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TELEVISION News

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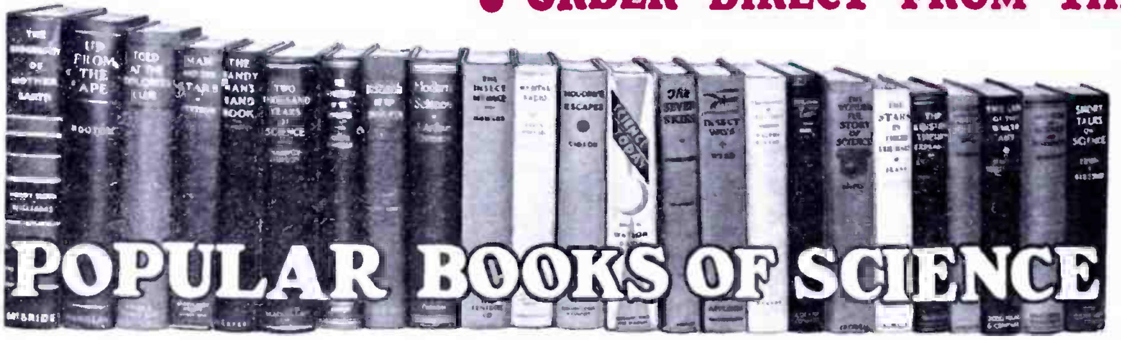

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TELEVISION News

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HUGO GERNSBACK, Editor

H. WINFIELD SECOR, Managing Editor

ROBERT HERTZBERG, Associate Editor

VOLUME II NUMBER 4

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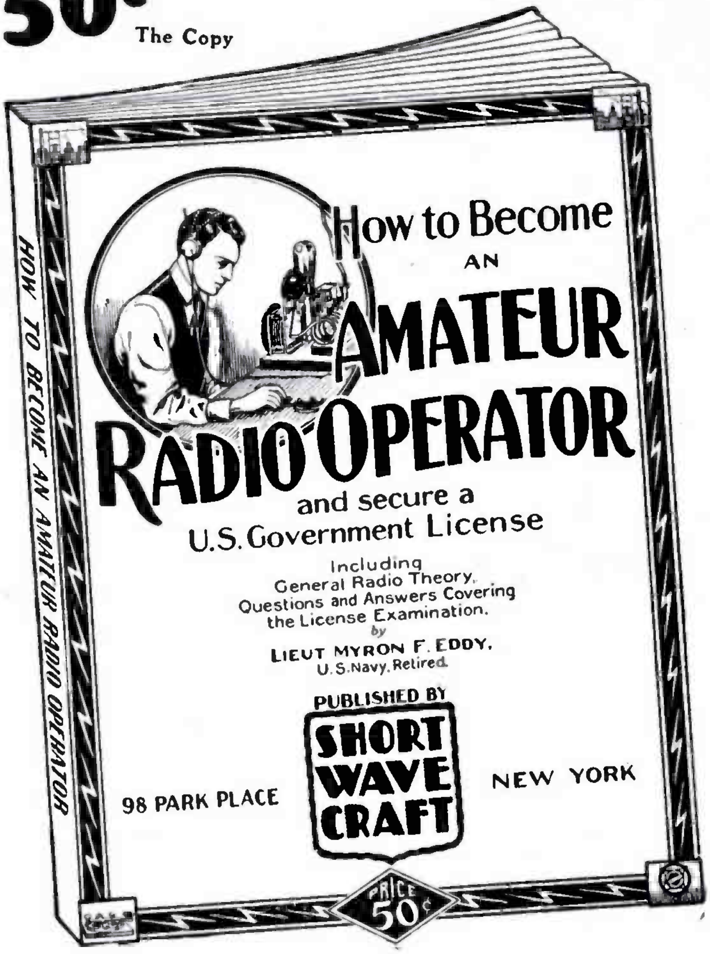

Announcing-

THERE are at the present time, in this country alone, about 25,000 licensed radio amateurs. For the past several years we have been bombarded with requests from radio readers for a reasonably priced book to cover the subject on "How to Become a Radio Amateur and Obtain a Government License."

While there have been some books of this type on the market before, most of them are either obsolete and of little use to the newcomer or otherwise are so high in price that the average man cannot afford them.

We therefore commissioned Lieut. Myron F. Eddy, U. S. Navy, Retired, to write a book on this subject that would answer EVERY possible question on the subject in such a way as has never been done before. We chose Lieut. Eddy for this difficult task because his long years of experience in the amateur field have made him preeminent in this line. For many years he was an instructor of radio telegraphy at the R.C.A. Institutes, and in this capacity he obtained a vast knowledge and insight on the subject such as is had by few men. He is a member of the I.R.E. (Institute of Radio Engineers), also the Veteran Wireless Operators' Association.

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In general get-up this book is a companion volume to our first book, "How to Build and Operate Short Wave Receivers." It comes with a heavy colored cover, and is printed throughout on fine bond paper. No expense has been spared to make this the outstanding volume of its kind. The book measures about 7½ x 10 inches.

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CHAPTER 3 takes up general radio theory particularly as it applies to the beginner. The electron theory is briefly given, then waves—their creation, propogation and reception. Fundamental laws of electric circuits, particularly those used in radio, are explained next and typical basic circuits are analyzed.

CHAPTER 4 contains descriptions of receivers that are being used with success by amateurs at this time. You are told how to build and operate these sets, and are told how they work.

CHAPTER 5 takes up transmitters of interest to amateurs. Diagrams with specifications are furnished so that their construction is made easy. Operating instructions are also furnished.

CHAPTER 6 describes the power equipment that may be used with transmitters and receivers, rectifiers, filters, batteries, etc.

CHAPTER 7 includes all of the regulations that apply to amateur operators.

CHAPTER 8 is the appendix, which contains the international "Q" signals, conversion tables for reference purposes, etc.

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TELEVISION News

VOLUME II NUMBER 4

SEPTEMBER-OCTOBER, 1932

HUGO GERNSBACK, Editor
H. WINFIELD SECOR, Managing Editor
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TELEVISION IN EUROPE

An Editorial by HUGO GERNSBACK

THE writer recently made a survey in a number of European countries as to the status of television at the present time. In the course of his travels he visited Germany, France, Belgium and England, which countries, perhaps more than others, are today occupying themselves a great deal with the new art.

The study reveals that of all the countries visited, Germany is outstanding in television research. The other countries have not added anything noteworthy or new to the art. Indeed, there is not much activity going on except in some of the better laboratories. In France and in England, nothing noteworthy is reaching the public, and the Nipkow disc in one form or another is still the main stay of the television industry, if such it may be called.

Throughout Europe, there are practically no television broadcasting stations, with the possible exception of England, where some little broadcasting is now done, similar to what is being conducted in the United States.

The results achieved abroad are about the same as here in the United States. While the United States is at least from three to five years ahead of Europe in general radio technique, it may be said that both the United States and Europe are about in the same position when it comes to television, with the possible difference that in the United States there is vastly more television broadcasting on regular schedule than in Europe.

Germany is perhaps the one country in the world today where the cathode ray tube is at its height. It is certain that Germany today produces the only worthwhile television tubes in the world, and in my opinion, the best. At least, this was so during June and July of this year. What the situation will be later on is, of course, difficult to predict.

Through the courtesy of the German Government it was possible for me to visit the huge television laboratories maintained at the Reichspostamt (Government Post Office). Inasmuch as all broadcasting activities in Germany are government controlled, the lion's share of the research work is done by the Post Office Department as well. This department maintains a large and well equipped laboratory which is as up-to-date as any institution anywhere. The laboratory not only does a great amount of experimental work, conducted by a corps of scientifically well-trained assistants, but also makes its own cathode ray tubes right on the premises. A large room is devoted to glass blowing and to the exhausting of the tubes, and all phases of the work are supervised with proverbial German thoroughness. One may see tubes measuring from one foot up to six feet, in all varieties. Indeed, one gains the impression in this state-owned laboratory that nothing is left to chance, and that if anything worthwhile is being produced in cathode ray tubes, it probably will be produced here. Under the able leadership of its director, Dr. F. Banneitz, a tremendous amount of television research work is performed here.

The German Government will open what will probably be the world's most powerful television broadcasting station in Berlin in September of this year, in time for the Berlin Radio Exposition.

Another laboratory of note is that of Baron Manfred von Ardenne, who also produces his own cathode ray tubes, which are understood to be of high quality.

Some of the German radio set manufacturers intend to have complete radio and television sets featuring cathode ray tubes on the market by September. Television sets are not a novelty in Germany, as a number have been produced by several of the larger radio set manufacturers, but these, up to now, have been of the disc type. The Berlin Radio Exposition will probably bring out the first cathode ray tube television sets to be offered anywhere, unless in the meanwhile American manufacturers do likewise, which, at this time of writing, seems unlikely.

It may be said on the whole that television in Europe has not reached the public as much as it has in the United States. The average person to whom one speaks about television assumes an air of incredulity and unbelief whenever the word "television" is mentioned. The reason for this probably is that television has not been played up to the public as much as it has been in this country, and has not been publicized to the same extent.

As far as fundamental or revolutionary novelties regarding television are concerned, there are none to be found as yet in Europe, unless they are behind locked doors. It is quite possible, however, that some of the manufacturers may spring surprises during the coming Berlin Radio Exposition, which will be carefully watched by all radio and television experts.

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Editorial and Advertising Offices, 96-98 Park Place, New York, N. Y.

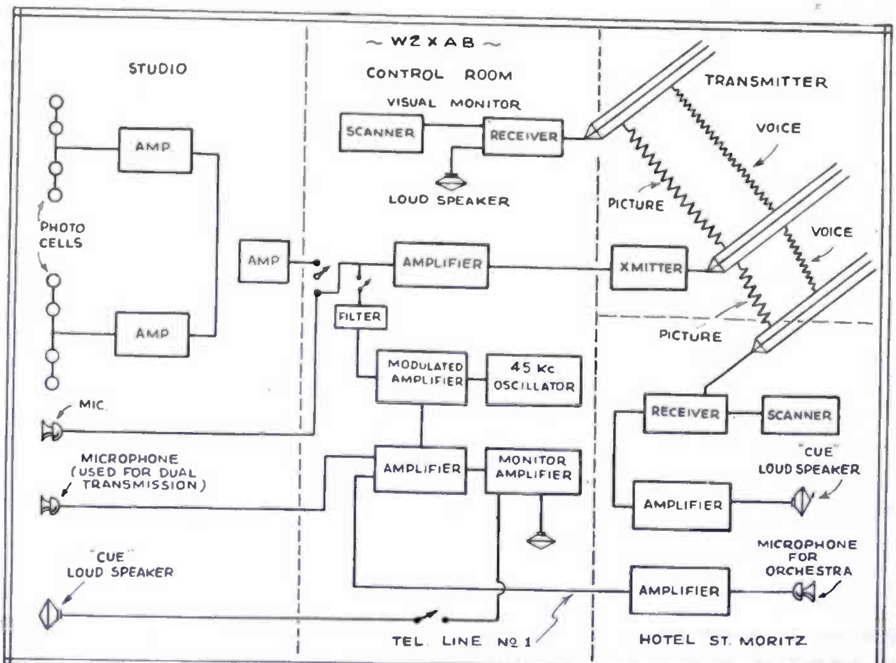
SIGHT - AND - SOUND BROADCASTING ON ONE WAVELENGTH!

Station W2XAB of the Columbia Broadcasting System is well known to television experimenters because of the fine work it has been doing for the past year. Now it advances a step further in the art and offers both image and voice on a single wavelength. Its transmissions will provide many interesting hours for owners of television receivers.

STATION WABC and the coast-to-coast Columbia network stations were synchronized with W2XAB's television facilities when the first anniversary of Columbia's regular transmission of television programs was celebrated from 9:00 to 9:15 p.m., EDST, Thursday, July 21, 1932. The same event also inaugurated regular broadcasting of simultaneous sight and sound on one wavelength, a revolutionary development in visual broadcasting.

In addition to brief talks on television by William Schudt, Jr., director of Columbia's television programs, and Edwin K. Cohan, Columbia's technical director, another innovation was introduced as the entertainment feature of the program. Harold Stern's Orchestra, which broadcasts over the net work from the St. Moritz Hotel in New York, played at the hotel roof garden as their leader talked to them and directed them from W2XAB's studio. Receivers set up in front of the band enabled the musicians to follow Stern's baton and to hear his instructions as he faced the flying spot nine blocks away.

Schudt and Cohan spoke briefly on the engineering aspects of the past year's television operation and the prospects for the years to come, also giving a non-technical description of the application of the principles which enable Columbia to broadcast sound and images simultaneously on the same wavelength.



Above right: William A. Schudt, Jr., director of visual broadcasting for the Columbia Broadcasting System (left) congratulates William E. Lodge for his work in making the sight-and-sound transmission possible. Bottom: schematic layout of the apparatus used in the Lodge system.

This double transmission is another achievement Columbia has contributed to the pioneering era of visual broadcasting. Although the feat has been achieved in laboratories by research engineers, it is believed that Columbia is first to use the method for regular broadcasting.

With W2XAB transmitting sight and short-wave station W2XE broadcasting the synchronized sound, Columbia started its regular schedule of visual broadcasting on July 21, 1931, with a program which included the opening of the station by Mayor James J. Walker of New York, acts by prominent stars of the stage, and explanations for the layman of the principles and fundamentals of television, given by Columbia engineers. Since then a regular sight and sound schedule was maintained until May, when the synchronized sound was temporarily omitted in order to make special experiments with the visual medium alone. All television broadcasting was suspended for two weeks during July in order to make the changes and installations necessary for the new double transmission.

The year's achievements have been gratifying to those entrusted with Columbia's part in guiding the destinies of the infant science. Lookers-in have reported excellent image reception from local and distant points, and the number of television "fans" has been surprisingly large. Columbia made valuable experiments with make-up, costumes, scenic backdrops, and other features to originate a technique of visual broadcasting that resulted in continually increasing clarity of images. Many novel, interesting, and instructive program features were scheduled, and on several occasions Columbia features were presented simultaneously over the combined facilities of television and the regular network.

Experimental work for this double transmission has been under the guidance of William B. Lodge, Columbia development engineer.

Double Modulation Used

"Double modulation," Lodge said in explaining the new method, "is the term which best describes the principle upon which the system depends. The average user of a radio set is familiar with the fact that when he tunes his receiver to a certain broadcasting station, he is tuning to the particular carrier frequency of that station. The signal which reaches the set from the antenna consists of this carrier frequency combined with the frequencies of the speech or music. The receiver has the ability to separate the speech or music from this complex wave, and to reproduce it in the loud speaker. Thus the carrier frequency is said to be modulated by the audio signal.

"The first step in the new system is to modulate a carrier of 45 kilocycles with the signal picked up by a microphone in the television studio.

"This produces a complex wave, from which the original sound could be obtained by a receiver tuned to 45 kilocycles. Actually, the signal is not radiated at 45 kilocycles.

"The television signal such as is emitted by Columbia's W2XAB transmitter consists of frequencies up to 40,000 cycles per second, or 40 kilocycles. In the operation of the sound and picture broadcast, the television signal, up to 40 kilocycles, and the modulated 45 kilocycle carrier are combined and both transmitted over the one station.

"At the receiving station the set is tuned to the frequency of the transmitting station, and then detects and reproduces the above signal. Frequencies up to 40 kilocycles are applied to the terminals of a neon tube and reproduce the television picture. As previously stated the 45 kilocycles modulated carrier wave contains the sound signal, and a receiver tuned to that frequency can be used to obtain the original sound.

Simple Filter Needed

"In the television receiver, therefore, it is only necessary to insert a simple filter at the terminals of the neon tube to prevent the 45 kilocycle voice carrier from interfering with the picture, and to add a second detector with a circuit tuned to 45 kilocycles to obtain the audio signal.

"It may be interesting to note that the sound program may also be detected by a conventional selective receiver tuned to a frequency 45 kilocycles either higher or lower than that of the transmitting station's carrier, or in the case of W2XAB either 2755 or 2845 kc."

Advantages of the new system are obvious. Where it was previously necessary to use two transmitters and two receivers, slight modifications allow the use of but one transmitting or receiving channel for both sound and picture signals.

A PREDICTION COME TRUE!

RADIO NEWS

H. GERNSBACK, Editor and Publisher
SYLVAN HARRIS, Managing Editor

EDITORIAL AND GENERAL OFFICES, 53 PARK PLACE, NEW YORK

Vol. 7 MAY, 1926 No. 11

Radio Television

By HUGO GERNSBACK, F. R. S.

...e same wave to wh...h you are ...
...mple reason.

The range of acoustical frequencies is really very narrow, and does not take in a wide band; the human ear responds to no vibrations above a frequency of 23,000 per second. That is the reason why the so-called radio "carrier" is inaudible. To the non-technical reader it may be explained that the "carrier" is the fundamental wave emitted by a broadcast station, which is on the air at all times when the station is transmitting. When no one is speaking or singing at the broadcast studio, you hear nothing but a faint rushing sound in your receiving instrument. The vibrations of this carrier run into millions per second, and that is why we cannot hear them directly.

If however Television is perfected (as it almost surely will be during the next two years, or perhaps sooner) it will be possible to impress the Television impulses upon this same "carrier" which brings the sound impulses to your set. The Television impulses, being of a frequency too high to be audible, will not interfere with your loud speaker; and the Television picture for the same reason, will not be mixed up with the speech, any more than a violin or a piano, both of which you can readily distinguish with your ear. This is an inadequate comparison, because the separation between the acoustical band or audio frequencies and the radio frequency band is enormously wider than that between any two audible notes of music; and it will therefore be practically impossible for the "sight" waves and sound waves to interfere with each other.

I have pointed this out to bring home the point that, when Tele...ision is finally brought about, it is quite probable that today's radio ...ts will be adapted to this new purpose; and that it will be possible ...nect a Te...ision attachment right to your present set a... ...s going ... the country whil...

More than six years ago, Hugo Gernsback, then editor of RADIO NEWS, *predicted simultaneous transmission of sight and sight signals on the same wavelength. The idea was generally ridiculed at the time, but for that matter a lot of competent radio engineers thought that radio television itself was impractical. Now the second largest broadcasting organization in the world, which has always displayed considerable progressiveness, announces regular sight-and-sound broadcasting on exactly the basis described in Mr. Gernback's original editorial, part of which is reproduced above. Note the date—May, 1926!*

Beginning July 21 and continuing thereafter daily except Saturday and Sunday, from 8.00 to 10.00 P.M., EDST, W2XAB will transmit combined sight and sound, William A. Schudt, Jr., Columbia television director, stated.

The television programs broadcast by W2XAB during the past year have been staged with ingenuity and care. That they consist of something more than a few black and white cartoons is indicated by the following sample program:

Columbia Broadcasting System
Experiment Television Sight
and Sound Station
W 2 X A B

* * *

New York

* * *

Monday, July 25, 1932
Sight and Sound Station W2XAB
2800 Kc.—107 Meters

8:00 P.M. The Television Ghost. Murder stories as told by the ghost of the murdered. Close-up projection with weird effects.

8:15 P.M. Television Beauty Review.

8:45 P.M. Scanning Baseball Scores and Correct Time.

8:50 P.M. Dance Recital, featuring Marion Harwick, assisted by Natalie Schoenfeld and Lloyd Gessler. Presentation scanned against metropolis backdrop. Close-ups and long shots.

9:15 P.M. "Clarence," a television comic strip drawn by Frank Fogarty, cartoonist of the New York Herald-Tribune.

9:30 P.M. Muriel Asche and Her Kingsway Kiddies. Juvenile stars perform for the flying spot. Full length pictures against various backdrops.

10:00 P.M. Sign Off with Columbia's sliding sign.

VISIO-TELEPHONY IN FRANCE

by H. J. BARTON CHAPPLE

WHILE it is part of our everyday activities to see and talk with our fellow creatures when in close proximity to one another, it has been the privilege of only a few to see *and* hear one another when separated by walls, buildings and other obstacles. Recently I was a privileged participant in the inaugural ceremony of a commercial system which enabled this use of the twin organs of the eye and ear to be effected simultaneously. It was possible to see and hear, and be seen and heard at the same time, and the process involved has been called "visio-telephony".

As far as can be ascertained, this demonstration differed fundamentally from anything hitherto achieved. First of all, it was outside a laboratory in every respect, and secondly "noctovision" was applied for the first time to two-way television, as will be shown later. It will be remembered that in April, 1930, the Bell Telephone Laboratories demonstrated two-way television between their premises in West Street and the American Telephone & Telegraph Co. building at 195 Broadway, New York. A double disc receiver and transmitter were employed, and a visible light scanned the sitter's face.

Since the persons carrying on a conversation with one another had to look into a flickering light beam and at the same time endeavor to watch a necessarily dim television image, the scheme did not progress beyond this stage, it being emphasized by both Dr. Ives and Dr. Gray that this was merely experimental apparatus.

The use of noctovision has now raised two-way television to a commercial plane, and furthermore the demonstration about to be described was outside the laboratory in every respect.

The inauguration ceremony actually took place in Paris on Thursday, May 11th, 1932. The setting for this was an office at the French newspaper *Le Matin* at one end, and a studio at the Galeries Lafayette at the other end.

M. Louis Rollin, Minister of Commerce & P.T.T., took a leading part in the inaugural ceremony, and after replying to an address of welcome, he entered a booth at the offices of *Le Matin* which had been set aside for the purpose. Here he was able, while speaking on an ordinary telephone, to see the person to who he was speaking, and know that his own head and shoulders were visible at the other end.

Numerous distinguished people, technicians, representatives of the French and foreign press succeeded the minister in the booth, and all testified to the excellence of the image, the general scheme adopted, and the simplicity of the apparatus employed.

A study of the accompanying photographs and diagram will help to explain the layout, both ends being identical, so that a description of one will suffice for the two.

Seated at the table and carrying out a visio-telephony conversation. Note the banks of photo-electric cells and the aperture cut in the wall.

Four pairs of lines linked each booth, two pairs being used to handle the vision signals, and the remaining two pairs the sound.

The person sat down before a table and faced a rectangular aperture cut in a partition dividing the room from the control room. A bluish violet light provided a diffused illumination, and flanking the sitter were two banks of four photo-electric cells, mounted in metal cases and supported on stands.

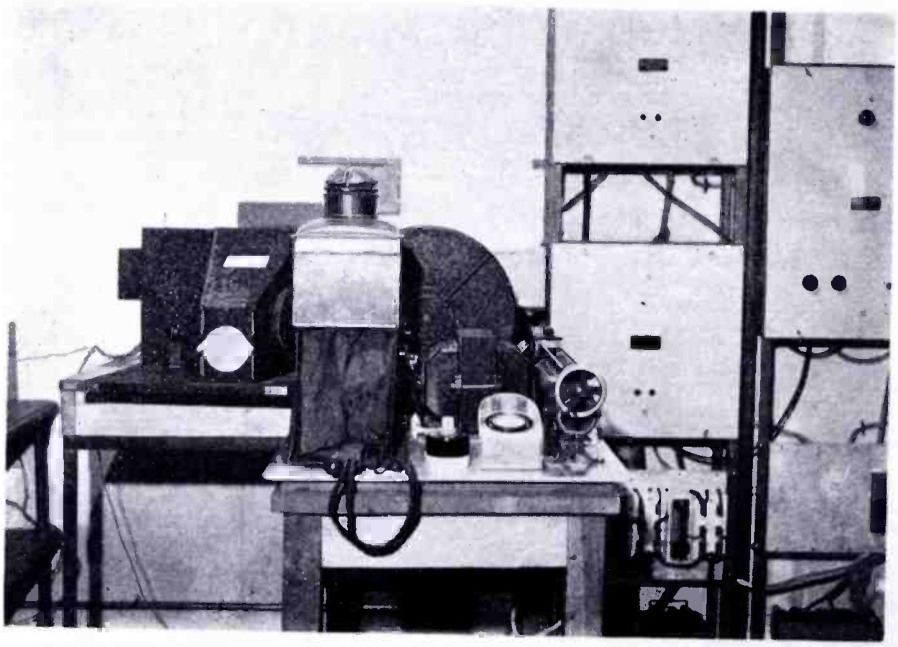
When the telephone receiver was lifted and connection established, the head and shoulders of the individual seated at the other end appeared on a translucent screen about ten inches high and five inches wide, occupying the right hand half of the wall aperture. The features were clear and distinct, and the image remained quite steady throughout, the normal Baird automatic system being employed. Lip and head movement could be followed with ease, and the play of expression on the face was most impressive.

The people holding a telephone conversation found it difficult to realize that they were being "scanned," but behind the rectangular aperture and on the left of the image screen, could be seen the end of a telescopic focussing lens. This was part of the familiar Baird spot light transmitter complete with the scanning disc enclosed in a dust proof cover, driving motor and incandescent metal filament projection lamp.

The disc had a spiral of twenty-four holes arranged near its periphery, and the speed of rotation was fixed at 750 revolutions per minute, giving 12½ explorations per second. Instead of a visible spot of light playing on the sitter's features, however, a thin disc of ebonite was positioned at the end of the lens, and this effectively filtered out all the visible and invisible rays except the infra-red.

The photo-electric cells used were specially sensitive to the infra-red end of the spectrum, and in consequence of the variations of "light" intensity were faithfully translated into terms of electrical currents and sent to the other end after amplification.

(*Continued on page 204*)



A rear view of the combined transmitter and receiver. The receiver is on the left, while on the right is the spot-light transmitter.

Automatic Synchronization

by F. B. DUVALL*

A SYSTEM that would permit us to sit at home on a rainy evening, turn on our radio set—then our television set, settle easily in an arm chair and l.sten to our artist while visualizing him on the screen, would indeed be wonderful. Unfortunately, however, this condition heretofore has only existed for a few of us.

Television fans in New York, Boston, Chicago and Washington have had this ideal condition for some two years, much to the envy of fellow "lookers-in" who are located in remote places. By remote places we mean towns and states not tied in on the same power supply as the one which feeds the transmitter. This condition spells "remote" in capitol letters as far as television is concerned. To sit there watching the pictures weave crazily around and race past and trying vainly to hold the motor in step by some manual means is pretty tough and bound to exhaust the patience of even a "dyed-in-the-wool" television fan.

Let us explain—the television picture is really an optical illusion and can be likened to the moving picture. There are really 20 distinct pictures per second, but due to the time lag of the eye (called "retentivity of vision") it appears to be a picture of continuous action. Take the small boy for instance with his pad of pictures of some baseball game or movie star; as he slowly lets them slip between his thumb and forefinger they are "changing" still pictures but as he lets them slip faster they are actually moving pictures. The eye does not follow each successive picture instantly but retains the last scene as the next one is superimposed, giving the impression of animation. Now, if the eye were fast enough, it could follow each individual dot of light coming through the scanning disc. This condition would spoil movies and television because of the fact that the eye could not be tricked. The eye retains an impression for 1/10th of a second and an individual spot of light in our radiovisor lasts only 1,/86,400th of a second. These simple figures explain the lack of objectionable flicker in 60-line, 20-frame per second picture.

At the transmitter is a scanning disc containing 60 holes rotating at 1200 r.p.m., which gives us 20 pictures per second. The standard frame of our picture is 60 elements by 72 elements. In other words, the picture has a 5 to 6 ratio. If our picture is 60 hole widths high, then it is 72 hole widths wide or in one picture we have 60 x 72 or 4,320 individual light spots in one twentieth of a second; as there are 20 pictures per second, we have 86,400 exposures of the photo-cell in that time. Theoretically this is not true cross line frequency. If we are not located on the same power system as that supplying the transmitter and our disc is traveling faster or slower than the disc at the transmitting end, you can readily see the difficulty of keeping the radiovisor disc in step hole by hole or exposure by exposure with the transmitter disc in order to maintain a steady picture.

*Television Engineer — Jenkins Television Corp. De Forest Radio Company. Instructor of Television—Brooklyn Institute of Engineering. Radio W2ANE, Assoc. I.R.E. Chairman of the Board, K. Wilson Taggart, Inc.

Let us now take into account the systems and means to this end.

We are all more or less familiar with the principle of automatic synchronizing by the use of a synchronous motor on the same power supply for broadcast and reception. To build up the picture in the receiver and radiovisor point by point, the motor in the radiovisor must not only operate at the same speed as the transmitter, but it also must be in synchronism revolution by revolution, or, in the proper phase relation.

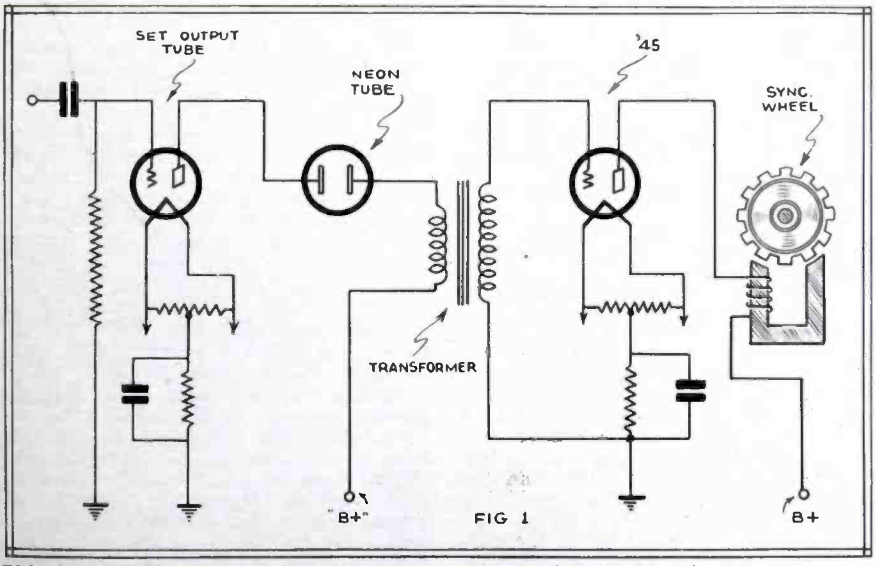
As the photo-cell is actuated by the spot of light being impressed and coming through, we shall say, hole number 30 in the transmitter disc, at that particular instant hole number 30 in the disc of the radiovisor is coming past the neon tube or crater lamp. Thus the picture is assembled point by point in the radiovisor as the transmitter breaks it down and impresses it on the radio waves.

By using a synchronous motor that runs 1200 r.p.m. (the same speed as the transmitting motor) and on the same power supply, we automatically obtain the desired result. True, the picture may form out of frame horizontally or vertically, but there is the simple corrective agent in the form of a rotatable field.

The Rotating Field

Such field is attained by bringing the motor connection out to two slip rings on the frame and two brushes riding on the slip rings. This permits the field and frame of the motor to rotate while maintaining its power connection with the A.C. lines. The frame of the motor is geared to a small knob on the front of the radiovisor cabinet. By simply turning the knob in either direction, the operator is able to frame the picture vertically or horizontally. This is the system employed in the Jenkins Radiovisor Model R-400.

