tube is about seven inches in diameter, and it is possible to throw on this an image as large as 4 x 5 inches. However, a serious problem attending its operation is that of the voltage necessary. The tube should operate with at least 3,000 volts of anode (corresponding to plate) potential; and more if images larger than 3 inches square are required. The picture thus formed is green, instead of red, as with a neon glow-lamp; the new tube requires, however, less power output from the amplifier of the radio receiver to produce brilliant images.

A Proposed Design

The arrangement shown in Fig. B, for a home television receiver, shows the tube built in a vertical position, into the console of a set of commercial design. A mirror set in the lid of the console, when turned up to an angle of slightly more than 45 degrees, makes the image visible to a large number of spectators, even in a moderately-lighted room. The automatic scanning system holds the image in frame;

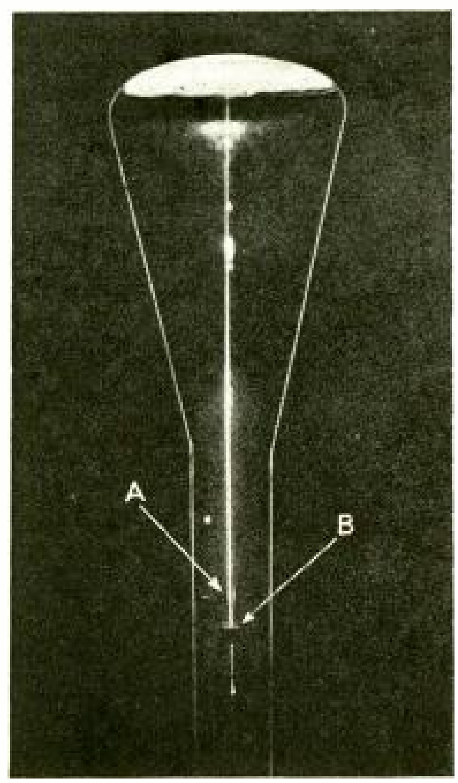


Fig. C
This extraordinary photograph of a cathode-ray oscillograph shows the action of a device very similar to Dr. Zworykin's. The electron stream is governed, in its motions from side to side, by the magnet coils A and B.

(Photograph by Baron Manfred von Ardenne Berlin, Germany.)

ELIMINATES *the Scanning Disc*

Fig. A

At the right, Dr. Zworykin is shown holding his new tube, the "kinescope"; on the large or target end of which moving images are built up by a ray of moving electrons. Its essential parts are shown below in cross-section in Fig. 2, and the cathode filament on a large scale in Fig. 3.

since the impulse of the ray upon its fluorescent target has a persistence comparable to that of the human eye, the image lingers slightly, and it is possible to reduce the number of "frames" needed per second. This, again, makes it possible to transmit more scanning lines on a single radio channel, and give larger images in more detail.

As with other experiments in television at these laboratories, images have been broadcast through the transmitters of KDKA; being taken from reels of moving-picture film to assure standard modulation. The film is run through a projector, resembling in many ways those of the "talkies," but all the images it contains are converted into electric impulses by means of a photo-electric cell. The output of this, after tremendous amplification, is used to modulate the carrier wave of the transmitters. The scanning of the image on the film, at the transmitting end, is accomplished by projecting through it a very minute ray of concentrated light, reflected from a vibrating mirror which is driven, in a magnetic field, by an alternating ("sinusoidal") voltage impressed upon the coils to which it is fastened. The result of this is that the mirror moves most rapidly in the center of the image. It was therefore necessary to exclude a portion of the mirror's swing from the scanning transmission; but the light-ray is effective 85% of the time.

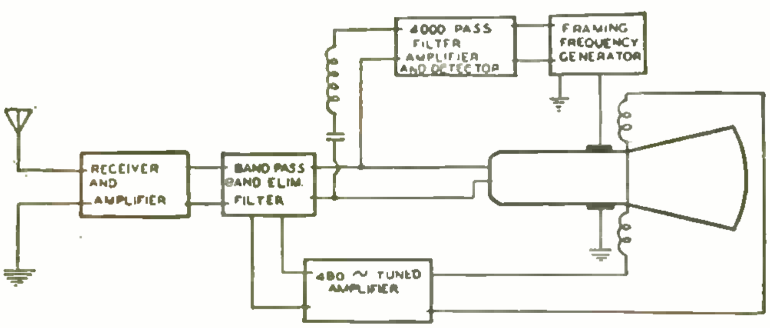


Fig. 1

The circuit used in the reception of television signals and their reproduction in visible form by Dr. Zworykin's tube: the signal is sent as a double modulation; part of which represents the image; and part the "framing" frequency, which synchronizes the movements of the cathode ray with those of the scanning beam at the transmitter.

The "Cathode Ray"

At the receiver the signal is detected and amplified in the usual manner, led to the band-pass filter (Fig. 1) and then to a "controlling element" regulating emission from filament of the cathode tube, just as the grid controls the current passed by an ordinary vacuum tube. (See detail of the "electron gun" in Fig. 3). Through the narrow opening in this control element, a stream of electrons darts into the first anode A, and then out, past the deflecting plates. The first anode, with a potential of 300 to 400 volts, gives the electron stream a certain velocity; this, when the stream passes through the opening in the first anode, is further highly increased by a potential of 3,000 to 4,000 volts impressed on the metallic coating of the inner walls of the bulb.

With no deflecting influence from either side, the electron stream would continue straight down the center of the tube—as shown in an interesting photograph made from an oscillograph tube operating on similar principles (Fig. C). However, in the neck of the new Zworykin tube there are two sets of deflecting devices; the first, working electrostatically, swings the ray back and forth, to correspond with one motion of the scanning transmitter. The second detector, having coils, sets up a magnetic field and moves the beam at right angles to the first deflection. The result is a complete scanning of the fluorescent screen on the target. At the same time, the modulation of the biasing voltage (on the controlling element or grid, next to the filament) varies the intensity of the ray, and consequently the brilliancy of the moving spot of light. The result is that an image of light, and dark points is built up, in synchronism with the transmission; just as in the system of mechanical scanning in front of a glow-lamp.

In order, however, to accomplish this purpose, it was necessary to design a special tube; the device Dr. Zworykin has produced for television, he calls the "Kinescope." In laboratory cathode-ray tubes, a high degree of vacuum has been maintained only by connecting them to an air pump in constant operation; this is impossible for home apparatus. The previous low-voltage tubes have not given enough light for the duty imposed in this case. The kinescope has an oxide-coated, indirectly-heated cathode, and its various operations are under thorough control through the means described above.

Synchronizing Methods

For the radio transmission of television signals in a single "channel,"

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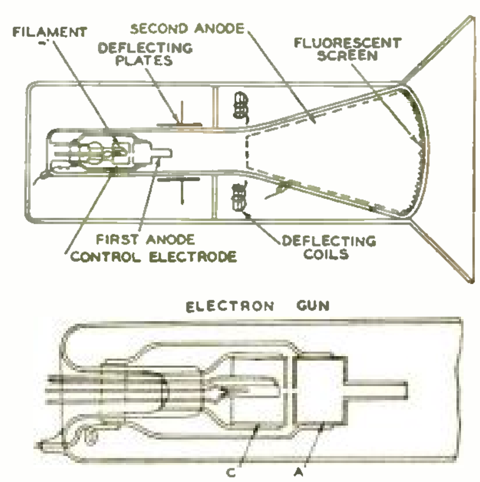

Fig. 3

Details of the cathode-ray projector.

Fig. A
The radiovisor in its plain cabinet; the image is formed at the end of the "shadow box."

"A Scanning Drum" TELEVISOR

Perfected by Jenkins

A very interesting and radically different design of television receiver, which employs a scanning "drum," a neon lamp and an ingenious selector shutter.

By D. E. Replogle

TELEVISION, radio television, or radiovision for short, is in its formative state. It is an experiment about to become an industry.

Meanwhile, the commercial radiovision apparatus is about to be introduced. It will be in relatively simple and foolproof form, although necessarily high in cost at the beginning, because of a limited production. The Jenkins organization, in order to meet the requirements of the layman who is interested solely in the radiovision programs and not in the technique—the end rather than the means—is about to introduce a complete radiovisor in a handsome cabinet; a simple kit, for those who want to start out with a device that works, but is capable of changes and alterations; and a short-wave receiver especially designed for radiovision work.

Earlier Radiovisors

The earlier form of radiovision reproducing unit designed by C. Francis Jenkins comprised a wooden cabinet, containing a horizontally-mounted scanning drum which had a four-plate neon glow-lamp in its center, a synchronous motor and a commutator switch; and an inclined mirror, with large magnifying glass, mounted on its top.

The drum itself was pierced by forty-eight openings, arranged in four spiral turns of twelve holes each. Quartz rods from these openings extended along the radius of the drum from these points and terminated at the inner side of the hub; so that each was opposite the corresponding target of the glow-lamp during a time of rotation equivalent to the passage of its outer end over an angle corresponding to the picture width.

This is clearly shown in Fig. 5. In Fig. 6, the path of a beam of light from the glowing end of a quartz rod to the mirror, and from thence to the magnifying glass, is illustrated.

The lamp in the center of the scanning drum has its plates so wired to a distributor, or "commutator," that the first, second, third and fourth quarters of the scanning drum are illuminated, one at a time; each being flashed on in succession, at every fourth turn of the drum.

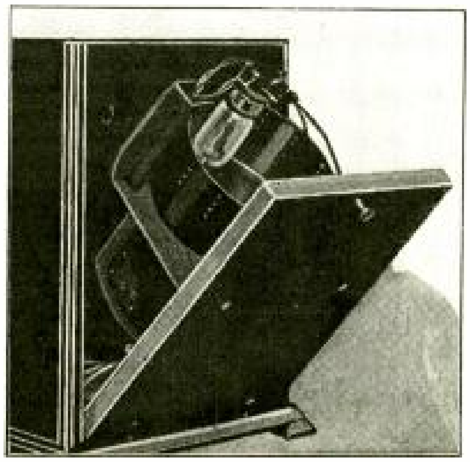

Fig. B
The rear of the new radiovisor opened, to show the simple lamp-and-drum arrangement now used.

Each "target" or plate of the light-source is to serve only during one turn, and the picture-current input to the device is "commutated" by a rotary switch geared in the proper ratio to the drum-rotating shaft.

The distance traveled by the *inner* or lamp end of the quartz rods is much less than that traveled along the outer circumference and the "targets" need be but a fraction of an inch square; since the rods are sloped inward to the target.

The property of the quartz rods utilized in this method is that the light admitted at one end is transmitted undiminished through the length of the rod to its outer end, like the flow of water through a pipe.

The four turns, illuminated in rotation, serve to make up a view or "field" *equivalent to that obtainable from a disc-scanning device some thirty-six inches in diameter.*

The New Model

Because of production demands, and the expense of the quartz rods, this model was torn down to its basic principles, and an entirely new design worked out.

At first, the same form of scanning drum, with light-conducting rods and a four-plate neon lamp, was retained; but the optical system was changed to view the scanning drum through the magnifying lens direct, without the mirror to reflect the beams. This simplified the cabinet; since everything was then placed inside, with the magnifying lens recessed in an opening in front, to form a "shadow box." Further development, however, has resulted in a much simpler mechanism; comprising a plain scanning drum, a single-plate neon lamp, and an ingenious selector shutter. This not only reduces the cost to a very marked degree, producing a quieter mechanism, but actually secures far better detail in the pictures.

The cabinet measures approximately 18 by 18 by 24 inches. The front end

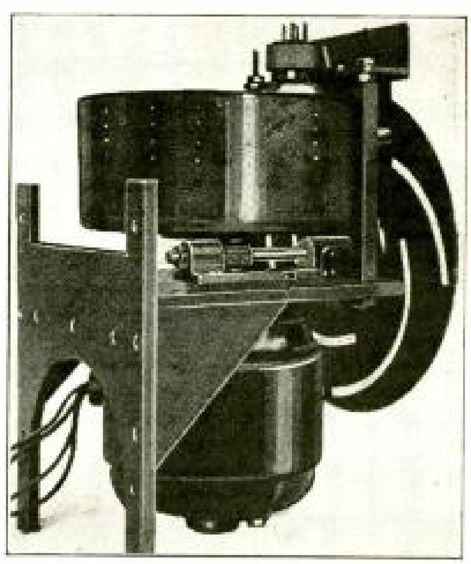

Fig. C
The works of the new radiovisor; the slotted disc in front obscures all but one hole to prevent the formation of multiple images.

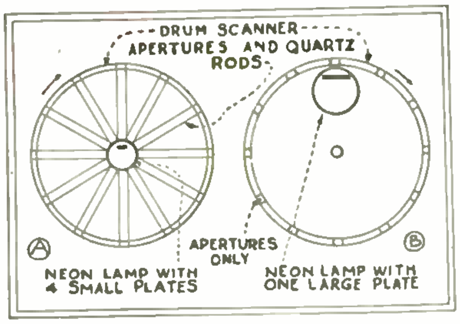

Fig. 4
Left, the old system; right, the new.

contains the shadow box; through which the radio movies are viewed in considerable enlargement, due to the concealed magnifying lens. Below the shadow-box opening is a control panel with "framing crank," and toggle switches controlling the loud-speaker and picture functions, as well as the starting, accelerating and stopping of the motor.

The first switch snaps on the neon glow-lamp. The short-wave radio set, employed in conjunction with the televisor, is tuned in the usual manner, until the characteristic buzz-saw note of the television signal is at maximum in the loud speaker. The second switch serves to turn off the loud speaker, so that the visual interpretation may now be obtained. The third switch turns on the motor and also serves as a simple method of bringing the scanning drum into step with the picture. The crank is turned to frame the picture properly from left to right.

The scanning-drum holes, when viewed through the magnifying lens, give an apparent screen size about 6 inches square; sufficient for the simultaneous entertainment of six to eight persons.

The combination is no longer obtained electrically but by means of a mechanical substitute called an "obscuring disc," which reveals to the eye only the hole then traversing the field of the light source (in this case a neon-tube having a discharge surface slightly larger than the image to be secured.) This is illustrated in Fig. 7. The relation of the obscuring disc to the drum and magnifying lens is shown in Fig. 8.

The neon-tube is placed directly behind the wall of the drum; with its plate exactly in line with the shaft of the motor and the drive-shaft of the obscuring disc. The positions of the scanner and single-plate neon tube are pictured in Fig. B.

In Fig. C. the motor, drum scanner, and obscuring disc are shown, with the neon-lamp in position.

It goes without saying that the selected signal must be matched to the particular radiovision apparatus available. In other words, a 48-line picture signal must be tuned in for a 48-line scanning mechanism.

Which brings us to a consideration of the apparatus required to receive radiovision signals properly. Television broadcasting, being now carried on in the frequency band between

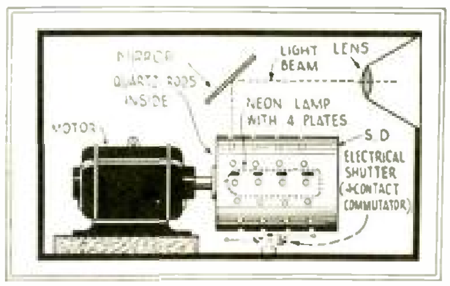

Fig. 6
A reflecting system, indicated here schematically, was needed with the older quartz-rod drum.

2,000 and 3,000 kilocycles, cannot be handled with the usual broadcast receiver. *A short-wave receiver, covering the wavelength range of 100 to 150 meters, at least, is essential to tune in radiovision signals.*

Amplifier Faults

The usual short-wave receiver today comprises a stage of screen-grid radio-frequency amplification, a regenerative detector, and one or two stages of transformer-coupled audio stages. While such an arrangement may be satisfactory for *sound* signals, it falls far short of meeting good radiovision requirements. To begin with, the radio-frequency end is usually too selective and, therefore, cuts off the wide side-bands so essential to good pictorial detail.

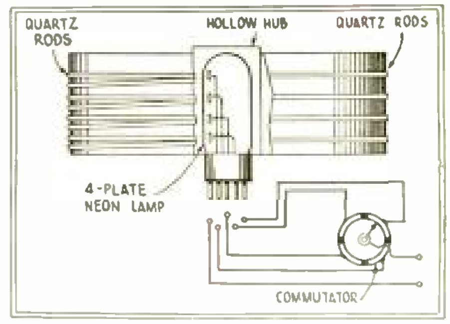

Fig. 5
The ingenious but expensive mechanism of the earlier Jenkins radiovisor.

Then the "regenerative" feature, if pushed to any considerable degree, tends to sharpen the tuning, resulting in a further elimination of sidebands. If the detector circuit is permitted to oscillate, marked distortion is introduced in the picture.

Finally, the audio end, in even the best short-wave receivers with good audio transformers, will begin to cut off at 3,000 cycles; which, while not noticeable in sound reproduction, is fatal to pictorial reproduction. In radiovision, we do not get much of a picture unless we can amplify frequencies up to 10,000; and 30,000 cycles is the present goal.

What does "frequency cutoff" mean in pictorial terms? If the audio amplifier cuts off at, say 5,000 cycles, which is the result with a good circuit, it is possible to obtain a fair outline of figures of a *silhouette* effect, *without half-tone values* and fine detail. Plain black-and-white pictures, such

(*Continued on page* 68)

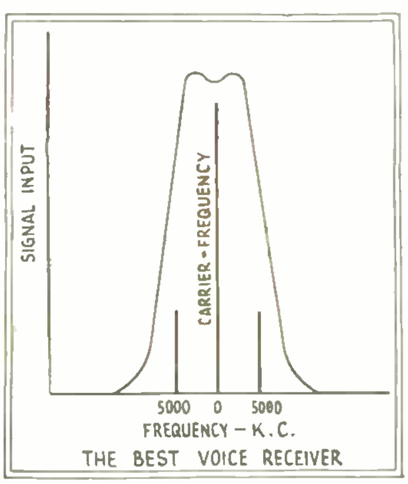

Fig. 2
The characteristic curve of a high-quality radio receiver, with very good R.F. and A.F. channels.

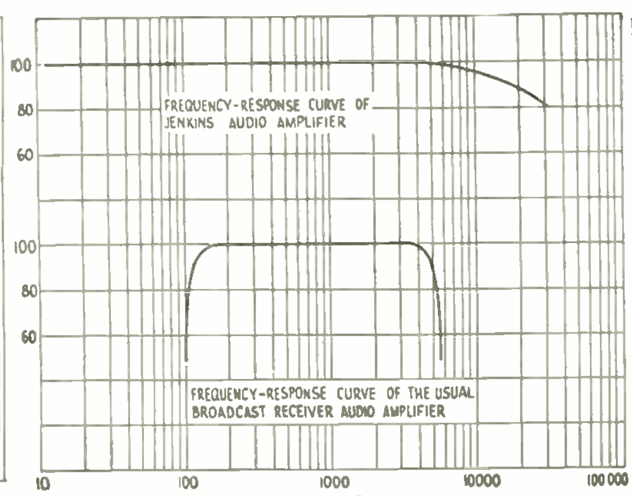

Fig. 1
The efficiency of the new Jenkins' amplifier for television, compared on a logarithmic scale with that of a receiver good enough for all audible reception.

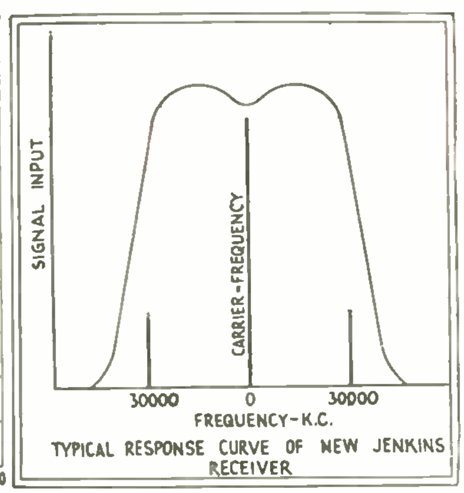

Fig. 3
Satisfactory reception of television requires an amplification curve like that shown above.

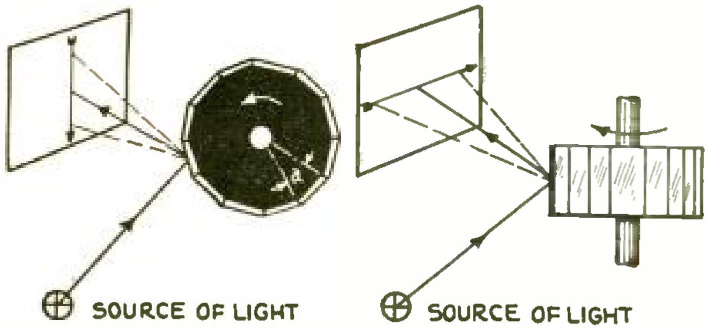

Fig. 1 (right). Horizontal or pictorial element scanning. Fig. 2 (left). Vertical or line scanning.

The MIRROR WHEEL

Universal Televisor

Aside from the factor of novelty and the elimination of the scanning disc, this mirror wheel system of scanning possesses several unique advantages as pointed out by the author.

By Rudolf Schadow

FOR the further development of television, it would be of great value to produce receiving sets capable of being adjusted and changed for any desired type of television. On the other hand, there is danger that, if the advanced state of technology made improvements possible on the transmitting end, these could not be carried out because they would require unduly expensive changes at the receiving end.

Lately, there has been proposed universal apparatus which can take the place of the simple Nipkow disc, and make possible an adjustment for any desired number of pictorial elements, as well as for various sizes of the individual elements. For simple sets, as televisors with disc scanning ought to be, such apparatus is, however, very complicated. The question arises whether it is not more advantageous to replace, with a new disc, one which has become useless through a changed scanning system.

On the other hand, the demand for a mirror-wheel televisor, which can be arranged for any number of pictorial elements, is much more pressing. After all, a mirror wheel is an article which one does not buy twice, and to exchange which would perhaps raise even greater difficulties.

A Double Reflection System

To construct such a televisor, we must deal with the horizontal and the vertical scanning separately; let us call the horizontal the pictorial-element scanning, and the vertical the line scanning. Then each component of the scanning requires a mirror wheel, and each mirror wheel has arranged along its outer rim or periphery, at equal intervals, a number of mirrors (any number, within certain limits), all of which are fixed on the edge tangentially, and parallel to the axis. Since each mirror, therefore, lies in the same plane of reflection as the one preceding it, a beam of light striking the mirrors while the wheel rotates will always describe simply a narrow line of light on the projection screen. The pictorial-element scanning is then effected by the horizontal or pictorial element wheel, as in Fig. 1; the line scanning by the vertical or line wheel as in Fig. 2. The line wheel, therefore, has its axis ar-

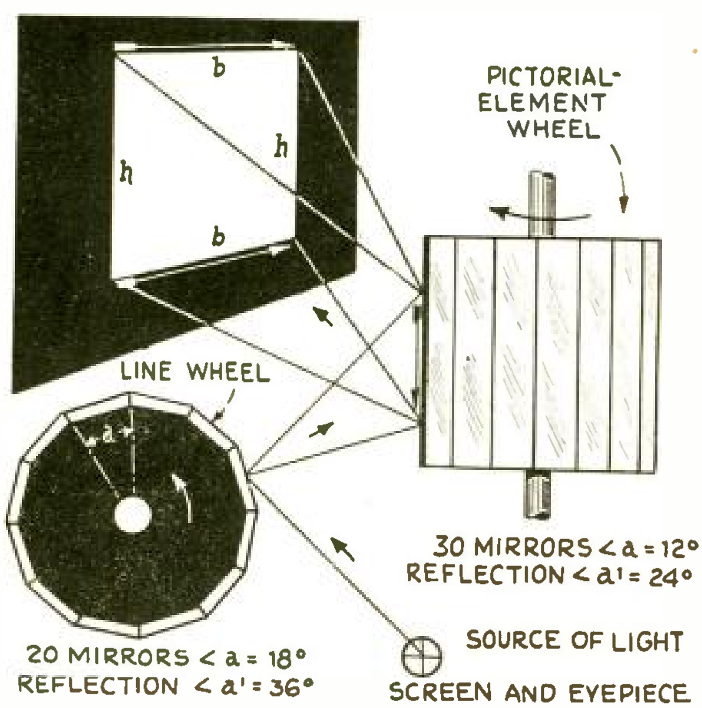

Fig. 4. Source of light—line wheel—pictorial element wheel—projection.

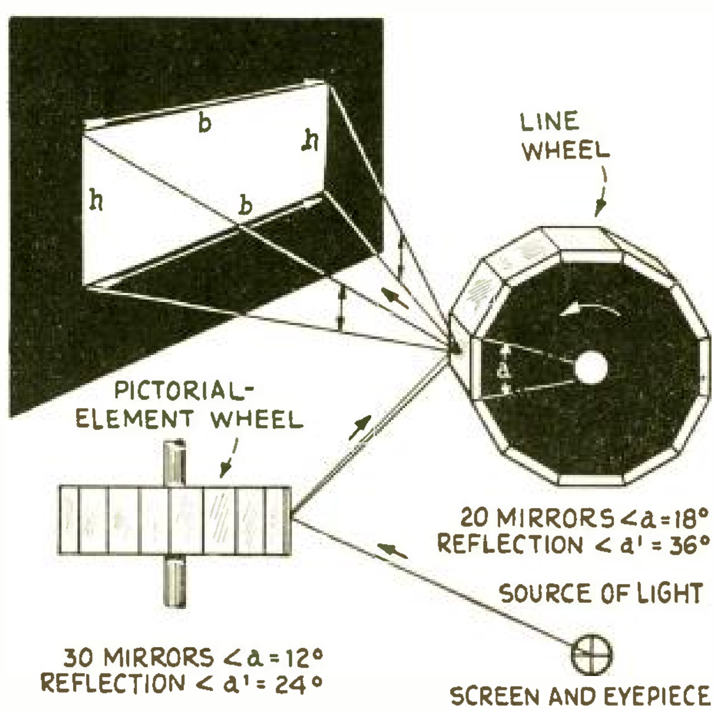

Fig. 3. Source of light—pictorial element wheel—line wheel—projection.

ranged perpendicular to that of the pictorial-element wheel. This is true for the German horizontally-scanned image, as well as for the English vertically-scanned image; but for a vertical picture (*i. e.*, one with the long sides vertical) the arrangement of the two wheels must be turned through 90 degrees.

To scan a given pictorial field, both wheels must work together. The ray from a glow-lamp, or a light-relay, is first projected upon one of the two wheels; and the rays reflected by this reach the second wheel, from which they are reflected upon the projection surface. The two wheels must rotate in such ratio that, while a mirror of the line wheel is describing a line, the pictorial-element wheel presents to the ray of light as many mirrors as there are lines necessary.

The gear-ratio i for a given number of pictorial lines Z we can formulate thus:

i equals $\frac{Z}{Ah} : \frac{1}{Av}$

In this Ah is the number of mirrors of the horizontal or pictorial-element

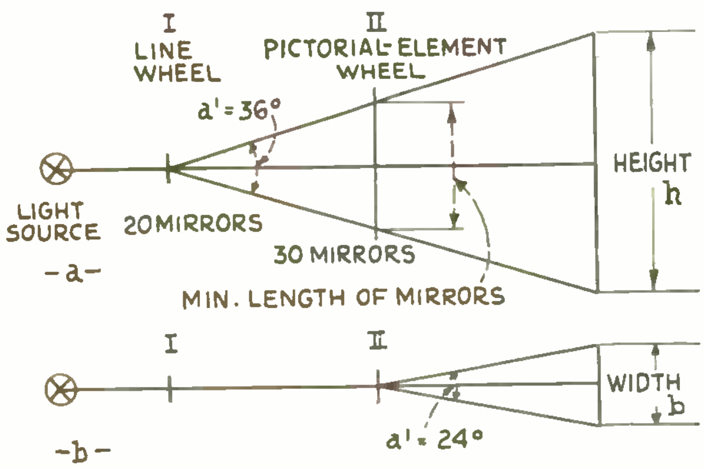

Fig. 6. Ray path of the arrangement in Fig. 4.

wheel, Av the number of mirrors of the vertical wheel. If we assume the horizontal wheel to have 30 mirrors and the vertical wheel 20, then with thirty-line scanning we get a ratio of 1:0.05. At the rate of 12½ pictures a second, that gives a ratio of 750-:37.5.

It therefore depends only on the choice of suitable speeds of rotation, and any number of pictorial elements can be scanned.

From the calculation we can, however, further assume that more favorable mechanical conditions arise if the line wheel has fewer mirrors. It might seem that the number of mirrors could be so far reduced that only one mirror is necessary: but, obviously, that would not do; for the angle of reflection would then became so great that the light ray would no longer fall on a plane.