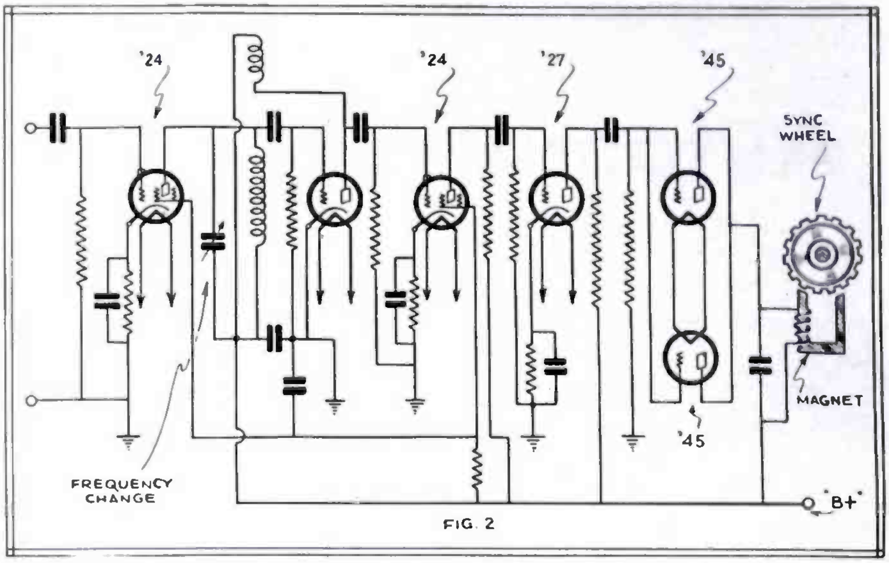
What of the man operating his radiovisor in New Jersey or Pennsylvania? His power supply is different from the one employed at the transmitting station. Even with the use of a synchronous motor, the pictures he receives will drift by. The use of the synchronous motor would bring about the revolution of the disc at 1200 revolutions per minute, but it would not be in proper phase relation with the transmitter. Then would ensue an endless procession of pictures drifting out of frame vertically, with a tendency to horizontal floating as well. The rate of change or drift between such divergent power agencies has been gauged for each five minutes



This is probably the simplest synchronizing method used by television experimenters. The scanning disc is attached to the synchronous wheel.

to be 2% plus or minus. In figures, this might appear insignificant, but in actual practice it is quite sufficient to spoil image reception.

If the various power systems should come to the point where a central generating station tied them together, as proved by experimenters, much would be gained in economy and exchanges in power between the various branches in the network. Such a condition would bring joy to the hearts of radiovision fans, who could then DX to their hearts' content and have their images in frames. When radiovisors are as numerous as radio sets, folks will probably enter a mighty plea with the power companies for a tied-in system. As this is only a remote possibility at the present time, there must be a means devised for keeping the images in frame even when the radiovisor is on a converter in a D.C. district.



Complete circuit of the automatic synchronizer of the author, showing the modulated self-excited oscillator-amplifier.

Using the 1200 Cycle Component

This brings us to picture frequency synchronization or the use of the 1200 cycle component to control a "floating" motor at the receiving end.

One of the standard scanning practices recommended by the Television Standardization Committee of the R. M.A., according to Chairman D. E. Replogle, is 60 lines, 20 frames per second pictures. This gives a strong 1200 cycle component that may be used for synchronizing at the receiving end.

Various systems have been tried experimentally. Some companies have been marketing receiving and synchronizing devices, although the Jenkins Television Corporation has a basic patent covering the use of any scanning frequency as a synchronizer and companies or individuals using such a system are liable for damages in suit for infringement brought on the aforementioned patent.

The first and most simple system used by experimenters and now employed by some manufacturers may be described as follows:

Between the neon or crater tube lead and the high side of the power pack is placed a transformer primary, peaking the primary and secondary by condensers, or by the distributed capacities of the windings themselves, to 1200 cycles. This is fed into a '45 tube, biased to the individual liking of the user. Some allow it to draw a little grid current to get a square-topped wave, others use it as a class B amplifier and still others as an ordinary Class A linear amplifier. The magnet coil assembly is placed in the plate lead of this '45 tube, getting a fair pull from the 1200-cycle component when the teeth are opposite the rotor on the radiovisor and a D.C. breaking action when the teeth are in off position. Figure 1 shows the hookup for such a system.

Disc Will Run Wild

This system is not entirely satisfactory, however. Should there come a sudden change in line voltage, a burst of static, or a slight fading condition, the disc runs wild and if we wait for the motor to correct itself and catch up again, it is usually out of frame horizontally. Another serious defect in the operation of this system is the introduction of a frequency discrimination in the plate circuit of the output tube in the set due to the transformer's impedance change with frequency and the resultant factor to deal with in the neon or crater tube. The task of getting enough power to hold the disc in step by using this system is quite hopeless. After having learned this sad truth, the experimenter's next thought is "more pull." In this search for more pull, various systems have been tried with interesting results.

To obtain more pull, an assembly using two magnets and coils has been used. Because of the better results that were secured by this device, a third assembly was introduced. Each of these assemblies was placed at a 45° angle from the other. This gave a total of six teeth meeting the phonic wheel. The pull exerted by this tri-magnet coil assembly, although it was apparently ample, did not arrive at or near the saturation point in the plate lead of the two type '45 tubes in parallel, whose plate current was from 55 to 65 milliamperes.

One Stage Sufficient

The amplification factor is not a problem, one stage being all that is necessary. With the set volume control almost off, an A.C. component of at least 30 volts at 1200 cycles can be realized, and better than 100 volts with normal volume. This high amplification factor is realized by the combined use of the set amplifier and synchronized outfit, consisting of a 1 to 20 step-up transformer feeding the '45s.

With the necessary pull and signal strength taken care of, the next step was the attainment of a peaked amplifier, or one so constructed by the use of filters to pass 1200 cycles only. An amplifier of this type would not be so prone to fall out with every burst of noise at or around its resonant frequency. The cost of such a system discouraged the experimenter and led to search of a system that would improve the phonic wheel.

By seeking to cut down on the current required in the amplifier and construct a phonic motor in another form with the object of doubling or tripling the pull, tests were made employing magnets with as many as ten teeth, actuated by a larger magnet coil with about 70 ma. running through it. The pull exercised by this outfit when mounted on a shaft was strong enough to make the rotor run slightly eccentric. This opened up the possibilities of using two such units on a horizontal axis 180° placement.

Pull Too Strong

This arrangement had its possibilities and it was doubtlessly figured by the engineer that it would hold shaft and rotor perfectly true and that the pull exerted would be enormous. However, it was found that with this type of construction, a pull so strong was exerted, in the form of a magnetic break, that a motor of the eddy current type was prevented from attaining proper speed. Moreover, the small air gap between the teeth did not count on the rotor.

There are many types of phonic wheel design. Some are small and some are large. No matter what size is used, they all lay claim to certain advantages. In order to avoid having the experimenter build up several models, the following specifications for a phonic wheel are suggested.

The diameter of the wheel should be 4½ inches and the thickness should be ¼ of an inch. The teeth should measure 3/32 of an inch in width. They should be spaced ⅛ of an inch deep.

Such a rotor, constructed of lamination of good quality silicon steel, will show very low hysteresis loss and eddy current effect while exerting great magnetic pull when the teeth are opposite the magnet poles and a mild breaking action when they are not.

Having an amplifier and suitable phonic motor, the desirability to incorporate some device or system for holding the disc in step whether the signal is on or not should be obvious. An operative device or arrangement which would enable the operator to adjust his scanner at the outset of the program and watch it in its entirety without worrying about static or fading throwing his motor out and necessitating readjustments would be an ideal one.

To attain the results referred to in the preceding paragraph, by far the most simple system employs an oscillator with a frequency of 1200 cycles. This oscillator could be so arranged that upon cessation of the incoming image frequency (1200 cycles) as is the case during an announcement, the oscillator would feed the phonic motor and hold it in step until after the announcement or fading had ceased and the images were resumed.

Numerous Oscillators Available

Types and styles of oscillators to attain this end have been known to experimenters for many years. Some of them are favorable and others not so favorable. To mention a few of the expedients tried out—the tuned plate tuned grid, Hartley, Colpits, ultra audion, dynatron, etc. Another is the ancient and honorable tuning fork with a fundamental frequency of 1200 cycles, excited by the incoming signal and constantly in action through the agency of a "keep-alive" coil that was fed back from the plate circuit. By using the fork, filters could be eliminated due to the fact that the fork will respond to only 1200 cycles. However, the fork is expensive and because of the fact that its pitch would vary slightly due to expansion and contraction caused by atmospheric conditions, it would be necessary to keep it in a container where the temperature was evenly regulated. Should either of the above mentioned conditions occur, the action of the motor would be either speeded up or retarded and consequently the picture would drift from side to side.

Another system which has been tried is that of feeding a 1200 cycle component generated by the phonic wheel which changes the impedance of the plate magnetic coil, back through a condenser to the grid coil. This system operates nicely but slows up the motor during an announcement. Upon the return of the picture frequency, we find that the picture will be out of frame horizontally due to a braking action.

Other Systems

Still another system in use is that of feeding to the screen grid of a coupling tube (the control grid of which is fed from the set proper) a 1200 cycle note from an oscillator. The combined frequencies are amplified in the usual manner. This works fairly well, but a double frame line may be observed in the picture, due to the feed back action to the set from the oscillator.

Another system calls for a '24 coupling tube, the output of which, with that of a '27 in a Hartley circuit, is proportioned accurately through resistors and condensers to a '27 as the first stage of amplification. The combined output, after phase correction, feeds to a '24 for voltage amplification and this output feeds two '45s in parallel, this stage drawing 2½ ma. grid current and giving an square topped wave so essential in synchronizing. The plates of the two '45s are matched to a 10 to 1 step-down transformer whose secondary impedance is matched to a few turns of wire on the magnet assembly. This results in a large power transfer to the synchronizing wheel—3 amperes A.C. at 1200 cycles. This will hold the disc in step. This action may be intensified by flanking the A.C. coil with two purely D.C. coils, one on each side, that are in the filter circuit of the power pack and properly by-passed. This results in a dynamic action to the A.C. interaction on 1200 cycles. To make this system operative, the experimenter must have costly meters of the thermo-coupled type to make his measurements and adjustments.

Let us refer to Fig. 2 and explain a system that is highly practical and which is used by the Jenkins Television Corporation.

This system permits the looker-in to adjust his scanner and watch the picture for the duration of the program, also to tune from station to station and find his pictures falling in step automatically. This is accomplished by the use of a modulated self-excited oscillator amplifier whose frequency is controlled by the incoming signal and made to vary sufficiently to conform or be in phase with the received frequency. The frequency of the received signal may vary slightly from that of our oscillator but an adjustment of the oscillator tuning condenser can be made at the start of the programs, bringing them in step merely by listening to the combined outputs of the set and oscillator and bringing them to a zero beat. This unit is easy to install. Merely plug in an adapter in the second audio stage of the television receiver. Our second amplifier tube is then placed in the adapter socket, a ground connection from the synchronizing amplifier is connected to the ground post of the set and the set connections are completed. The adapter socket contains a ½ megohm resistor and has a connecting wire from it to the synchronizing amplifier. The use of the resistor permits a small amount of signal to reach the grid of the coupling tube in the synchronizer. This does not cause any frequency discrimination in the set, due to its high resistance, which is by far greater than the impedance of the coupling condenser (500 ohms) feeding the next stage in the set proper.

The feeble signal picked up from the set in this manner is fed to a '24 tube in our synchronizing amplifier for voltage amplification. This screen grid tube does not permit feed back and we have eliminated all objectionable double frame line effect.

The plate coil of the '24 acts also as a tuned grid input for the '27 tube, whose plate coil, wound on the same core, gives us the self excited oscillator whose frequency is 1200 cycles.

The output of the oscillator has two stages of amplification before its introduction to the grid of two '45s in parallel. The power stage is permitted to draw two or three mils grid current, giving us a square topped wave to impress on our phonic motor coil.

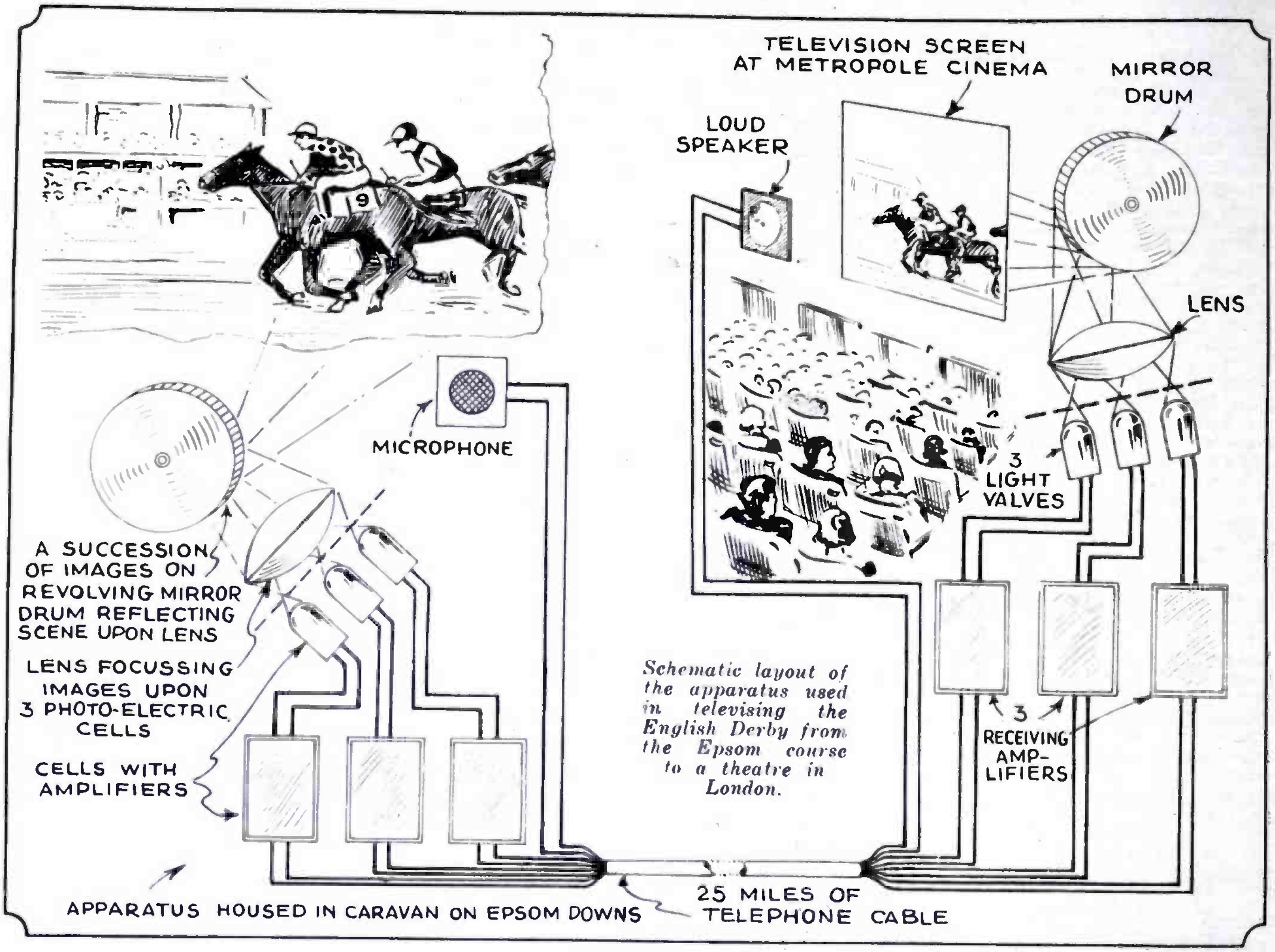
Now that we have described the ideal system, to attest to its effectiveness we will say that it will hold a 14½ inch lens disc made of aluminum in step.

TELEVISION IN THE AIR

The problems of synchronization hold no terrors for Harry Lubcke, director of television of the Don Lee Broadcasting System, of the Pacific Coast. While flying over Los Angeles recently in a tri-motored plane, he successfully reproduced television images transmitted from station W6XAO, using a cathode ray receiver. He is shown above at the controls of the set in the cabin of the plane.

TELEVISING THE ENGLISH DERBY

by
H. J. BARTON CHAPPLE



Schematic layout of the apparatus used in televising the English Derby from the Epsom course to a theatre in London.

ON Wednesday, June 1st, 1932, the English Derby was televised, and while horses were thundering down the Epsom course, 2,500 people, gathered fifteen miles away in a motion picture theatre, watched them, and saw the finish at the same moment as the crowds on the course.

This sums up in one sentence what may be regarded as one of the most ambitious television experiments ever planned in any part of the world, and everyone marvelled at the attempt so ably engineered by Mr. J. L. Baird and his staff, especially when it was fraught with so many difficulties.

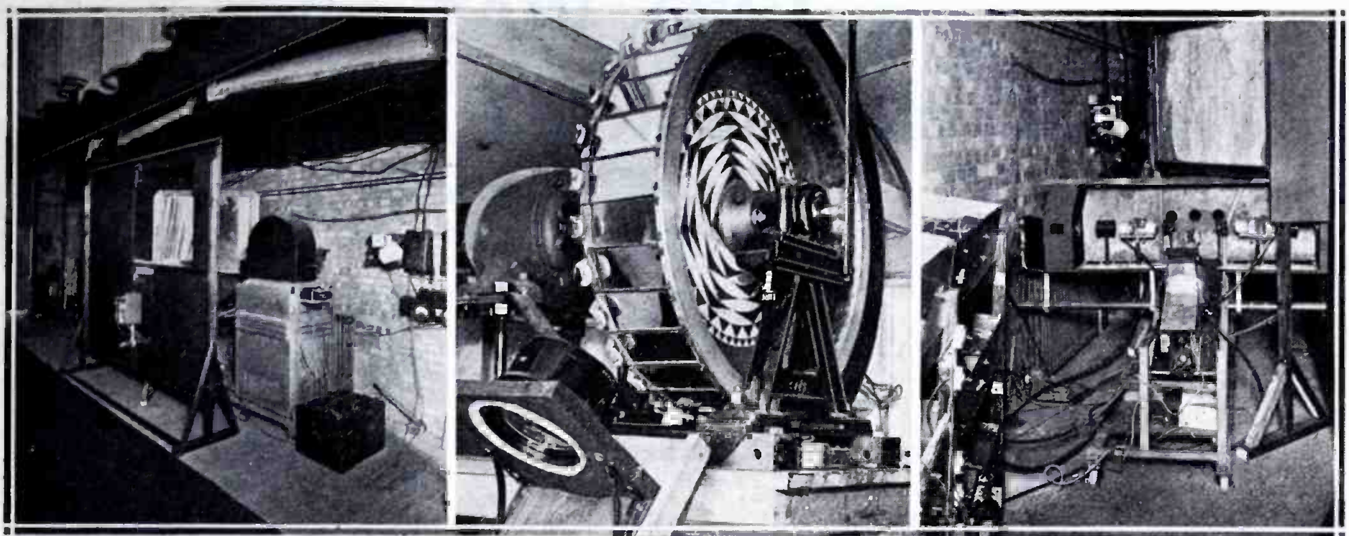
First of all, let me portray what happened at the Metropole Cinema, Victoria, London, on the day in question, and follow this up later with a description of the apparatus employed.

The public had been invited to participate in the experiment, and although no guarantee was given as to the nature of the results that would be obtained, the theatre was packed to overflowing capacity long before the race was due to start. Every seat being sold and unavailing offers of several dollars a seat were offered by disappointed patrons.

An announcer from the stage dealt first of all with the developments of television, paying special credit to what had been accomplished by Baird in England, and drawing an analogy between the progress of films and television. Asking the audience to, metaphorically speaking, come with him to Epsom, the auditorium was at once filled with noises from the race-course, and a commentator, actually perched on the roof of the transmitting van, was heard to speak, his voice being made audible through the medium of two huge loud speakers installed in the stage wings. This running commentory was kept up during the whole experiment and provided additional excitement.

The curtains were not drawn aside until the commentator announced that the horses were approaching the range of the Epsom daylight transmitter. When they did, a murmur of amazement spread over the whole house, and as it dawned on the audience that they were watching the shapes of horses and jockeys parading, with the Grand Stand as a background, the murmur grew to a round of applause.

Admittedly, the images were far from perfect, but horse and rider were definitely recognizable. They were big enough and clear enough to notice the different patterns of the jockey's blouses, while another factor which called for commendation was the absence of picture hunt. The audience then watched the horses canter by as they hastened to the starting post, and despite the flickering and occasional blurring, everyone present began to dwell on the possibilities opened up by the "miracle" now being performed before their very eyes.



A pause ensued while the horses were lined-up and about two and a half minutes after "They're off" had been heard, the screen came to life again, and the winner flashed by, his thudding hoofs sounding all over the house, and being mingled with those of the rest of the field who followed close on the leader's heels. Before the curtains came together, Mr. Tom Walls, the popular English actor-owner, was seen to lead his horse to the paddock, a mounted policeman being noticed keeping back the crowds.

Calls for the inventor were persistent, but when Mr. Baird was at last persuaded to show himself on the stage, he was too excited to speak. He had scored a triumph, and left it at that, but a fitting epilogue was forthcoming in a studio transmission from the Baird offices at Long Acre. Mr. Sydney A. Moseley addressed the audience as a televised image, alluding in no mistakable manner to the marvel that had just transpired.

It is opportune now to turn to an explanation of how this television experiment was brought to its successful conclusion, and the accompanying illustrations and pictorial diagram will help in this respect.

At the Course

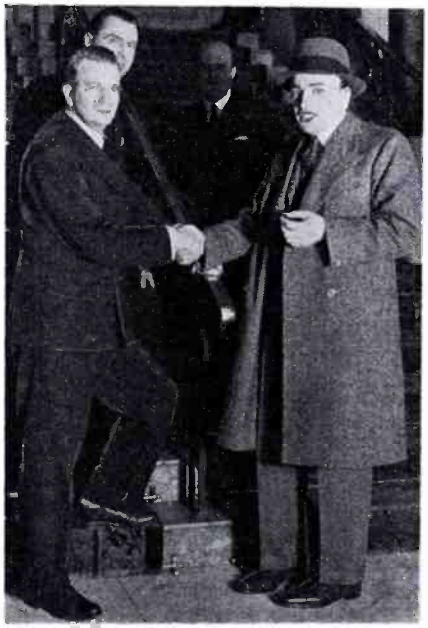
About a fortnight before the race was due to run, a small trailer caravan took up a position close to the course rails, and opposite to the Grand Stand. Six pairs of telephone cables were laid from this van, under the course, three being employed for the vision signals and the remainder for control and sound transmission.

Inside the van was a heavy drum, driven at a speed of 750 revolutions per minute by an electric motor. Fixed to the drum periphery were thirty rectangular mirrors, each having a shade more "tilt" than its immediate neighbour.

When revolving therefore, a succession of images of the scene reflected on the mirrors was thrown on to a lens, and these were made to move over three distinct apertures admitting the different degrees of light and shade comprising the scene, to three individual photo-electric cells.

Each of these cells converted in the usual manner the light and shade effects into equivalent terms of electrical variations in the associated amplifier circuit, and the separate signal zones each had powerful amplifiers for the purpose of increasing the signal strength before being passed to the telephone lines for transmission to the Baird Company's Control Room at Long Acre, London.

Above left: a side view of the television receiving apparatus, showing the mirror drum and one of the arc lamps. Center: a close-up of the mirror drum. Right: the stage projector in course of erection.



John L. Baird, left, being congratulated after the television showing in the theatre.

This large sign outside the London theatre attracted a large and curious audience.

From here they were relayed to the back of the stage at the Metropole Cinema, Victoria, where the television receiving apparatus, complete with amplifiers, had been installed.

A reference to the photographs will make clear how this ingenious piece of apparatus had been constructed. Three arc lamps, set at three points of a compass, directed three beams of light on to three separate light valves. Each valve was operated by a single zone signal and caused each light beam to be modulated exactly in accordance with the nature of the received signal. The centre zone beam passed in a direct line to another revolving mirror drum built identical to the one at the transmitting end, but somewhat smaller in size.

Three Light Beams Used

The other two beams, however, since they were situated on either side of this direct path, had their beams bent at right angles by means of two small mirrors. The three separate light beams, varying in intensity, were reflected from each of the thirty mirrors as the drum revolved, but owing to the lack of depth at the back of the stage it was not possible to throw these resultant reflected beams directly on to the screen, and the light was diverted by means of a large plate glass mirror set at an angle of 45 degrees. This is clearly seen in one of the photographs.

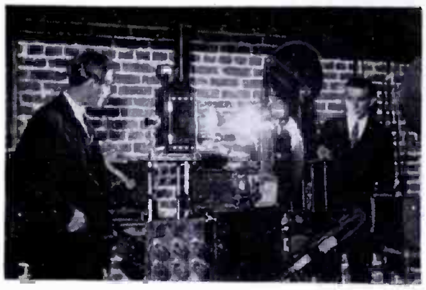
By careful matching, framing and phasing, these three zones of thirty light strips built themselves into a composite picture, the resultant size being ten feet wide and eight feet high. It was sufficiently brilliant to be seen clearly in any part of the house, and the special nature of the translucent screen enabled the images to be seen from any angle of view.

It is important to place on record that the center zone of this transmission was broadcast by the British Broadcasting Corporation from their London National transmitter, on a wavelength of 261 me-

(*Continued on page 207*)

A TWO WAY CATHODE RAY TUBE FOR TELEVISION

Mr. Morandini, who is well known for his excellent contributions to Television News, has devised an ingenious cathode ray tube which holds out much promise for two-way television work. He is engaged in experimental work on this new tube and is already obtaining encouraging results.



Mr. Lindsay, left, and Mr. Morandini, with the cathode ray television transmitter of the California Television Society.

by DYONIS MORANDINI, M. A., M. E., E. E.

IN the May-June number of the TELEVISION NEWS I described our novel method of developing saw tooth, or other desired shape, oscillations for cathode ray scanning, so that the frequency ratio and phase relations may be kept constant automatically, regardless of the kinetic changes in the device.

This, however, is only one part of the work which is on the schedule of the California Television Society. Recently I conceived new ideas regarding sending and receiving tubes employing cathode ray scanning, which ideas are, at least partly, substantiated by experimental results.

These new cathode ray tubes, which in their construction comply with the latest requirements in eliminating superfluous parts, not only simplify design, but, as it appears to me, also provide for new possbilities by making the resolution and synthesis of the image (into and from its elements at the sending and receiving station, respectively) more refined and the definition clearer. Also the previously existing limitations regarding the number of image elements are considerably reduced, if not removed. This is so because neither the distortions that result from the regulation of the cathode beam width, nor the diffusions that result from the predetermined size and mutual isolation of the picture elements (as e.g. in the squared surface of the screen in the Lora tube, etc.), are present in the new device.

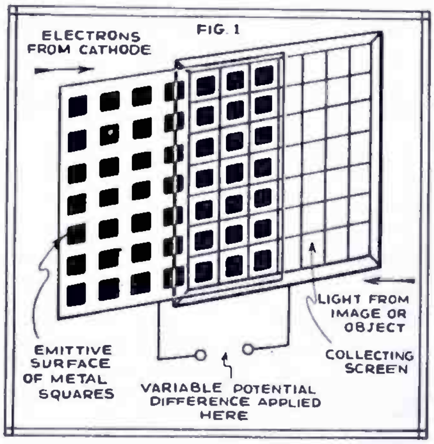
Large Images Possible

Furthermore, the tubes provide for means of obtaining intensive projection beams which will facilitate the reception of large size images, since the sender will focus a distinct and strong image within the sending device (which fact insures clear transmission by definite cathode beam variations) and since the localized ionizations in the neon enclosure of the receiver will serve to create powerful, quasi-crater, glows that will easily accommodate a projection screen device used in front of the receiver tube.

To centralize our thought, let us not forget what modern television experimenters are striving for: the synchronous transmission and reception of large size, clear images with satisfactory detail, definition and brilliancy, without mechanically moving machine parts, is the aim which most of the television engineers keep in their mind when looking for innovations and simplifications in television. To reach this aim, a practical television system must incorporate methods for: 1) perfect synchronization between sender and receiver; 2) distortionless amplification and transmission of the signal output and input; 3) resolution into as many image elements as is desired for satisfactory detail (and this depends also on the size and nature of the scene to be transmitted), so that a pleasing definition is obtained upon a large size screen, which may be anything between 1x1 foot to 10x10 ft. or larger; 4) enough projection light; and 5) possible mechanical simplicity.

In order to satisfy the first requirement, I described a practical method for the development of inter-related saw tooth scanning frequencies. The aim of this article is to supply new material as to Number 3, 4 and 5. Number 2, which has been dealt with many times by able writers on these pages, constitutes an independent field, extended in itself. I shall consider this point here only as far as the new devices include arrangements for the elimination of distortions in the generation and usage of the signal itself, amplification not included.

During the last two decades, or more, we may have observed a continuous effort to develop cathode ray transmitters and receivers which are practical in the above described sense. As early as 1908 or even earlier, i.e. before the practical development of radio, suggestions were made and devices built for cathode ray television. Campbell-Swinton, in a letter to "Nature", on June 18th, 1908 (in London)* proposed a cathode ray television system, which he described in more detail in his presidential address before the Roentgen Society, on November 7th, 1911. Also Professor Rosing of Petrograd devised a television cathode beam scanner. Campbell-Swinton's device already has all the characteristics in embryo of the modern cathode ray scanners. In fact, the cathode tube and photo-cell combination as a single unit at the sending station, and the cathode tube-fluorescent screen combination at the receiver is found in detail in his device. What is more, we see in his sender a "gas tight screen," separating the cathode tube and the sodium vapor cell, which screen consists of small metallic cubes which correspond to the picture elements. These metallic cubes are used in the same way as in modern cathode ray devices, as e.g. in the Lora tube, described in the March-April issue of the TELEVISION NEWS.



Details of the cube screen of the Morandini apparatus.

The device which I am about to describe is so constructed as to omit the elaborate "metal-cube screen" and still obtain what the cube-screen aims at and obtain it in a higher degree.

The function of such cube-screen is to define the image-elements as to their size and pictorial order. The horizontal and vertical cube rows of the screen in Fig. 1, in which the shadowed parts are metallic, while the rest of the screen is isolating (and non-transparent) material, define the image elements. The image of the picture is focussed on the cube screen from one side, while the

*See description of proposed apparatus in T. Thorne Baker's "Wireless Pictures and Television," Van Nostrand Company, New York, 1927. Pages 174 to 181.

scanning cathode beams hits the cubes from the other, in accordance with the scanning oscillation, one cube after the other, in the proper order.

It is well known since Hertz and Hallwach that metals can be made to loose their negative electrical charges if exposed to suitable light-radiations. In Fig. 1 the negative charges of the metal cubes are, in defined scanning time intervals, supplied by the electrons (cathode beam), while the suitable light is supplied constantly by the light reflected from the object. If now provision is made, by any convenient way, to maintain a potential difference between the individual metal cubes on one side and a "collecting" metal net in front of the cubes on the other, then, according to the amount of light falling on a certain cube, more or less electrons, that is negative electricity, will be lost by the suitably prepared (e.g., sodium-coated) metal cube surfaces, always by that cube which is being scanned. Naturally, in this case it is not the metal cube that looses electrons but rather the metallic coating which is responsive to ordinary light.

Current Follows Light

Accordingly, the current impulses between the coated cubic screen (cathode) and the collecting screen (anode) will vary in harmony with the lights and shadows that make out the image focused on the emittive cubic screen. These impulses, after amplification, are then transmitted to the receiver, re-amplified and introduced into another cathode tube, if the station is a cathode ray receiver, in which tube they will cause, within a gas (usually neon) enclosure, ionization in front of similarly arranged cube surfaces, thereby giving the effect of an image as the result of synchronized cathode beam scanning. Of course, the entire described process takes place only if in the air-tight enclosure that lies in front of the cubic screen of the receiver tube, there is a collecting net and an inert gas, the gas molecules of which will be ionized, thus providing a glow which will be visible by one looking upon the end of the tube.

In the March-April issue of TELEVISION NEWS cathode tube devices also by Sabbah and Zworykin are described, which tubes utilize emittive surfaces at the end of the cathode tube in such a manner that the division of the emitting surfaces into image-element-areas is not necessary, according to the description. The present writer is not entirely convinced that either of these methods insures transmission of the desired picture definition, not so much on account of electron dispersion on the matter, but as a result of the metal plates employed in connection with the alkali-metal coated emitting surface. The conveyance of the necessary potential difference between this surface and the grid or collector should be obtained, in the writer's view, *without* the application of such auxiliary devices (metal plates) and the operation of the emitter as a series of separated photo-cell-cathodes should be reached in a more definite manner; that is, with not less definition than in the case of mechanically separated elements of the Lora tube, which, however, presents a too complicated device to be practical from a manufacturer's view point.