A Spiral-Mirror Wheel

This reflection led to the construction of the single-mirror wheel as a substitute for the line wheel (Fig. 7). Imagine a plane mirror's surface bent around a spiral wooden wheel, and fastened; one revolution of the wheel then corresponds

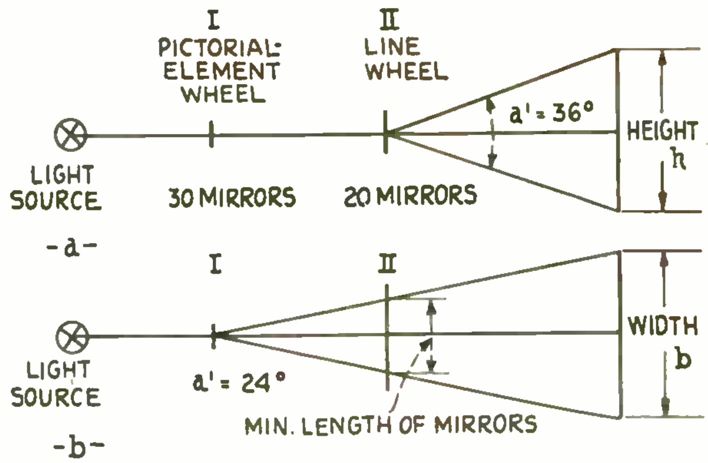

Fig. 5. Ray path of the arrangement in Fig. 3.

to the passage of a mirror of the line wheel. To be sure, with such a wheel, greater losses in reflection have to be put up with.

Since we always want to use the smallest possible number of mirrors but, also, not to increase the rotation number of the pictorial element wheel too much (with only ten mirrors the speed of rotation would be trebled), we put the pictorial-element wheel first in the system (Fig. 3), and let the rays reflected from it reach the line wheel. Thereby the path of the ray from the pictorial-element wheel is lengthened, while the line wheel requires a smaller number of mirrors. Fig. 4 shows the order reversed.

Until now, the size of the mirrors has been neglected. While the first wheel may have relatively small dimensions, in the design of the second wheel, the path of the rays or the distance apart of the rays must be considered. Figs. 5 and 6 are arranged to represent the arrangements shown in Figs. 3 and 4, and afford a comparison. Here we see a further advantage in the arrangement of the mirrors described; namely, that by changing the distance separating the two mirror wheels (*i. e.*, by shortening or lengthening the path of the rays) the proportions of the image may be altered. The limits are set only by the breadth of the mirrors of the second wheel. Through such a mutual change in position, which one could easily calibrate, we would be in a position to adjust them for any shape of picture; *e. g.*, pass from the German arrangement to the English. For the English ratio of 3:7, the ray-path of the pictorial-element wheel has only to be made longer in proportion to the line wheel, and the collective arrangement turned through 90 degrees.

The arrangement of a televisor with

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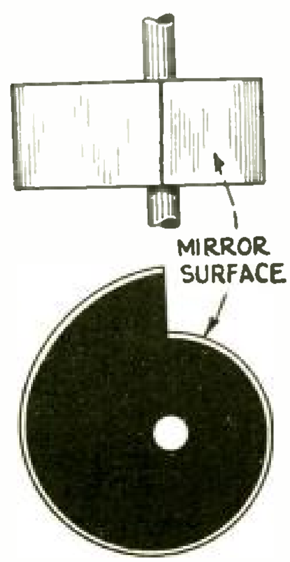


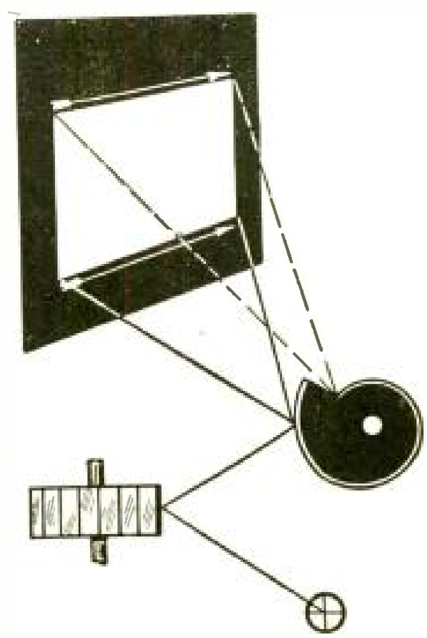


Fig. 7 (left). The one-mirror wheel.

Fig. 8 (right). Principle of the universal mirror wheel televisor.

TELEVISION GOSSIP

Buy Your Stock Via "Television"

Transmission of both the New York and Chicago Stock Exchange quotations by **television** will be inaugurated in Chicago, it is announced. The service will be inaugurated on a permanent basis over station W9XAP operated by "The Chicago Tribune."

Transmission of the quotations will take the form of a ticker tape at the receiving apparatus. In the transmitting station, the ticker recordings will be run across the front of the television camera. The letters printed on the tape will be recorded electrically by the photoelectric cells in the television apparatus, and transmitted by short wave radio for reception on standard television sets capable of reconstructing the electrical impulses on a small screen.

Exchange officials are reported to be interested in the idea. They believe that when developed, it will be possible to transmit recorded quotations at a much more rapid rate than by present methods.

The Chicago television station which will transmit the quotations has been used generally for the sending of entertainment, although on one previous occasion, police reports and "line-ups" were transmitted on a similar experimental basis.

Operation of the station is under the direction of the Chicago newspaper, in cooperation with the Western Television Corporation, builders of the station. The transmitter operates in conjunction with WMAQ, which is also operated by the newspaper.

Those attending the initial demonstration of the ticker tape broadcast will see the quotations float across the television screen in uch the same manner as they now do on the translux machines in use in many brokers' offices.

Television's "Great" Speak to Us

. . . I am glad to learn you are starting a new magazine on the subject of Television . . . I will look forward to seeing the first issue and wish you success in your undertaking.—John V. L. Hogan.

• • •

. . . I wish your new Television magazine great success, which I have no doubt it will achieve.—Dr. Lee de Forest.

• • •

A letter from Dr. E. F. W. Alexanderson is published elsewhere.

J. V. L. Hogan Speaks His Mind

By granting permission to WTMJ, of Milwaukee, Wis., to use a channel width of 1,000 kilocycles, or 43,000 to 44,000 kc. for experimental visual broadcasts, the Federal Radio Commission has made possible for exploration of little known higher frequency channels.

The present television broadcasting is being carried on with frequencies in the continental short-wave band. These channels are 100 kc wide, but are regarded as too limited for successful commercial use, according to J. V. L. Hogan, consulting radio engineer, appearing for the Milwaukee station. He said that on the basis of present indications bands of modulation considerably wider than 100 kilocycles will be necessary for satisfactory picture definition, and such bands are available only in the higher frequency regions of the spectrum.

Moreover, it was declared the information obtained from experiments will be of great value to designers and engineers in the development of television apparatus.

WABC Prepares To Send Pictures

WABC's experimental television transmitter will be ready for operation early this year, according to W. S. Paley, president of the Columbia Broadcasting System. He said, according to **Radio World:**

"Installation of the transmitter is going forward at the Columbia Broadcasting System Building, 485 Madison Avenue, New York, where an additional floor is being occupied for this and other expansion. The antenna will be on the roof of this twenty-four-story building. The 500-watt transmitter will broadcast on an experimental basis." It will operate in the 2,750-2,850 kilocycle band.

"It must be recognized that television still is in the experimental stage. We believe that the public will not get television in the form they expect it for some time to come. However, in our experimental television broadcasting we hope to contribute largely to the development of this important field of the future."

Here's a Good 18-Tube Radiovisor at $300.00

In the City of Chicago, Illinois, the Western Television Company has already introduced a Television-complete-receiver, to the consumer trade, at a price-range close to the $300 mark. This latest innovation is to startle the world in a year according to some.

The images as portrayed in the Western "Visionette" is approximately five inches square, or one inch larger than that produced by the Jenkins type of Television receiver. It is available in two models, and requires 18 tubes for reproduction.

Opera and Television As Seen by Rosa Ponselle, Soprano, Metropolitan Opera

I believe that the greatest modern ally to both musician and audience, on the common ground of genuine musical appreciation, is radio. Of course, opera lies somewhat apart from the musical productions available in entirety for broadcast purposes. One must see and hear the opera to get the fullest appreciation, but I believe we are rapidly approaching the day when radio and the opera will be entirely reconciled by the addition of **television** to sound programs (according to her article in the "New York Times"). When that comes it will be a great day for operatic appreciation, but I am uncertain as to whether such broadcasting will keep people away from the seats before the footlights or cause them to come in greater numbers. We shall see.

It seems that radio is awaiting television to give to the theatrical part of opera the wings now enjoyed by sound. However, this does not mean that the radio public at present cannot enjoy the operatic artists. Although opera on the radio cannot be given as a theatrical presentation listeners can tune in the music. Operatic singers are invariably heard as concert artists and the arias they sing are many times put on the radio.

This Photo-Cell Has Biggest Output!

The developments which have occurred in recent years in connection with talking pictures and sound recording have brought into prominence the photoelectric cell—a device which generates an electric current which varies in accordance with the amount of light falling on it. Hitherto, the sensitivity of such cells, that is to say the amount of current generated for a given amount of light, has been small, but the HIS MASTER'S VOICE Laboratories (English) have now developed a photo-cell which generates more current for a given light impulse than anything known up to the present. In a recent exhibit in London, a comparison was made between a good quality commercial photo-electric cell and the new HIS MASTER'S VOICE caesium vacuum photo-cell. It should be noted that these latter cells are of the vacuum type and are not filled with gas to increase their efficiency.

The electrical output obtained is, in fact, the greatest that has ever been attained with photo-cells. One of them was shown directly operating an electro-mechanical relay, without amplification by valves or any other device—the first time that this has been done by means of photo-electric cells (in England).

England Plans More Television Broadcasts

Plans for next year's broadcasting in England call for closer cooperation between officials of the British Broadcasting Corporation and the Baird television group preparatory to developing television broadcasts.

Advanced experiments with the Baird process have been conducted by B. B. C., officials of which announce the system will be employed in connection with sound broadcasting as soon as possible.

Look Out! Fellow Crooks! the Televisor Will "Get" You

Television is being seriously considered as a supplement to police radio broadcasting in the stamping out of crime.

Pictures of thugs and gangsters—fugitives from justice—would parade across the television screens in station houses or in police patrol cars to acquaint the minions of the law with the men they are assigned to get should this visual system be adopted. Now word descriptions are sent via short wave radio, or the patrolmen must attend "showups" at headquarters.

Chicago, already pioneering in television broadcasting, is the first city to consider the feasibility of police television. The police authorities in Chicago have recommended the adoption of visual radio in crime work, after witnessing a demonstration over the Chicago Daily News experimental television station.

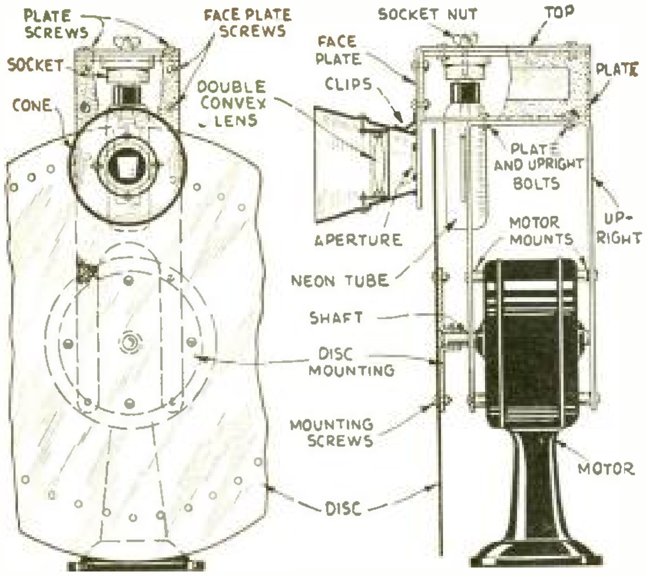
Two committees of the city council are considering ways and means of installing a central television service on the recommendation of officials who believe television would increase the efficiency of the police radio department.

A few days ago a demonstration of television's advantages in police work was given in the Daily News television studio. Living subjects and pictures of Chicago's "public enemies" passed before the faces of the officials.

The demonstration was given by Clem F. Wade, president of the Western Television Corporation of Chicago. He explained that the Police Department could have its own television transmitting station and television receivers in each outlying station house. The police cruising cars now equipped with short-wave receivers also could have television receivers. Well! Well!

Practical Hints on Building TELEVISION RECEIVERS

By H. W. SECOR



Simple home-made televisor built around an ordinary fan motor and which was successfully used by the Editor in picking up television images.

A NUMBER of how-to-make-it suggestions of interest to those about to build their first televisor, are given herewith and many variations of these ideas will, of course, suggest themselves to the student.

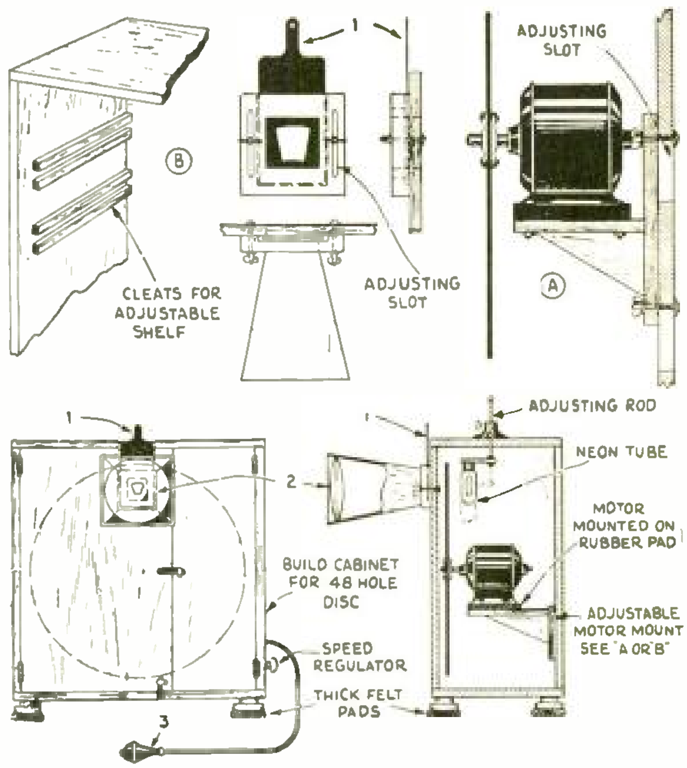
One of the simplest television receivers and one which can easily be built around the family fan motor is shown in the drawing above. One of these televisors was successfully built and tested and the speed of the motor is regulated by means of a variable resistance connected in series with one of the line wires supplying current to the motor. This resistance may have a value of say 100 to 150 ohms, such as the power Clarostat. If finer voltage and speed regulation are desired, an adjustable rheostat having 10 to 15 ohms may be connected in series with the larger rheostat.

In the fan motor televisor illustrated above, the socket supporting the neon tube is mounted with a machine screw and a wing-nut, so that the tube can be rotated on its axis in order to bring the flat plate within it parallel with the scanning disc. In this particular televisor the scanning disc itself was made from 1/16" bakelite and this was mounted on a brass spider taken from an old fan blade. A magnifying lens was placed inside of a conical visor (butt of a megaphone) and a diaphragm or aperture plate was placed at the inner end of the visor, so as to "frame" the picture properly.

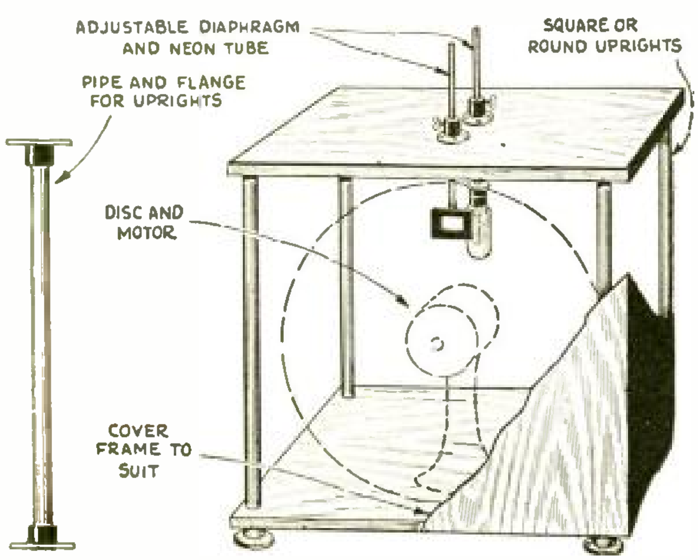
The drawing in the lower left-hand corner of this page shows how to rig up a simple yet substantial cabinet for a fan motor or other televisor. Here the socket supporting it is mounted on the end of a brass or other rod, which permits the tube to be adjusted in any direction. The diaphragm plate is likewise mounted on an adjustable rod and can be moved up or down so as to coincide with the neon tube, and in this way the experimenter can use scanning discs of different diameters, etc.

A third adjustable rod and bushing may be placed on the top of the cabinet and to the lower end of this rod you may secure a magnifying lens, an ordinary "reading-glass" being very useful for the purpose.

The third drawing shows the writer's suggestion for building a television receiving cabinet with a movable visor, which can be slid up and down and locked on the cabinet door by means of the thumb-nuts shown. Various diaphragm plates, (1) made from brass or other metal, or even from black fibre or bakelite, and having various size windows in them to suit different size discs, may be placed in a slot at the rear of the visor.



Suggestions for building a television receiver cabinet, after the writer's original designs.



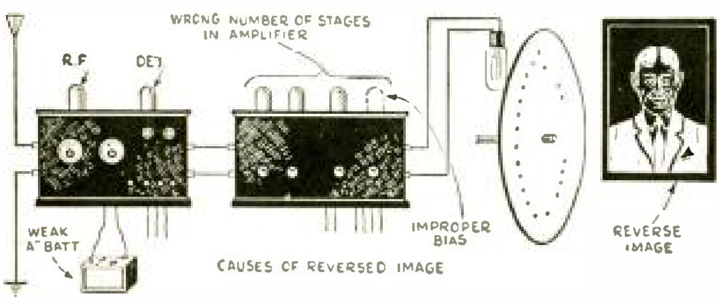
This cabinet for the "fan motor" television receiver may be left open or enclosed, at the option of the builder.

The TELEVISION QUESTION BOX

What Causes Negative Images?

John Moriarty, Bronx, New York, asks this department:

Q1. Please explain a few reasons why some experimenters obtain a "negative"



A negative image appearing on your television receiver may be caused by improper number of amplifier stages, wrong bias on power tube, weak "A" battery, etc.

or reversed shading image on their television scanner?

A1. The primary and most usual cause of a "negative" image being seen on the receiver scanning disc, is the fact that an improper number of amplification stages have been used after the detector. The output signal fed into the neon tube is electrically 180 degrees out of phase with the television signal picked up in the antenna circuit. About the best method to cure this trouble is to subtract or add an audio stage of resistance coupling. Another method is to change the detector, if of the condenser grid-leak type, to the grid-bias style.

There are some other peculiar reasons for seeing a negative image, which have occurred in practice. If an audio-frequency transformer is used, you can rectify a negative image to a positive one, by simply reversing either the primary or the secondary connections, *but not both.*

If you should happen to be using a neutralized stage of R.F. amplification, there may be a negative image even with the proper number of audio-frequency stages for the type of detector you are using, due to the fact that the R. F. stage happened to be over-neutralized. When this condition is rectified, by adjusting the condenser so that exact neutralization is established, the image becomes positive once more.

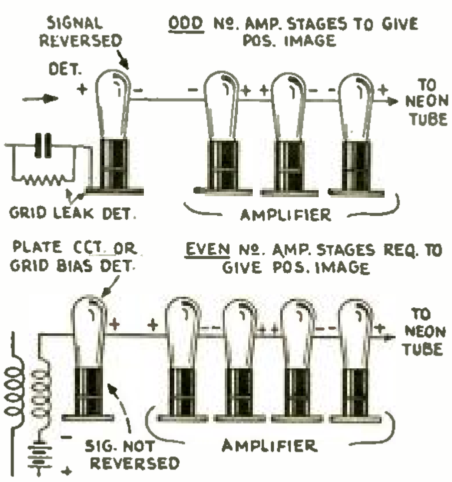
Another cause is the improper adjustment of the negative grid bias on the plate-rectifying detector. One English experimenter recites, in *Television* magazine (English), that he had the unusual experience of seeing his television image change from a negative to a positive one, because of the run-down condition of the storage battery which was supplying filament current to the tubes in his set.

How Many Stages of A. F.?

Irving Manley, Philadelphia, Pa., writes to the Editor of the Question Box:

Q1. How many stages of audio-frequency amplification should I use in a television amplifier and why?

A1. The accompanying diagram illustrates the reason why you should use three stages of resistance coupling after a detector of the grid-leak type; since, in a detector of this form, the signal current is reversed 180 degrees (that is, a positive impulse is changed into a negative one), an *odd* number of stages is required. If you are going to use



The proper number of amplifier stages for different detectors is shown above.

grid-bias rectification, then (as the second diagram shows) you will need an even number, such as 2, 4 or 6 stages of audio-frequency amplification, in order not to reverse a positive image impulse, for example, by the time it reaches the neon tube. In other words, if your televisor shows a negative image, one of the remedies is either to add or to subtract one resistance-coupled audio stage.

Synchronism and Isochronism

David L. Brown, Altoona, Pa., wishes to know:

Q1. What is the difference between *synchronism* and *isochronism?*

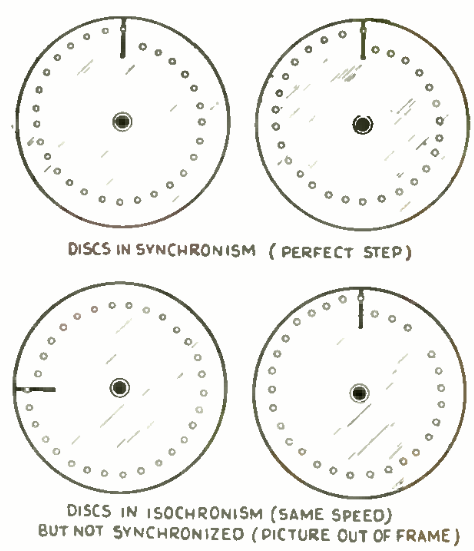
A1. Two scanning discs, running at exactly the same speed, are in *isochronism.* If they are *in step* also, so that the corresponding holes in each are at exactly the same position in the image, they are also in *synchronism.*

In the accompanying diagram, below, we see two discs (say, one at the transmitter and one at the receiver) in both synchronism and isochronism; they keep perfect step, and the received image corresponds exactly to that transmitted.

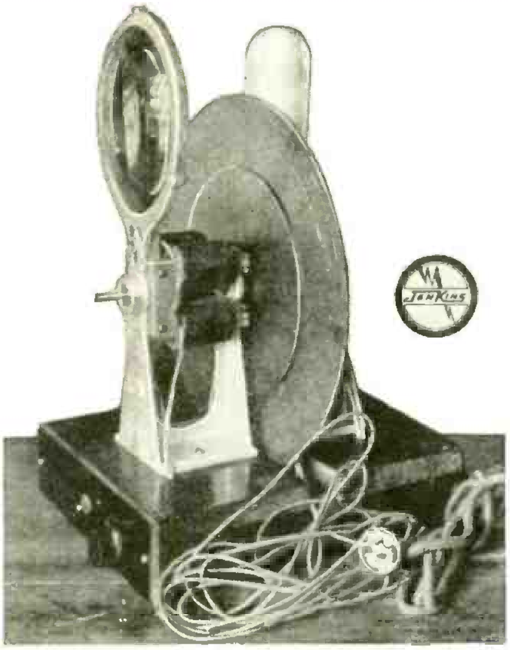
On the other hand, if they are running at exactly the same speed, but the receiving disc at the right (as shown below) is a quarter of a turn ahead of the transmitting disc, the isochronism of the discs will keep the picture out of frame (that is, one-quarter of the way down the window on the receiving disc), because synchronism is lacking.

Two electric clocks, one in New York and one in San Francisco, operated from the same master clock, would be in *isochronism.* Nevertheless, they would not be synchronized, if each kept its own standard time; because the hour hand of the New York clock would be three hours, or one-quarter of a circle, ahead of the San Francisco clock, like the lower-right disc in the illustration.

Commonly, however, when we speak of "synchronism," we mean also "isochronism"; because the receiving disc must be exactly in step with the transmitting disc, in order to reproduce a properly-framed image; and, once in step, it must continue to revolve in isochronism, in order to remain in synchronism.



The illustration above shows that while you may have transmitter and receiver scanning discs revolving in step, the picture may still be out of frame.



It Works!

YOU can now enjoy radiovision programs. Don't waste time, money and patience trying to work out your own equipment. Start right with Jenkins apparatus in convenient kit form or in ready-to-use form. Jenkins self-synchronous feature makes reception possible wherever signals are heard. Jenkins receivers, combined with Jenkins radiovisors, provide real television entertainment.

RK-1 JENKINS RADIOVISOR KIT

Complete kit of parts, fully machined, ready to assemble and wire. Mounting brackets, field coils, wedges, ball-bearing shaft, rotor, complete scanning disc assembly, speed control, condenser, lamp socket and housing, wires, screws, nuts, bolts, packed in neat box as shown below, with complete instructions. Assembled in a few hours as shown at left. Choice of 48, 60 or 45-line scanning system. Magnifying lens optional. **PRICE: $42.50. Lamp, $5.00.**

JENKINS TELEVISION RECEIVER KIT

To tune in television signals, employ a Jenkins radiovision receiver. Usual short-wave receivers are not satisfactory for good results. If you wish to build your own receiver, use Jenkins JK-20 receiver kit. Components fully machined, ready to assemble and wire in a few hours. **PRICE: $69.50.**

Or if you prefer a ready-made receiver, there is Type J for use with Radiovisor on common A.C. power system for automatic synchronization. **PRICE, $150.00.** Tubes Extra. Type JS, with self-synchronized power supply, is also available for those outside common power system area.

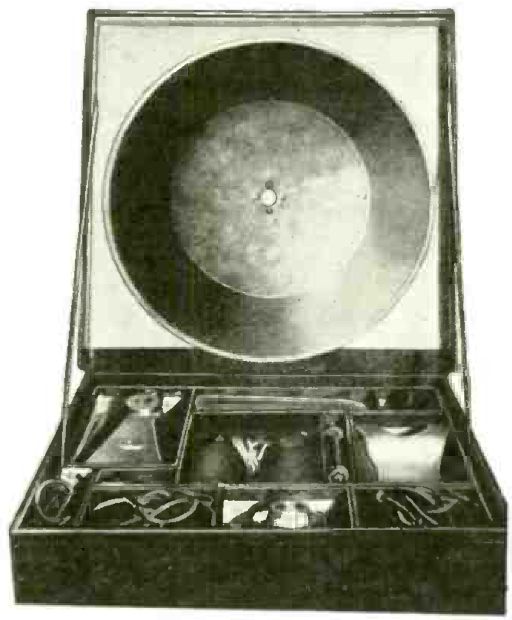
One-dial tuning, A.C. operation, highest type amplifier, ample output for brilliant pictures, self-contained power pack, sturdy all-metal chassis, are features of Jenkins radiovision receivers.

READY-TO-USE EQUIPMENT

If you prefer assembled equipment, ready to use, there is the Model 100 Radiovisor. Same components as RK-1 Kit, but including lens assembly and cast metal base. Finished in bronze. Ideal for laboratory or home use. Two-inch square image. Self-synchronizing attachment optional. **PRICE: $69.50.** Lamp extra.

Model 200 Radiovisor is intended for living-room use. DeLuxe walnut cabinet. Drum scanner. Eight-inch image. A.C. synchronized. **PRICE: $100.00.** Lamp extra.

Model 300 Radiovisor. DeLuxe walnut cabinet. Self-synchronized by incoming signals. Five-inch image. **PRICE: $135.00.** Lamp extra.



Television is here! It is ready for experimenter, service man and dealer! Television programs are steadily improving. Now is the time to get into television! Experience the thrills of pioneer broadcast days all over again! Just fill out and mail coupon below.