In the advice prepared by the writer the cathode ray principle is applied in such a way that the transmitter tube combines in itself both the cathode ray tube and the photoelectric cell *as a single unit, with or without two separate air-tight chambers and without auxiliary metal plates.*

The principles of the sending tube are shown in Fig. 2. Through a focusing lens arrangement 1 the image of the object to be televised is focused, after perpendicular deflection by mirror surface 2, upon screen 3, so that every part of this screen receives light energy proportional to the corresponding part of the object. Thus we may see that the tube is used in connection with a photographic camera arrangement and may be operated also for transmission of large, outside scenes, especially since the number of applicable scanning lines is not limited by constructional features. The tube itself, of course, is shielded against light except for the surface *Ia* through which the light rays from the object penetrate.

Screen 3, which is a transparent or translucent isolating surface, is coated, preferably on its upper surface, by a photo-sensitive, electron-emitting material from which emission takes place in proportion to the light focused at any portion of it. The photo-sensitive layer is a thin enough layer, having high enough resistance not to permit an appreciable diffusion of the scanning cathode beam, which, as we shall see pre-

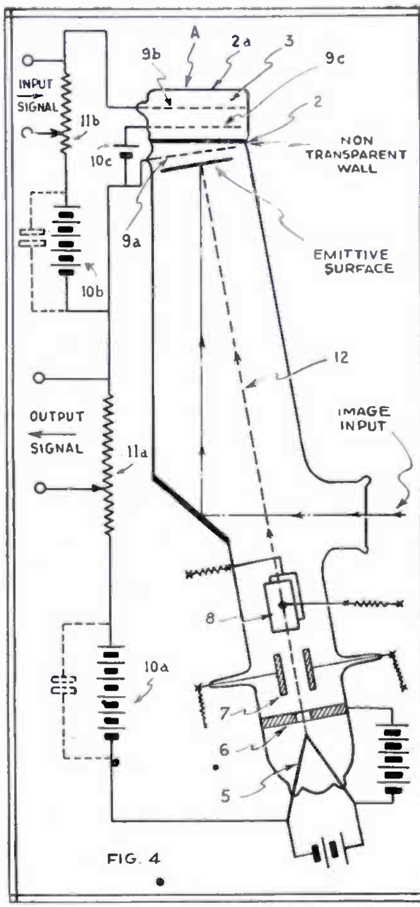


FIG. 4

Below left: the new cathode ray sender. Below right: the receiver tube. Right: the "two-way" television tube.

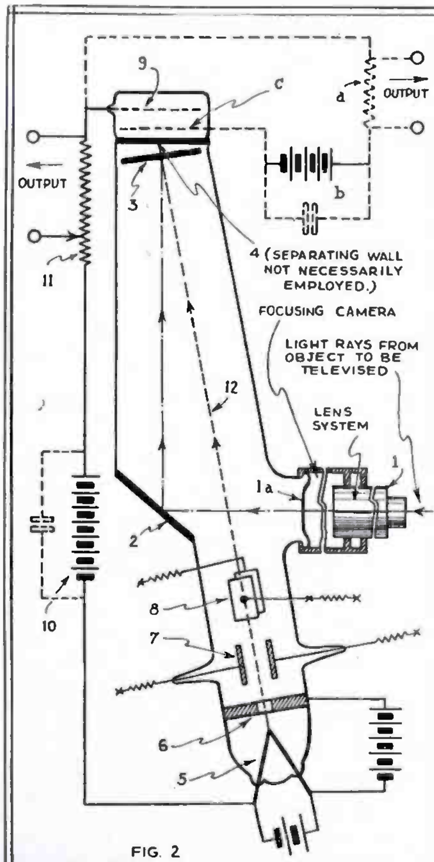


FIG. 2

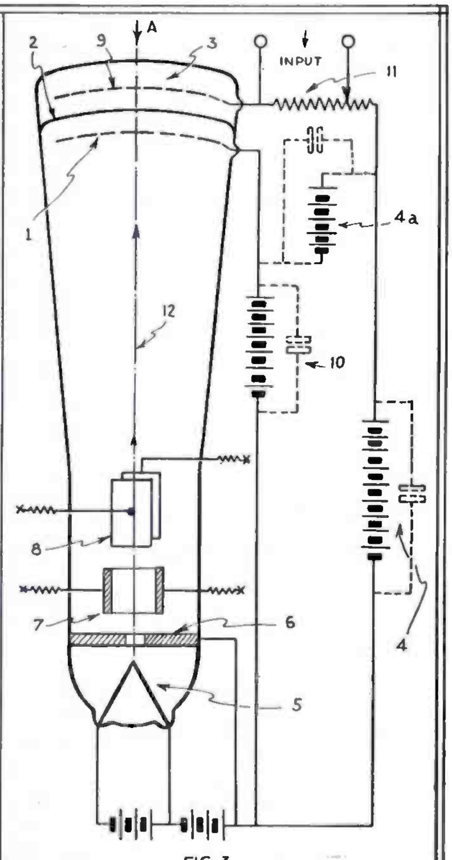


FIG. 3

sently, is emitted from the lower portion of the tube. The structure of the emittive surface is such that it ensures clear definition and sufficient pictorial detail.

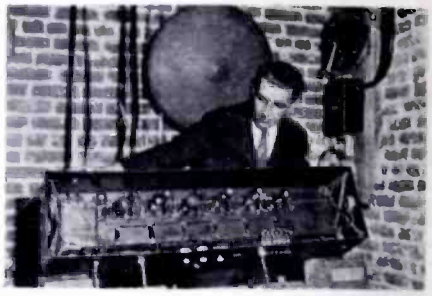
Part 5 is an emitting cathode and 6 the anode through which the cathode beam passes between two pairs of deflecting plates 7 and 8, which obtain the necessary saw tooth scanning voltages for the proper deflection of the scanning beam from a generating device such as our "frequency disc" arrangement described in the last issue. Above screen 3, there is a collecting grid 9 which is kept at a high potential with respect to the cathode. The whole tube is filled with an inert gas at a low pressure.

As the scanning beam 12 sweeps over screen 3, a conductive path is provided for within the tube so that we have a circuit through screen 3, beam 12, cathode 5, collector battery 10, and output resistance 11. (This latter may be replaced by other suitable coupling devices.) Voltage variations through 11 will take place in proportion to the photo-electronic emission from the coated surface of screen 3. These emissions, in turn, are regulated by the light focused on the spot which is being scanned. In this manner, we have a signal output which will be amplified and used for the modulation of the carrier wave.

Part 4 is a transparent or translucent separating wall which is *not necessarily employed*. In case of its application the output resistance 11 is not used, but the output circuit is through resistance *a* and battery *b* (drawn in dotted lines). If there is a separation of the tube into

The author looking-in on the receiver unit of the California Television Society.

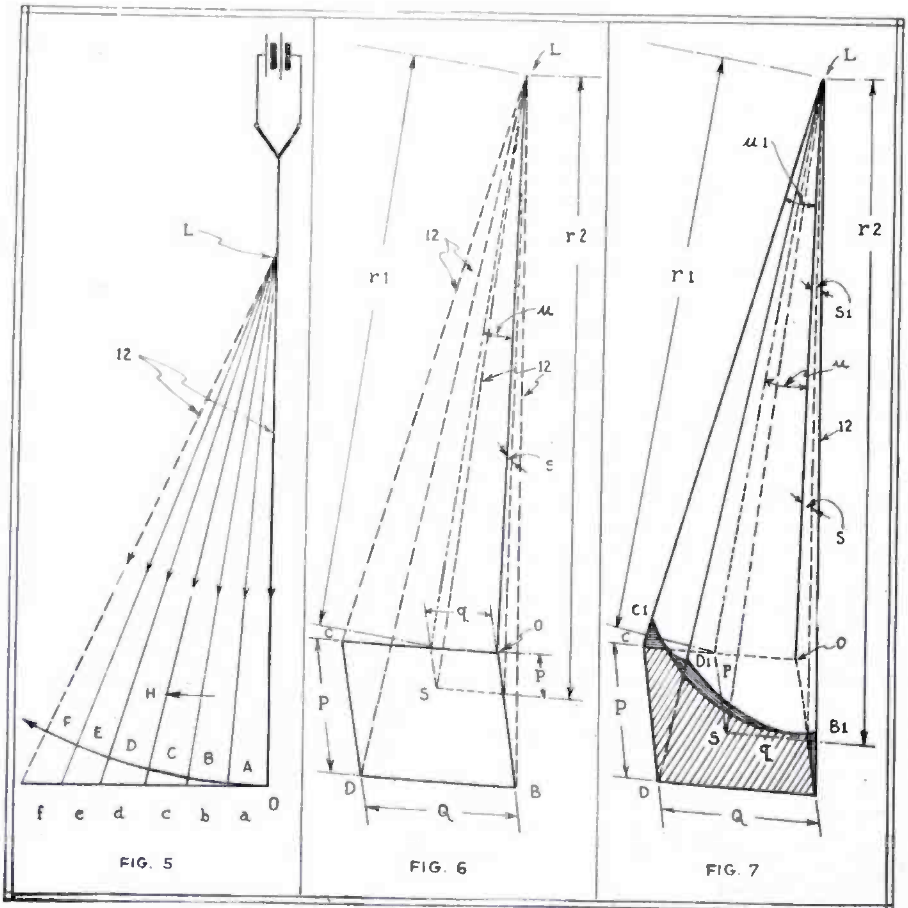
two enclosures by wall 4, the wall 4 is coated on its upper surface and serves as an emittive area. Above 4 is a new auxiliary grid *c*, and the output circuit in the upper tube, which also is a gas filled tube, is obtained through grids 9 and *c*. The coated wall 4 serves to start emission, but the amplified ionization current will take place between 9 and *c* only as a result of the applied potential difference *b*. The corresponding receiving tube is shown in Fig. 3. Here the usual cathode and deflecting device is employed. At the opposite end of the tube is perforated screen 1, through which the cathode beam penetrates and then impinges upon the wall 2 of the cathode tube. Parallel to this wall, in a gas tube 3 (filled with neon or other inert gas) built together with the cathode tube itself, is a collecting grid 9. In this gas tube, ionization takes place as



Amplifier unit of the television film projector, held by Mr. Lindsay.

the result of the applied potential difference 4 and/or *4a*, at that portion of 9 which is opposite to that part of the translucent wall 2 upon which the scanning cathode beam 12 happens to impinge. This ionization flow is regulated in its intensity by the voltage variations of the amplified signal input applied at 11, between 1 and 9.

Since the ionization discharge in the gas tube takes place at a single spot at a time, we have a concentrated glow at that spot. This way the total glow is utilized in each element of the image which is observed from direction *A* through the end of the tube. On account of the quasi-crater characteristic of the gas tube, we have enough energy to project the received image, by means of a suitable projection lens system, upon a screen and thus to receive a large size picture.



Deflection effects of the electrons in the cathode ray tube described by the author.

Saw Tooth Oscillations Used

The deflections of the scanning beam are obtained by the saw tooth output of the generator. In order to insure strict synchronization, this generator, as at the sending station, may be a two-disc frequency-disc device, which is "radio-interlocked" with a similar device at the sender. (As long as the frequency disc devices of both the sender and receiver are driven by synchronous motors fed by the same community power supply, there is, of course, no need for such a "radio-interlock").

Two more important things deserve mention in connection with the tubes described.

1. The design of the sending tube is such that it lends itself to the *construction of a cathode tube which unites in itself both sender and receiver*. In other words: *a single tube may be employed, by proper construction, for a two-way television system.* (In a following article we shall describe this system in connection with secret television communication by means of frequency-disc generators.)

2. On account of the fact that the scanning cathode beam does not hit the photo-sensitive screen under right angle in general, in case a *short* tube is needed (to gain certain advantages not mentioned here) certain scanning discrepencies are present which may not be negligible. To eliminate these discrepancies also in case of a short tube, we will employ a scanning method in which the deflections of the cathode beam are retarded in proportion to the increasing

(Continued on page 201)

AN A. C. OPERATED TELEVISION TRANSMITTER

Part 3 (Last Part)

The handsome sight-and-sound receiver used by the author in demonstrating his television system.

THIS article, which concludes a group of three, will cover the modulator, oscillator, and receiver used with the amplifier, scanner, and photocell rack previously described.

The main amplifier, which was shown in the July-August issue of TELEVISION NEWS, and which terminates in a parallel stage of two '47 tubes, may be used to operate a neon lamp directly, if desired, or it may be coupled to a power stage which can be used either to operate a crater lamp or to modulate an oscillator.

In a demonstration which was given in St. Louis last year in which this amplifier was used, a power stage consisting of four fifty-watt tubes in parallel was employed to operate a Taylor hot cathode lamp, which projected its beam through a large lens disc and afforded a picture nearly four feet high.

The Taylor lamp used in this set-up was a tube capable of handling a current of about 1000 milliamperes. Its elements were enclosed in a standard 50 watt envelope and so arranged that an intensely bright spot of pink light was visible at the end of the tube. The filament of the Taylor neon arc, which was supplied from a six volt storage battery, is of very rugged construction and operates at a dull red heat.

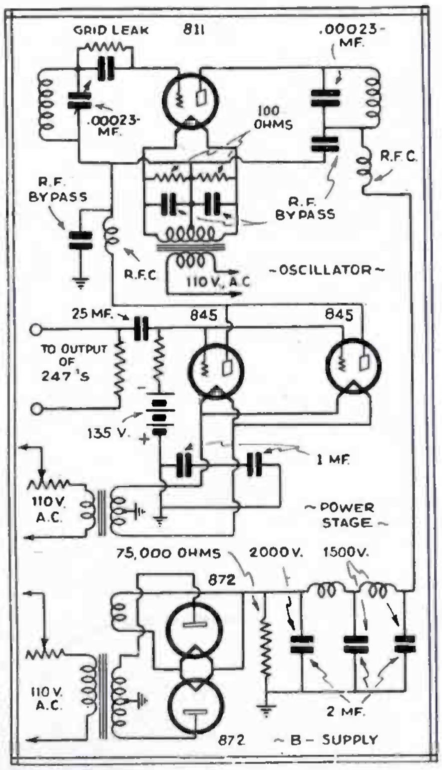
The amplifier, however, is ordinarily used with only two 50-watt tubes in parallel, either to operate a smaller Taylor tube in a standard UX-201A envelope or to modulate a 50-watt oscillator.

By referring to the diagram, it will be seen that two 845 tubes are connected in parallel and coupled to the load in the plate circuit of the main amplifier by means of a ¼ mf. condenser. Three 45 volt "C" batteries are connected in series to provide grid bias for these tubes. A wire wound enamelled resistor of 70,000 ohms is used as a grid leak. The filaments are supplied by a small transformer whose center tap is grounded. Both ends of the secondary winding are also by-passed to ground through 1 mf. condensers.

The power supply for this amplifier and its associated oscillator consists of two 872 mercury rectifiers arranged in full-wave fashion, as shown in the diagram. The power supply is located on the lower shelf of the rack and the amplifier on the upper deck. The 75,000 ohm resistor shown before the first filter condenser is a wire wound unit and is used to protect this condenser from surges which might puncture its dielectric. The final filter condenser is located on the amplifier shelf rather than with the power supply, so that audio currents will be by-passed to ground without traversing the long leads from the upper to lower shelves.

It will be noted that resistors are used in the primaries of the filament and plate supply transformers to control their secondary voltages. This was done for the sake of flexibility of operation, so that from two to six 50-watt tubes can be used in parallel.

The oscillator employs a tuned-grid tuned-plate circuit with a grid leak and condenser. Instead, however, of using Heising modulation with a resistor or choke as plate load, series modulation is utilized. This circuit, while quite simple, gives surprisingly good results.



Complete wiring diagram of the power supply, power stage and oscillator of Mr. Conrath's television transmitter.

The filament transformer secondary which supplies the 811 oscillator tube, must have a low capacity to ground and must be well insulated to withstand the plate voltage of the 845's. The tuning condensers are .00023 mf. transmitting condensers and the coils are made of ⅜" copper tubing. There are twenty turns on each coil, spaced ⅛" between turns, and the diameter of the coils is six inches. The entire oscillator is mounted on an aluminum panel with all major components supported by porcelain stand-off insulators. No provision was made for coupling an antenna to this oscillator since sufficient radiation was obtained from the oscillator coils themselves for our experimental work over short distances.

The receiver used in connection with this transmitter was a lens disc console job with an aluminum disc 12¾" in diameter. The disc was mounted on the shaft of a synchronous motor supported in the cast aluminum assembly pictured in the January-February issue of TELEVISION NEWS. The receiver used in conjunction with this disc was almost like that described in the article mentioned above, except that the output stage consisted of two '45's in parallel. A small Taylor tube mounted vertically behind the disc was connected directly in the plate circuit of the receiver's output stage, and its beam was focussed on a ground glass screen, mounted in the front of the cabinet. A bright picture about six inches square was obtained in this way. Pictorial detail was enhanced by proper use of the regeneration control previously mentioned and by proper adjustment of the amplifier and receiver gain controls. By removing the ground glass screen from the front of the cabinet and replacing it with a larger one at a distance from the cabinet, pictures more than a foot square were obtained.

The filament of the Taylor tube in this assembly is supplied from a small transformer, and the tube is mounted on an adjustable bracket to facilitate focussing the spot on the screen. Framing of the image is accomplished by rotating the entire motor in its supports by means of the bakelite framing knob located just beneath the screen.

The cabinet also contains a ten-tube superheterodyne broadcast receiver and dynamic speaker for use in receiving co-ordinated sight and sound programs.

CONTROLLING LIGHT WITH METAL FILMS

by DR. IRVING J. SAXL

Consulting Physicist

IT IS necessary for the recording of sound pictures, and for other problems embodying light sources of variable intensity, to control large quantities of light with means practically free from inertia and with such electro-optical characteristics which are as proportionate as possible to the acoustical impressions picked up by the different types of microphones. This pertains particularly to the true recording of the higher frequencies, the beatnotes and overtones which give the individual speaker or musical instrument its characteristic speech pattern or timbre of sound.

In addition, the problem of controlling greater light energies with a light valve free from inertia becomes a fundamental one for the purpose of television, picture transmission, oscillographic research, etc.

While glow-lamp recording, or the recording with the vacuum type of oscillograph of the Braun-tube type, is satisfactorily free from inertia, the production of the light intensity with these devices is a limited one only. In addition, it takes a definite time until a glow lamp warms up and it is necessary to use rather large voltages in this type of recording, making necessary amplification in several stages and tone-controlling equipment so as to compensate the distortion of the electro-acoustical impulses resulting therefrom.

Electro-Chemical Methods

The electro-chemical methods, for instance, the use of the Nitro-Benzole Cell (Kerr Cell), are complicated in their transportation (spring suspension) and maintenance and also they need a considerable wattage in their operation, so it is difficult to consider them in their present state of development a final solution of the practical problem of recording sound effectively. Besides, nitro-benzole freezes at 41° F. so it is difficult to use in the open during the winter.

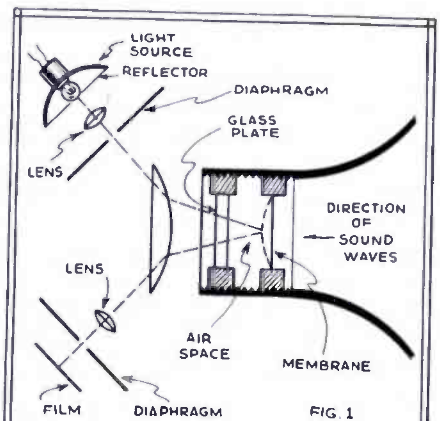
While certain constructions of the string-galvanometer systems are able—if properly handled—to control a slit of light, concentrated upon a narrow area through the objective of a microscope up to 8,000 cycles and more, they still use a considerable wattage for exciting the magnetic field, and for amplifying the current trespassing one or more strings.

A sufficient light density transmitted upon the film is necessary. It becomes the more important the shorter is the duration of the individual exposure of each line of the sound track. In this connection, a brief mathematical consideration might be in place.

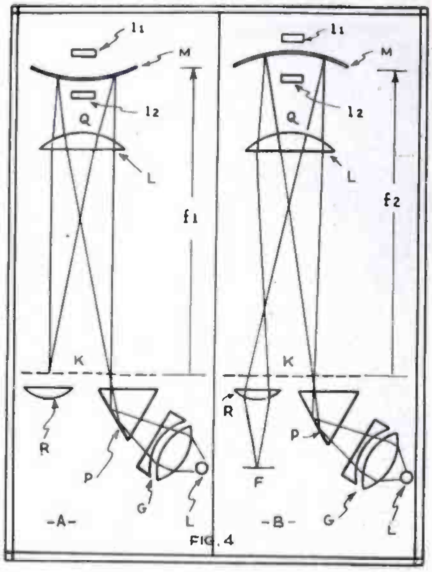
At a normal film speed of the sound film of twenty-four (24) pictures per second, the film travels 45.6 centimeters per second. That means for an oscillation of 8,200 cycles per second—which is still entirely within the audible range—that not less than *eighteen (18) lines to the millimeter have to be printed* upon the light sensitive emulsion, whereby each line is exposed only for one eight-thousandth of one second!

Supposing the grain of the film is fine enough to receive 18 lines to the millimeter, then only a highly intensive beam of light concentrated upon a narrow area will be able to trespass at such a short period over the threshhold of photographic sensitivity as to be able to make a photogaphic impression at so short an exposure.

The higher the sound quality the higher a speed of the film is necessary. As 18 lines to the millimeter is already considerably high, a finer recording of still higher frequencies may be made necessary to raise further the speed of the film—provided always that the rest of the equipment, especially the loud speaker—is able to follow the still higher oscillations. Higher frequencies too will have to be recorded for picture transmission and still higher ones if television will become practical, with a necessity of transmitting about 100,000 picture elements per second.



Schematic arrangement showing the fundamental idea of the apparatus for controlling light with metal films.



How variations in the position of the metal diaphragm M cause the beams of light to be deflected.

The various recording systems known suffer at the higher frequencies from aberrations, resulting in differences between the form of the original sound wave falling upon the transmitter and the sound as finally reproduced from the loud speaker. In addition, the sound recording devices known heretofore are so heavy that their weight is a serious drawback for "sound" reporting.

All these facts are brought out to show clearly the importance of a device that is able to control much higher intensities of light than possible heretofore with so small an inertia and a small expenditure of energy that a practically undistorted output is received, which was measured thus far up to 10,000 cycles per second. The frequency characteristic, however, is so ideal within this range that reasonable hopes may be entertained that it will go still higher.

Films Are Very Thin

This device has been developed by Doctors Carl Mueller and Karl Mey, of Germany. These two physicists were working from the very thin metal films developed previously by Dr. Mueller. The metal membranes have a thickness of not more than one to two-thousandths of one millimeter! They are excellently plane and have high light-reflecting properties that make it possible to control by their movement a beam of light which is more intensive than possible heretofore.

Due to their unusual thinness, these membranes are so sensitive that the force of the sound waves as such falling upon them is strong enough to deform them elastically. It is therefore possible to make an acoustic-optical recording directly without any intermediary apparatus, vacuum tube amplification, etc.

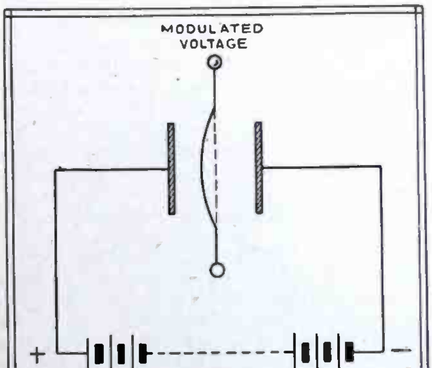
Figure 1 shows schematically the fundamental idea of the apparatus. Sound waves, coming from the right side (here is a directional effect) are collected in a horn and exert pressure upon the thin metal film expanded like a membrane at the base of this horn. According to their influence the elastic membrane is deformed, similarly to the membrane of a condenser microphone; however, to a larger quantitative extent than this. The pressure and suction of these sound waves deforms concavely or convexly the membrane directly in the rhythm of the sound oscillations.

Air Acts As Cushion

At the back side of the membrane, averted from the sound-source, is a plane-parallel glass fitted in the wall of the photo-acoustic receptor. The air between the glass plate and the film serves as an elastic cushion so as to make it possible for the thin membrane to move back to its old place without too much strain on the material. The damping of the membrane is dependent upon the volume of air between the film and the glass plate in this construction. It can be regulated by screwing in the glass plate deeper or less deep.

Upon the back side of the highly reflecting metal membrane falls the light from not more than a small, low voltage incandescent lamp of altogether 3 watts, a small fraction of the light intensity used in ordinary equipments. This beam of light is collected by a lens system and passes a slit—in the perfected forms, a grating. This is practically a number of slits of microscopic dimensions. Then it is concentrated upon the membrane, from where it is deflected according to its convex or concave form. After passing another slit of special construction, the light falls upon the sensitive film, making there either a variable area or variable density record, according to the design.

The sound sensitive organ — the metal film—has, at a useful diameter of fifteen (15) millimeters, a weight of only about *one quarter of one milligram* at a thickness of 1 or 2 ten-thousandths of one millimeter. In spite of the fact that its useful light-controlling area is therefore many times greater than the area of a string in the various types of oscillographs, its inertia is almost negligible.



Illustrating how the position of the metal diaphragm is changed by changes in the electro-static field in which it is placed.

If it is not desirable to have the sound recording mechanism too near to the sound source (the movement of the film band may make some noise which too would be partly recorded) than it is simple to deflect the shape of the thin metal mirror electrostatically. For this purpose, the membrane is brought within an electro-static field and deflected therein. In this field small changes in the electric charge of the membrane can exert considerable force, resulting in the deformation of the membrane. (See Fig. 2.)

If the two electrodes have the potenial V_1 and V_2 and the distance, d, than the field intensity within this condenser is given by the equation (1)

$$F = \frac{V_2 - V_1}{d} \quad \ldots\ldots\ldots 1)$$

If we bring into this electrostatic field another electric charge, Q, then the force, P, exerted upon this new charge will be (2)

$$P - F.\ Q = \frac{(V_2 - V_1)\ .\ Q}{d} \quad \ldots 2)$$

If d is small, the two electrodes therefore are near to each other and if the voltage drop between the two electrodes is considerable, relatively *large electromotive forces* will be exerted upon the material upon which the charge, Q, is attached even if this charge is a small one.

At the high sensitivity of this membrane, however, relatively small electrostatic forces are used. A constant service voltage of about 60 — 80 volts from one dry battery and a modulated voltage of only 5 — 7 volts is sufficient. This compares most favorably with other recording methods. The Kerr Cell, for instance, needs 450 volts main tension plus 300 volts modulated voltage. In addition, the little air condenser that practically constitutes the Mueller-membrane between the two electrodes has a capacity of only 80 mmf. and, naturally, works practically without losses. Its controlling wattage is therefore negligible.

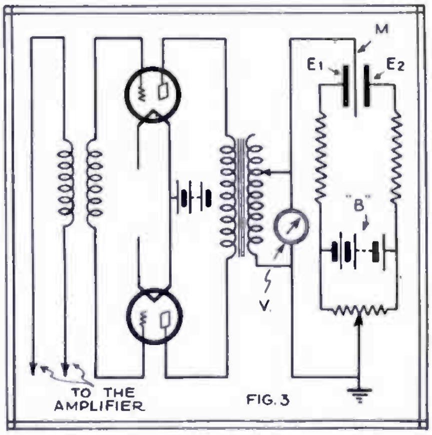
The last stage of an amplifier, working finally upon the electrostatic mirror, is therefore constituted similar to the wiring shown in Fig. 3.

Film in Electro-Static Field

The electro-acoustic impulses, amplified in some previous stages, work finally upon a push-pull amplifier. The output side of its transformer is bridged with a potentiometer of about 50,000 ohms total resistance. A part of the voltage V is taken from it and impressed upon the moving diaphragm M. This membrane is suspended in an electrostatic field between the electrodes E_1 and E_2. The voltage from the battery, B, is impressed upon these electrodes through two resistors on each side, of 5000 ohms each. Should the membrane, therefore, touch one of these electrodes by too large a deformation, no short circuit would occur, as the resistors are put in series and therefore the thin membrane would not be hurt. If the voltage is regulated properly so that it does not go over a certain maximum—by regulating the potentiometer—the operation of the metal film is safe.

How is the actual control of the light effected? Figures 4a and 4b show a schematic diagram of this action. Light coming from the light source, L, is concentrated first by a lens system, G, and dispersed and reflected thereafter by a glass prism, P. It passes a grating, K, and is concentrated by a lens, Q, upon the metal membrane, M. The direction of the light rays is such that the entire area of the membrane is covered with light. In order to make this actual working area as big as possible, the deflecting electrodes are made relatively small so that not much light is blocked out. As they are placed in such a way that they create an electrostatic field preferably through the center of the membrane, a homogenous deflection of the latter takes place.

It depends now upon this deflection how light rays falling upon the membrane and trespassing the lens, Q, for the second time are focused. The en-



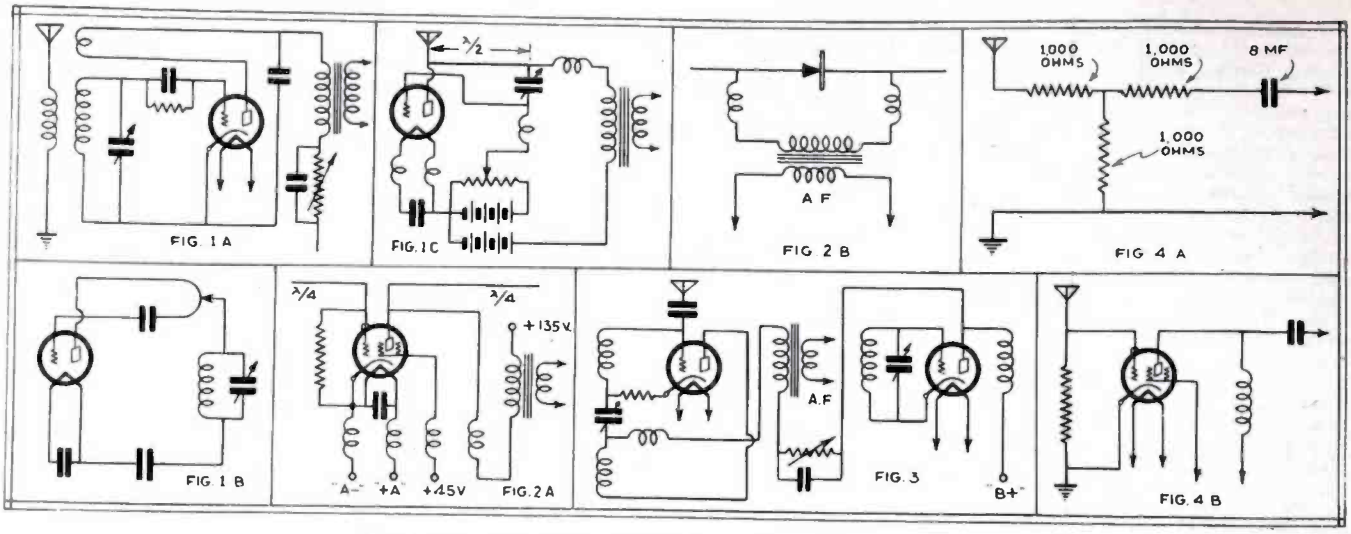
Wiring diagram of the final amplifier stage that feeds the electrostatic mirror.

tire optical system is arranged in such a way that its focal distance is a longer one if the membrane is bent towards the light source. This is the case in picture 4a with the focal length f_1. The path of light is such a one that in this case practically all the light rays fall upon the dark parts of the grating, so that they are blocked out.

It is different, however, if the membrane is bent in the opposite direction. Then, with a shorter focal length, f_2, as shown in Fig. 4b, the light rays already cross each other some distance before the screen and the grating so that a large amount of light is made to pass the openings of the grating. This light is collected thereafter in a lens system, R, and concentrated upon the film, F.

While these two positions as pictured show a maximum deflection in both ways, all the points in between these maximum movements are given by a distance which lies in between the lengths f_1 and f_2. This is especially true for a plane, non-deflected membrane, upon the metal film of which no controlling voltage is impressed. At this zero position of the membrane, therefore, just medium illumination will take place. The total light intensity can be easily controlled thereafter by bringing into the converging

(*Continued on page 205*)



See text for explanation of the various diagrams above.

REVIEW OF HIGH FREQUENCY RECEIVER DESIGN

by A. C. MATTHEWS

THE ultra short wave band allocated by the Federal Radio Commission to television transmission and accompanying synchronized sound lies between the frequencies of 43,000 to 80,000 kc. In engineering practice this is referred to as 43 to 80 megacycles. (A megacycle [mc.] is equal to 1,000 kilocycles.) The choice of this particular band was governed by the increased absorption of waves by buildings above 50 mc. and the presence of a sky wave below 37.5 mc. At the highest frequency end of the band the absorption due to buildings, and the pronounced shadow effect caused by metallic structures, becomes of great importance. The service range is appreciably affected by any building of more than average size which happens to be in the intervening area between the receiver and transmitter. About the only method of overcoming this difficulty is to erect the antenna system of the transmitter and receiver above the surrounding structures. This has a much more pronounced effect on extending the service range than increasing the power at the transmitter. Experiments carried out in airplanes and dirigibles have shown this to be true.

Literally, the receiver antenna must be able to "see" the antenna of the transmitter. This limits the service range of the band conservatively at about 25 miles. This, however, would include practically all suburban towns in a metropolitan district. Due to the fact that the range is so limited it is therefore possible to re-assign the same frequencies to several parts of the country without fear of mutual interference.

At the other end of the band (43 mc.) the reduction of field strength due to intervening buildings is of no consequence. However, the appearance of a so called "sky wave" brings about as perplexing a problem. The presence of a sky wave due to reflection from the Kennelly-Heaviside ionized layer brings about such phenomena as ghost images, fading, freak distance reception, etc. These are much more annoying than weak but steady signals. Ghost images, for instance, together with selective fading, can distort the incoming signals so that they can be barely distinguished even by an expert. Such devices as automatic volume controls, vertical antennas at the transmitter and receiver and suppression of the sky wave by reflectors, are steps in the right direction to obviate these annoyances. As for man-made interference and static, this band will be found particularly quiet with the one exception of ignition systems on automobiles. The field of this interference, however, is usually confined to include only those receivers on the ground floor of a building.

Summarizing the situation we find that this particular band is ideal for local broadcasting of television (because of the large frequency bands available, thus permitting greater detail) and accompanying synchronized sound, since fading and interference from electrical disturbances are practically negligible. Knowing the conditions that prevail, let us now consider the type of receiver which will give the best results.

A few simple calculations will soon show that tuned radio frequency amplification at this high a frequency is impractical. This is due to the low impedances encountered in the ordinary tuned circuit. Therefore let us consider the ordinary regenerative detector. Regeneration, of course, would only be resorted to since a high order of sensitivity is required for satisfactory reception. The shortcomings of a regenerative detector in regards to fidelity could be compensated for in the design of the audio frequency amplifier following the detector. Such sets have been operated with fair success. The service range, however, is quite small and it was found necessary to resort to three stages of audio frequency amplification to obtain loud speaker volume at distances of 25 miles. Large buildings in the intervening area of course would reduce the range proportionately.

Among the many regenerative receiver circuits the following are particularly worth noting: Fig. 1A, straight parallel tuned circuit with fixed tickler, regeneration controlled by resistance in the plus "B" supply lead; 1B, circuit due to Karplus.[1] This is an adaption of the familiar Barkhausen-Kurz principle with a tuned circuit for varying the amount of regeneration; 1C, B-K receiver. The last two circuits are particularly adaptable to frequencies much in excess of the present 43-80 mc. band.

A.C. operation of regenerative ultra high frequency receivers has shown the desirability for a new tube having a rugged heater, low interelectrode capacity, and high mutual conductance. It should also be capable of entering into oscillation smoothly. Another circuit worthy of note is shown in Fig. 2. This is employed by the Bureau of Standards in their airplane beacon receivers. An adaption of this crystal detection is also shown. The horizontal doublet receiver is not as practical as the usual type because of the mechanical design necessary for tuning over a specified band. Selectivity, of course, is poor, but this is an asset rather than a liability when used for airplane beacon service since

(*Continued on page 204*)

TELEVISION BY THE LINE CONTROL METHOD

by MANFRED VON ARDENNE

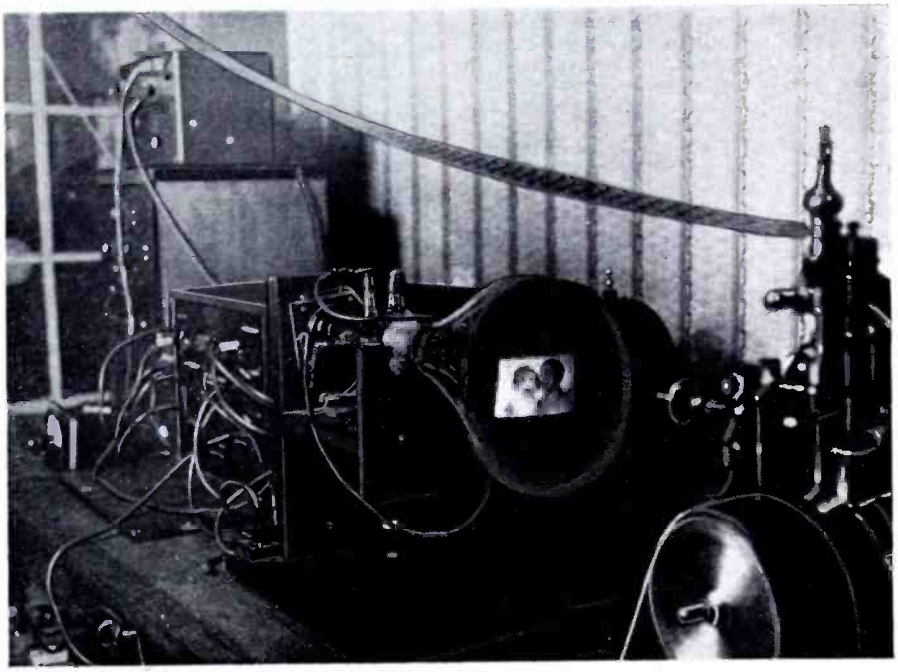
The brightness toning is effected by modulation of the scanning speed. 10,000 pictorial elements in the case of film transmission. Synchronization takes place automatically from the transmitter.

Simultaneously with the perfection in the last year of synchronization and light control in cathode ray tubes for the familiar intensity method operating with constant scanning speed, in the Manfred von Ardenne laboratory, the line control method suggested by Thun has been realized in practice and extensively simplified.

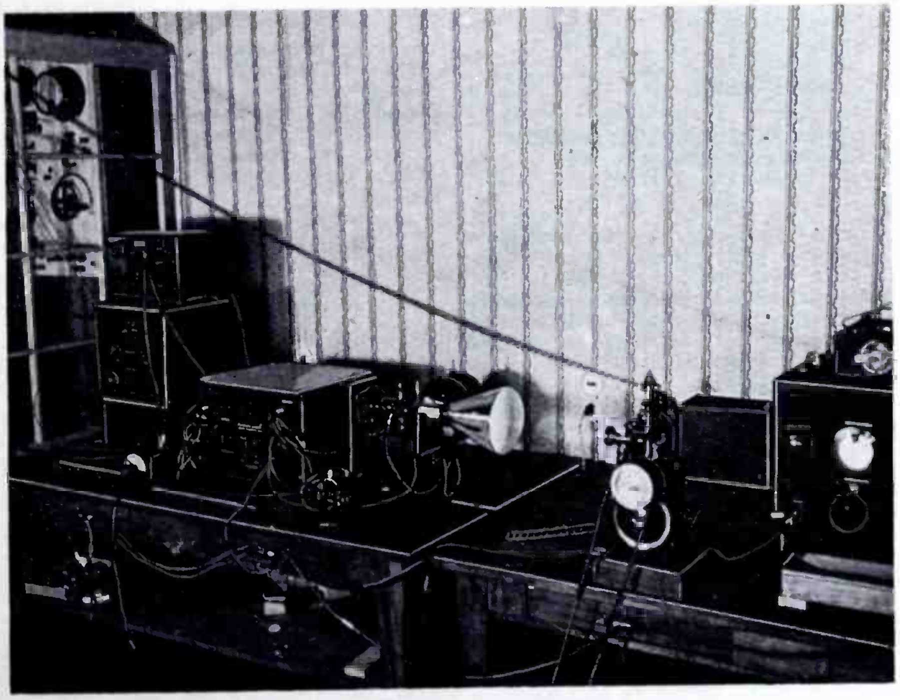
Scanning Speed Varied

In the case of light control, the perfection of which has hitherto met with extraordinary difficulties, the different brightness values are attained by corresponding variations of the scanning speed. This system requires practically massless scanning devices and therefore demands cathode ray tubes both in transmitting and in receiving. In the new form it has the advantages that the synchronization takes place by the light control itself and that there is the utmost simplicity at the receiving end. The practical importance of the system lies also in the elimination of special ray control electrodes in the receiving tubes and in the decidedly higher pictorial brightness already prophecied by Thun.

The peculiarity of the indicated new system lies in the fact that the picture transmitted becomes visible directly on the screen of the transmitter.



An unusual close-up of the Von Ardenne cathode ray television transmitter in operation. The image is thrown on the end of the tube by the motion picture projector at the right. Although this picture has been retouched to make it suitable for reproduction, the original showed the image on the tube quite clearly. Both photos on this page were made in Baron Von Ardenne's laboratory in Berlin, probably the largest independent research laboratory in the world.



A side view of the cathode ray transmitting apparatus. Note that a separate table is used for the motion picture projector, so that its vibration does not affect the tube and its associated instruments.

The technology of this system is so far developed that analyses up to 10,000 pictorial elements per picture and film could be shown.

Through the work and results of the author in this field lying aside from the usual television technology, now for the first time becoming known, there has been successfully pursued a course subjected to much theoretical discussion during the last few years.

How far the further development of line control can influence television technology cannot be foretold today. Certainly however the new work has made very clearly recognizable the possibilities of line control.

AMPLIFICATION IN TELEVISION

Part 1 (2 Parts)

by C. H. W. NASON

THE problem of designing a satisfactory low frequency amplifier is troublesome even in those cases where a frequency range extending from about 50 to 8,000 cycles is concerned. Where this range is still further extended, as in the case of television, so as to include (as in the case of the 60 x 72 element image repeated 20 times per second) from about twenty cycles out to about 45,000 cycles, the situation becomes acute.

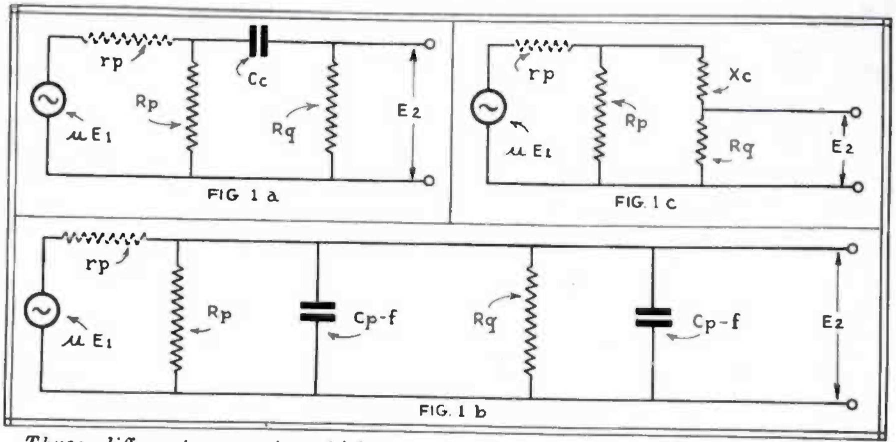
It might well be stated that the resistance coupled amplifier alone is of a satisfactory character for television service. To be sure transformers have been used in coupling the amplifiers to wire transmission lines with great success, but it should be remembered that these cases exist under conditions not obtaining to normal commercial design proceedure. What the Bell Telephone Laboratories can do is one thing—what you or I can obtain in the way of core material and testing apparatus, to say nothing of designing genius, is a horse of quite another color.

First we must develop the equations for the frequency response of the resistance capacity coupled stage, consider the forms of distortion obtaining in such circuits and the methods for eliminating them, and lastly we must consider the final or output stage of the amplifier as operating into the neon tube. It is of course necessary in a complete treatment to consider the amplification of a television signal as originating in a photo-tube and also the characteristics of that device as a source of A.C.

Three Analyses of Circuit

In the design of the resistance-capacity coupled stage for a given frequency response, we must consider the fact that three possible analyses of the circuit are possible, dependent upon the frequency under inspection. In Fig. 1a we have the circuit as taken at some intermediate frequency at which stray capacitance effects, etc. are inoperative. Here we have r_p, the plate resistance of the preceding tube shown, as in series with uE_1, R_p — the resistance in the plate circuit, R_g — the grid leak resistance, E_2 — the voltage across the grid of the second stage and C_c — the coupling condenser.

Considering the amplification at some high frequency where stray circuit capacitances and the interelectrode capacitances of the tubes themselves become important, the equivalent circuit is as shown in Fig. 1b. Here we have the same elements appearing in 1a augmented by the two capacitances $C_{p\,f}$ and $C_{g\,f}$ appearing in parallel plus a further capacitance not shown but due to the wiring of the circuit. It will be noted that C_c does not appear in this analysis nor should it appear in 1a, for the reactance is sufficiently low in both these cases to justify our ignoring it in calculating the gain through the stage.



Three different ways in which a resistance coupled audio amplifier may be considered.

This last statement does not hold good at the low frequency limit, for here the reactance of the coupling condenser may be quite high. The equivalent circuit is as shown in Fig. 1c, where it is apparent that the voltage across the grid of the tube is reduced through the fact that the input voltage to the second tube is taken off across the potentiometer formed by X_c and R_g in series.

The gain through the stage at some midrange frequency can be readily obtained by calculating the parallel effect of R_p and R_g and applying this as the plate circuit load or Z_1 of the first tube. This may be quite simply done through the formula

$$Z_1 = \frac{R_p\ R_g}{R_p + R_g} \qquad \text{1.}$$

and the gain through the stage is (for a triode)

$$A = E_2/E_1 = u\,\frac{Z_1}{Z_1 + r_p} \qquad \text{2.}$$

For a screen-grid tube the amplification can be roughly estimated with fair accuracy by the simple relation

$$A = E_2/E_1 = G_m \times Z_1 \qquad \text{3.}$$

These formulas hold good only at those frequencies where the reactance of the coupling condenser is negligibly low and where the interelectrode and circuit capacitances are also low enough to have an appreciable effect in their appearance in parallel with the established circuit constants.

At some low frequency, where the reactance of the coupling condenser becomes high in comparison with the value of R_g, a loss in the effective gain will result. In order to really hold to exact figures a new calculation of the effective load must be made, for the load now comprises R_p in parallel with the series circuit formed by X_c and R_g in series. This effect can be neglected, however, in all but the most rigorous treatments. In a network such as is shown in Fig. 1c the coupling efficiency can be determined by means of the equation

$$E_3/E_2 = \frac{R_g}{\sqrt{R_g^2 + X_C^2}} = \frac{w\,R_g\,C}{\sqrt{w^2\,C^2\,R_g^2 — 1}} \qquad 4$$

From this it may be seen that the magnitude of the response is purely dependent upon the factor RC which is also the Time Constant "T". Rewriting the equation in terms of T we obtain

$$E_3/E_2 = \frac{wT}{\sqrt{w^2T^2 — 1}} \qquad 5.$$

In all these E_3 is the voltage apparent across the grid of the tube as compared with the voltage developed in the plate circuit (E_2) and the arithmetical result is indicated in *percent normal response.* It may be readily understood that since the product RC determines the response rather than the individual resistance or capacitance values, we may employ almost any value of resistance so long as a suitable capacitance is provided or vice-versa. In calculating the value of T we express C and R in ohms and farads or in megohms and microfarads. We may calculate a table giving the values of T necessary to a response of 95% for various frequencies so as to obtain the following table:

Frequency	T
10 cycles	.05
20 cycles	.025
50 cycles	.01
95 cycles	.005
190 cycles	.0025

Thus, it may be seen that if the high frequency response dictates the use of a low value of resistance to avoid the effects of shunting capacitances, we must use a correspondingly larger capacitance in coupling between stages if no loss at the lower frequency limit is to be incurred. In certain tubes the input resistance must be held low for other reasons. This is particularly true, as we shall later see, in the case of tubes drawing grid current. In such a case where the grid resistance R_g might be 10,000 ohms or .01 meg., we will find that in order to maintain the response at 20 cycles to 95% of normal we would need a coupling condenser of 2.5 mf. in order to attain a value of .025 for T.

In the calculation of the response at the higher frequencies we must take into account the interelectrode capacitances of the tube themselves and the shunt capacitances due to the circuit wiring. This wiring capacitance may be kept low with due care and a value of about .00001 mf. may be accepted as attainable in most cases. The tube capacitances depend upon circuit conditions. The plate-filament capacitance is the true geometric capacitance of the tube, while the grid-filament capacitance is effectively increased by the feed back of voltage from the plate circuit of the tube across the grid plate capacitance in phase opposition to the voltage appearing across the grid. This capacitance may at times be quite high, as may be seen by an inspection of the equation

$$C_{eff\ (g\text{-}f)} = C_{g\text{-}f} + (\mu_{eff} + 1)C_{g\text{-}p} \qquad 6.$$

Where $C_{g\text{-}p}$ is the geometric value of the grid-plate capacitance and μ_{eff} is the effective gain through the tube as determined by the relation

$$\mu_{eff} = \mu \frac{Z_1}{Z_1 + r_p} \quad \text{as in equation 2.}$$

We might note here that when the tube is operated for the maximum undistorted output with Z_1 equal to twice r_p

$$\mu_{eff} = 2/3\ \mu \qquad 7.$$

Through an inspection of the interelectrode capacitance values of various tubes, it may be seen that the capacitance may be effectively a quite high value. For purposes of calculation we may represent the two resistances as a single resistance of value

$$R = \frac{R_p\ R_g}{R_p + R_g} \quad \text{as in equation 1.}$$

and the capacitances may be added arithmetically to achieve a less cumbersome equivalence. The resulting circuit is as shown in Fig. 2. We have neglected the possible grid conductance due to the flow of grid current in all calculations, although with certain of the larger tubes such as the '50 and the '45 this added parallel resistance must be considered.

The parallel branches shown in the figure give to Z_1 a value of complex nature—viz.

$$Z_1 = \frac{1}{\sqrt{1/R^2 + 1/jX_c^2}} \qquad 7.$$

This is a cumbersome expression for the novice but it may be solved quite readily by considering the current flow through the two branches. This may be done by assuming any voltage as appearing across the terminals—let us say 1 volt. Then if the resistive branch be taken as 50,000 ohms and the capacitance considered as totalling 60 mmf., or a reactance of 66,000 ohms at 40,000 cycles (from $X = 1/wC$ or $1/2\pi fC$), we may calculate the current through R and through jX_c. The current through R at 1 volt will be .02 ma. and through jX_c .0151 ma. The j in the equation (7) indicates a vectorial quantity since the current in the capacitative branch leads the voltage by 90°. The total current will be

$$I = \sqrt{I_r^2 + I_x^2} \qquad 8.$$

substituting the current values already obtained will give us

$$I = \sqrt{.02^2 + .0151^2} = .025 \text{ ma.}$$

and substituting this in the Ohm's Law relation $Z = E/I$ we obtain an effective value for Z_1 at 40,000 cycles of about 40,000 ohms, as compared with the value of 50,000 due to the resistances themselves. If we substitute these two values in the equation (3) for the effective gain through a '24 tube, we find that the effective amplification for such a stage at 40,000 cycles would be 80% of the normal response factor. This represents a loss of about 2 db, which is entirely allowable in a television circuit. Unfortunately, this is the factor of response for a single stage. Where a succession of stages is employed we may obtain the response factor at any frequency for two stages by squaring the response for one stage, as $(80 \times 80)/100 = 64\%$, and for three stages by $(80 \times 80)/10000 = 51.2\%$. It may therefore be seen that the response must be held high in the individual stage if serious frequency distortion is not to be encountered in the amplifier as a whole.

The effects noted in the previous paragraphs have to do with the estimation of the frequency response of the resistance-capacity coupled amplifier under normal circumstances and where no second order effects are involved. Perhaps the first consideration involving the influence of second order effects on the response of the amplifier is that of the out of phase voltage developed across the biasing resistor in circuits where the negative bias is obtained by making the cathode of the tube slightly positive with respect to ground and by making the grid return directly to ground. The effect is not of great importance save in those cases where the resistance across which the required voltage drop is taken is comparable with the load of the tube in magnitude. In the case of the '45 the effect is troublesome and with the pentodes, '47 etc., downright disagreeable. Consider first the circuit arrangement shown in Fig. 3, which represents a single '45 or other triode stage with a resistive load and a resistance between filament and ground across which the grid bias is obtained. The arrows represent the relative phase of the signal components appearing across the resistances. Were the biasing resistance effectively short circuited to all desired low frequency signal components, no voltage would be apparent across that branch. Note that the voltage set up across the biasing resistance because of its being in series with r_p across the load is in phase opposition to the voltage input across the grid. The magnitude of the voltage developed depends upon the gain through the tube and the ratio between the impedance of the biasing resistance and its bypass condenser and the load impedance of the tube. At some low frequency the bypass condenser will have a reactance so high as to be negligible in comparison with the resistance and the voltage set up across that branch, being in phase opposition, will be subtractive from the input signal. With a '45 tube which has a biasing resistance of 1450 ohms, a bypass condenser of at least 20 mf. is required if the low frequency response is to be maintained down to and including twenty cycles. Where a pentode tube such as the '47 is to be operated in a similar circuit, the high amplification of the tube would make the signal component appearing across the biasing resistance still larger in comparison with the signal voltage at the grid.

Obtaining Grid Bias

In order to get down to twenty cycles the by-pass condenser would have to be of tremendous proportions, so we must turn to another method of obtaining the bias for the tube. Such a circuit is shown in Fig. 4. Here the filament or cathode return is taken directly to ground, while the grid return is made through a decoupling resistance and condenser. Such a filter may be made highly effective through the use of a high resistance—no current flows in the circuit—and a relatively small condenser. The grid return is made to a point on the voltage divider more negative than ground. Since the system as shown has been used in a number of commercial broadcast receivers it should be fairly familiar to all readers. Indeed the arrangement as shown would be ideally suited to use with triodes as well as with the pentode so that the necessity for the large by-pass noted above would be removed. However, one fact remains which must be taken into consideration before applying such a circuit in the case of a low impedance output tube prone to overload.

Many readers will recall the fact that certain tubes are delivered with the warning not to employ them in resistance coupled circuits unless the resistance in the grid circuit is below a certain limit. Indeed, even the use of transformer coupling is cautioned against unless the grid to filament resistance is maintained at some low figure. The warning pertains mostly to those cases where the grid bias is obtained from batteries or from a circuit arrangement such as is shown in Fig.

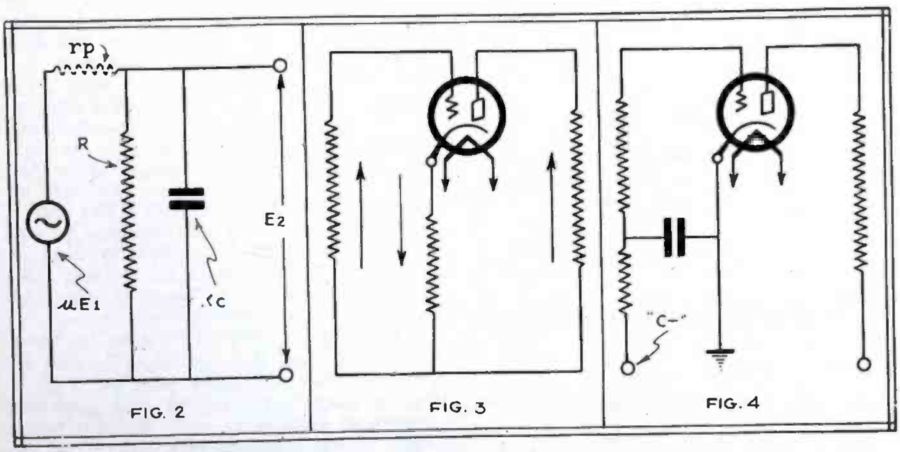


Fig. 2: Equivalent load of high frequencies. Fig. 3: Failure to by-pass biasing resistor destroys gain. Insufficient by-passing results in loss of low frequencies. Fig. 4: By-pass condenser in this system may be small.

(*Continued on page 203*)

COMPLETE DATA FOR A HIGHLY ACCURATE LENS DISC

by E. NATHANIEL SKOKAN

THE lens scanning disc, due to its decided advantages over other existing scanning devices for the reproduction of large size, brilliant images at the receiving end, is forging into accelerated popular favor. It is, therefore, reasonable to assume that the lens scanning disc will remain a useful and practical device over a period of time sufficiently long to warrant its purchase or construction.

Naturally the average television enthusiast regards the lens scanning disc as a piece of precision made apparatus. Although this assumption is correct, the reader need not dispair when mention is made concerning the construction of a lens disc, because from actual experience, the writer has learned that it is no more difficult to construct a highly accurate disc employing lenses than it is to construct a highly accurate disc having plain apertures. The reader will be thoroughly convinced of this after acquainting himself with the simple procedure of construction as outlined in this article.

Several lens scanning discs, which were built by the author in accordance with the constructional details of this article, are being used with great success at the receiving end of experimental television transmitting and receiving apparatus of his own construction.

The finished disc is 22" in diameter and employs sixty lenses 13/16" in diameter. (These lenses are procurable from several firms, through TELEVISION NEWS, at prices quoted.)

The Disc Material

The selection of duraluminum, aluminum, or brass approximately 1/10" thick is highly recommended for the disc material. Whichever material you select, do not lose sight of the fact that the disc has to be cut from material that is absolutely flat. You can have the disc cut out and drilled in the exact center by an expert machinist, or else do the work yourself as follows, in which case you obtain a flat piece of disc material 22½" by 22½". First drill a hole of the required diameter in the approximate center of the disc material. Then drive a tight fitting circular plug, preferably made of hardwood, into this approximate center hole all the way in, so that one end of the circular plug will lie even with the surface of the disc material. By means of small rigid dividers locate the exact center of the edged circular plug. The center of this plug will now be used as the pivot for one of the needles of a beam compass. Let one of the needles of the beam compass occupy the center mark of the circular plug and draw a circle, with an 11" radius, on the disc material. Fig. 1. A suitable beam compass can be made by driving two phonograph needles 11" apart, through a slender piece of wood about 12" long. A hack saw can be used for cutting out the disc, by sawing carefully along the outer edge of the circle.

After the disc is cut out, the temporary removal of the circular center plug is necessary, since it is advisable to check the disc at this time by rotation of it at 1200 r.p.m. This test is especially necessary when you are doubtful concerning the practicability of a disc cut from material apparently not absolutely flat. Vibration must be kept at a minimum. Since the disc is mounted on a shaft for the test, mention will be made, therefore, concerning the proper mounting of the disc at this time.

Spring Coupling Shaft

The use of a spring coupling between the disc and the motor shaft, as explained in previous issues of TELEVISION NEWS, is suggested. Attach the flange to the disc by means of bolts and nuts thus making possible the easy removal of the flange if occasion arises to make this necessary. Fig. 2.

In one scheme the writer uses a 1/6 h.p. 1800 r.p.m. synchronous motor for driving the disc by utilizing belt and pulleys to reduce the speed of the disc to the required 1200 r.p.m. In this case, the disc is mounted on the threaded portion of a ½" shaft. Instead of attaching a flange, two large washers are used, one on each side of the disc. Fig 2. While the disc is mounted on the shaft work down the projecting edges along the circumference by holding a file, under light and even pressure, against the circumference of the disc while it is rotating. Following the removal of the disc from the shaft, replace the hardwood circular plug into the center of the disc.

Since sixty line scanning is the accepted standard in present day television, our 22" scanning disc will employ sixty lenses. The circumferential separation between the adjacent lens hole centers will be 6° and the radial intervals of the lens hole centers will be .015 of an inch. These two values are maintained during the drilling of the entire spiral of holes by means of the drilling jig (about to be described) in connection with a large size 360° paper protractor fastened to the exact center of the disc. A 360° paper protractor approximately 14" in diameter can be purchased from blue print concerns and printers' supply concerns.

To facilitate placing the center of the protractor over the exact center of the disc, drive a slender phonograph needle into the exact center of the circular wooden plug, which is the center of our disc. Place the center of the protractor down over the projecting needle (a magnifying glass will prove useful at this stage and elsewhere) and with dabs of glue fasten the protractor to the blank disc. It is advisable to first glue the protractor to a thin metal disc having a 14" diameter. This is then firmly fastened to the regular scanning disc. By this method the protractor is easily removed, thus enabling you to use the same protractor several times. Now mark every sixth degree on the protractor, starting with the 0° mark. By using the scale on the protractor, during the drilling of the spiral of holes in the disc, the circumferential separation of 6° between the adjacent lens hole centers is readily and accurately accomplished as will be explained later. Figs. 3 and 4.

The improved drilling jig, shown in diagram form in the center of Fig. 3, was designed from odds and ends into a device which enables the user to drill the spiral of lens holes easily and accurately. It is designed for drilling ¾" holes to accommodate lenses 13/16" in diameter, but by deviating in a few respects from the constructional details of this article, it is possible to design it for drilling holes of a diameter required for the proper mounting of any predetermined diameter lenses.

Build Micrometer Screw Carefully

The micrometer screw of the device, by means of which the radial interval of .015 of an inch between the lens hole centers is accurately accomplished, has to be built with the greatest care. The purchase of a small buffer shaft approximately 6" long and ½" in diameter, and having a fine pitch thread over at least a 2" portion along one end of the shaft, is suggested. (These are available at Kresges 25c—$1.00 stores.) The nut is soldered to the vertical portion of the movable base as indicated in Fig. 3. Drill a ½" hole through the vertical portion of the stationary base to accommodate the micrometer shaft.

The same precaution has to be exercised in fitting the bushings B^1 and B^2 tightly. See left-hand part of Fig. 3. Use a small quantity of fine grinding compound with oil to work in tight bushings. Keep inserting B^1 into B^2 gradually while moving one within the other by hand or mechanically. If a little

(*Continued on page 203*)

Too frequently the directions given for the construction of a lens scanning disc are incomplete, and leave the builder virtually in mid-air before he is half through with the job. We especially recommend Mr. Skokan's article because his "dope" is all-inclusive and can be followed very easily.