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☐ Model 200 Jenkins Radiovisor (-line scanning) 100.00
☐ Model 300 Jenkins Radiovisor (-line scanning) 135.00
☐ Self-Synchronous Motor for Kit RK-1 .... 25.00
☐ 601A Television Lamp for Kit or Models 100 and 300 .... 5.00
☐ 601 Television Lamp for Model 200 .... 7.50
☐ Free literature on Kit, Circuits and Complete Apparatus.

NOTE: Indicate 60, 48 or 45-line scanning system

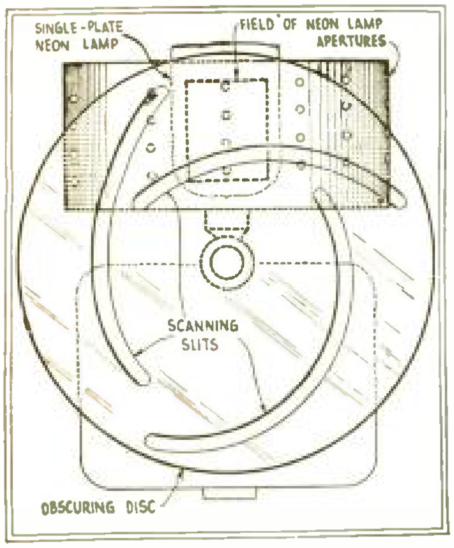


Fig. 7

The mechanism of the new Jenkins visual reproducer, shown from the rear in Figs. B and C.

The "Scanning Drum" Televisor Perfected by Jenkins

(*Continued from page* 61)

as the Jenkins "radiomovies," reproduce well with the better types of short-wave receivers and audio amplifiers now in use; which accounts for the broadcasting of these simple *silhouette* pictures during the experimental period of radiovision.

When it comes to *half-tones*, however, an audio amplifier capable of handling frequencies up to 10,000 cycles at least, is *essential* for "detail" and half-tone values in the form of finer shades.

Regeneration is a troublesome and even detrimental feature. There is no harm in having regeneration available, for the sole purpose of locating signals by means of an oscillating de-

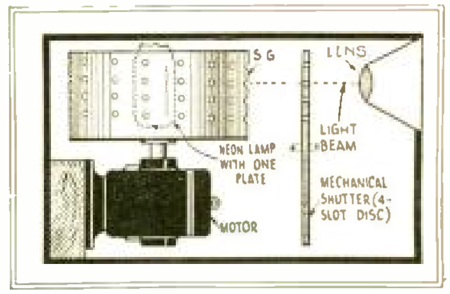


Fig. 8

A schematic diagram of how the image is thrown directly into the "shadow box" of the new model.

tector. Once the signal is located, regeneration should be reduced to an absolute minimum. The effect of regeneration is to sharpen tuning excessively, and *when the detector oscillates, the television picture will have a checker-board pattern.*

Television in Twelve Colors

By DR. FRITZ NOACK

(*Continued from page* 53)

other spiral; it is then clamped tightly to the main disc. The English image, received sideways at the top of the disc, is made to appear right-side-up by the use of mirrors.

Four Discs Required

However, the inventor has carried his idea to the point of making it possible to receive transmissions on other systems, with holes of different numbers and different sizes. He accomplishes this, as shown in Fig. 2, by the use of four discs—two pairs of which are alike. Two of these have spiral slits and two have radial slits; the latter pair 20 each, presumably the least number of pictorial lines which will afford an image.

One disc of each pair is keyed to the axle, while the other may be turned, as before, to open or close the slits, before clamping it to its mate. The result is, that the holes apparently produced by the passing of a radial slit over a spiral slit may be made of any size suited to the image being received. The spiral disc turns once while each frame of the image is being scanned; the radial discs are rotated by a separate shaft, at a speed sufficient to provide the necessary number of lines in each frame.

For instance, in the case of the German and English transmissions, the spiral discs revolve 12½ times a second; but since the number of lines in the received images is 375, the 20-line radial discs must turn at the rate of 18¾ times a second, or 1125 R.P.M. The width of the slots is, necessarily, related to the number of lines in the image: the more lines, the finer the slots must be.

The Mirror Wheel Universal Televisor

(*Continued from page* 63)

a single-mirror wheel is shown in Fig. 8; for this the same formula as above holds true. But the single-mirror wheel can be operated with the prescribed number of revolutions and therefore, can also be synchronized with the pictorial-line alternating current.

A suitable arrangement also makes possible the production of sector-shaped image frames, perfectly free from distortion; this permits scanning in curved lines, such as are formed when the transmitter uses spiral-hole disc scanning.

Now a little more about the practical side of the new televisor. Through doing away with angular adjustment, and other processes hitherto necessary, the cost of manufacture ought to be less than with a Weiller mirror wheel. It will also be easier, with these simple symmetrical mirror wheels, to undertake mass production. A few difficulties only are offered by a gear system alterable within the widest possible limits.

The adjustment of any number of pictorial elements could, for instance, be so arranged that, where interference by neighboring transmitters is not to be feared, television could be effected with a decidedly higher number of pictorial elements. For instance, from 9-10 A. M., television with 60-line scanning; 7-8 P. M., with 30-line scanning.

The Effective Height of the K.-H. Layer

(*Continued from page* 47)

this retarded arrival is. can be determined by the relative displacement of the second image noted in our first figure.

This observation recalls the phenomenon of fading and we arrive at the conclusion that the second component may arrive either in phase or out of phase with the main signal. In this event the two components will be sometimes additive, and sometimes subtractive, with the net result that the signal varies in its average intensity, and gives rise to unpleasant effects where audible reception is to be carried out.

In England Professor Appleton has noted that, at times, the variation in arrival time between the two components from a station from sixty to eighty miles distant amount to 1/3000 of a second. In the case taken for an example in Fig. 1, we will assume a 48-line picture repeated 15 times per second, and the time required for any one aperture to traverse the field of view will be 1/720 of a second. The displacement indicated is half the width of the image or, in units of time, 1/1440 of a second.

Hence, since we know the speed with which the waves travel (it is approximately 186,000 miles per second) and the time elapsed between the arrival of the first component and the arrival of the second, we may arrive at a figure representing the difference in the distances traveled, or about 130 miles. With this knowledge, together with an accurate knowledge of the actual mileage between the two stations, we may calculate the probable height of the reflecting layer.

TELEVISION *with a Converter!*

The Model PR-3FS Short-Wave Converter that is, in fact, an all-wave converter, as it enables also the reception of broadcast frequencies. The range is 25 to 600 meters, so you are sure to cover the television band, too.

WITH high-gain radio frequency amplifiers characterizing experimenters' broadcast receivers today, and audio amplification remarkably faithful, it is convenient, economical and easy to tune in television with a short-wave converter. In that way you use your entire broadcast receiver just as it is, and besides the television band, tune in other short waves. The range is 25 to 200 meters, when the broadcast set is worked at a high frequency, around 1,500 kc.

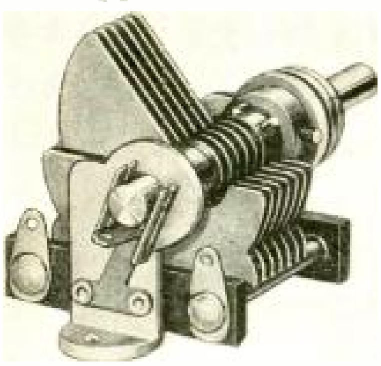
The converter illustrated is model PR-3FS and has a filament transformer built in. There are only four external connections to make, and one of these is to a positive B voltage, 50 to 180 volts, taken from the receiver. If you have a screen grid set you may take this voltage from the screen of a radio frequency tube, by looping the bared end of the B plus lead and slipping the screen prong of the tube through the loop before reinserting the tube in the set.

The converter uses three 227 tubes and plug-in coils of the tube base type. There is an AC switch built in, but there is only one tuning dial (at right). The condenser is the new Hammarlund Junior Midline of .0002 mfd. capacity.

This short-wave converter has proved highly satisfactory, developing great sensitivity and enabling the penetration of great distances. There is no body capacity, no squealing, no squawking and no tricky tuning.

By all means provide yourself with the complete parts for this dandy converter, as specified by Herman Bernard, the designer.

▽ ▽



The new Hammarlund Junior Midline Short-Wave Condenser, capacity .0002 mfd. The rotor plates turn in a diameter of only 2 inches, while the total frame depth is only 1⅝ inches. So this is an extremely compact condenser, made by one of the foremost condenser manufacturers in the world. It is our Model No. PR-H-20, made specially for US.

THE newest condenser to come from the laboratories of the Hammarlund Manufacturing Co. is the Junior Midline, made especially for us, and designed for highest grade short-wave performance. The capacity is .0002 mfd. and the Midline tuning characteristic prevails. Single hole panel mount, in a ⅜-inch hole (with option of subpanel mounting by built-in brackets); end stop provision at both extremes; rigid plate assembly and the fine workmanship of Hammarlund mark this compact condenser. The overall depth of the frame is 1⅝ inches, while the rotor plates turn in a diameter of only two inches. This condenser, our Model PR-H-20, is a superb product, in line with the modern vogue of compact parts.

▽ ▽

PRECISION short-wave plug-in coils, three coils to a kit, not counting as a coil the movable tickler. Used with .0002 mfd. for tuning, this kit of coils affords coverage of from 15 to 160 meters. These coils are wound on 97% air dielectric and are precision, de luxe products. A receptacle base, on which the adjustable tickler is mounted, is supplied with each coil kit. This kit is our Model No. PR-AK-1 and represents the pinnacle of short-wave plug-in coil achievement.

▽ ▽

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☐ $12.00 for two years' subscription (101 issues) for RADIO WORLD at the regular rate. Please send as a premium all parts to build the Short-Wave Converter, including filament transformer and 5½x7-inch cabinet, but not including tubes. This is your Model PR-3FS.

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The Television Program — A New Nut to Crack

By A. C. LESCARBOURA

(Continued from page 15)

jects, rather than depending upon bringing the subjects to the studio. It is the counterpart of the remote-pickup microphones of the sound broadcaster and likewise, in due time, it must accompany the radio reporter in search of thrills for his audience.

By means of the television camera, it becomes possible for radiovision broadcasters to put on news events. It is not intended here to propagate the fairy tale of televising baseball games, parades, football games and other large scenes. Needless to say, such events cannot be seen through 48 or 60 lines, no matter how refined the technique or how keen the imagination at both ends of radivision.

However, any news or sporting event has television possibilities today, particularly in conjunction with the conventional sound broadcasting of such events. For instance, in the case of a baseball game, the television camera may be placed alongside the microphone. Prominent players and visitors to the game may be brought before the came to be flashed over the air, either with or without synchronized sound; since the television pickup includes its own microphone for aural announcements whenever desired. Thus the television presentations may be announced over the same radio channel, the lookers-in switching to a loud speaker and back again to the televisor in following the successive aural and visual features. If an accompanying sound channel is available (perhaps as the regular sound-broadcast feature) the television presentation is all the more effective, since the "blind" audience can see as an optional matter.

The chief drawback to the use of the television camera out in the field, aside from inherent problems which remain to be worked out in camera design, is that of remote-control lines. The usual telephone circuit may be entirely satisfactory for sound-broadcast purposes; but the far greater range of frequencies demanded for good pictorial detail disqualifies the use of existing telephone lines. Yet this drawback may be circumvented by employing a portable transmitter. Some television workers have portable transmitters of, say, quarter-kilowatt rating, which they carry to different places for television demonstrations. The same practice might well be followed in making television programs available to the lookers-in, either in cooperation with sound broadcasters or entirely independently.

Television At the Turning Point

When far-seeing officials of the Westinghouse organization saw fit to focus attention on the possibilities of mass communication, by transmitting the presidential election returns through their radio-telephone transmitter KDKA, in 1920, sound broadcasting was definitely launched. The public became interested in receiving the programs of that and other stations which followed.

Today, an outstanding broadcast program by television workers would immediately focus public attention on the practicability of radiovision, and would lay the foundation for the sale of home equipment. *We are definitely beyond the demonstration stage!* The public has known for some time back that pictures can be transmitted over the air. It expects a fair degree of detail; although the thrill of some kind of animated picture, with or without sound accompaniment, made available in the average home, will compensate for most pictorial shortcomings.

Although engineers have long sought to perfect television, they are by no means through. In fact, they have just begun. However, the chief difference between their past efforts and their work henceforward, is that in the past they have worked alone on television, in the laboratory; from now on, they must refine the science as it is manifested in actual field practice. This field practice presupposes interest in television on the part of the public. Such interest can be created and maintained only by presenting programs, not only technically good but entertaining. Technical failures may be excused on one basis or another for years to come, but lack of showmanship has no excuse.

Television stands at the parting of the ways. Ignore the showman, and it is doomed to failure for lack of the very quality that is its only excuse of existence. Accept the showman, and incorporate the quality that he alone can furnish in regularly broadcast programs; and the engineers can work on towards perfection, aided by public acceptance of the science as it is. And as it improves, with his problems and mistakes the while covered over with the smooth veneer of the laugh, the cry—television will win by *entertainment value.*

New British "H-M-V" Television System

(*Continued from page* 33)

by a specially-developed form of "light-valve", capable of operating at a high frequency and handling a considerable amount of light.

Reference to Fig. 4 shows that these special cells are situated between the arc lamp and a revolving drum having on it highly polished mirrors, which correspond exactly, both in speed of revolution and relative instantaneous position, to the transmitter lenses.

To take a simple example, when a spot of light is being received through a lens which accepts it from the top right-hand corner of the picture, the correct mirror must be in position to throw a spot of light upon the top right-hand corner of the received image, and that spot of light must be of the proper intensity, with relation to the rest of the transmitted picture, in order to get tone graduation.

This arrangement has made possible an over-all distortionless amplification of nearly a million, over the frequency range—a feat which has never before been attempted in low-frequency amplification.

Synchronizing Arrangements

In order to prevent the picture having the "jumpiness" which has been an unpleasant characteristic up to now of television images, it has been found necessary to employ a synchronizing frequency of about 1200 pulses a second. These signals are supplied from a special generator (seen on the extreme left of Fig. 2) which is mechanically coupled to the lens-drum and the film projecting apparatus; and they energise at the receiving end a special form of "phonic motor" on which is mounted the revolving mirrors, which cast upon a translucent screen the light of the arc lamp, received through the five light-modulating cells which correspond to the five scanning channels.

A Short Course in Television

By C. H. W. NASON

(*Continued from page* 31)

television and in sound motion picture work. An amplifier suitable for use in this case is shown in Fig. 5; it was intended primarily for television service, but is exceptionally good for use in any experimental set-up where the cell' is operated by rapid changes in light intensity.

The operation of the relay circuit in Fig. 4 may be a bit obscure, but will be readily understood after a little thought. The vacuum tube is supplied with a grid bias sufficient to maintain its plate current at a fairly low value, so long as the photo tube is dark and is, therefore, a non-conductor. The instant that the photo-sensitive surface is illuminated it gives off electrons; providing a conductive path between the positive end of the plate battery and the grid of the tube. The grid of the '12 is now highly positive, and a strong plate current is drawn. The relay shown is readily obtainable, and will operate with a fairly low current through its windings.

The neon tube consists of two electrodes in an atmosphere of gas. This gas ionizes and glows when an electrical current is passed through it. Over a certain range, *this glow varies in its intensity in direct proportion to the current flowing through it.* This is the exact counterpart of the operation of the photo-tube, where the emitted current varies in proportion to the intensity of the light.

If we place in the output of a television receiver a neon tube with its elements designed so that one is in the shape of a flat plate, of the same size as the image to be formed on our receiving scanner or disc, we will upon looking through the disc, see a square field of light of even intensity. The light visible to the eye at any one instant is that passing through one of the apertures in the scanning disc.

Now, if the transmitting equipment consisting of scanning disc, photo-tube and amplifier is set in operation, the light emitted by the neon lamp will at all times be proportional to that falling on the surface of the photo-tube. If, then, we rotate the two discs in exact relation to one another—that is if they are "synchronous"—the light variations in the neon tube will construct a replica of the scene scanned by the disc at the transmitter. That is, if the transmitting disc is traversing a bright spot in the scene, the brightness of the neon lamp will increase. In the same manner the neon tube will lose in brilliancy when the light at the transmitting disc is at a minimum, corresponding to the current through the photo-tube.

(*To be continued.*)

Latest Progress in Two-Way Television

By DR. HERBERT E. IVES

(*Continued from page 57*)

image. The effect of using only blue light for scanning, however, was to make the yellows and reds in the face too dark in comparison with the whites (such as a linen collar), because very little blue light is reflected from yellowish or red surfaces.

Red Component Adds Detail to Image

To secure greater naturalness in the image, a deep red component has now been incorporated in the scanning beam—making it purple instead of blue—and there have been added two photoelectric cells of the caesium-oxygen type, which are very sensitive to red light. The result of scanning with light from both ends of the spectrum is to produce an image that is a much more faithful reproduction of the original. The effect is very much like that which would be obtained by scanning with light from the middle of the visible spectrum: an orthochromatic image is obtained, and the definition of certain important points, such as the eyes, is distinctly improved.

How Caesium-Oxygen Cells Are Employed

The two caesium-oxygen cells are mounted directly in front of the observer—as shown in the photograph—one on each side of the rectangular opening through which the incoming image is seen. These cells are only about half the size of the potassium cells but, because of their high sensitivity to light of long wavelength, and the richness of the incandescent lamp in light at the red end of the spectrum, two of them are about as effective as the twelve potassium cells.

The caesium-oxygen cells, in addition to being highly sensitive to red, respond somewhat to yellow light; but deep purple filters are mounted in front of them, so that only light in the red region is admitted to their active surfaces. The effect of the filters, used both with the scanning beam and with the caesium-oxygen cells, is to make the system completely unresponsive to yellow light; and advantage is taken of this to illuminate the booth with a yellow light of low intensity. This light, while taking no part in the image transmission, prevents the scanning beam from being seen against too dark a background—thus further decreasing its effect on the eye—and also gives enough light in the room to enable the user to locate himself.

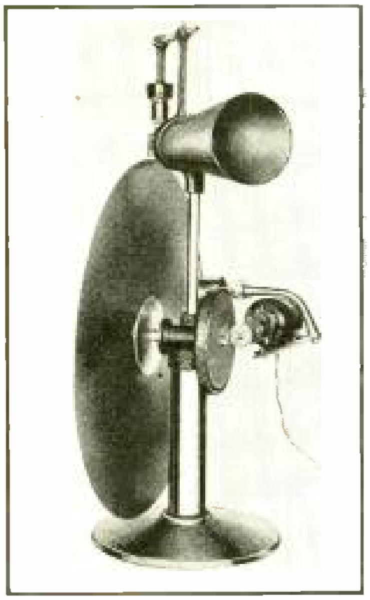
Neon Crater Tube Gives Brighter Image

A third change, that has been made, is the provision of a new type of neon tube which has a considerably smaller electrode, located farther back from the front of the bulb. The general appearance of the tube is shown in one of the illustrations. A lens mounted in front of the tube, together with lenses carried on the scanning disc, focus images of the glowing anode on each hole of the disc: a very efficient optical arrangement, whereby the necessity of the large electrode-area and the high currents employed in the earlier tubes is avoided. The small aluminum anode is screwed into a large copper cylinder, so that water cooling is not required; and the greater distance of the anode from the glass gives a longer life, since the sputtering of the hot anode onto the glass surface is one of the factors that limits the effective life of the tube. The arrangement of tube and optical system is shown in one of the photos.

Television in the Experimenter's Laboratory

By A. G. HELLER

(*Continued from page* 41)



The simplified design of the receiver. In later models, gears replace the friction drive shown. The cone serves to "mask" the image.

The light to actuate the Insuline potassium-magnesium gas-filled photoelectric cell is obtained from a 500-watt, special ribbon-filament Mazda stereopticon lamp; its rays are concentrated in a beam on the film by a concave mirror, as indicated in Fig. 1.

An optical focusing system is mounted in front of the reel housing, to project the image on the scanning disc. A condensing lens focuses the scanned diverging rays, coming through the scanner, into the photoelectric cell, which is operated at a bias just below "glow point", for maximum sensitivity. To boost the energy picked up by the photoelectric cell to a value sufficiently high to give good contrast at the neon lamp of the receiver, a four-stage resistance-capacity-coupled amplifier, including three type '40 tubes and one type '12A (or '71A) tube has been designed; the schematic circuit being shown in Fig. 2.

It is advisable to have the amplifier near the transmitter, to prevent extraneous interference from affecting the "electrical pattern"; but the output may be wired into another room where reception is obtained by placing there the receiving scanner and the neon lamp.

The amplifier is shielded. There is also a shielded "phase-shifter", the purpose of which is to enable positive (black on white background) or negative (white on black background) film to be televised.

The aluminum photoelectric-cell house is grounded to the aluminum shield can of the amplifier by the shielding around the leads of the photoelectric cell.

Design of the Receiving Televisor

So much for the transmitter. The next point is to receive the picture at the other end of a pair of wires; for this purpose, the essential mechanism comprises a photoelectric cell, a suitable scanning disc, and a driving motor in step with that of the transmitter. In the equipment we have developed, there is an 1800 r.p.m. synchronous motor, geared to the scanning disc by a two-to-one reduction worm gear, instead of the friction drive which we employed in an earlier model. The same A.C. supply must be used for both motors, in order to obtain the perfect synchronism that is essential if transmitted and received pictures are to be in perfect step. When the pictures are not in synchronism, a hopeless mess appears at the receiving end. Obviously, the first dot of light, which breaks down the transmitted picture into suitable pictorial signals, and the second dot of light, which reassembles the signal elements into an understandable picture pattern, must be in step and in proper sequence.

The simplest form of receiver which we have developed for laboratory purposes comprises a suitable neon lamp of rare sensitivity and maximum response, in front of which is placed a condensing lens which focuses the light on a 16-inch aluminum scanning disc with its two turns of spiral scanning holes, operating at 900 r.p.m. The usual mask is employed to pass one perfect picture to the observer. The use of a two-turn spiral facilitates framing, by the simple process of raising or lowering the mask, with its 1⅛x⅞-inch opening, between the scanning disc and the neon lamp.

The present 48-line scanning equipment is open to the criticisms of insufficient detail. There are many beginners in this field who would like to handle motion-picture film with equipment which can reproduce finer detail and shading. It is not generally realized that such pick-up would require at least 500 to 1000 lines for the scanning system, with an enormous refinement in any existing amplifying system now known. For the present, we may well be satisfied with the 48-line technique; especially since there are so many other details involved aside from just the scanning system. With every factor worked to the utmost, excellent detail may be obtained from the 48-line scanning system, particularly with silhouette or plain black-and-white pictures.

It is the writer's belief that the experimenter will find most satisfaction in experimenting with the transmitter.

Scanning With An Electric Pencil

By PHILO T. FARNSWORTH

(*Continued from page* 51)

a ratio, of aperture to cathode area, greater than one to five thousand.

Receiving System

The receiving system used in connection with the dissector tube is closely similar to that proposed by Nicholsen and Rosing, and to that recently demonstrated by Zworykin. The oscillite tube differs from Zworykin's "kinescope" in the means used for focusing the spot and in the detail of the "electron-gun" element.

The magnetic focusing principle, as stated before, permits all electrons having a source in the same point to be focused back to a point on the fluorescent screen. The electron-gun element has been designed with the idea of securing the greatest possible number of electrons through a given-sized aperture, and limiting the angle of this beam to that which can be accurately focused. This element (as shown in Fig. 3) comprises a spiral filament coated only on the inside. A shield, perforated by a hole of the same diameter as the filament helix, is placed over this filament. The anode is tubular in form, and placed in front of the cathode; while a ring grid is placed about midway between the filament shield and the anode.

The merit of this type of element lies in the fact that the anode tube is located, approximately, at the focal point for the electrons leaving the emitter. The anode voltage, required to create this focal point at the entrance to the anode tube, may be of any value between 1500 and 2500, for the tubes we are using at present.

An interesting effect has been noted with regard to the operation of these tubes; they function only when secondary electrons are emitted from the fluorescent screen. Sometimes a black spot will appear on the end of the tube, due to that point's charging up negatively. It will be recognized that an unstable condition exists here, and that a point on the fluorescent screen will assume either a large negative or a large positive potential with respect to the anode. This effect is not bothersome at all; in fact, it is necessary to have very high current density, in order to observe it.

The deflection-coil system used with the oscillite tube is exactly similar to that used with the dissector tube; the power required in these coils for the largest possible pictures may be generated with a '10 tube, while that for the focusing coil is quite negligible. One type of scanning generator used at the receiver embodies a helium glow-tube feeding a '10 power tube.

The circuit required to get the requisite amount of power from a '10 tube into an entirely inductive load has been developed over a period of several years; the details will not be given here.

These generators are synchronized by coupling them with the main picture-frequency circuit since, as explained before, the requisite pulses are induced at the transmitter.

The writer wishes to acknowledge his indebtedness for valuable assistance received during the progress of this work, to Mr. Donald K. Lippincott, particularly for his assistance in working out the principles of magnetic focusing, but also for the constructive interest he has shown during the entire course of development; to Mr. Carl J. Christenson, for many valuable ideas contributed during the early stages of the work, and to the staff of Television Laboratories for their unstinted co-operation.

A Good A.C. Receiver for Television

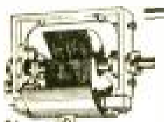
By C. H. W. NASON

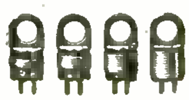
(*Continued from page* 26)

tube are well suited. If, however, the builder desires to incorporate a power supply in his receiver the writer would suggest the use of an '80 rectifier tube with 350 volts A.C. on each plate. The total drain of the receiver is very small, since it is seldom necessary to pass more than 20 ma. through the neon lamp. The Electrad tapped resistors are ideal as voltage dividers, for the various voltages may be set by means of the variable taps and a high-resistance voltmeter.

This article has been written with the thought in mind that the reader has had some experience in the construction of radio receivers and, in consequence, some of the usual cautionary remarks have been omitted. Shielding in the receiver is unnecessary if the R.F. coil mounts are placed with the axes of the coils at right angles to each other. Except for the fact that several stages of A.F. amplification are employed, the problem is not different from that encountered in the construction of any short-wave receiver.

Bear in mind the fact that the circuits are unusual in their theoretical aspects (from the use of the high ratio of "C" to "L"), and that certain benefits will accrue through their use. If anyone is still unconvinced as to the advisability of employing regeneration in a television receiver, the





writer will be pleased to forward detailed theoretical proof of the points at which he and his readers may be at variance.

In a later article which will describe the construction of scanning discs and driving mechanisms, the writer will give an elaborate description of the operation of the receiver in conjunction with the scanning disc.

The apparatus listed below corresponds to the markings on the schematic circuit. Although substitution of other parts of equal merit and identical value cannot result in inferior operation of the receiver, the writer can vouch for the performance of the items listed, through personal experience over a long period.

R1 350 ohms Electrad flexible resistance unit.
R2 .50 meg. Aerovox Resistance—New Carbon Type.
R3 .05 meg. Aerovox Resistance—New Carbon Type.
R4 .10 meg. Aerovox Resistance—New Carbon Type.
R5 .25 meg. Aerovox Resistance—New Carbon Type.
R6 100,000 Pot. Electrad Super-Tonatrol.
R7 20 ohm C.T. Electrad.
R8 1000 ohm 5 watt Aerovox Resistance.
R9 1500 ohm Electrad Potentiometer.
M Model 301 Weston 0-50 ma. meter.
C1 MC—23 .0001 mfd. Hammarlund Midget Condenser.
C2 ML—11 .00025 mfd. Hammarlund Condenser.
C3 .10 mfd. Aerovox type 260 Condenser—200 volt.
C4 .0001 mfd. Aerovox type 1450 Mica Condenser.
C5 .25 mfd. Aerovox type 450 Condenser.
C6 2.0 mfd. Aerovox type 400S Condenser.
C7 4.0 mfd. Aerovox type 502 Condenser.
C8 1.0 mfd. Aerovox type 400S Condenser.
L1 Hammarlund SWI—80 Coil with SWIB Base.
L2 Hammarlund SWT—80 Coil with SWCB Base.
L3 Hammarlund RFC — 85 R.F. Choke.

The Radio-Controlled Television Plane

By HUGO GERNSBACK

(*Continued from page* 10)

about if such an operation should be necessary, or he can increase its speed if it is desired to escape.