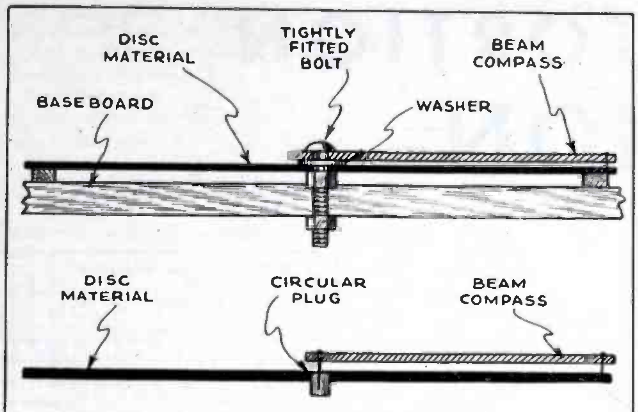


FIG. 1

Two methods of drawing the disc circumference.

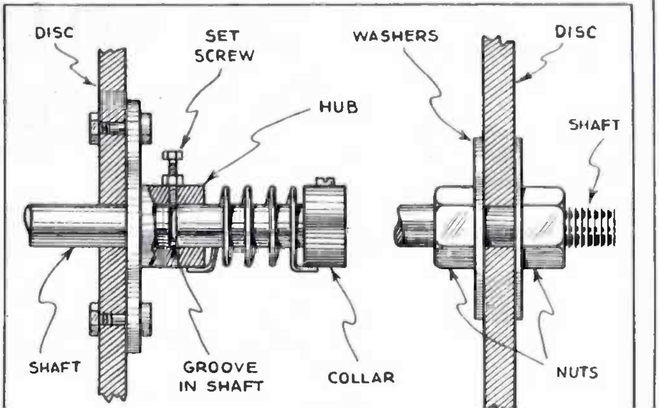
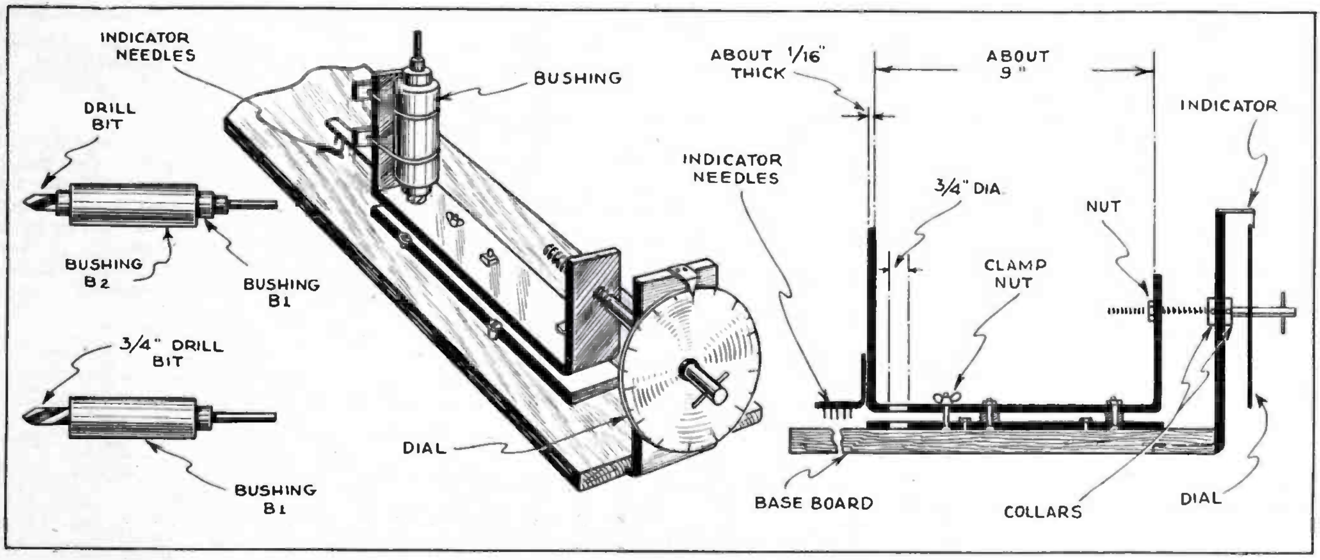


FIG. 2

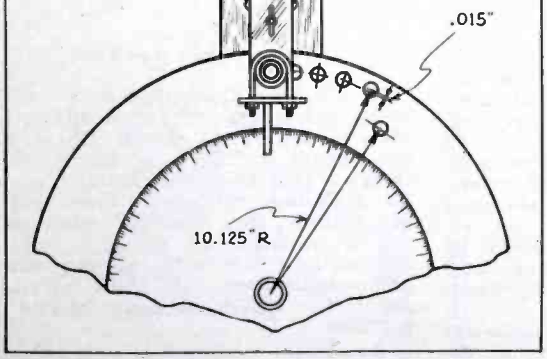
Two methods of mounting the disc on the shaft.

Below, Fig. 3: The mechanical jig for accurately laying out the holes for a lens scanning disc. At the right are constructional details for the micrometer screw and other parts of the device. The two metal pieces forming the movable base are approximately 1½" wide. The indicator arm is permanent-



ly fastened to the left vertical position of the movable base. The baseboard should be of hardwood and sufficiently long to permit attaching center of disc to same. At the left the bushing B^1 with the ¾" drill bit wedged tightly and centrally within it is shown. Also the complete bushing assembly, ready for mounting, with B^1 inserted within bushing B^2, is shown. The fit between B^1 and B^2 must be tight. The bushing assembly is clamped and soldered in place.

FIG. 4



Left: the mechanical jig in drilling position. Lens hole layout details are given. Right: the counterboring tool used by the author. The lens hole dimensions are given.

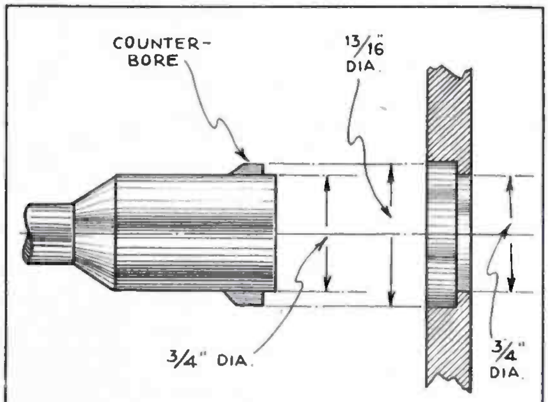


FIG. 5

COLOR DISTORTION IN TELEVISION

By C. BRADNER BROWN

HALFTONE reproduction in newspaper pictures is accomplished by the printing of dots, the variation in light and shade depending on the number of dots in a given area. The more dots used, the darker that particular section of the picture. The detail which can be obtained depends on the size of the dot used. Sixty dots per inch of line is the usual halftone, although this may be increased to 133 for better detail such as is used in many of the higher class magazines.

In television, however, the reproduction is carried out by varying the amount of light along a line. This allows a much more perfect control of shade and light than is possible with the dot method, as the wash of light can be changed to correspond to an innumerable number of shades. A much smoother picture may be obtained in a television image than in newspaper half-tones therefore providing an equal number of elements is printed in both systems.

From Color to Shade

When an article or subject having certain definite colors is to be reproduced in halftone, some transformation from color to shade must be made. In photographs, this transformation is made at the sensitive plate or film. Since the silver sensitive chemicals used in the most modern negatives have a sensitivity which comes somewhere near the human eye, the degree of light and shade appears the same in the resultant picture as it did in the original.

It can be seen that the response of the human eye determines the translation from color to shade. A curve showing the relative response of the eye is reproduced in Fig. 1. The eye responds to colors on the color curve as is shown by a test on the standard color charts used in these experiments. These colors (standard color charts) were furnished by the Milton Bradley Company and have the following absolute values:

Red	6571	Angstrom units
Orange	6085	" "
Yellow	5793	" "
Green	5164	" "
Blue	4695	" "
Violet	4210	" "

These standard colors are shown in their respective places on the color curve in Fig. 1. An examination of the color charts show that the eye discriminates color in the order given on the curve in Fig. 1. Thus, if the subject is wearing yellow apparel trimmed in red, the eye perceives light clothing with dark trimming. In order for the television image to be reproduced in the same order, the response on the system must approximate that of the human eye. Color discrimination causes distortion in the form of shadows on the face of the subject. The human countenance tends toward a red or pink, which means that a system which is responsive to blue only will introduce considerable distortion, and faces may be very difficult to recognize.

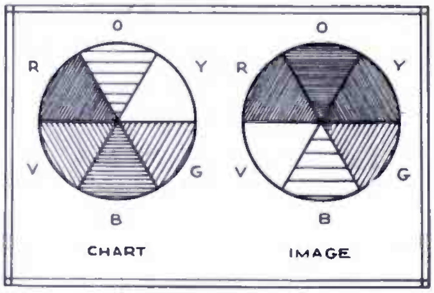
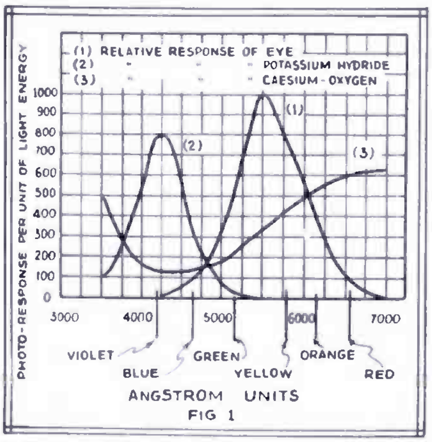


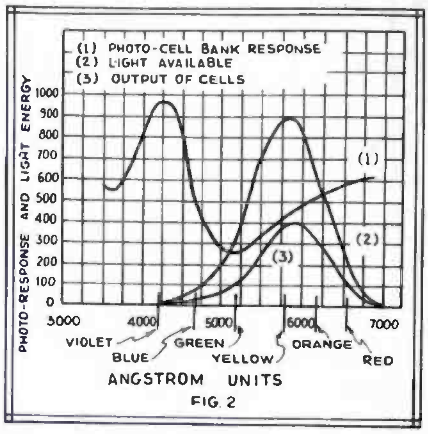
Fig. 3: how the colors orange, yellow, green, blue, violet and red are reproduced through potassium hydride photo-electric cells.



These curves show the relative color response sensitivity of the eye and photo-electric cells of the potassium hydride and caesium oxygen types.

Since the response of a television system depends entirely upon the response of the photo electric cells used to change the light used into electrical pulses at the transmitting or sending end of the television system, the solution of the problem appears to depend on an investigation of the photocell response. In the laboratory, the response of the cells is measured by measuring the current flowing with equal light inputs of different wavelength or color.

Although the necessary equipment was not available, the response of the cells used was checked against the standard color charts which were on hand. The response curve for the potassium hydride cells used in the television equipment under test is shown in Fig. 1. This curve was given by the manufacturer and the results of viewing the standard color charts through the televisor are given below:



These three curves show the photo-electric cell response, the light available, and the output of the cells.

Cell	response
Red	0
Orange	0
Yellow	0
Green	30
Blue	250
Violet	250
Violet	790

Image	
R-O-Y	dark
G	lighter
B	still lighter
V	lightest

The results of these experiments check the color curve exactly. The figures which were given were relative only, and simply show the difference between the current pulse flowing with an equal amount of light at the various colors. It is apparent that this system will not even approximate the results obtained by viewing directly. The actual results are shown by the comparison of the color charts in Fig. 3.

Three Colors Are Lost

It will be noticed that none of the colors red, orange or yellow affects the cells in the least. Hence, these colors appear as black in the received image. This results in a total loss of all definition whenever these colors are before the scanning equipment. Actual experiments using a subject dressed in yellow with red and orange trimmings showed only black for clothing. The defect obviously should be rectified.

A search was immediately started for a photo-electric cell that would have a response curve which would come somewhere near that of the human eye. The metals of the rare earths were investigated with the result that caesium was chosen. The curve for metallic caesium came very close to that of the eye, so close in fact that it seemed ideal. However, caesium has such an affinity for oxygen that the construction of a metallic caesium cell seemed to be almost impossible. The addition of oxygen shifts the response curve until a very objectionable low point appears in the blue area. The comparison of the potassium hydride and the caesium-oxygen cell is shown in Fig. 1.

Correcting the Response

It was finally decided to correct the response of the television system by the addition of caesium-oxygen cells to the bank of potassium hydride cells already in use operating through separate head amplifiers in order to be to control the coupling of the cells, as the potassium cells take a high value resistor while that used by the caesium-oxygen cells is fairly low.

An added advantage was secured in that the amount of each pickup could be changed to suit the operator's taste, and the results of adding the caesium cell bank could be observed. The addition of the two response curves is given in Fig. 2. It will be noticed that the combination has a low in the yellow area. We have not, however, taken into account the selective radiation of the tungsten lamp used. The curve of light distribution is shown in Fig. 2. The combination of the light distribution curve and the cell response curve gives us the result shown in Fig. 2.

This curve holds only for a tungsten lamp, whose radiation falls mainly in the red end of the spectrum. If an arc light were used having excessive blue in the spectrum, the results would be entirely different. Hence, we will have to modify our original statement and say that the response of a television system depends on the response of the photo cells and the scanning light used. This problem would not appear in direct or camera pickup where daylight illumination is used.

Comparative Results

The results of the set up used indicate that the response for the system would now line up as follows:

Television system
light
dark
Y-O
R-G-B
V
eye
Y
O
G
V-B

The response is sufficiently the same to produce substantially the same results in the television images as if the image were viewed directly as to shade and light responses. The system of color compensation makes for much better images with an object that has a larger percentage of red and yellow than blue. Detail is considerably improved, as slight variations in red and yellow which formerly made no difference are now brought out, resulting in a much better image.

TELEVISION DISC SPEED INDICATOR

This handy chart will prove valuable to the experimenter who uses disc scanning

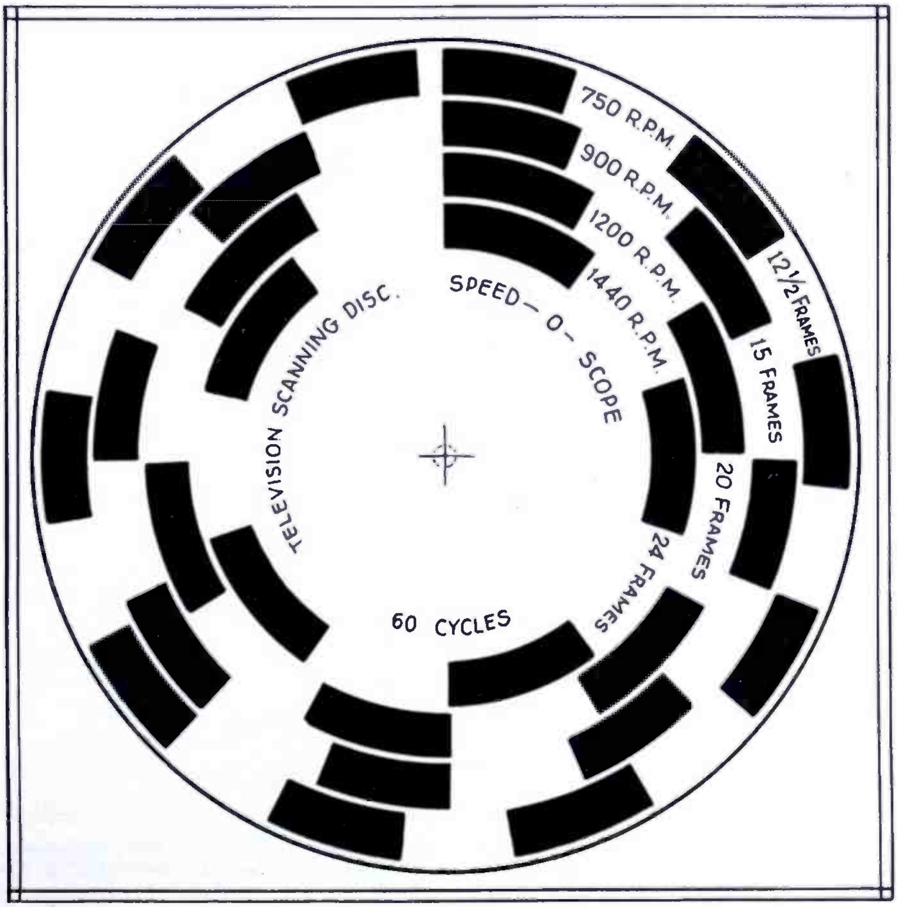
By CARROLL PFLEEGOR

IT is very essential that the speed of a television scanning disc be the same as that used at the transmitting station.

Different television systems operate at various speeds. Foreign stations use 12½ frames per second. Most of the United States stations use 15 or 20 frames. Available data indicate the standard may become 24 frames per second. This is the same number as is now standard for talking movie films. W2XK, the RCA station located on the Empire State building, New York City, is reported on 61 megacycles (4.91 meters) with 120 line scanning at 24 frames per second.

It is very essential that the television experimenter have a means of knowing when his disc speed is correct. This problem is admirably solved by a speed indicator operating on the stroboscopic principle. One which is designed to cover present television requirement is illustrated. If this chart, or a tracing of it, is glued to a cardboard disc it forms a speed indicator which can readily be slipped on one end of the shaft or mounted directly against the disc. An electric light (preferably a neon 110 volt type) is mounted so that its light shines directly on the disc. If the latter is now brought up to speed one will apparently be able to see the segments on the disc standing still. For instance, if run at 1200 revolutions per minute (20 frames per second) that series of segments will appear to be stationary and you will be able to count 6 segments with alternate light spaces. If the disc speed is slightly below normal, the indicator will appear to be revolving slowly *opposite* to the direction of the disc. If running too fast it will appear to be revolving in the *same* direction as the disc. At the correct speed the indicator appears to be standing dead still. One apparent revolution of indicator either way per minute corresponds to loss or gain of one revolution per minute.

This indicator gives correct speed at a glance. It is accurate due to the fact that the frequency of most power stations is controlled by a master clock in order that electric clocks of consumers be correct.



A SIMPLE TELEVISION MIRROR DRUM SCANNER

by R. W. TANNER

IT is well known among television engineers and experimenters that the Nipkow disc for scanning is a very inefficient device. The lens disc is a very great improvement over the aperture disc, but still is far from being easy to construct and requires a rather large diameter. The cost is also considerable.

The Weiller mirror wheel has heretofor been considered a "tough proposition" from the viewpoint of construction. However, the efficiency of this type of scanner is equal to any and superior to nearly all others. Correct design will result in a scanner of reasonable weight, allowing a small motor to be used which can be easily synchronized. For a given size picture, the diameter will be somewhat smaller than that of a lens disc. And since only one lens is required, the disadvantage of obtaining a set of 60 perfectly matched lenses is thereby eliminated.

Simple Tools Used

Some time ago, the writer decided to determine if it were not possible to work out a design of a mirror drum scanner which would be reasonably simple to construct without a machine shop. The design was completed and a model built up which produced more than satisfactory results. With a crater neon having a .015 inch point source, a 5" by 6" picture on a ground glass screen was obtained with a very satisfactory degree of illumination.

The entire job was accomplished with only a hack saw, hand drill, screwdriver, file, protractor, dividers and pencil with the exception of one operation, that of turning out a drum of wood on a lathe.

For the benefit of those experienced experimenters, sufficient details will be given which will enable them to duplicate the results originally obtained.

It is first necessary to turn out on a lathe a drum of wood 17" in diameter by 1" thick. Hard wood is undoubtedly preferable but soft wood will be much lighter in weight. The lighter the weight of the finished scanner, the easier it will be to stay in synchronism and the less power will be required to rotate it at a speed of 1200 r.p.m. The constructor is advised to use his own judgment on this problem. When turning out the wooden drum, do not drill the center hole until later.

After the drum is turned out to the required size, with a protractor scale draw lines from the center to the periphery 6 degrees apart until a total of 60 lines are drawn. If this is done accurately, each line will be exactly 6 degrees apart. Figure 1 shows how to lay out the lines. At each line drill a hole through the drum at a radius of 8" from the center with a 6/32 drill. Then measure 1" towards the center on each line and drill another hole. The drum may now be sanded down to a smooth surface and given a couple of coats of shellac. The center hole should be drilled before shellacking; its size will depend upon the size of the motor shaft and type of flange used.

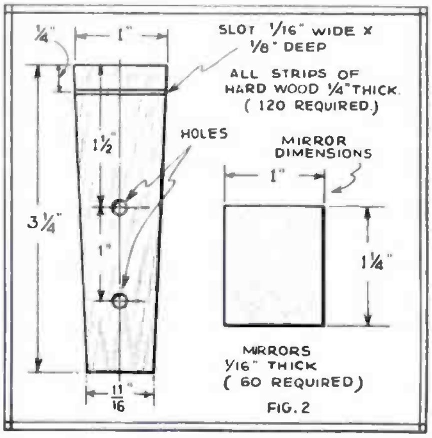


FIG. 2

Dimensions of the wooden strips that hold the mirrors to the drum.

Cut Mirrors Carefully

The mirrors may next be cut or if this is considered too great a job, have them cut by a company that does mirror work. The mirrors are 1/16" thick, 1" wide and 1¼" long. Care must be taken to see that each individual mirror has absolutely no flaws, otherwise the picture thrown on the screen would be greatly distorted.

Each mirror is supported by means of two hard wood strips, one fastened to the top and one to the bottom of the wooden drum. The dimensions are given in Fig. 2. A slot 1/16" wide and ⅛" deep is cut in each strip approximately ¼" from the wide end. It will undoubtedly be necessary to finish the slots with a small file, a nail file being OK if not too old and worn. This filing process is a rather tedious job so it is advisable to saw the slots first with a coarse hacksaw blade and then finish with the file. The slots should be slightly wider than the thickness of the mirrors for reasons given later. Holes may then be drilled in 60 of the strips as shown in Fig. 2. The remaining 60 strips will have the holes drilled the same as the others but it will be necessary to lengthen the holes approximately 1/16" both ways. This is for the purpose of adjusting the mirrors to the correct angle when placing the scanner into operation by sliding the strips either forward or backward, as the case may be. The adjustment is the reason for making the slots slightly wider than the thickness of the mirrors. Use a small round file for lengthening the holes.

Unless the cutting of the strips was

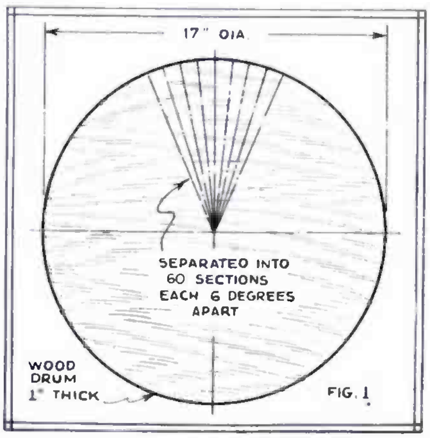


FIG. 1

How to lay out the radial lines on the wooden drum. This work must be done carefully and accurately.

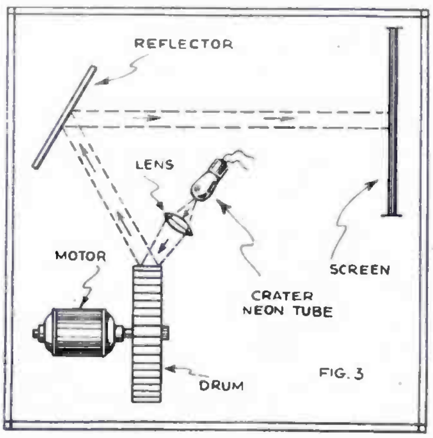


FIG. 3

Placement of the screen, reflector, drum, lens and crater tube as suggested by the author.

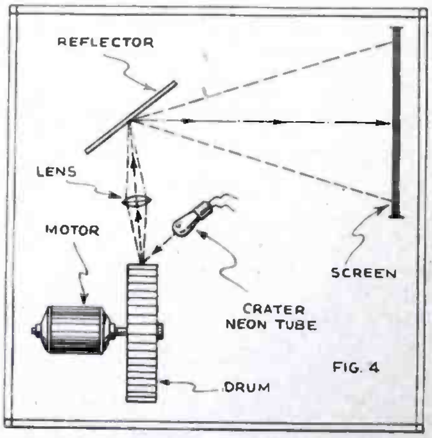
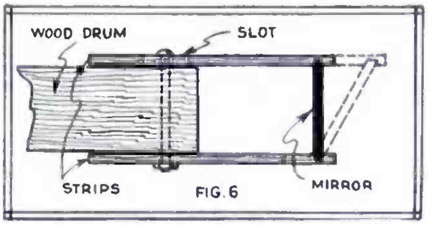


FIG. 4

Another suggested arrangement of the parts of the scanning mechanism that minimizes loss of light.

The mirror drum scanner has always been regarded as a difficult undertaking for the amateur television constructor, but Mr. Tanner dispels this notion in the accompanying article. The apparatus he describes has actually been made and actually works.



This shows how the wooden strips that hold the mirrors are bolted to the edge of the disc.

done with the utmost care, it may be necessary to file the edges to a greater taper in order to make them fit properly on the drum.

The bottom strips are fitted to the drum first by inserting machine bolts 6/32 by 1¾" long through each strip and thence through the drum. The slots should face upward. A mirror is placed in each slot with reflecting surface outward. Then place the top strips, slots facing down, and fit the mirrors in the slots. Place a nut on each bolt and tighten only temporarily.

If everything has been done accurately, the strips should fit perfectly and the mirror edges should come together.

Mounting the Drum

The completed scanning drum may now be attached to the motor, which should be at least 1/6 h.p. The fitting to the motor shaft is an individual problem and depends upon the shaft size and length. A flanged bushing will probably be necessary in any case. A vertical motor, while undoubtedly the best, is not essential, a horizontal type allowing the picture to be made right side up by means of a reflecting mirror. The arrangement of the motor, mirror scanning drum, lens, reflecting mirror and screen is shown in Fig. 3. This is an exaggerated sketch and merely serves to show how the various components are placed with respect to each other.

The crater neon glow lamp should have a point source of .015 to .02 inch. The lens need not be an expensive one but should have a magnifaction of approximately 5 to 5½ diameters since the size of the dot element of a 5" by 6" picture is about .083 inch. The reflecting mirror, like the drum mirrors, MUST be free from flaws in the glass and may be almost any size from 2" by 2" up to 6" square.

The exact distances between screen and scanner, scanner and lens and lens and neon will depend upon the focal length of the lens; however, the total distance from screen to lamp will be in the vicinity of 36 inches.

Alternative Method

Another method of placing the various components is shown in Fig. 4, but this has not been tried as yet. This method was advised by an optical expert as being more efficient than that shown in Fig. 3. The light rays are first thrown onto the scanner mirrors. From the mirrors, the rays are then magnified by the lens and thrown onto the reflecting mirror. From this the rays are projected on to the screen.

It is readily apparent that there is a loss of light at the sides of the picture when using the method in Fig. 3. The diameter of the light cone as applied to the scanning mirrors would, with the average lens, be in the vicinity of .3 to .5 inch, in which case maximum light would be obtained in the center of the picture. At both sides the efficiency would fall off rapidly due to the fact that, at the sides, only a portion of the light cone would be useful, since the light cone is from ¼ to ½ that of the individual mirror surfaces.

In the arrangement in Fig. 4 the loss of light is very small, providing the crater neon is located not more than 2" from the scanner. The reflecting mirror is shown to be a focal length from the lens but this is not at all critical. If the reflector is closer to the lens, the distance from reflector to screen must be lengthened proportionately. On the other hand, if the reflector is greater than the focal length away from the lens, the distance to the screen must be shortened.

The experimenter is advised to try both methods and decide for himself which is the better.

Before describing the adjustment of the mirrors, it would be well to add a word or two in regard to the screen. As stated before, this should be of ground glass. With a picture 5" by 6" a piece of ground glass at least 8" square should be provided. This may be mounted directly in the open but then it will not be possible to "look in" during the daylight hours or if there is any illumination in the room at night. It is by far better to build a visor around the screen and either mount the scanner, reflector, lens and neon in a light proof box or drape a curtain around the apparatus. The visor may be merely four pieces of wood, or even wall board, slightly over 8" square at the screen end, spreading but to 10" or 12" at the opening. A depth from screen to opening of 3" would be sufficient.

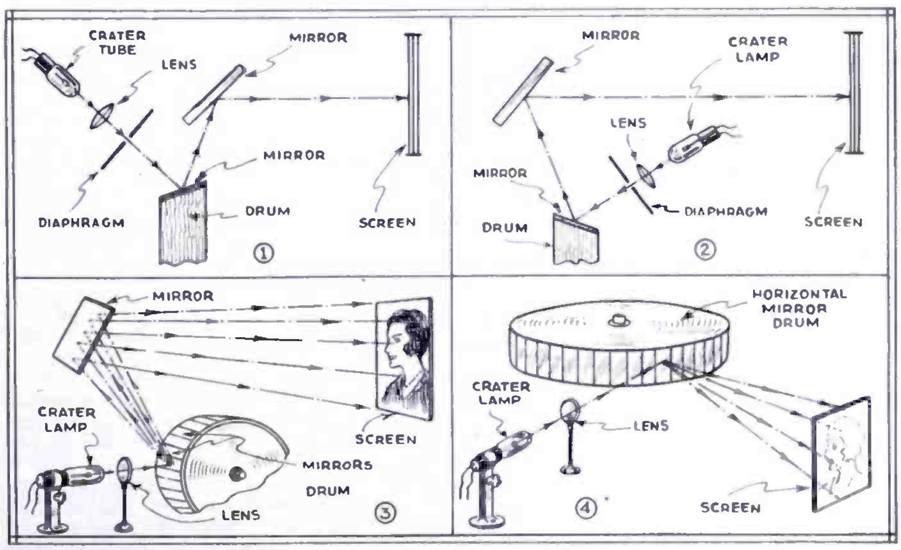
For adjusting the mirrors on the scanner, it will be necessary to draw on a sheet of white paper an oblong 5" by 6". Then draw 60 horizontal lines exactly .083 inch apart; in other words, draw 60 lines equally spaced. Place this paper over the screen and adjust the lens so that the dot element is properly focused. It will be necessary to experiment somewhat with all spacings such as screen to reflector, lens to scanner, etc. before the focusing is correct.

Now adjust one of the drum mirrors, by sliding the top strip slightly forward or backward until the dot on the screen travels across the top line as the drum is turned slightly. The drum is then turned so that the second mirror may be adjusted to scan the second or next lower line and so on until all 60 mirrors are correctly set. As each mirror is set properly, tighten down on the two machine bolts.

When all are adjusted, no black lines should be visible unless the distances from lens to scanner, screen to reflector are changed.

It is assumed that the builder is experienced otherwise he would not attempt such a completed piece of apparatus as a television mirror drum scanner, therefore details of mounting the motor, lens, reflector, etc., will be left entirely to him. It is needless to state that all parts MUST be mounted rigidly.

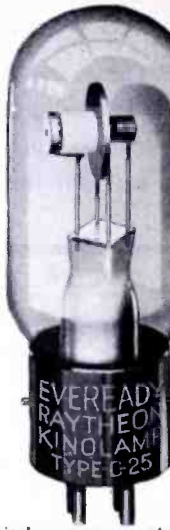
(Continued on page 202)



Four more suggested schemes for the mirror drum scanning apparatus. The experimenter would do well to try them all, and to see which works best in his own particular case.

HOW TO USE
CRATER LAMPS

In this interesting and instructive article Mr. Messing tells a few facts about crater lamps that are not generally appreciated by television experimenters who use them. His advice is practical and useful.



A typical neon gas crater lamp used for television purposes.

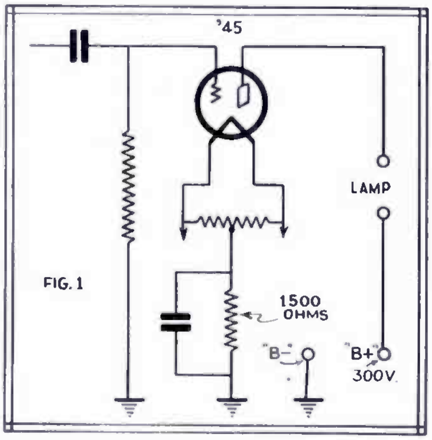
By EDGAR MESSING

WHILE much has been written and said about crater lamps, there still remains a great deal to be told, a point proven by the diagrams that illustrate their use.

We know what crater lamps are, their advantages over the old neon lamp, and from previous issues of TELEVISION NEWS just why the work. So far as the lamp's theory of operation is concerned the outstanding point is that it is a gaseous discharge tube with a highly concentrated and intense discharge glow. There are purely electrical characteristics, however, that are particularly important and which we must recognize in order to use the tube correctly.

The more important of these points are: first, the crater lamp is a current-operated device and not a piece of power apparatus like a loud speaker; second, it has a negligible impedance characteristic; and lastly, it has a fixed D.C. resistance giving a constant load effect. These constitute an altogether different picture from the problem of securing a certain speaker load impedance. One other point that will be developed later is the fact that crater lamps are always rated in maximum operating D.C. mils with a stern injunction that this current is not to be exceeded.

For simplification of our discussion, we shall consider a standard crater lamp rated at 5000 ohms and 25 mils maximum operating D.C. The allowable current swing is then 20 mils or from 5 to 45 mils, a minimum current of 5 mils being required to keep the tube lit. Since the tube's reactance is negligible we consider the tube as being a constant 5000 ohm load. With these facts in mind we can proceed to examine existing circuits using the lamp and comment on ways and means of improving them.



Connections of a typical single output stage using a '45 power tube.

The output stage of a television set when comprising a single 245 is in its usual form similar to Fig. 1. The "C" bias resistor is 1500 ohms, a value we know is suitable for loud speaker operation. The three hundred volt B supply is supposed to divide itself between tube and bias so that 250 volts is across the tube and 50 volts across the "C" bias resistor. But a 5000 ohm D.C. load considerably complicates the situation, which requires the help of Fig. 2 to understand.

Some Valuable Curves

Fig. 2 represents what we call a family of plate characteristic curves—plate current plotted against plate voltage for different values of grid voltage. These curves, very unfortunately, do not seem to be getting much attention outside of commercial design laboratories. Experimenters and television experimenters especially will find them invaluable for prediction of tube and set performance. They are manipulated very simply, eliminate a great deal of guess work and make the construction of a radio set a design problem rather than an assembly job. Our use of the diagram will be the best method of explaining its manipulation.

Our object is to learn from the family of curves just what kind of output we can expect with different values of grid signal voltage.

We know that a total of 300 volts is being supplied across the load, tube and bias resistor. Since there is a D.C. drop in the load the current will be less than the normal 32 mils; the bias may be about 30 volts. The voltage available for the tube and its load will then be about 270 volts. Since the grid resistor is by-passed so that it offers theoretically negligible A.C. impedance, it need be no longer considered.

When the instantaneous plate current is 10 mils there will be a 50 volt drop across the 5000 ohm load resistor and therefore only 220 volts across the tube. We mark this point on the diagram—10 mils at 220 volts. At 20 mils the tube voltage will be 170, and we mark this point. We draw a line connecting these points and extend it in both directions as shown. This is our 5000 ohm load line and by reference to it we can see what the effect of a signal voltage on the grid will mean with respect to load current and plate voltage. Any grid voltage is regarded as acting along the load line and the plate voltage and current corresponding can be read off from the curves.

When the instantaneous grid voltage (E_c) which may be the result of steady bias and signal voltage) on the tube is 30 volts, point A in Fig. 3, for example, the plate current is 21.5 mils and the voltage on the tube is 160.

The lower limit of current we have said is 5 mils, which corresponds to a grid voltage of about 68 and a plate voltage of about 246. The allowable total grid swing is then 68 volts and the bias should be around 34 volts, corresponding to a plate current of 20.5 mils. This is the "normal" operating point under these conditions of load and plate voltage and is to be fixed by the "C" bias resistor. The 1500 ohm resistor we have put in will mean a bias of 31 volts, which is close enough.

Anticipating the Quality

From the curves we can obtain an idea of the quality we may expect. This is done by noting what change of plate current we get with a given change of grid voltage. A 10 volt signal will cause the grid to swing from 31 volts to 41 volts on one side and from 31 to 21 on the other side of the operating point. On each side the plate current change is 6 mils, which means a peak A.C. of 6 mils has been developed. But a 30 volt signal, causing a swing to 1 volt and to 61 volts, results in a plate current change of 18 mils on the high side and only 14 mils on the other. This unsymmetrical effect means even harmonic distortion. It will also be noticed that if the bias had been set at 35 volts or more a 30 volt signal would have been even more distorted than with the lower operating point.

The point of this discussion is that the switching over to the crater tube from the speaker has materially changed operating conditions, allowable grid swing, and current variation.

The signal voltage cannot be 50 volts, for which the output stage was originally designed, the maximum output is correspondingly reduced, and the light variation of the crater tube is limited.

Why Parallel '45's?

The tendency now in television output stage design is to use parallel '45s. The reason for this, the designers say, is to secure greater output for the same input signal. But, and a mighty big "but" it is, do they?

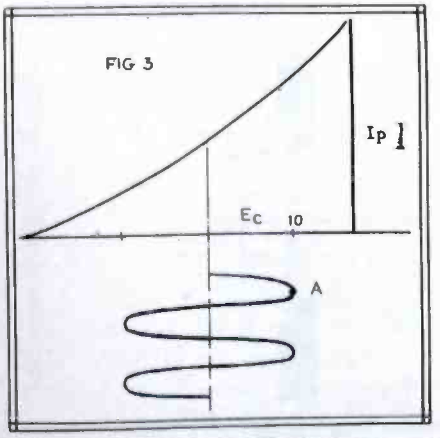
Applying our family of curves gives us a very interesting picture. Since the tubes are parallel we simply double the current scale at the left and draw in our new load line in the same manner as before. When 20 mils is being drawn (10 mils per tube) the drop will be 100 volts and the tube voltage will be 170. The lower curve or rather line "B" is the load line for this case.

The voltage swing on the grid is governed as before by the minimum crater lamp current at one and and the zero grid voltage at the other. The total swing as derived between these limits is 78 volts. The operating point should then be set at 39 volts, corresponding to a plate current of 21 mils. To provide this bias this normal current should pass through a *1850 ohm resistor.*

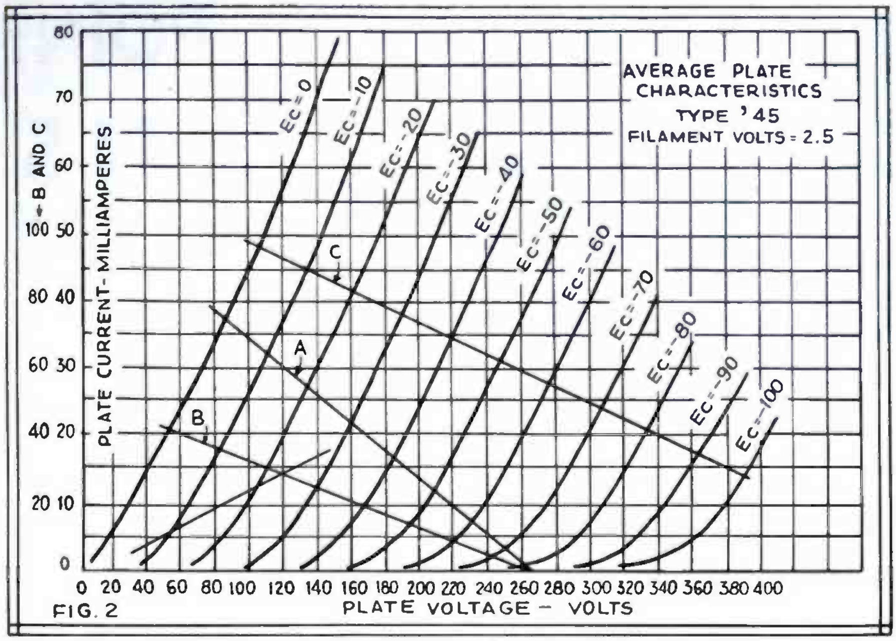
A Big Difference!

Take a look at Fig. 4, the usual diagram for parallel '45s; the bias resistor there is 750 ohms! This value we will admit without any argument to be quite different from 1850. The 750 ohm resistor means that the normal operating bias with no signal will be about 22 volts, as derived from curve 3 (which is simply grid voltage plotted against plate current with 750 ohms in the circuit).

Note this carefully—placing the two '45s in parallel and using a 300 volt source and a 750 ohm bias resistor (normal values), has *resulted in a low operating point with resultant low permissible signal voltage, low overload point and much less undistorted output than might be expected.*



This old, old diagram illustrates a new point in amplifier operation as applied to television reception.



This family of plate voltage—plate current curves can be used with profit by television experimenters. The significance of the lines A, B and C is explained in the text.

That is the reason, or one of them, why so many television sets giving a terrific ear-blasting signal seem to produce a picture not at all commensurate with the sound. It is not necessary, we believe, to emphasize this point.

One other characteristic should also be examined. We must remember that the reason for adding a tube in parallel was to secure greater output for the same signal input. With the help of Fig. 2 we can compare sensitivities directly in terms of plate current, which, since the crater lamp is a current device, means in terms of light output. We can consider first the same where the 750 ohm resistor is used for biasing.

A 20 volt excursion above and below the operating point causes a current variation from 42 to 19 mils or 23 mils. Before going further with our comparison it seems very pertinent at this point to emphasize that the important point about getting a good picture is getting good contrast.

Obtaining Good Contrast

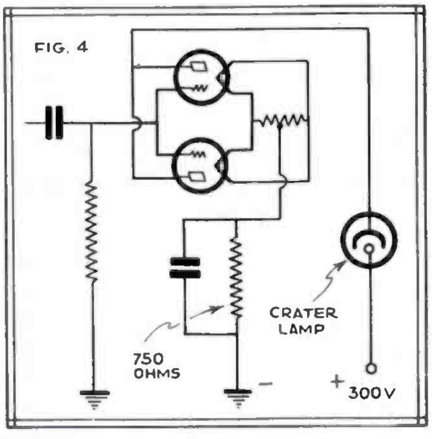
So far as the light producing device —in this case the crater lamp—is concerned, it is the variation of current that produces good contrast and good pictures. The crater lamp having a variation of 15 mils will produce as clear cut a pattern whether the variation range is from 30 to 15 mils or from 50 to 35 mils. The lamp has an excellent straight line characteristic for light output against exciting current.

Returning to our sensitivity comparison we note that a 20 volt swing with a single tube means a current change of approximately 24 mils. In other words, the 20 volt swing caused the same *variation* of current whether a single tube or the parallel tubes were used! There is evidently nothing to be gained in the way of sensitivity by using two tubes and it looks highly probable that we would have done a better job by sticking to one tube.

It is, of course, possible to make two tubes do more than one and this can be accomplished by putting them in parallel, but from the foregoing it is quite obvious that some care must be exerted in the process. Such information will provide material for a future article.

Editor's Note

The author of this article has had considerable experience as a design engineer for several large companies. He was prominent in the design of the well-known Super-Wasp short wave receivers, and is now actively engaged in short wave and television research work. This article is the first of a series that will appear in Television News. If you are interested in any particular phase of television reception, write to Mr. Messing in care of this magazine and he will place the topic of his list for discussion.



A usual amplifier output stage using two '45 tubes in parallel.

The author illustrating the method of using the plumb bob for adjusting the lens scanning disc.

POINTERS IN LENS DISC DESIGN

The author of this article has had considerable practical experience with lens scanning discs. He tells how to lay out and adjust a disc that produces clear, sharp images.

By SAUL SCHILLER

IN part 1 of this series on lens disc design, the necessity for constructing an adjustable lens disc was explained. Summarizing briefly, these reasons are: (1) the difficulty of machining a perfect disc; (2) the expense and scarcity of anastigmatic lenses. So with these hindrances and lack of facilities, the television constructor is limited to a hand adjusted lens scanning disc.

The criterion of a good lens disc is in the actual reception of television images. Before this feat is accomplished the disc must exhibit these qualities: (1) run smoothly and synchronously; (2) project a frame of 60 uniformly spaced and evenly illuminated bands in the ratio of six to five; (3) possess the necessary overlap of 20 to 50 per cent. Only a precision lens disc will answer the purpose. The directions for assembling such a disc are described below.

Drilling the Holes

Assuming that the disc is laid out and the 60 center punches indented on the intersection of the radial and angular displacements according to the specifications of the simple hole type of scanner, the next step is to drill the holes a trifle smaller than the lenses which you intend to use. For example, lenses which have a diameter of .81" (13/16") requires a 11/16" drill. By cutting down the aperture in this manner, the lens is "stopped," thereby avoiding aberrations to some extent. Then follows the process of counterboring. The shoulder is recessed to one half the thickness of the stock material used, and the diameter of the reamer made larger than the lens by a sixteenth of an inch or more—the more accurate the disc is drilled originally, the less free play of the lens in its seat is required. This free play of the lenses in their seats constitutes the adjustable feature of the lens disc, and enables the constructor to align the lenses accurately, irrespective of the initial mechanical errors in drilling or off-centered lenses. The lenses are shifted in their seats until the 60 images of the point source fall on the horizontal and the vertical intersection of the test screen.

An accompanying photograph illustrates the simple apparatus which has been set up by the engineers of the Television Optical Equipment Company for completing their 18"—24" precision lens discs. Such an arrangement for locating the exact position of the lenses in their respective seats prior to cementing can be duplicated with ease, and is not outside the facilities of the televisionist who desires a projection outfit. It eliminates the micrometer stage and geared teeth for shifting the disc into position and does away with the expensive microscope with its filler cross hairs required to examine the image. Moreover, the conditions under which the lenses are mounted simulate actual operating conditions in that the projected image is fixed for a 10" $\times$ 12" picture.

The lower vertical post in the photograph serves as a ring stand for the point source object—the crater tube. By using suitable chemistry clamps the object position is shifted in every direction—and up and down for focusing; a right and left for the six degree plane and the back and forth for centering. In a similar manner the vertical post attached to the table carries the image screen. The disc with its six degree divisions marked off has a quarter inch hole in its exact center through which is fitted a quarter inch rod. This axle is threaded at one end and screws into a steel palte (2" $\times$ 3" $\times$ ¼") which slides back and forth between grooves in the table. Permitting the whole disc to move back and forth eliminates the necessity of moving the object when it is in focus, but not centered over the 31st lens. The optical bench must be free from vibration and preferably anchored to the floor and wall. It is necessary to cut out a 3" square window from the bench directly above the crater tube. Finally, a pointer is fastened onto the table on the same line as the axle, and rests on the disc. When the disc is turned by hand until a sixth degree division coincides with the pointer, the disc is in its six degree plane.

Fixing the Crater Tube Distance

The simple lens formula $1/p + 1/q = 1/f$ and the object image size relationship $P/Q = p/q$ serves to fix the crater tube distance tentatively. The 18" disc, having a vertical pitch of .72" and using 1.5" focal length lenses, requires an image distance of 18.5" for the 10" $\times$ 12" frame. The displacement of each radial line on the screen is 10"/59 = .169". It is not 10"/60. Nor is lens No. 30 the exact center of the disc. These two details will become clearer on a little reflection. For those who are unable to figure this out, the author will be glad to supply the answers.

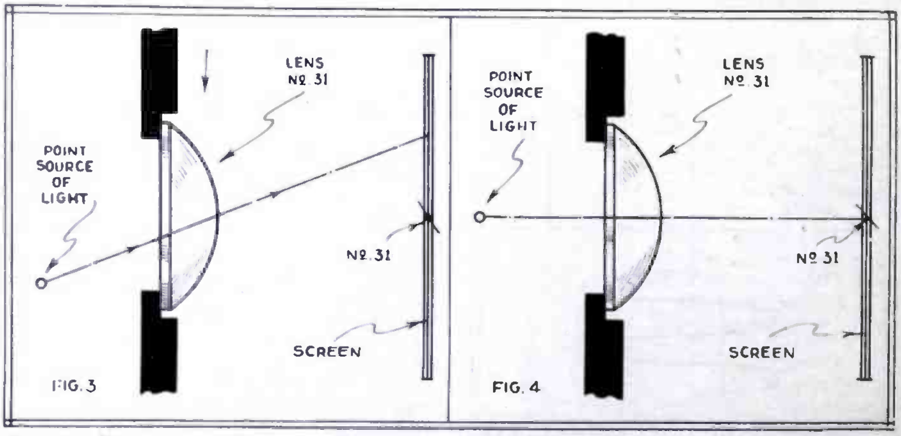


Fig. 3: Direction of arrow indicates amount of shift necessary to bring disc into vertical plane. Fig. 4: Correct alignment for the vertical plane of the optical center.

This method, then, consists of shifting the lens in its seat until the image of lens No. 1 falls on line one; the image of lens No. 2 falls on line two of the screen, and etc.

The image screen consists of soft grain wood (11" × 3" × ½") with a small hole bored in its exact center. An iron rod attached to the center and at right angles to the wooden screen support serves to attach the screen to the vertical post (see photograph). A glossy sheet of cardboard which is divided into the 60 vertical divisions (.169"), is tacked onto the wooden frame and is the screen proper. The hole previously drilled locates the position of line and lens No. 31.

Conditions To Be Satisfied

The following conditions must be satisfied before the lenses are mounted into place:

(1) the point source of lens 31 sharply focused on the screen.

(2) the longitudinal line of the screen must fall on the six degree plane of the disc—corresponding to the pointer-axle line. This adjustment determines the amount of freedom for the right and left movements of the lenses.

(3) vertical plane of the screen, taking line No. 31 as standard, must coincide with the vertical plane of lens No. 31.

The precedure for fulfilling these conditions is as follows:

(1) sharp focus—merely raise and lower point source for maximum intensity and definition.

(2) right and left adjustment—drop a plumb line from the center of the screen and when it is centered over aperture No. 31—the disc being rotated into position by hand—clamp the screen permanently. Place the lens in the center of the shoulder, remove the bob and move the crater tube back and forth; clamp into position where the image falls on the longitudinal line. See Fig. 1 and 2.

(3) vertical plane adjustment—move the whole disc back and forth on its slide. Fig. 3 illustrates the shift necessary to bring lens No. 31 over line 31.

Temporarily insert a lens in aperture No. 1, swing disc around its pivot until the pointer falls on the six degree line for lens No. 1. Oscillate the lens in its seat. Its image should circle around the intersection of line one of the screen. Repeat for lens 60. The same results should be duplicated. These check up tests indicate that the object-image-disc relation is satisfied.

Checking the Lenses

After these adjustments have been completed, insert the 60 lenses into their seats and rapidly check up by swinging the disc into position. Draw up a column from 1 to 60 and keep track of the lenses which do not click into position. The chances are that these lenses are not optically centered. It takes a little experience before the technique of manipulating these variables is achieved. In fact, the actual cementing of the lenses is the easiest part of this job, but make sure that the images fall exactly on the proper intersection points before allowing them to set.

This set up resulted after a great number of experiments, and was finally selected in preference to their predecessors. These included: (1) shifting the point source after every 15 lenses in order to secure a sharp focus and a large image distance; (2) reflecting the emerging beam at a 45 degree angle and projecting the image on the wall; (3) using parallel light and amplifying small resulting image points with a projection system. In other cases the point source played an important part. A true point source of light is one in which the light is emitted in all planes, (Fig. 5). The point source illustrated in Fig. 6, utilized in the early experiments, is obtained by punching a small aperture in a cylinder housing an a frosted incandescent lamp, was discarded because the angle of radiation is too narrow and is consequently not completely incident to lenses 1-60. Besides, the refracted image of this point source exhibits chromatic aberration. So in keeping with the idea of simulating actual operating conditions the crater tube was the only logical thing to use. Here, (Fig. 7) the angle of radiation is sufficient to cover the pitch of the spiral. This necessitates a D.C. voltage supply to ignite the tube, and a high resistance to prevent overloading and damaging the tube. A milliammeter is used to monitor the crater tube circuit. Once the tube is ignited the external resistance is increased to its maximum; approximately one megohm is suffiiient to keep the tube glowing.

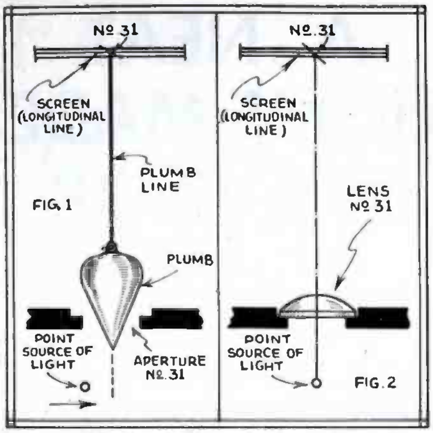


Fig. 1: Mechanical centering of aperture No. 31. Direction of arrow indicates correction required for moving point source into sixth degree plane. Fig. 2: Corrected optical alignment for the sixth degree plane of the optical system.

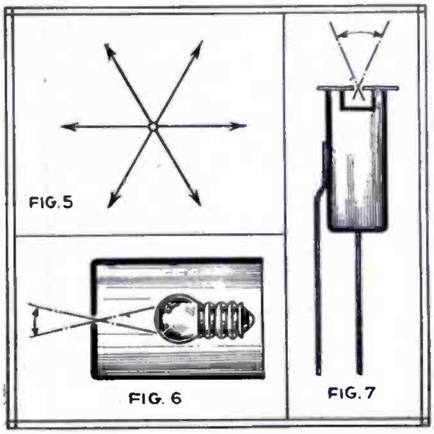


Fig. 5: Illustrating a true point source of light. Fig. 6: an experimental light source, consisting of an incandescent lamp in a housing. Fig. 7: a crater lamp arrangement that proved very workable.

HOW TO BECOME A TELEVISION ENGINEER

Many radio men wish to prepare themselves for engineering work in the promising field of television. Some good advice on getting started is given by Mr. Baird.

"WHAT should a young man study in order to prepare himself for television work?" This question has been asked very often lately and its answer, as given by Hollis Baird, chief engineer of the Shortwave and Television Corporation, shows that there is much for the embryonic visual radio engineer to absorb and digest in order to succeed.

In the first place, mere radio training doesn't mean that a man is at all qualified for television. A man can be a crack radio engineer and have as much difficulty approaching television as the former electrical engineer did when he tried to tackle radio. Yet it is absolutely essential that a television engineer be exceptionally well-versed in radio, for radio is the connecting means which brings television from the pickup to the television receiver output device.

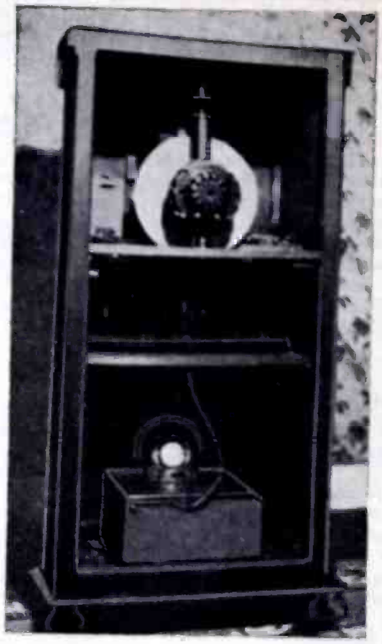
But once radio is mastered, the question of television itself comes up and the point long neglected by radio engineers trying to work on television is that television is primarily an optical device and that therefore a thorough knowledge of optics is essential. Very few radio men who know anything about optics and Mr. Baird strongly advises study on this subject. Incidentally, the best known text book on this subject is "Physical Optics" by Woods. Having a knowledge of radio and optics the television engineer has a third subject which should be mastered, physics, since much of television transmission and reception work is based on physical laws and particularly on that branch of physics known as mechanical engineering. A television pickup and projector offers many delicate mechanical problems, states Mr. Baird.

It is quite obvious from the foregoing that television engineering is a distinct and high art in itself, one demanding engineering talent of diversified character and high efficiency. Television also demands a good practical sense, as the purely theoretical engineer will not get very far in this subject.

While studying the three subjects outlined, their apparent relation in the art of television will be realized by a good deal of practical work on actual television apparatus and Mr. Baird advises prospective television engineers to get equipped with a first class television short-wave receiver and television picture reproducing machine and start making observations on the present television broadcasting.

A NEAT HOME MADE TELEVISOR

by ARTHUR HAMELIN



THE receiver I am using has two stages of radio-frequency amplification, using screen grid tubes, a screen grid detector and three stages of resistance-coupled audio-frequency amplification, using '27 tubes with two '45s in parallel.

The set has given me excellent results, and for those who wish to make this receiver I have included a list of parts and a complete schematic wiring diagram.

Ample isolation is obtained in the radio-frequency amplifier by the use of resistance-capacity filters.

In the power stage two '45-type tubes give ample power output for the new crater lamps. The power transformer includes two 2.5-volt windings, a 5 volt winding and the plate winding for the rectifying tube, which should have about 350 volts on each plate. The rectified high voltage is then filtered by means of two chokes of 30 henries each, designated in the diagram as No. 51-52 and the needed filter condensers blocks 48, 49, 50, 53 and 54.

The coils are wound on bakelite plug-in forms 1¼ inches (outside diameter). For the three coils wind 45 turns of No. 24 single-silk-covered copper wire on each coil. These coils take in television, police calls and amateur phone stations.

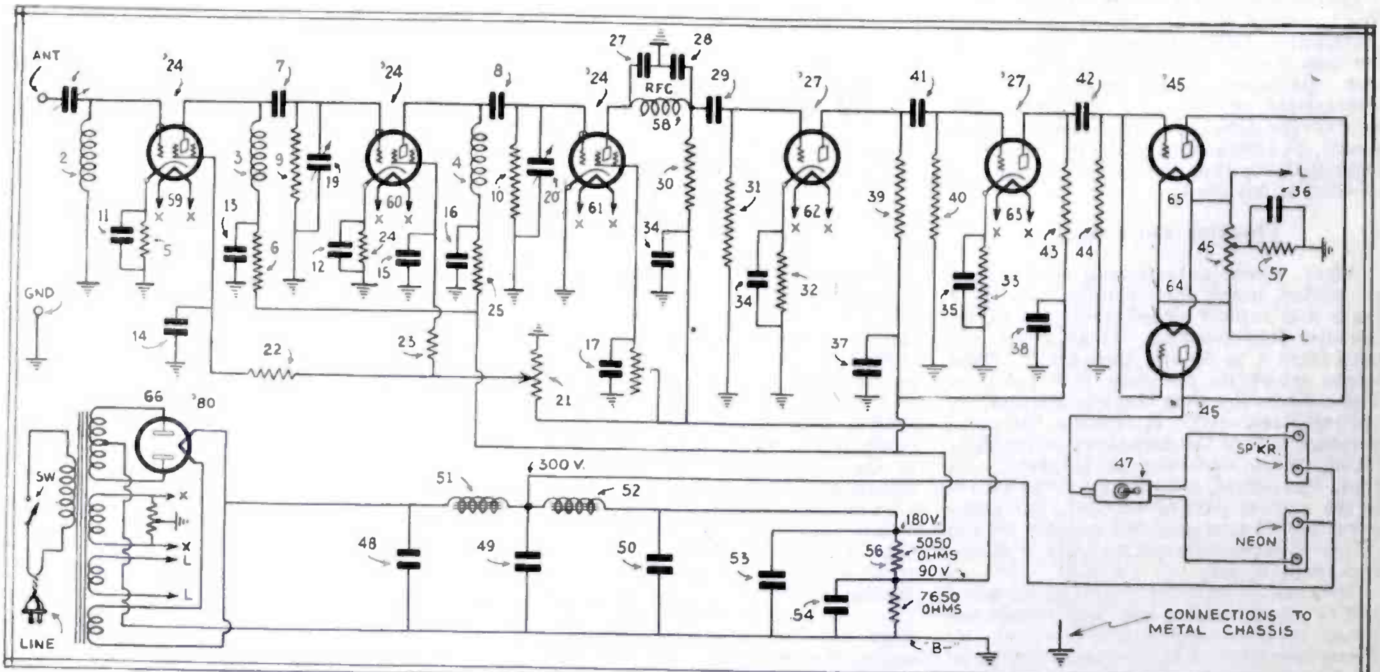
The next item to take up is the scanning system which consists of motor, disc and glow lamp. The motor I am using is a squirrel cage induction type, and I find it is very easy to control with a synchronizing wheel and amplifier.

The disc is a 60 line square hole double spiral scanning disc made of special alloy aluminum. Anybody constructing this set will be more than satisfied with the results.

LIST OF PARTS

1 Pilot Micrograd 0 to 0005 mf. (No. 1)
3 Plug-in forms 1¼ (outside diameter) (2, 3, 4)
2 .00016 mf. variable Condensers (19, 20)
4 .00015 mf. Fixed Condensers (7, 8, 27, 28)
2 .5 Meg. Resistors (9, 10)
6 450 Ohm Wire Wound Resistor (5, 6, 24, 25, 22, 23)
10 .1 mf. Rolled type Fixed Condenser (11, 14, 13, 12, 15, 16, 17, 18, 37, 38)
5 Pilot 5 prong sockets (59, 60, 61, 62, 63)
3 Pilot 4 prong sockets (64, 65, 66)
1 Pilot Resistograd (26)
1 R.E. choke 30 Milhenries
3 50,000 Ohm Resistors (30, 39, 43)
3 .25 Meg. Resistors (31, 40, 44)
3 .01 mf. Fixed Condensers (29, 41, 42)
2 2000 Ohm Resistors (32, 33)
3 1 mf. bypass Condensers (34, 35, 36)
1 Frost type 21349 H & H 3 point Double throw switch (47)
1 Pilot Volumgrad—50,000 Ohms (21)
1 750 Ohm Resistor (57)
2 20-Ohm center tap resistors (45, 46)
2 30 henry chokes (51, 52)
2 4 mf. Dry electrolytic Condensers (48, 50)
1 8 mf. Dry electrolytic Condensers (49)
2 1 mf. filter Condensers (53, 54)
1 Pilot 960 Resistor 12,700 Ohms (56)
1 Power Transformer (55)

Note: Numbers in parentheses refer to parts in diagram.



Complete wiring diagram of Mr. Hamelin's receiver.

W9IQG - AN AMATEUR TELEVISION TRANSMITTING STATION

by E. H. REED, Jr.

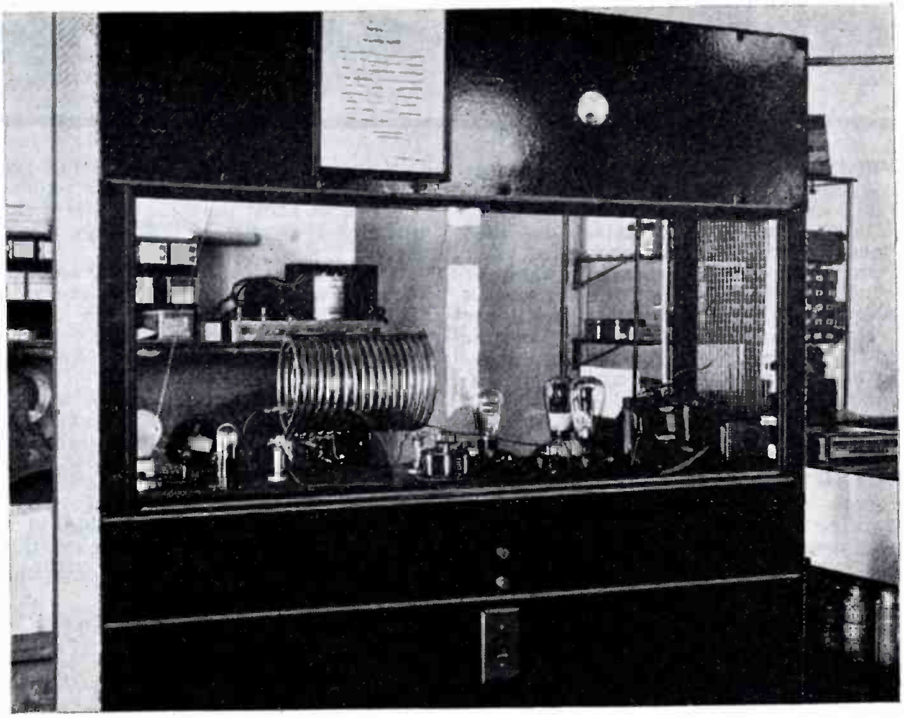
READERS of TELEVISION NEWS may be interested in these photographs of my television pick-up and transmitter, including a picture of Mary Brian as coming in on the monitor. This was taken with a commercial type camera on super-sensitive panchromatic film and I gave it two minutes exposure.