If he outdistances, or otherwise eludes the enemy, the radio-controlled television airplane can then be directed to the spot where it is supposed to drop its bombs. Moreover, the distant-control operator can see exactly when his machine arrives over a given spot. A sighting arrangement can be attached to the plane in such a manner that, when the object to be bombed comes over the cross-wires in the range-finder, the bomb or bombs are dropped at the exact moment. Suppose that the enemy becomes too strong and that a great number of machines attack the radio-controlled plane and that there is no escape from the enemy. In that case the control operator will simply set the radio television plane on fire, bringing it down in flames! Thus it would be useless to the enemy and no lives will have been risked or taken—it being cheaper to destroy a machine than the valuable life of a highly trained pilot.

In the future such radio-controlled television planes may be used not only singly but in squadrons as well. They can be used for attacking the enemy if necessary. They can be used in pursuit of the enemy, for taking aerial photographs, and for any other military or peace-time operation, just the same as a present-day plane piloted by an aviator. Suppose the enemy has the same kind of machines, which, of course, he will have. It then becomes a matter of "playing chess," the same as if the machines contained live aviators. The battle, of course, would not be bloody, but practically the same results will be achieved as far as the military maneuver is concerned.

For peace-time purposes it goes without saying that the advantages of such a mechanical and "almost human" airplane are unlimited. It will be possible in the future to send mail planes from one end of the country to the other without a human being on board and such planes will be just as safe letter-carriers, as if they were manned by human beings. Every second of the flight would be watched by a Post Office Department operator and the plane would, of course, be able to defend itself against attack. It could readily be equipped with electrically-operated guns if such should be necessary or desirable. Particularly for transporting mail and the like, the radio-controlled television plane will be invaluable.

There are, of course, hundreds of other applications of the idea which readily suggest themselves to anyone. The writer is certain that such planes will be in existence during the next ten years.—*From "The Experimenter," Nov.* 1924.

Television – Its Future

By E. E. SHUMAKER

(*Continued from page* 34)

have on radio receivers of the present-day type. The answer to that is fairly obvious, I think. Television will be *a part of the radio set*—a vital part—and it will add immeasurably to the entertainment value of radio. I think there is a perfect parallel in the motion-picture field. Motion pictures were a going concern in a high stage of development before the coming of talking pictures; yet it was sound that really brought them to life, and now sound is as vital and organic a part of motion-picture entertainment as the visual part of the picture.

In the movies, sight came first and was subsequently joined with sound; in radio, sound came first and will certainly be united with visual impressions—but it is sound that vitalizes and gives realism to the motion picture, just as it will tc television. There would be no more point in offering television as a thing complete in itself than there would be in going to work to make a silent motion picture today. The public has become accustomed, through the modern sound motion picture, to the synchronization and simultaneous impressions of sight and sound. Surely television will not offer anything less and, indeed, it will offer more.

Combination receivers for sound and television are logical, and inevitable. The RCA Victor Company believes that, with the ultimate perfection of television, a new and undreamed-of field of entertainment for the home will be explored. Its possibilities seem almost magical. The theories of the imaginative writers, who wrote their tales of incredible scientific marvels long before there was a radio, will certainly come true within the next few years.

And What of Television?

By DR. A. N. GOLDSMITH

(*Continued from page* 9)

Members of the radio industry, in any capacity, are fortunate in being associated with so remarkable a field, which is so rapidly expanding, and which carries so definite a promise for even more glorious a future.—*Courtesy R. C. A. Radiotron "Good News."*

How Cathode Ray Eliminates the Scanning Disc

(*Continued from page* 59)

there is superimposed upon the image-frequency (from the photoelectric cell) a series of high audio-frequency impulses, occurring only when the light beam passes the interval between pictures, and lasting but a few cycles. A band-pass filter removes the picture component, which is of the same frequency as that of the horizontal scanning. Then a portion of the voltage which drives the vibrator, at the transmitter, is impressed upon the signal, and the complex current thus produced is passed into the modulator and registered on the carrier wave.

At the receiver, the band-pass filter (Fig. 1) separates the synchronizing frequency from the signal; the latter goes to the control element and the former to the deflecting coils of the kinescope. The modulation caused by the framing impulses does not affect the pictures because it occurs only in the intervals between frames.

In the operation of the kinescope, the deflecting plates are connected in parallel with a condenser which is charged by a constant current supply from a current-regulating (two-element) tube. As the condenser charges, the attraction of the deflecting plates moves the ray from the bottom to the top of the fluorescent target at increasing speed. The impulses sent out from the transmitter, between pictures, cause the condenser to be discharged, automatically returning the beam to the bottom position, where it is ready to scan another frame.

Photo-Cells and Glow-Lamps

By A. C. KALBFLEISCH

(*Continued from page* 55)

tary photo-cell circuit. Two simple, photoelectric-cell circuits are shown in Fig. 3. So closely connected are the photo-cell and the thermionic vacuum tube, that we find them almost inseparable, as Fig. 3 indicates. The voltage output of the photo-cell circuit is impressed upon the biased grid of a standard three-electrode tube or "triode". Fluctuations of light at the cell cause corresponding changes in the grid voltage which, in turn, modify the plate current. The grid resistance R_1 in Fig. 3 is usually quite large, of the order of 10 megohms. The plate resistance R_2 is of the order of 100,000 ohms, and is the ordinary plate coupling resistance; which we find in the usual resistance-coupled amplifier. From now on the circuit corresponds exactly to the standard multi-stage resistance-coupling amplifier in which we find, in the first few stages, voltage-amplifier tubes and, in the final stage, a suitable power tube. In order to insure high gain per stage, we use the UX-240 tube in the voltage amplifying stages of this amplifier. A 250 tube is quite sufficient, in the output of the amplifier, to modulate the carrier frequency of the broadcast station.

Types of Glow-Lamps

Let us turn now to the heart of the receiving equipment; namely, the glow-lamp. The glow-lamp has made possible the transmission of radio movies, by its ability to follow variations in current as rapid as 100,000 cycles or changes per second. The glow-lamp most familiar to us, perhaps, is known as the neon lamp which was developed by D. MacFarland Moore.

This property of glowing is the basis of the glow-lamp used in talking pictures and television. The neon glow-lamp consists of two electrodes in a highly-evacuated tube filled with neon; the high vacuum makes it much more sensitive to light changes. As the current changes, the number of electrons combining with the gas atoms changes; hence the intensity of the light produced by the glowing gas changes also. This whole phenomenon takes place so rapidly that, it is estimated, a current variation as rapid as 100,000 cycles per second can be followed by the glow-lamp.

The reason neon is used is the brightness which can be produced by a very small current passing through the gas.

Fig. 4 shows one commercial type of neon glow-lamp. Different manufacturers have different methods of construction; some place the negative electrode in the center for the purpose of concentrating the light for easy focusing by a lens system.

The Raytheon "kino" lamp manufactured by National Carbon Company, is typical of the glow-lamps used by amateurs in the field of television today. Its construction and properties are well worth studying; Fig. 5 illustrates the design. The kino lamp does not concentrate its glow for the purpose of focusing, as do some lamps, but rather spreads the glow over a large surface. The reason for this is that the negative glow, as it is called, should cover an area equal to that of the picture we are trying to receive. Up to the present time, however, this picture is about the size of a small kodak snapshot, if the receiver is for home use. The arrangement of the two plates in this lamp is such that the observer may see the negative glow on one of the plates, without obscuring his vision of the other plate. Thus the life of the tube is lengthened by reversing the terminals when one plate becomes blackened from use. In actual operation, these glow-lamps have sufficient voltage applied to the terminals to give from 10 to 20 milliamperes through the tube. If only the alternating signal voltage from the receiving set were impressed on the terminals of the glow-tube, there would be sufficient voltage to excite the lamps. We must have D.C. voltage as a background; the lamp will then respond to the variations in signal intensity as picked up by the receiver, corresponding to the light and shadows of the scene we are trying to receive.

Fig. 6 represents a screen-grid television receiver, operated entirely by alternating current. It will be seen that band tuning is employed in the R.F. stages of this set, in order to facilitate the reception of the necessary wide range of frequencies.

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KOLSTER 245 POWER AMPLIFIER WITH MATCHED DYNAMIC SPEAKER

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Less Tubes

Our Net Price $24.50
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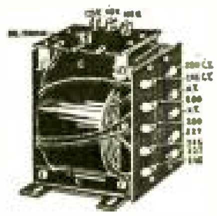
For radio, phonograph or public address systems. Reproduces speech and music with marvelous fidelity of tone. The amplifier has 2 stages, using a 227 in the first and two 245 tubes in the push-pull stage with a 280 rectifier. For 115-volt, 60-cycle alternating current.
The Kolster Dynamic speaker chassis supplied with and included in the price of this outfit, is ACCURATELY MATCHED.

RADIART POWER TRANSFORMER

All Secondaries are Center-tapped

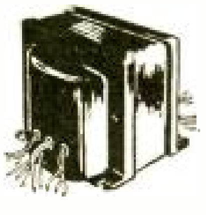
SUPPLIES VOLTAGES AS FOLLOWS:



Primary—110 volt, 50 to 60 cycles A.C.
Secondary—2.5 volt, supplies filament for five or more Screen-Grid or 227 type tubes.
Secondary—2.5 volt, supplies filament for two 245 Power tubes.
Secondary—5 volt, supplies filament for one 280 Rectifier.
Secondary—High Voltage, 375 volts each side of tap, supplies sufficient plate current for two 245 Power tubes.

Our Net Price $3.75

245 POWER TRANSFORMER



For use with a 280 rectifier tube, to deliver 300 volts D.C. at 100 milliamperes, slightly higher voltage at lower drain, from 105 - 125 - volt A.C. line (marked 110 v.), 50 - 60 cycles. The primary is tapped at 82½ volts in case a voltage regulator is used. The black primary lead is common. If no voltage regulator is used the other primary lead is the green one. If regulator is used, the red and black form the circuit. The secondary voltages are all center-tapped: 672 volts A.C. for 280 plates, 2½ v. 3 amps. for 245 output, single or push-pull; 5 v. 2 amps. for 280 filament; 2½ volts 16 amps. for up to eight 224 or 227 tubes. Center taps are red and all leads are identified on name plate. Laminations are hidden except at bottom. Eight-inch leads emerge from the sides, but if preferred may be taken off through the bottom of the transformer by pushing them through the rubber grommets. Shipping weight, 12 lbs. Overall size: 5" extreme width x 4½" high.

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No. 250 POWER TRANSFORMER
Same as above
Our Net Price.......................$8.50

No. 171 POWER TRANSFORMER
Same as above
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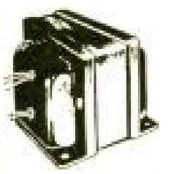
245 B SUPPLY CHOKE



100 m. choke coil for B filtration in 245 circuits; 200 ohms D.C. resistance, inductance 30 henrys. A continuous winding tapped in two places, giving three sections and four outleads, and permitting a "choke input" to filter. This method lengthens rectifier tube life and filter condenser life, yet filtration is splendid. The black lead goes to the rectifier filament center, the red, green and yellow leads are next in order. Capacities suggested: black, none; red 1 mfd.; green, 8 mfd.; yellow, 8 mfd. In shielded polished aluminum case. Shipping weight, 4 lbs.

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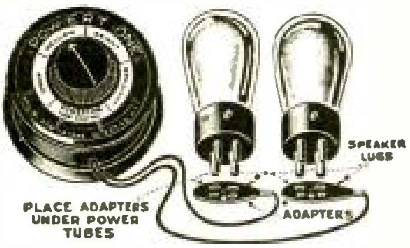

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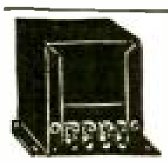

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X226	.40	X250	1.25
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Y224	.75	UX199	.60
X245	.50	UV199	.65
X280	.75	UX120	.65
X171A	.50	WD11	.75
X112A	.50	WD12	.75

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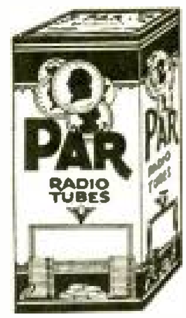

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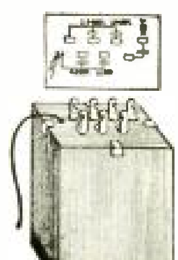

Tapped at
2.3 800 Volts
1.8 600 "
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5" High, 4" Wide, 2½" Deep. Ideal for replacements in "B" Eliminators — Power Packs — or the average Electric set.

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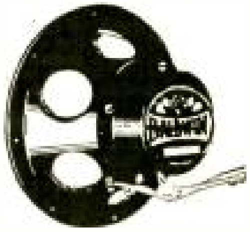

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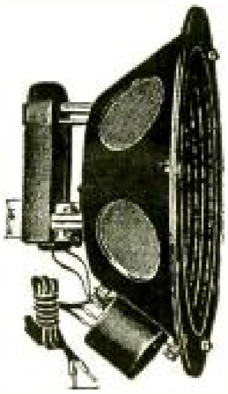
This chassis is the identical one used in the R.C.A. Model 100A and 100B Speakers, which list for as high as $35. Note built-in Output Transformer — this enables the speaker to be used with voltage applied to it as high as 600 volts, without any trace of distortion, rattling or blasting. Equipped with generous over-sized Magnets. The thick armature is accurately centered. The sturdy metal frame is lined with a special fabric, greatly improving the acoustic properties of this sensational speaker! Note the corrugated surface of the cone, an exclusive feature—enhances perfect tonal reproduction qualities considerably. Most compactly made: 9" outside diameter, 4½" deep overall.



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Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

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1802	2	1 in.	2⅛ in.	.45
1804	4	1⅛ in.	2⅛ in.	.85
1808	8	1⅜ in.	4½ in.	1.25
1816	16	3 in.	4¼ in.	2.12
1824	24	3 in.	4¼ in.	2.75
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R.C.A. Double Filter Chokes
(No. 8336)

This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R. C. A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 15 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5¼ x 3¾ x 2⅞. Shipping weight 6 lbs.