The photo cells and scanning equipment were purchased from the Western Television Corporation in Chicago and the amplifiers and transmitter constructed by myself in accordance with their circuit diagrams. The transmitter consists of a 245 crystal stage on 1765 kc. followed by two stages of R.F. amplification using 210's and then into a final R.F. stage also using a 210 modulated by two 250's in parallel. The modulation system is the series type and is giving exact reproduction of the image.

Demonstration Given

I have not had time as yet to determine my coverage, but have had reports from the entire Greater Cincinnati district of very strong and clear signals. My first public demonstration and scheduled test broadcast took place Wednesday, May 18th, from 7:30 to 9:30 p.m. with approximately 1,500 people attending. The demonstration consisted of the pick-up and scanner with monitor in one room and transmitter in another room with a home type receiver in operation picking up the broadcast. Thus they were able to see the picture before and after going out over the air. Everyone seemed to be well pleased with the results.

The station is located at 10th and Central Avenue, Newport, Kentucky.



Above: the actual radio transmitter of Amateur Station W9IQG. The parts are laid out in symmetrical fashion and are readily accessible.

The television scanner of W91QG as it appears to the person being televised. The round white objects are the two photo-electric cells. The scanning disc may be seen behind the large curtain in the foreground.

"Ham" Television Pictures Wanted

Many amateurs do not seem to know that experimental visual transmission by amateurs is permitted on a limited scale. The general impression is that this privilege is restricted to commercial organizations. Every licensed amateur should read the sheet of rules and regulations that accompanied his license for the full "dope" on this subject.

TELEVISION NEWS would like to see more television activity on the part of experienced amateurs, as it believes that this is a great and promising field for them. Television *transmitting* amateurs are invited to send us photographs and descriptions of any apparatus that they build and actually put "on the air."

A full size, unretouched photo of an image of Mary Brian as "shot" by Mr. Reed in front of his receiving monitor.

TELEVISION COURSE

Lesson 10 -- Double Images and a Suggested Cure

THE tendency today is toward the ultra-high frequency waves for television for the main reason that they do not suffer from the so-called "ghost" effects. While there are other reasons for their use, the advantages of a wider permissable band of modulation frequencies does not exist if the higher frequency bands are to be employed for 60 line images. Were the "ghost" images to be eliminated in the bands surrounding 3,000 kc. there would be but small reason for a shift under the present standards.

Electromagnetic waves were supposed to travel in straight lines, and for that reason there was some skepticism regarding our ability to transmit a wireless message over long distances due to the intervening curvature of the surface of the earth. It was suggested that the reason for the success of Marconi's trans-Atlantic venture was to be found in a conductive or reflecting layer above the surface of the earth, a layer which has since been proven beyond all doubt to be a physical entity.

Obey the Law of Optics

Now, it stands to reason that if a signal is transmitted from an antenna at one point and has several components in space—one leading along the earth's surface and others travelling upward to the Heaviside layer to be reflected back again to the receiving antenna, those reflected components will have traversed a greater distance in their journey. The reflections follow quite definitely the laws of optics regarding refraction and total reflection. These components are termed "ground waves" and "sky waves" respectively. If the added distance of path is sufficient the time element will result in a definite tailing or blurring of signals and if an oscillograph is employed with the transmitter sending out regular impulses of short duration the time element involved may be accurately measured.

Light waves, and presumably electromagnetic waves, travel in space at a rate of 186,300 miles per second, so that a wave will travel completely around the earth in the interval of approximately 1/7th second.

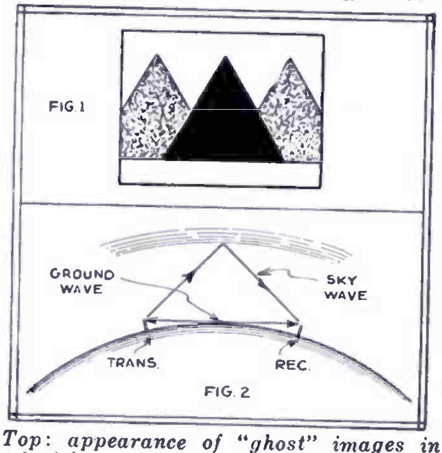
Barring the possession of an oscillograph of such accuracy the experimenter may carry out his own tests by means of a standard television scanning disc. The width of the field of vision represents an angle of 6° or 1/60th of the total circumference. With a sixty line image at a rate of twenty images per second this corresponds to a time element of .00083 second.

If, therefore, we were to receive a signal from a transmitter ten miles distant and find that a secondary image appeared—offset from the original by about one third of the field—we might consider that the secondary image had arrived .00027 second late, corresponding to a difference in the path travelled of about 50 miles; so that it might be stated that the path travelled by the "sky wave" component had been sixty miles as against ten miles for the ground wave. The appearance of such an image is as shown of Fig. 1. We could assume by a mathematical interpretation of the facts that the reflecting layer had been about twenty-eight miles above the surface of the earth, as indicated in Fig. 2.

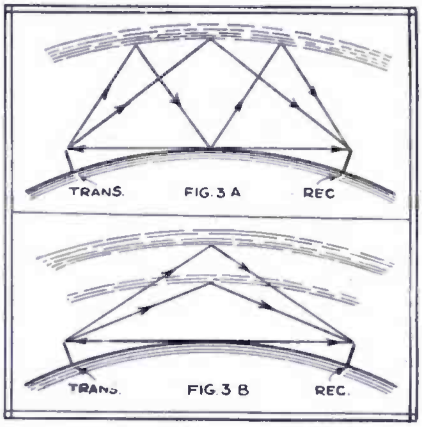
This represents the simplest case where a single ghost image has put in an appearance. Where three or even more ghosts have appeared we may accept one of two theories. The first involves a situation such as is shown in Fig. 3a and the second a condition such as in Fig. 3b, where more than one reflecting layer is the assumption. Either case will serve our purpose.

Effect of the Sun

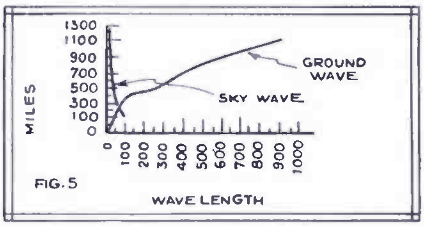
That such a reflecting layer is in existence is no cause for puzzling, for the sun itself may possibly give off rapidly moving electrons capable of ionizing the gas particles in the upper atmosphere. We know for a certainty that gases may be ionized by ultra-violet light and it is one and the same to us which theory is correct. The reason for the marked disturbance at sunset, when multiple images are most evidenced, lies in the fact that the lowering angle of the sun results in a change in the height of the layer which



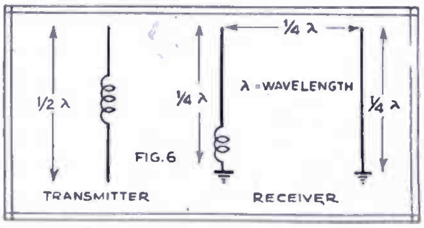
Top: appearance of "ghost" images in television reception. Bottom: Illustrating the different lengths of the paths covered by the sky and the ground waves.



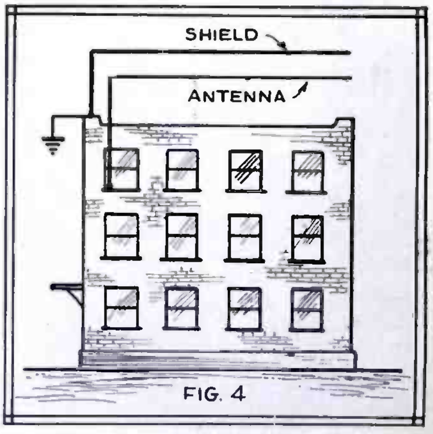
These diagrams show two possible causes of "ghost" images in television reception.



Relative distances covered by sky and ground waves of various wavelengths.



Low angle transmitter (left) and directional receiver with reflector wire (right) suggested by the author.



A shield above the regular receiving antenna to minimize the effect of the sky wave is suggested by Replogle.

may not come about in a smooth manner.

Indeed, either case as shown in Fig. 3 a and b might exist in the transient condition existing at sunset.

It is possible for the ghost images to be positive or negative in their action so that were we situated beyond the ground wave limit and limited as to reception to the sky components only it is possible for negatively phased waves to arrive at the same time as those of positive character and of the same order of amplitude, so that a complete loss of the image might result. This is what is termed as *selective* fading in the communications art and is of but short duration.

Height Varies Rapidly

Investigation has shown that with the sun directly overhead the penetration of the electrons and of the ultra-violet light is great, so that the height of the reflecting layer may be as little as twenty miles, while after dark it may range from 150 to 400 miles. Some idea of the rapidity with which changes in the height may occur can be gathered from the fact that observations have been taken in which the layer has risen through a height of six miles in a minute and fallen through a distance of twenty-five miles in the same interval. That the disturbances should be violent and annoying at sunset is not an illogical result.

Bown, Martin and Potter have shown (Proc. I.R.E., Feb. 1926) that where the frequency of the transmitter is not constant those components arriving over differing paths may differ also as to frequencies and produce a beat note—one with the other. This results in an appalling loss in the quality of the signal and where such effects are likely to occur it is essential that the frequency of the transmitter be well stabilized.

Shielded Antenna Suggested

Replogle has suggested the use of a shielded antenna at the transmitter, in the manner shown in Fig. 4, to minimize the sky components. While such a system has been tried in Germany, presumably with a vertical quarter wave antenna (advices are not specific), it is doubtful whether the system shown is entirely practicable. For various frequencies at various distances the ratio of the two components may be seen from Fig. 5. Since the actual service area of a transmitter cannot be said to exceed 200 miles or so, and in the ranges surrounding 3000 kc. (100 meters) it may be seen from the figure that the ground wave is well defined, there is the possibility of directing the radiation at a low angle so that the angle is large where the sky components reach the reflecting layer. If we were to employ a low angle radiator such as a vertical dipole or half wave antenna (Fig. 6), not an impracticable dimension at the transmitter, and at the receiver employ a vertical quarter wave antenna as indicated in the figure, the conditions would be fulfilled at both points. The use of a quarter wave reflector backing the receiving antenna would add to the effectiveness of the system. While this last requirement complicates matters for the amateur it is not too large an order where public demonstrations of any importance demand exceptional quality from the signal.

With the low angle radiation the sky waves might be lost entirely within the desired service area by virtue of their long reflected path.

THE PHONIC DISC

By MARTIN GAISER

BECAUSE of the number of systems that are employed, it is necessary that an experimental television receiver be extremely flexible in design. With forty-five and sixty-hole discs, running fifteen and twenty frames per second, and now talk of ninety and one hundred and twenty hole discs, the experimenter is at a loss as to how to design a cheap receiver today that will not be obsolete tomorrow.

The problem of synchronizing the receiver is the first obstacle to be surmounted. In the peep-hole machines there have been offered various forms of phonic wheels and synchronous motors. These are of very little value where the power supply is from D. C. lines or from batteries. Perhaps the most practical system would be the use of a phonic disc in connection with an universal motor and a spring hub. The disc would consist of a scanning disc constructed of soft iron and having a toothed periphery, and an energizing magnet, which is driven by the low frequency component of the television signal.

The most essential thing in this system is the design of disc. This, however, is easy to make. The first step is to secure a piece of twenty gauge stove pipe iron a little larger dan the disc is to be. The size of the disc is optional. However, the examples given are for a twelve-inch disc. A disc is laid off bringing out the radii on which the holes are, to the circumference. These intersection points are to be the centers for drilling the holes which are between the teeth. To find the size of the drill necessary, find the circumference of the circle and divide it by two times the number holes of the disc.

Example:

Diameter of disc = 12 inches

Number of holes = 60

$$\frac{12 \times 3.1416}{2 \times 60} = .31416 \text{ aprox. } \frac{21}{64} \text{ inch}$$

After the holes are drilled the extra metal may be cut away from the disc. This disc must be used with a spring hub.

The energizing magnet consists of the primary of an old audio transformer and a special iron core. The core is constructed of the same kind of iron as the disc. The only important dimension of this is the distance between the two points A and B (see Fig. 1). If the magnet is to be used with both forty-five and sixty-hole discs, the distance between the points A and B (Fig. 1) must be such that the points will correspond with the teeth on either. The holes on a forty-five hole disc are 8° apart, and on the sixty are 6°. Since 24° is the least common multiple of 6°, and 8°, the points must be 24° apart. To find the distance in inches use formula $a_2 = b^2 + c - 2bc \cos A$.

Example

Diameter of circle = 12 inches

Radius b = 6

Radius c = 6

Log 2 = 0.301030

Log b = 0.778151

Log c = 0.778151

Log cos A = 9.960730

Antilog .818062 = 65.78

$6_2 + 6^2 = 72$

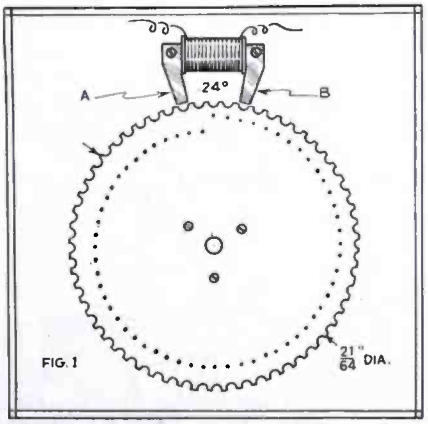
72 — 65.78 = 6.22

$\sqrt{6.22} = 2.49$ or approx. 2.5 inches

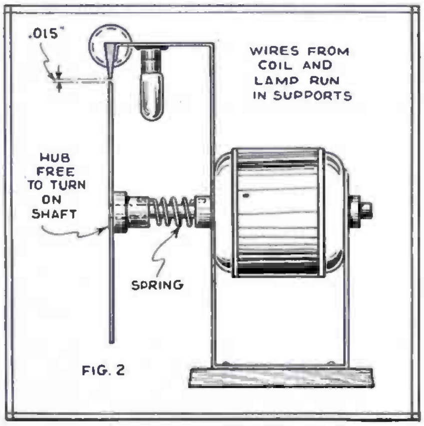
Thus the distance between the points A and B should be 2.5 in. for a twelve-inch disc. The laminations are made in two parts similar to those of a transformer, so that they may be inserted into the coil. A and B should be tapered off to a width of 1/16 inch at the point. Other dimensions are optional with the individual. The magnet assembly should have as little air gap between the points and disc as possible when assembled (about .015 inch).

The magnet may be energized by any suitable amplifier such as have been used by both Baird and Jenkins for synchronizing. It is only necessary to adjust the speed of the driving motor to the approximate synchronous speed and the disc will automatically maintain synchronism.

While many details and dimensions are left to the individual experimenter it is desirable to follow Fig. 2 as closely as possible, for this permits the change from one disc to another, by the removal of three screws from the hub.



Appearance of the unusual scanning disc constructed by the author.



This arrangement of parts should be followed as closely as possible.

TELEVISION WITHOUT MODULATED LIGHT

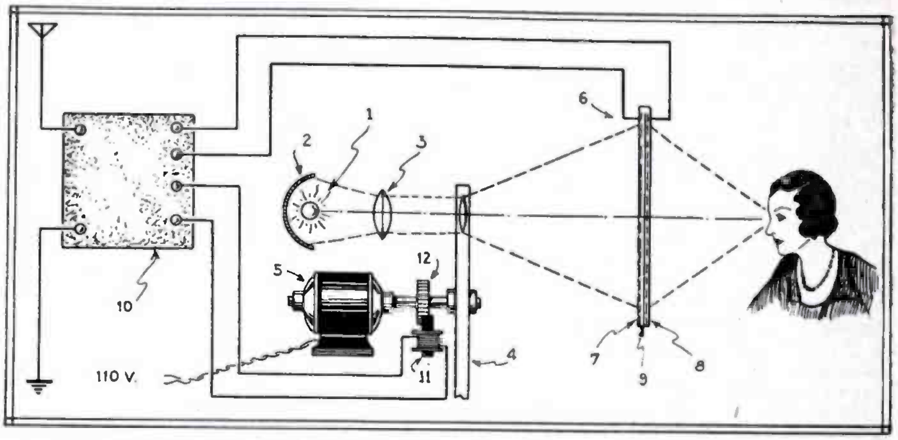
By HENRI DALPAYRAT

This system does away with the modulated light source and its objections. A novel screen having both photo-electric and fluorescent properties is employed. Less distortion and a very brilliant image are predicted by the inventor.

THE problem of designing an efficient source of modulated light has not been solved yet. Although great progress has been made with crater and crater arc tubes, there still remains much to be done. The life of our present television light sources is too short. Many tubes become overheated easily and then are rendered inoperative or become sluggish, which tends to produce a blurred picture. The fidelity of response over a wide range of frequencies is a problem which cannot be solved in the amplifying system alone but also in the light source itself. Overheating, deterioration of the gas, sluggishness and the resulting blurred picture, are the main difficulties which cannot be corrected easily and are most objectionable.

The new television receiver which is to be described in this article employs an ordinary electric bulb of 50, 100 or 200 watts, according to the distance one wishes to project the image and the size of the screen. For a home televisor having a screen two feet square, a 75-watt lamp is recommended. The light of this lamp is constant and no attempt should be made to vary it in any way. Instead of modulating the light source, the screen itself is modulated. This is accomplished by employing a special screen which may be obtained from the Taylor Vacuum Products, Chicago, Ill.

Referring to the illustration, 1 is an electric light bulb of 75 watts, 2 is a silver or chromium plated reflector, and 3 is a focussing lens which converges the light into a narrow beam. This beam is scanned by a lens disc 4 rotated by a motor 5. The light passing through the lenses is projected upon a flat glass cell 6. The surface of this cell receiving the light rays is made of photo-electric substances coated over a metallic wire cloth.



This schematic drawing shows the general arrangement of the parts in the novel system suggested by Mr. Dalpayrat.

The opposite side 7 contains another wire cloth 8, coated with fluorescent materials. Part 9 is a thin coating of opague, non-fluorescent substance. These electrodes are enclosed within a flat glass cell which has been evacuated. The cell is to be connected directly in the output of the last power tube of the signal receiver 10, and its voltage varies according to the signal voltage variations. 12 is the synchronizing toothed wheel and 11 is the field magnet.

With light source 1 shut-off, the photo-electric surface 6 does not emit electrons and the fluorescent screen 8 does not glow. With the light source turned on, the scanning lens disc 4 traces lines of light upon the photo-electric surface and causes it to emit electrons. The various beams of electrons striking upon the fluorescent surface 8 produce various glowing spots of different intensities according to the voltage that this screen may have when it receives each beam of electrons.

This invention is very practical for average size screens to be used in home televisors.

A NOVEL SCANNING DISC

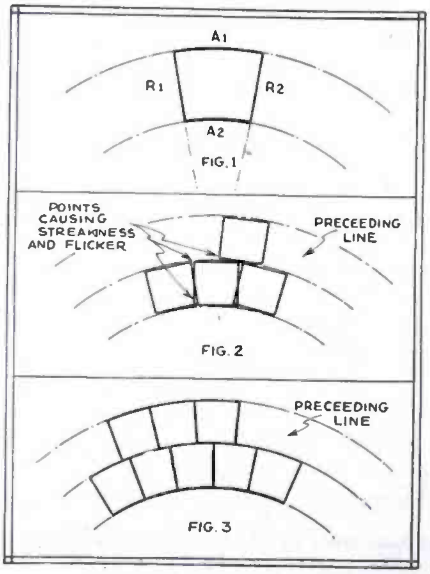
By VINCENT ANYZESKI

THE Nipkow disc of the usual television receiver is the part in which the greatest accuracy and care must be exercised in construction. Every article explaining the action or construction of a scanning disc stresses the necessity of perfect shape, size and alignment of holes. Experimenters who have built discs will readily recognize this fact.

It is only the laboratory disc which can show us the true possible efficiency of the Nipkow disc in producing a dead flat image, free from bright or dark streaks, flicker and distortion.

I have been working on a commercial method of producing scanning discs in quantity which will equal the laboratory master discs.

My disc uses the really perfect hole, that is, a hole bounded by arcs and radii as in Fig. 1. This type of hole produces even illumination and a motionless field. Figure 2 shows the imperfections of the square hole as compared to my matched holes with slanting sides and curved top and bottom. In Europe the Mihaly system uses this type of hole with great success.



As for my method of producing precise discs for use in the present receivers, the transcription of phonograph records is symbolical.

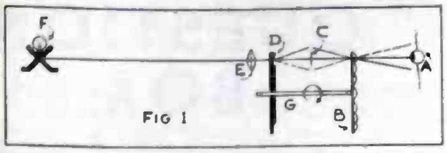
A master disc is first constructed in the laboratory. This master disc is placed on top of a "mother" disc made of very thin clear glass coated with a photographic preparation, not necessarily over the entire surface but in the hole area. We have therefore a photographic plate. Light shining through the holes of the master disc will affect the photographic film exposed by the holes. This "mother" when developed will be a negative of the master disc.

Reproductions of the master disc can now be secured in quantity by placing the "negative" on a thin clear disc also coated with a photographic film and exposed to light. When developed the resulting disc is a positive print of the same quality as the master disc. Due to the extreme thinness of the disc it is supported between two aluminum discs having larger holes punched in them to accommodate the scanning points of the glass

(Continued on page 207)

DIGEST OF TELEVISION PATENTS

This section does not pretend to be a complete review of the patent situation, as it changes from month to month. The patents chosen for review or for comment are those having the greatest value to the amateur or to the independent investigator either from the standpoint of instructive value or general interest. Some are highly technical as to content while others are based entirely on constructional methods adaptable to the uses of the amateur.



Patent No. 1,559,437

Double-Image Scanning Method

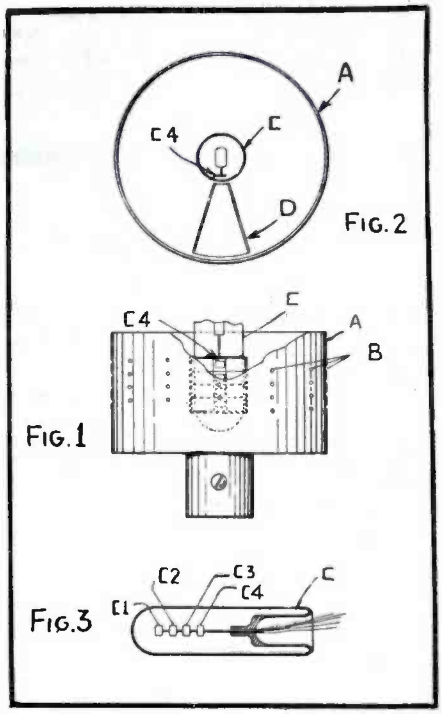
Patent No. 1,559,437, issued to Charles Francis Jenkins of Washington, D. C., October 27, 1925.

In Fig. 1, *A* is a light-sensitive cell; B a lens disc; *C* a ground-glass screen; *D* a prismatic disc; *E* an objective lens; *F* the scanned scene; and *G* the shaft upon which both lens-disc and prismatic disc are rotated. In operation the objective lens focuses an image upon the ground-glass screen, except for the intervention of the prism, which causes the image to be swept across the glass screen from top to bottom as the prismatic disc rotates. This disc (Patent 1,385,325) is a glass disc into which has been ground a surface of continuously variable angle, resulting in a continuous displacement of the image during each rotation of the disc. The lens disc serves to sweep the second image formed by its lenses which are arranged about a circumference across the aperture of the photo-sensitive device. The result is a "direct-pickup" transmitter of excellent characteristics. The ground-glass screen remains in place only during the focussing of the lenses; it is then removed to prevent loss of light. The patent specifications are quite simple as set down above a claim also being made for the use of the device without the prismatic disc, where the vertical scanning component is provided by the downward motion of the film in a film transmitter. This is an interesting variation of the "lens-disc" principle.

An Electro-Optical System

Patent No. 1,773,785 issued to Harry Nyquist of Millburn, N. J. (assignor of the A. T. & T. Co.), August 26, 1930.

Mr. Nyquist is, by the way, one of the world's greatest engineers—specializing in cable problems. This provides a simple system for secrecy in television transmission by employing an odd pattern scanning disc. Its main purpose is to defeat the effects of cross-talk from adjacent television channels. This is accomplished by breaking up the interference pattern; the premise being that interference is less troublesome when not taking a homogeneous form. If we desire to receive Fig. 4, while a nearby transmitter is sending out Fig. 5, the interference pattern—were both discs alike—would be as shown in Fig. 6. If we were to employ the off-standard disc, as shown in Fig. 3, for one channel, the interference would be broken up into the form shown in Fig. 7. The system is of particular value in two-way channels, where both signals may be transmitted in the same cable sheathing.



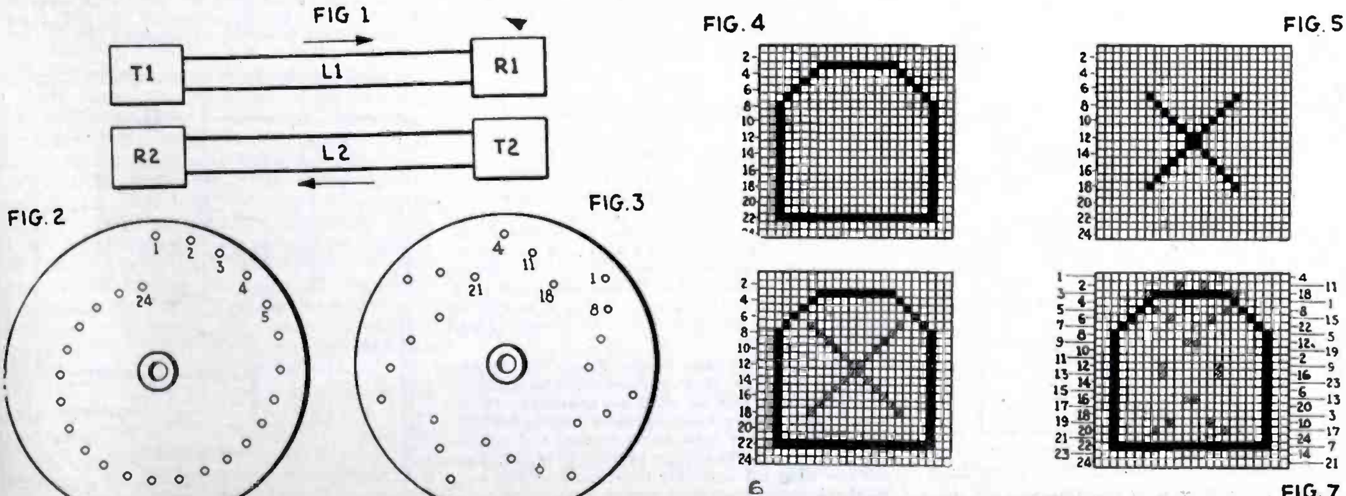
Patent No. 1,730,976

Jenkins Drum Scanner

Patent No. 1730976—Issued to C. Francis Jenkins of Washington, D. C. Assignor to the Jenkins Laboratories. Patented Oct. 8th, 1929.

This is a forerunner of the present-day Jenkins drum-and-shutter scanner. By means of a rotating switch member not shown in the figures the signal is commutated in turn to the four tiny plates of an especially developed neon tube. Four complete spirals of apertures are cut in the drum—15 apertures per spiral for a 60 line image—and one is thus able to keep down the size of the arrangement materially. The circumference of the drum is but one quarter that of a standard Nipkow disc for the same image size.

In the three figures shown the general structure of the device is carried out to such an extent as to require no further explanation.



Patent No. 1,773,785

THE TELEVISION QUESTION BOX

Trouble With Negative Images

G. L. Lalli, Hazleton, Pa.

I am a regular reader of your magazine TELEVISION NEWS, and would appreciate a few answers about obtaining a better picture on my television outfit. I am employing a National short-wave set with a three stage resistance coupled amplifier added thereto. This amplifier feeds a standard Raytheon Kino Lamp. I have been troubled with a negative image. How may this be corrected? May I expect to receive only silhouettes or will I get a detailed image with a sufficiently strong signal?

Answer:—It is true that a grid-leak type of detector should be followed by an odd number of low frequency amplifying stages. This requirement is often upset when too much regeneration is employed at the detector. There is no way of correcting for this where the initial signal strength is so low as to require pushing of the circuit to the utmost sensitivity by use of regeneration. The only hope is a more sensitive receiver.

Where the signal strength is fairly strong you will be able to receive good images, not, however, when using regeneration.

Television on 25 Cycles

G. Murray,
53 Elm Grove Ave., Toronto, Canada.

I have been trying to make a television set operate on 25 cycle A.C. such as is the standard form of supply in this part of Canada. Somehow or other the images will not come clearly, a cloud seems to be passing before the screen. Can you give me a few pointers on making the set work in conjunction with the 60 cycle scanned images now sent out from the U. S. A.?

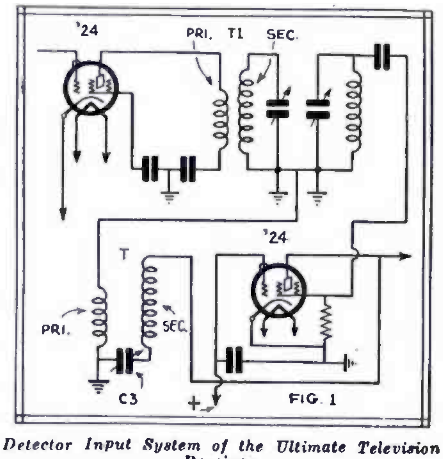
Answer:—A friction drive system such as appears on page twenty-three of the Mar.-Apr. 1932 issue of TELEVISION NEWS may be used to synchronize the 25 cycle and 60 cycle driven discs. The driving motor may be a synchronous or induction job of a speed commensurate with the 1200 r.p.m. required at the disc. The fact that a cloud seems to be continuously passing over the field seems to the writer to point to excessive hum in the receiver. Additional filtration will undoubtedly cure the fault.

Circuit Values

Milton B. Parseley,
368 Central Ave., Brooklyn, N. Y.

I am interested in the prize winning receiver of the New York *Sun* contest. I wish to build that receiver but cannot until I have the values of R1 and C8 and the meaning of the notation Ret 100,000 ohms. I would also appreciate your opinion on this receiver.

Answer:—R1 may be of the order of 10,000 ohms and C8 about .1 mf. The values are not critical in the ranges mentioned. I can find no position in the schematic circuit for anything conforming with the specification RET 100,000 as given in the parts list. This might mean Rdet and refer to R1 since this is the detector biasing resistance. The writer considers this receiver to be one showing great initiative on the part of the designer, yet feels that the complexity of the circuit is hardly called for. No provision is made for the pre-detector selectivity so necessary to satisfactory service from a superheterodyne receiver.



Detector Input System of the Ultimate Television Receiver.

Suitable Motors

J. C. Baird, Bay St. Louis, Miss.

What type of synchronous motor may I use to rotate a 20 or 24 inch lens disc such as has been described in TELEVISION NEWS in recent issues?

Answer:—The Baldor Electric Co. at 4357 Duncan Ave., St. Louis, Mo., will be able to supply a satisfactory motor together with a mechanically filtered hub which aids in starting.

Calculating Reflected Light

Melchor Centeno V.,
151 West 72nd Street, New York City.

In the flying-spot scanning system how is it possible to determine the amount of light available to the photo-cells so that the input voltage to the preliminary amplifier stages may be calculated? In other words, how much light is received by the subject and how much is reflected to the cells from the surface of the subject?

Answer:—The writer successfully ducked this question once before, but Signor Centeno seems to have a thirst for knowledge which knows no rebuffs—so here goes. No tables are available giving the efficiency of reflection of various substances to light of varying color constituency. Were this known it would be possible for us to definitely calculate the light available to the cells under given conditions. First we must know the amount of light reaching the subject, which is that available through a single aperture in the scanning disc. We must then have an idea of the average reflection coefficient of the scene to be scanned, and finally the aperture of the cells or reflectors and their distance from the scanned scene. These facts are best attained experimentally rather than mathematically, as illogical conclusions may be reached. Five years ago outstanding authorities on television stated that the direct pick-up system was impossible because even with the best available lens (having the highest ratio of aperture to focal length or "speed") in order to form a one inch image at the disc the subject would have to be lighted by a 16,000 c.p. arc at a distance of four feet for the cell output to be above the irremediable noise level of the amplifiers. These results were based upon mathematical calculations of the highest order of precision.

Engineering Instruction

G. A. Stapp,
U. S. Submarine Base Coco Solo, C. Z.

In an earlier issue of TELEVISION NEWS you answered a letter from C. R. Johnson which is of considerable interest to me. I have three years of high school and have been in the Navy for three years (Radioman 2nd Class) and have completed a correspondence course in radio. What is the tuition at the Moore School and what kind of examination do they give? Would I be able to get some sort of job to help meet expenses? I am twenty years old.

Answer:—Write the Moore School of Engineering, University of Pennsylvania, Philadelphia, Pa. for information on all these questions. They will undoubtedly grant you some special consideration because of your naval service and resulting practical experience in radio. They will also tell you what aid they give those needing jobs and what minimum amount of money you should have available before starting the course.

Were you a year younger I would suggest your trying for appointment at the Naval Academy.

Perhaps if you have just turned twenty it is not too late. Ask your immediate superior officer to obtain information for you. You will probably need a year more of high school work before you can enter any of the accredited courses at a regular university.

Using a Crater Lamp

Charles B. Tauber,
2301 Broadway, Carlattsburg, Ky.

On page 432 of the February issue you have an article on the Ultimate Television Receiver. You say there that this set can be adapted to the use of a crater lamp. Please show me how this is done and tell me what size crater must be used with my lens disc.

I am having some trouble with my receiver which appears to be in the R.F. end since an alternating current applied to the detector input is satisfactorily amplified. Will you give me more detailed information on the connections to the band-selector system in the detector system in the detector input circuit?

Answer:—The circuit as shown may be operated with the crater tube without changes, as the elements of such a lamp are identical in function with those of a flat-plate tube.

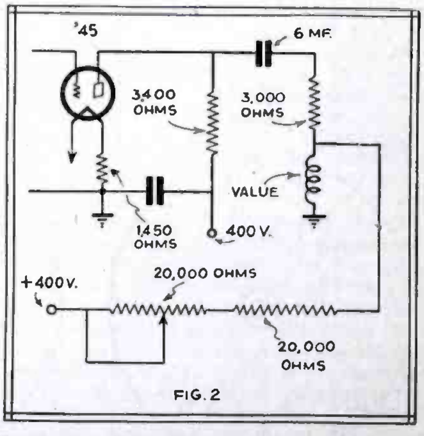
The crater or aperture size is determined by the "pitch" of the spiral along which the lenses are located. The aperture must be about 10% larger than the pitch of the spiral to permit a slight overlap to avoid dark lines due to inaccuracy of the disc. The accompanying figure gives the needed data on the band-selector circuit.

Cathode Ray Screen Construction

George H. Morse, Consulting Engineer,
Harrisburg, Pa.

I have a Jenkins Television receiver purchased about a year ago and I desire to pass about 125 ma. through a coil to be placed in the neon lamp circuit of this receiver. I am willing to use external batteries in order to do this. The arrangement is for a new type of light valve which I am trying.

Answer:—The circuit given herewith will enable you to pass the required current through the winding without affecting the output of the receiver in any marked degree. The series resistance feeding the coil is effective only as regards the D.C. in the circuit and does not short circuit the signal voltages. Variation of the current flowing may be accomplished in the manner shown. If the signal current is to compare in magnitude with the D.C. biasing current in the coil, a much larger output tube will be required.



Obtaining separate biasing current through a magnetic light valve.

TWO WAY CATHODE RAY TUBE

(*Continued from page 176*)

obliqueness under which the scanning beam impinges upon the screen as the scanning cycle proceeds.

As to number 1. The "two-story cathode tube" is demonstrated in its working principles in Fig. 4, where the image of the object to be televised is focused on the emitting surface within the argon-filled cathode ray tube in the way described, while the received image is viewed from, or projected on a screen against, the direction A.

The device in Fig. 4 operates as follows. The output signals leave the device for the amplifier and transmitter through 11a, as already described. As to the scanning beam 12 of the sender, however, it not only scans the emittive surface upon which the transmission image is focussed, but also serves to cause a conductive path in the cathode tube between *9a* and wall 2, as a result of the electronic flow between the emittive surface and *9a*.

The dividing wall 2 separates the cathode ray tube from the gas tube 3. This dividing wall is not transparent for light beams. The collecting grid 9a is placed near enough to the dividing wall 2 so that the potential difference 10b (applied between *9a* and *9bQ* will result in ionization in the gas tube 3 whenever and wherever there is an electronic flow between the emittive surface and the collecting grid 9a of the cathode tube. The conductive path between 9a and 9b, in its short cathode tube portion, is obtained by either stray electrons shooting through 9a or electrons reaching wall 2 as a result of a small additional potential difference 10c applied between 9a and 9c (the latter being an auxilliary electrode near wall 2 in tube 3), or by both means. Part 9c can be a metallic surface upon wall 2 in tube 3.

Modulating the Glow

The glow in the gas tube 3 is modulated by the amplified signal imput voltages which are imposed on 11b and serve to modulate the ionization flow between 9b and 9c. The crater-like glow, which results only around that spot of 9b (when viewed from direction A) which is opposite the spot just scanned of the emittive surface of the cathode tube, is intense enough for large size screen projection in the direction A of the received image. Of course, the end wall 2a of the tube is transparent.

This "two-way cathode tube" may be made the principal part of a two-way television communication, when two stations are built with circuits accommodating the two-way tube. If we also include synchronized saw tooth frequency generators with shafts revolving with equal speeds at the two stations, also a two-way secret television system is possible. Increasing the number of such "radio-interlocked" stations (common or secret), reciprocal television communication may be arranged among any desired number of stations.

2. It remains to sketch the nature of scanning discrepancies which are not negligible in case of "short" cathode tubes and the method of eliminating the same.

The replacement of screen 3 in Fig. 2 shows that beam 12 is oblique to the surface of 3. If point I (see Fig. 5) is taken as the center of deflection, that is from which the cathode beam may be considered to bend, then to the equal horizontal arcs A, B, C, D, E, and F on an imagined spherical screen in front of screen 3 there will correspond unequal scanned surfaces a, b, c, d, e and f, on screen 3; the rate of scanning, that is, the deflection per unit time, increasing as the scanning process goes on in the direction of arrow H. (At starting point 0, which may be taken as the upper right corner of the scanned oblong surface of screen 3, cathode beam 12 is supposed to fall perpendicularly on screen 3.

A similar increase of the scanning rate is experienced in the vertical direction.

Discrepancies in Scanning

Thus, the shorter the cathode beam distance between L and screen 3, the greater the scanning discrepancy as a result off the scanning accelerated in direction H. The vectorially combined result of the horizontal and vertical scanning discrepancies is varying picture detail and definition throughout the scanning cycles in an increasing manner. The total discrepancy at any moment is proportional to the tangents of the instantaneous deflections of angles counted from the L0 starting position of the scanning beam 12. If the instantaneous horizontal and vertical deflections are marked as angles s and u respectively, then a definite relation between these angles and the instantaneous linear deflections p and q of the screen surface P-Q (see Fig. 6 and 7) may be calculated.

Of course, radial distance r (from L-0) also changes between 0-B and 0-C points of the P-Q screen (see Fig. 7), taking up increasing r, and r_2 values in the two directions as the scanning goes on.

MIRROR DRUM SCANNER

(Continued from page 198)

When properly constructed, this type of scanner will produce satisfactory television pictures and at a cost of about one-tenth of a lens disc.

Figure 6 shows how the strips are mounted on the wooden drum. The screw holes in the top strip are lengthened so that it can be pushed forward or backward, which allows the changing of the angle of reflection. Each mirror is slightly offset so as to produce lines exactly as is done with the regular form of Weiller mirror wheel.

In adjusting the mirrors, an oblong 5" by 6" is drawn on a sheet of white paper and horizontal lines (60, of course) drawn equally spaced. The neon is lighted and the various spacings, lens to drum, lens to reflecting mirror, etc., are adjusted so that the point of light on the screen is of proper size. Then one mirror (number 1) strip is slid either forward or backward so that the light spot scans number 1 line as the drum is slightly rotated. Then adjust the next strip in the same manner so that number 2 line is scanned. Then number 3 and so on. Of course, as each mirror strip is adjusted, the bolts are tightened.

AN ACCURATE LENS SCANNING DISC

(*Continued from page 184*)

play exists between the bushings or if B^1 is slightly too large for insertion into B^2, cut through one side of the bushing B^2 lengthwise and then compress or expand the bushing as the requirement may be and solder together. Concerning bushing B^1 in which the drill bit should be centrally wedged, it is advisable to take the bushing, with the drill bit tightly wedged within it, to a machinist and have him cut down the bushing in a lathe so that the drill bit becomes accurately centered within bushing B^1.

Cut a hole into the baseboard about 2" long and about ¾" wide, to accommodate the lower end of the drill bit along its entire radial portion.

The Drilling Jig

In Fig. 4, the drilling jig is shown with the disc attached. As indicated in this diagram, the distance between the center of the outermost hole of the spiral (the first to be drilled) and the center of the disc is 10.125". The total pitch of the spiral, corresponding to the radial distance between the centers of the first and last hole, will be $59 \times .015 = 0.885"$. With these figures in mind the center of the disc is fastened in place by means of a bolt which is firmly attached in the baseboard. The fit between the disc center hole and bolt must be tight. Let a distance of approximately 1/6" exist between the center of the disc and the baseboard. This is easily accomplished by attaching the bolt within the baseboard by means of nuts, as shown in Fig. 1.

The protractor is shown with the indicator needles directly over one of the degree marks. The small metal arm, to which five phonograph needles are soldered, is permanently fastened to the vertical portion of the movable base as indicated. More than one needle pointer is necessary due to the necessity of using short degree marks on the protractor during drilling. The indicator needle points should lie as close as possible to the protractor, and lie absolutely parallel to a radial line drawn from the center of the disc.

Drilling the Holes

The micrometer screw is adjusted so that the distance between the center of the first hole to be drilled and the center of disc is 10.125". The disc is rotated to bring the 0° mark on the protractor directly under the needles. The clamp nut "C" of the jig is now tightened. It is advisable to use an additional clamp to ward off any possibility of the disc moving during the drilling. After the first hole is drilled unloosen the clamps and give the micrometer shaft the necessary fractional part of a turn to bring the drill bit of the jig .015" closer to the center of the disc. Now rotate the disc to the right through an arc of 6°, using the protractor as your guide, and again clamp the disc firmly within the jig and drill the second hole. Continue this procedure until all of the holes are drilled.

Procure or have made a counterboring tool. (The counterboring tool shown in Fig. 5 was used by the writer.) When counterboring the holes of a disc 1/10" thick leave a lens seat shoulder .020" thick. Fig. 5. When counterboring the holes in a thicker disc the thickness of the lens seat shoulder can be increased. While counterboring have the disc firmly attached to a flat surface, thus assuring lens seat shoulders of equal thickness throughout the entire spiral of holes.

The use of Duco cement for securing the lenses in the seats is recommended. Various methods of securing lenses have been described in past issues of this magazine.

The writer uses a Jenkins neon crater tube but other lamps can be used provided the diameter of the crater emitting the light is the same as employed in the Jenkins type. A focusing arrangement whereby the crater can be accurately focused with respect to the lens disc has been described in detail in past issues of this magazine and therefore further mention on this subject is not necessary.

A Suitable Motor

A screen suitable for the reproduction of images up to 10" × 12" has also been covered in past issues of this magazine.

A motor of 1/6 or 1/8 h.p., will be suitable for driving the disc. Under those conditions where a different A.C. supply is used at the receiving end than at the television broadcast station, a synchronous motor will not serve our purpose. In this case we will use an induction or series motor. To maintain synchronism between receiving and transmitter discs when using an induction or series motor, add a phonic wheel to the shaft, as explained in previous issues of TELEVISION NEWS.

The author invites inquiries from those readers who are contemplating the construction of experimental transmitting and receiving apparatus. Enclose a self-addressed envelope with sufficient postage to cover mailing charges.

AMPLIFICATION

(*Continued from page 183*)

4. Were the grid to be swung positive, so that grid current was drawn, the current flowing through the grid leak resistance would result in a voltage drop subtractive in polarity from the normal grid bias. If the grid voltage were obtained from some invariable source, the loss in bias would result in a large increase in plate current, followed by more grid current and a cumulative effect resulting in the loss of the tube. With the bias taken across a resistance in the cathode-ground return as in Fig. 3, where the biasing potential is dependent upon the plate current flowing, the increase in plate current would absorb the detrimental effects of grid current by a coincident increase in the grid bias. The writer can personally subscribe to the warning, having sent two 1 kw. modulators westward before realizing where the cumulative growth in plate current originated.

REVIEW OF HIGH FREQUENCY RECEIVER DESIGN

(Continued from page 180)

any slight variation in the frequency of either the transmitter or receiver will not disrupt the service entirely. The desire for greater sensitivity with less audio amplification led to the use of the almost forgotten super-regenerative circuit of E. H. Armstrong.

The operation of a super-regenerative receiver depends on an auxiliary oscillator so connected in the plate circuit of an oscillating detector that it starts and stops the oscillation at a predetermined rate, governed by the frequency of the oscillator. This gives a tremendous increase in amplification. The failure of the super-regenerative receiver heretofore was caused by the proximity of the auxiliary oscillator frequency to that of the oscillating detector. This made the circuit very critical to operate and eventually caused it to lose favor in the eyes of the public. However, in the present case the difference in frequency is sufficient to permit very satisfactory operation. The circuit shown in Fig. 3 due to Ross Hull[2] has been used successfully by amateurs in their 56-60 mc. band. Of course the problem of fidelity for television purposes is still encountered and special precautions have to be taken in order to obtain satisfactory results. Another adaption of the super-regenerative idea has been tried by Brown.[3] In order to keep the gain at maximum he has employed a series of U tubes filled with mercury and so arranged that the length may be varied, thus eliminating the condensers in tuning. Such a design could hardly be tolerated in the broadcast receiver of today although it served admirably in the instance for which it was designed.

Super-Regeneration

Super-regeneration seems to give very good amplification (as compared to the simple regenerative receiver) and by properly choosing the auxiliary oscillator frequency satisfactory results may be had. Experience, however, has shown that unless precautions are taken there is sure to be mutual interference due to the oscillating detector. This can be eliminated by several methods, two of which are shown in Fig. 4. One consists of a combination of resistors capacitively coupled to the detector, while the other is simply a coupling tube connected between the antenna and ground. Either one seems to fulfill the necessary requirements. So much for the super-regenerator.

We have now covered the tuned radio frequency circuit, regenerative receivers and the super-regenerative receiver, so that the only remaining circuit showing any promise for this work is the superheterodyne.

The development of this circuit for use in the ultra high frequency band has been rather slow. This has been due to the almost impossible feat of maintaining the beating oscillator at a constant frequency. For commercial use this has been accomplished, since the receiver was usually fixed as to frequency and any slight drift could be compensated for by the operator in charge. Such a drift would be very slow and small after the tubes has been operating for any length of time. The fact that a band from 43-80 mc. had to be covered, however, made the problem practically impossible to solve.

Recent developments have again brought the superheterodyne into the running. The fact that the heterodyning frequency can be radiated at the same time as the regular signal at the transmitting end of the circuit, thus eliminating the necessity of a local oscillator in the receiver, seems to solve the problem. Once the signal is transformed to a lower frequency enormous amplification is possible, thus giving the necessary sensitivity with satisfactory fidelity. No doubt the ultimate receiver for this band will be of the superheterodyne type.

In general the band from 43-80 mc. appears to be satisfactory for television with sound accompaniment but higher power than at first was thought necessary will need be employed for proper coverage of a reasonable service area.

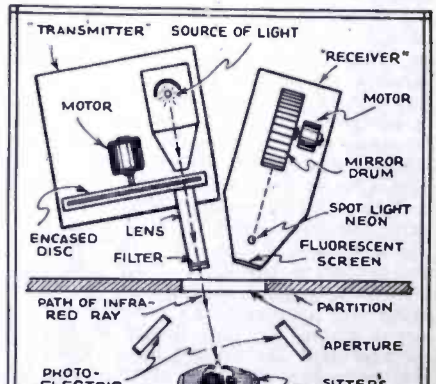
1. June 1930 IRE Proceedings.
2. QST July 1931.
3. July 1930 IRE Proceedings.

VISIO-TELEPHONY

(Continued from page 168)

No disc was employed in the television receiver, a revolving mirror drum complete with twenty-four mirrors taking its place. Each of these mirrors was mounted on the drum edge, being set at a slightly different angle to its immediate predecessor. A light beam from a "spot-light" neon lamp whose intensity pulsated in accordance with the television signal passed on from the other end, was focussed on to the mirror drum and in turn reflected back on to the translucent screen. In this simple way the light and shade of the original subject transmitted was built up from the twenty-four light strips laying side by side.

Undoubtedly the commercial development of this offshoot of television will open up endless possibilities and the French company that is handling it is fully alive to this, and progress should be rapid. Bearing on this, it is interesting to record that the public was invited to make free use of the apparatus for a week, and now steps are being taken to establish vision-telephony between the branches of Galeries Lafayette in Paris, Lyons and Nice, on a strictly commercial basis of a fixed sum per call.



Layout of the apparatus used in the visio-telephony tests.

WHAT THE CATHODE RAY TUBE MEANS TO TELEVISION

By Allen B. DuMont

Chief Engineer
Globe Television & Phone Corporation

So much has been said and so little shown regarding the cathode ray tube that many hopes have been built up pending its introduction. Yet to those intimately familiar with the workings of both the cathode ray and the lens disc scanning system, it becomes increasingly evident that until television broadcasters go to a greater number of lines, the latter system possesses many advantages which should not be overlooked.

In the first place, the real merits of the refined lens disc scanning system are realized by very few engineers and experimenters. The crude plain-hole disc, used in combination with the flat plate neon lamp, fails to provide the results now being obtained with a properly constructed lens disc and efficient neon crater lamp. The plain-hole disc produces relatively small images lacking in brilliancy. When enlarged by means of a magnifying lens, the images lack detail as well. Also, the scanning lines are too much in evidence in the form of an overall pattern. To obtain a fair sized image, a bulky disc is required, making for an awkward cabinet job.

With the refined lens disc, however, a marked improvement is scored in mechanical scanning. First of all, the amount of light available for the construction of the images is several thousand times greater than with the plain-hole disc, because of the more intense luminosity of the crater lamp as well as the greater amount of light passed by the lenses. Thus it becomes possible to project a spot of light on a screen, which feature is hardly feasible with the plain-hole disc and flat plate neon lamp combination. By means of projection, large images are obtained. With a 14-inch disc, for instance, a good 4x5 inch image may be projected, while with a 20-inch disc an 8x10 inch image is entirely practicable. The lens disc of course must be properly made, with lenses carefully matched as to size and diameter, and accurately mounted so as to place their respective crater lamp, a bright, detailed image is obtained, practically free from any trace of screen.

Cost Is A Factor

Due to the cost of the lens disc, most television receivers so far offered to the public have employed a plain-hole disc. Therefore, the entertainment possibilities of present-day television have been practically unknown to the public until now, when, at last, moderate priced lens disc receivers are becoming available. With reasonable production schedules, a good lens disc television receiver is available at the price of the good broadcast receiver, providing really good pictures for the usual home group. The images are quite detailed, even when handling two or three characters at a time. Titles and other printed matter are entirely legible. The entertainment possibilities indeed rest largely with the television studio, for the lens disc receiver has stepped well ahead of the material presented by the broadcasters.

While wishing to take a fair inventory of the lens disc possibilities of today, we must nevertheless look ahead to even greater technical possibilities with the cathode ray. To begin with, this electrical method of scanning has no moving parts. It is absolutely silent in operation. Again, it is easy to synchronize with the transmitter, irrespective of power supply and distance. The synchronization means no expenditure of power, as in the case of the mechanical scanner.

The cathode ray tube is certain to grow in desirability as television broadcasting attains higher standards, while the mechanical method must eventually lose ground. When the scanning system attains several hundred lines, the cost of present mechanical scanners will become prohibitive. Also, there may be more than one television scanning system employed by broadcasters, in which even the cathode ray possesses the advantage of ready change in number of lines. Even today, the cathode ray scanner can

(*Continued on page 207*)

CONTROLLING LIGHT WITH METAL FILMS

(*Continued from page 179*)

cone of light a small screen and by moving this screen up and down so that it stays nearer the focus point within the path of light or further away from it, in the latter case granting more light to pass through.

The higher the sensitivity of this entire system will be, the thinner and more flexible the membrane is. Changes in this sensitivity at different frequencies can be controlled by bringing the membrane into an optical chamber with lowered air pressure. It is now most interesting to note that the frequency characteristics, while irregular at normal atmospheric pressure, straighten out more and more the smaller the pressure within the chamber is. At 10 millimeter gas pressure the frequency response curve is almost perfectly flattened out and even at 10,000 cycles is still almost exactly the same as on 4,000, 6,000 and 8,000 cycles. Going down to still lower pressures, distortion again takes place. But at just about 10 millimeter pressure we have a response curve which is practically linear through the entire range. The curve has not as yet been measured at higher frequencies, in view of the fact that even if it should remain as perfect as before there would be difficulties in present loud speaker construction. But purely physically speaking, this characteristic curve looks so promising that we may expect with reasonable probability a response in frequencies above 10,000 cycles.

Thus the control of greater amounts of lights with means which at the same time are practically free from inertia is given. This new method therefore may become important in the photographic recording of sound films, telephotography, oscillographic investigations and similar tasks. Should the frequency response remain still as favorable for the highest frequencies as it is for the audible range, we might have perhaps the long awaited inertialess valve which is able to control relatively high amounts of light as needed in the perfection of television.

Experimenters are looking upon Short Waves not merely as a hobby but as an industry that will very soon call for trained men. Keep abreast of the latest developments in this fast growing field by reading SHORT WAVE CRAFT. See coupon on Page 207 for further details.

TELEVISION TIME - TABLE

Furnished by U. S. Dept. of Commerce, Radio Division, Washington, D. C.

Location of Transmitter	Lines and P.P.S.	Call Letters	Frequency in kilocycles (meters in parentheses)	Power (watts in antenna)	Licensee and Address
California:					
Bakersfield	—	W6XAH	2,000 (150) to 2,100 (142.9)	1,000	Pioneer Mercantile Co., 1526 Twentieth St.
Gardena (near)	—	W6XS	2,100 (142.9) to 2,200 (136.4)	500	Don Lee (Inc.)
Los Angeles	—	W6XAO	43,000 (6.97) to 46,00 (6.52), 48,500 (6.18) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	——	Don Lee, Inc.
Illinois: Chicago	48	W9XAA	2,750 (109.1) to 2,850 (105.3)	1,000	Chicago Federation of Labor.
" "	45-15	W9XAP	2,000 (150) to 2,100) (142.9)	500	Western Television Corp., 6312 Bway.
" "	24	W9XR	2,100 (142.9) to 2,200 (136.4)	2,500	Chicago Daily News
Downers Grove	24	W9XAO	2,850 (105.3) to 2,950 (101.7)	5,000	Great Lakes Broadcasting Co., 72 W. Adams St., Chicago.
Indiana:					
West Lafayette	—	W9XG	2,750 (109.1) to 2,850 (105.3) 60 holes, 1,200 r.p.m. Tuesday and Thursday, 2:00, 7:00, 10:00 p.m., C.S.T.	1,500	Purdue University, 400 Northwestern Ave.
Iowa: Iowa City	—	W9XAZ	2,000 (150) to 2,100 (142.9)	500	State University of Iowa
Maryland:					
Silver Springs	60-20	W3XK	2,000 (150) to 2,100 (142.9). Voice on W3XJ, 187 meters. Time 5-6, 9-11 E.S.T. eve.	5,000	Jenkins Laboratories, 1519 Connecticut Ave., Washington, D. C.
Massachusetts:					
Boston	60-20	W1XAV	1600-1700 kc. Voice on W1XAU, 104 meters.	1,000	Shortwave and Television Laboratory.
New Jersey:					
Camden	Varies	W3XAD	2,100 (142.9) to 2,200 (136.4), 43,000 (6.97) to 46,000(6.52), 48,500 (6.18) to 50,300(5.96), 60,000 (5) to 80,000 (3.75)	500	R. C. A. Victor Company (Inc.)
Passaic	60	W2XCD	2,000 (150) to 2,100 (142.9)	5,000	De Forest Radio Co.
New York:					
Long Island City	—	W2XBO	2,750 (109.1) to 2,850 (105.3)	500	United Research Corp., 39 Van Pelt Ave.
" " "	60-20	W2XR	2,100 (142.9) to 2,200 (136.4), 2,850 (105.3) to 2,950 (101.69), 43,000 (6.98) to 46,000 (6.52), 48,500 (6.19) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	500	Radio Pictures, Inc., 3104 Northern Blvd.
New York	60-20	W2XAB	2,750 (109.1) to 2,850 (105.3) 8:00-10:00 p.m. daily.	500	Columbia Broadcasting System, 485 Madison Ave.
" "	60-20	W2XBS	2,100 (142.9) to 2,200 (136.4)	5,000	National Broadcasting Co. (Inc.), 711 Fifth Ave.
New York	60-20	W3XDS	43,000 (6.98) to 46,000 (6.52), 48,500 (6.19) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	2,000	Jenkins Telev. Corp., 655 Fifth Ave.
" "	—	W2XF	43,000 (6.97) to 46,000 (6.52), 48,500 (6.186) to 50,300 (5.964), 60,000 (5) to 80,000 (3.75)	5,000	National Broadcasting Co., (Inc.)
Schenectady	Varies	W2XCW	2,100 (142.9) to 2,200 (136.4)	20,000	General Electric Co.
Pennsylvania:					
East Pittsburgh	60	W8XAV	2,100 (142.9) to 2,200 (136.4)	20,000	Westinghouse Electric & Mfg. Co.
" "	60	W8XT	660 (455)	25,000	Westinghouse Electric & Mfg. Co.
Wisconsin:					
Milwaukee	45	W9XD	43,000 (6.97) to 46,000 (6.52), 48,500 (6.18) to 50,000 (5.96), 60,000 (5) to 80,000 (3.75)	500	The Journal Co. (Milwaukee Journal).
PORTABLE					
New Jersey:					
Passaic	60-20	W2XAP	2,000 (150) to 2,100 (142.9)	250	Jenkins Television Corp.
Bound Brook	Varies	W3XAK	2,100 (142.9) to 2,200 (136.4)	5,000	National Broadcasting Co., Inc.
New York State:	Varies	W2XBT	43,000 (6.977) to 46,000 (6,522), 48,500 (6.186) to 50,300 (5.964), 60,000 (5), 80,000 (3.75)	750	National Broadcasting Co., Inc.
United States: (Throughout)	60-20	W10XG	43,000 (6.977) to 46,000 (6.522), 48,500 (6.186) to 50,000 (5,964), 60,000 (5), 80,000 (3.75)	500	De Forest Radio Co., Passaic, N. J.

Time on the Air: The daily newspapers in the larger cities—Chicago, New York and Boston, for example—carry television programs and time schedules.

W2XCR—N. Y. City. 3 to 5 and 6 to 8 P.M. daily; 6 to 8 P.M. Sunday. Voice transmitted over WINS, on 384.4 meters or 780 k.c.

W3XK—Washington, D. C., 7 to 9 P.M. and 10:30 to 11:30 P.M. daily (E.S.T.). 60 holes.

W2XCD—Passaic (De Forest Radio Corp.). 9 to 10 P.M. daily. Sound on 1,604 k.c.

Daily image programs are broadcast by the Boston station W1XAV (2-4 P.M. and 8-10 P.M. daily, except Sunday) and also by the Chicago stations W9XAA, W9XAO and W9XAP. (Voice on 447.5 meters; see newspapers for daily programs.)

THE CATHODE RAY

(*Continued from page 205*)

be built at no greater cost than the better type lens disc scanner. As television advances, however, the cathode ray scanner must become increasingly more economical. The matter of associated equipment also points to the economy effected by the cathode ray scanner, since it is possible to modulate the cathode ray with the detector tube output, or with not over 8 volts, thus doing away with the usual amplifier. This makes for simplicity and low cost on the receiver end.

TELEVISING THE DERBY

(*Continued from page 173*)

ters. Indeed, it was the requirements of this broadcast and its limiting factors entailed by a nine kilocycle sideband that prevented the Baird Company from increasing their picture speed and thus overcoming flicker. The reception of this wireless transmission was effected successfully all over the country.

The three zone Derby experiment was repeated for the Oaks race with identical results, while throughout Derby week transmissions were effected from the Baird Studios in Long Acre on a single zone, and these were shown at the Metropole Cinema, three times a day, except on Saturday, when four shows were given.

These single zone transmissions were first of all introduced from the stage, and then the Baird announcer appeared on the screen, speaking from Long Acre. After saying a few words he was instructed by telephone directly connected between the Studio and the cinema stage, to perform one or two simple things in order to convince any sceptics in the audience who may have felt that the television image was a projected film.

It was agreed on all sides that this ambitious attempt of outdoor television was a most praiseworthy effort on the part of Mr. J. L. Baird, and shows that the words spoken by Sir Ambrose Fleming after he had seen the first laboratory daylight television transmission, are coming true. His statement concluded in the following manner:

"It means a great step forward in the possibility of transmitting to a distance the image of moving objects or persons as seen in ordinary daylight, without exposing them to rapidly moving beams of light or to dazzling illuminations or dark heat radiation. The television transmitter becomes, in fact, a more complicated kind of camera, in which the screen on which the image appears is not immediately behind the lens, but may be miles or hundreds of miles away."

A NOVEL SCANNING DISC

(*Continued from page 198*)

discs. An alternative method is to fasten the glass to one metallic disc by a chemical compound.

The loss of light in passing through the glass is very slight due to the clearness and thinness of the glass used.

There are of course many minor considerations in the actual technique of the process of making the discs which however are not necessary to the explanation of the principle of the disc as described above.

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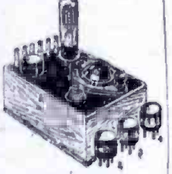

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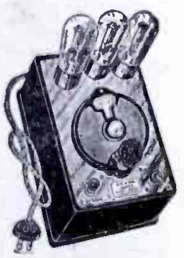

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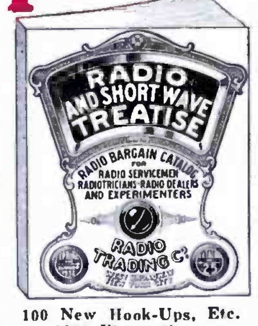

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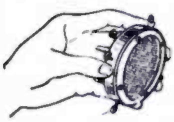

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