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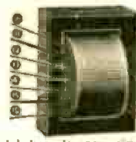
70 WATTS



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen - grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete fine power pack. Size 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. List Price $7.50.
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110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone.
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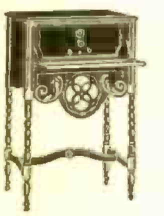

This beautiful and distinctive cabinet is sold with the built-in Peerless Speaker. It is designed to provide a maximum cabinet at a minimum price. Veneers of Figured Walnut with attractive carvings and unusual turnings. Set Compartment, 21¾ in. wide x 10½ in. deep x 8 in. high. Height, 38 in. Shipping weight 65 lbs. Packed in original crate. Complete with Speaker.
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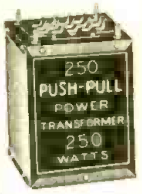
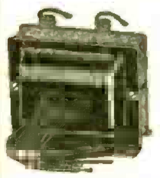
"250" A.C. Power Transformer



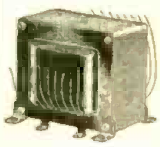
This power transformer supplies currents for five 15 - volt Arcturus tubes drawing 5 Ma. and ½ amp. on filaments; one 2.5 V. tube; two '50's, and two '81's. Two 227 or 224 (if suitable resistance is used) and 750 volts. Full wave "B" and "C." A line ballast resistor, such as the Amperite, in conjunction with the special 85-volt primary, will maintain even voltage over 105 to 125 volts. Entirely shielded in metal. 4¾ x 4¾ x 6½ inches high. Weight 15 lbs. For 110-120 volts, 50-60 cycles. List Price, $20.00.
No. 1412—YOUR PRICE........ **$4.75**

Shielded "A" Transformer



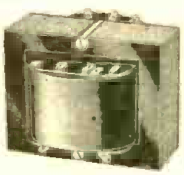
Modernize storage battery receivers by replacing '01A's with '26's and '27's heated by this filament transformer. Supplies 1.5, 2.5, and 5 volts; 2.5-volt winding center-tapped. Heats three '26's, two '27's, and two '12A's or '71A's. 3x3x4 inches. For 110-120 volts, 50-60 cycles.
Weight 3½ lbs. List Price, $4.50.
No. 1400—YOUR PRICE........ **$1.75**

Kolster Jumbo A.C. Power Transformer
85 WATTS



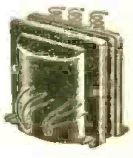
Will supply sufficient current and voltage for push-pull '10's, in conjunction with type '81 half-wave rectifiers. The 2.25-volt secondary output is just below the rated maximum for type '24 and '27 tubes; tubes will last much longer than when heated from a higher-voltage transformer. Four secondaries are rated as follows: Secondary S1, 7.5 V., 1.25 A.; S2, center-tapped, 7.5 V., 1.25 A.; S3, 1.5 V., 4.25 A.; S4, 2.25 V., 1.65 A.; S5, 725 V., 90 Ma. Primary is tapped for low line voltage. Has eight feet drilled for mounting to base of pack. Generous iron core assures cool performance under heavy load. For 110-120 Volts, 50-60 Cycles. Dimensions: 4½ x 4½ x 4¼ inches. Shipping weight, 12 lbs. List Price, $19.50
No. 4336—YOUR PRICE........ **$6.70**

Thordarson Standard Replacement Power Transformer
70 WATTS



This transformer may be used in building up inexpensive chassis; or for replacement in such standard combinations as three '24's, two '27's, two '71A's or two '45's, and an '80 rectifier. Suitable for the home - built rack-and-panel public address amplifier, or cabinet-type phonograph power amplifier. Just the foundation unit for an audio amplifier to be used as a standard of comparison. Well designed. Connections are made to soldering lugs on the two end plates. Dimensions: 3¼ x 3½ x 4 inches. For 110-120 volts, 50-60 cycles. Shipping weight 5¼ lbs.
List Price, $12.50.
No. 1405—YOUR PRICE........ **$2.75**

2.5 Volt Filament Transformer
60 WATTS



Has 2 center-tapped windings. Both deliver 2.5 volts. One winding gives 3 amperes; the other, 11 amperes. Pigtail leads. Heavy iron case, beautifully finished in brown crackle. 110 to 120 volts, 50 to 60 cycles. Dimensions: 3½ x 5 x 4½ inches. Shipping weight 9 lbs. List Price, $6.00.
No. 1414—YOUR PRICE........ **$3.45**

A. K. 37-38 Filter Choke and Condenser Block

Contains two filter chokes, a speaker output choke, two high-voltage filter condensers, a detector by-pass condenser, and an R.F.-A.F. by-pass condenser, each connecting lead being identified by colors. To make up efficient power pack for a receiver using a type '71A output tube you need only a rectifier tube socket, a voltage divider, a power transformer, and this filter block. 3¼x4½x5 inches. Shipping weight 6 lbs.
List Price, $7.50.
No. 1800-283—YOUR PRICE.... **$4.95**

The SONOLA 1931 A.C. Model Midget Receiver
RCA LICENSED

This Midget Receiver will outperform many of its larger brothers. Uses 5 tubes; 3 screen grid, 245 power tube, 280 rectifier. Rola dynamic. Large capacity filter. Perfectly shielded. Selectivity obtained by use of three tuned stages. High amplification is assured by screen grid RF, screen grid power detector and '45 output. Rola Dynamic gives wonderful reproduction. So small you can put it anywhere yet it will fit. There may be cheaper midgets on the market. We are fully aware of this. That's exactly why you should have a SONOLA. There is NO GRIEF with this high grade set. For 50 to 60 cycle, 110 volts. Dimensions: 14 x 9 x 18 inches high. Shipping weight 30 lbs. List Price, $59.50.
No. 2500—Your Price (less tubes) **$32.25**

Kolster Magnetic Cone Speaker Chassis

May be connected directly in the plate circuit of type '12A tubes; or to higher-power tubes through an output device. In push-pull circuits, speaker may be connected from plate to plate. "9-inch cone" type. Paper-rattle is prevented by a flannel damper; bass notes are well reproduced due to the "free-edge" effect. Its small dimensions make it eligible for use in home-constructed midget sets. Comes with 6 ft. cord. Dimensions: 10 x 5½ x 9½ inches. Shipping weight 6½ lbs.
List Price, $18.00.
No. 1500—YOUR PRICE........ **$2.85**

FREE

We have just issued our new "RADIO SERVICE TREATISE." It's red hot all the way through. 52 new hookups and circuit diagrams. 110 illustrations.

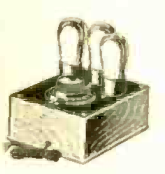
Partial contents: Modernizing old radio sets. How to convert battery to power sets. Selection of tubes. The detector tube. The power tube. Changes in grid or "C" bias circuits. Push pull amplifiers. Replacing audio transformers. Phono. attachments. How to choose power transformers. Voltage dividers. Wattage of power transformers. Selecting and installing replacement parts in radio sets. Filter condensers. Repairing "B" eliminators. ALL BRAND NEW DOPE—NOT A REPRINT. Chuck full of REAL radio information all the way through. Even the catalog section has dozens of hookups—never found anywhere before.

WRITE TODAY. Enclose 2 cents for postage. Treatise sent by return mail.

Genuine Magnavox Microphone
Do Your Own Home Phonograph Recording

Made by the world-famous Magnavox Co. While originally made to strap on the head. It is easy to screw a handle onto one of the side brackets. The side brackets are covered with soft rubber and place the microphone at the best speaking distance from the mouth. Comes with 6 feet of cord. The biggest mike bargain in America! Complete with straps and buckle to fit around head. Brand new, in original factory packing. Shipping weight 1 lb.
List Price, $10.75.
No. 1610—YOUR SPECIAL PRICE **$1.65**

Short-Wave Converter



Build a short-wave converter at lowest price on record, but with which excellent results are obtainable nevertheless. The voltage for the three 227 tubes used may be obtained from an external filament transformer or from a secondary winding of 2½ volts in a power pack. Wavelength from 30 to 110 meters. No plug-in coils; coil switch is used to cover wave band. Single dial tuning, no grunting, no body capacity, no squeals. Leak-condenser modulation. Converter consisting of all parts (less filament transformer) including cabinet, panel, diagram and 4-page instruction sheet (less tubes).
No. 1619—YOUR PRICE........ **$4.85**
No. 1615—6-Volt Battery Model, same price.

GUARANTEED 6 MONTHS NEONTRON TUBES

Sold on a 6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS! All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

Choice of	Choice of	Choice of	Choice of
226	112A	245	222
227	200-A-199UX	280	210
171A	199UV-120	171	250
201A	224		281
63c each	70c each	80c each	$1.60 each

"RTC" High-Voltage "Puncture Proof" Filter Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS Cat. No.	Mfd. Capac.	Your Price	800 VOLTS Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0 45
1703	1	.30	1707	2	.75
1704	2	.40	1708	4	1.10
1705	4	.60			

WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN $3.00. If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders; balance on delivery.

If the full cash amount accompanies the order, you may deduct 2% discount. Send money order—certified check—U. S. stamps (any denominations.)

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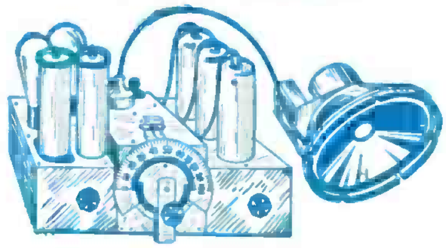
TRIPLE SCREEN-GRID
TONE CONTROL
MATCHED DYNAMIC SPEAKER

MANTLE SET



Dealers and Servicemen!

Be prepared to meet the great demand for this popular radio set during the holiday season. Equals the performance of any console receiver and yet you can sell it for less than $75.00 completely installed and still *double your investment.* Order your sample to-day and avoid the last-minute rush.

Housed in this gorgeous walnut Gothic Cabinet 16½" high, 14½" wide and 10¼" deep. Only **$26.95**

$24.50 Chassis uses 3-224, 1-245 and 1-280 tubes and is equipped with matched dynamic speaker. For chassis and speaker. Tubes, $2.50 extra.

REPLACEMENT Condenser Blocks

Peerless Courier, as illustrated, ea.	$1.75
A K 37	4.80
Majestic B	2.95
Victor R32	3.25
R C A 18, 33 and 51	1.60
R C A 17	4.95
R C A 41	4.25
R C A 60, 62	5.95
Zenith 11E	3.25
Brandes B15	2.95
Kolster 6H	2.95
Kolster K21	2.50
Kolster K43	3.25
Kolster K22, 20, 42	3.25

Voltage Dividers, Fixed Resistances and GRID Suppressors

Ward-Leonard, Aerovex, Ohmite and Hy-watt wire wound resistances from 33 to 250,000 Ohms for all standard sets at 20 to 50c each. Full description in our catalog.

Centralab, Frost, Yaxley, Clarostat, Bradleyohm, Carter and Electrad Variable Volume Controls and Potentiometers

All sizes from 2 to 500,000 ohms carried in stock for replacements in all standard sets. Prices from 20 to 45c each.
ALSO Wire Wound and Carbon pigtail resistances from 10 ohms to 5 megohms at $1.50 per dozen.

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We Carry a Complete Line of Microphones, Turntables, Pick-ups and Amplifiers for Public Address Systems and Theatres.

Universal Baby Mike. A real microphone, single button, with covers and 25 ft. of cable. List, $7.50. Our Price, $4.50.

Carryola Synchronous Motor

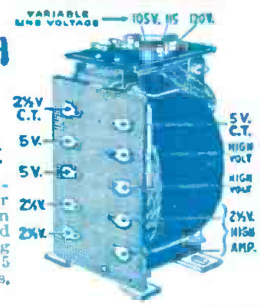
Complete with turn-table. Silent, sturdy and compact, only 1¼" thick. No brushes. Only $1.25.

Bosch Power Amplifier

Push-pull 245
Uses 1-227, 2-245 and 1-280 tubes. Cat. No. 7031

First Stage 227. Second Stage 245 in push-pull, with phonograph pick-up and field supply for 2500 ohm D. C. dynamic speaker with or without input transformer (specify which).
Also furnishes filament and plate voltage for 224, 227 tubes.
Can be used to convert any battery set into an up-to-date A. C. receiver with 245 push-pull audio.
OUR NET PRICE, $19.50

Power Transformers For all Standard Sets Carried in Stock



Model illustrated is for A C Dayton Navigator and other sets using 224, 227, 245 and 280 tubes, $3.85.

Freshman Q	$ 6.75
Freshman QD	7.85
Philco sets	3.75
Zenith 33, 35	3.25
Radiola 44, 46	4.95
RCA Double Choke	.95
AK40-42 Power Pack	11.50
AK46 Power Pack	15.00
Sonora B33	4.75
RCA Audio	.55
Earl 21, 22	2.26
Radiola 60, 62	5.95
Kolster K20	2.25
Stromberg-Carlson 642	3.95
Step down 220 to 110V	3.95
Kolster 6H	7.50

Dynamic Speakers

Peerless Giant Auditorium, 12" Diaphragm, 110 V., A. C. $14.50
D. C. with 1000 and 2500 ohm fields ... $10.00
Peerless Courier, 7", D. C. .. $7.50
Baldwin, 9", A. C. .. $7.50
Temple A. C., Model 2, in Walnut Cabinet . $9.75
Peerless 17A, in cabinet $11.50

TERMS:—20% with order, balance C.O.D. 2% discount allowed for full remittance with order only.

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It Revolutionizes the Short-Wave Art!

No changing of plug-in coils. The coils are fixed inside the set, and are controlled by a highly ingenious switch. The turning of a single small knob on the front panel carries you through from 15 right up to 650 meters.

Complete A.C. operated chassis **in cabinet!**

Highly sensitive and selective circuit!

Screen Grid TRF amplifier.

Regenerative Screen Grid Detector.

227 First Audio Stage.

Two 245's in push-pull output stage.

Will operate electro-dynamic speaker at **full efficiency.**

Provision for **Phonograph Pick-up.**

Earphone Jack **on front panel.**

Stations can be **logged permanently on dials.**

Regeneration control **does not alter tuning.**

All **metal** chassis.

Most advanced construction yet used for Short-Wave work.

Complete **coverage of all wave bands from 15 to 650 meters.**

In kit and factory-built models.

The NEW UNIVERSAL Super-Wasp covers all short-wave broadcasting, commercial, amateur, television, trans-oceanic telephone and police radio stations. On broadcast ranges, the Universal Super-Wasp covers the absolute minimum and maximum limits and brings in **broadcasting** stations **not audible at all on regular broadcast receivers.** Above broadcast ranges, UNIVERSAL Super-Wasp covers ship stations on 600 meters.

This most versatile of all radio receivers is just another evidence of Pilot progressiveness.

As the original Pilot Super-Wasp has made radio history all over the world in the hands of licensed amateurs and short-wave listeners, so will the new Universal Super-Wasp make new radio history in the hands of all people who want more from radio than ordinary broadcast sets can give them.

Look for our March 1st announcements. Ask your dealer to be ready to demonstrate the New Universal to you.

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