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# Television

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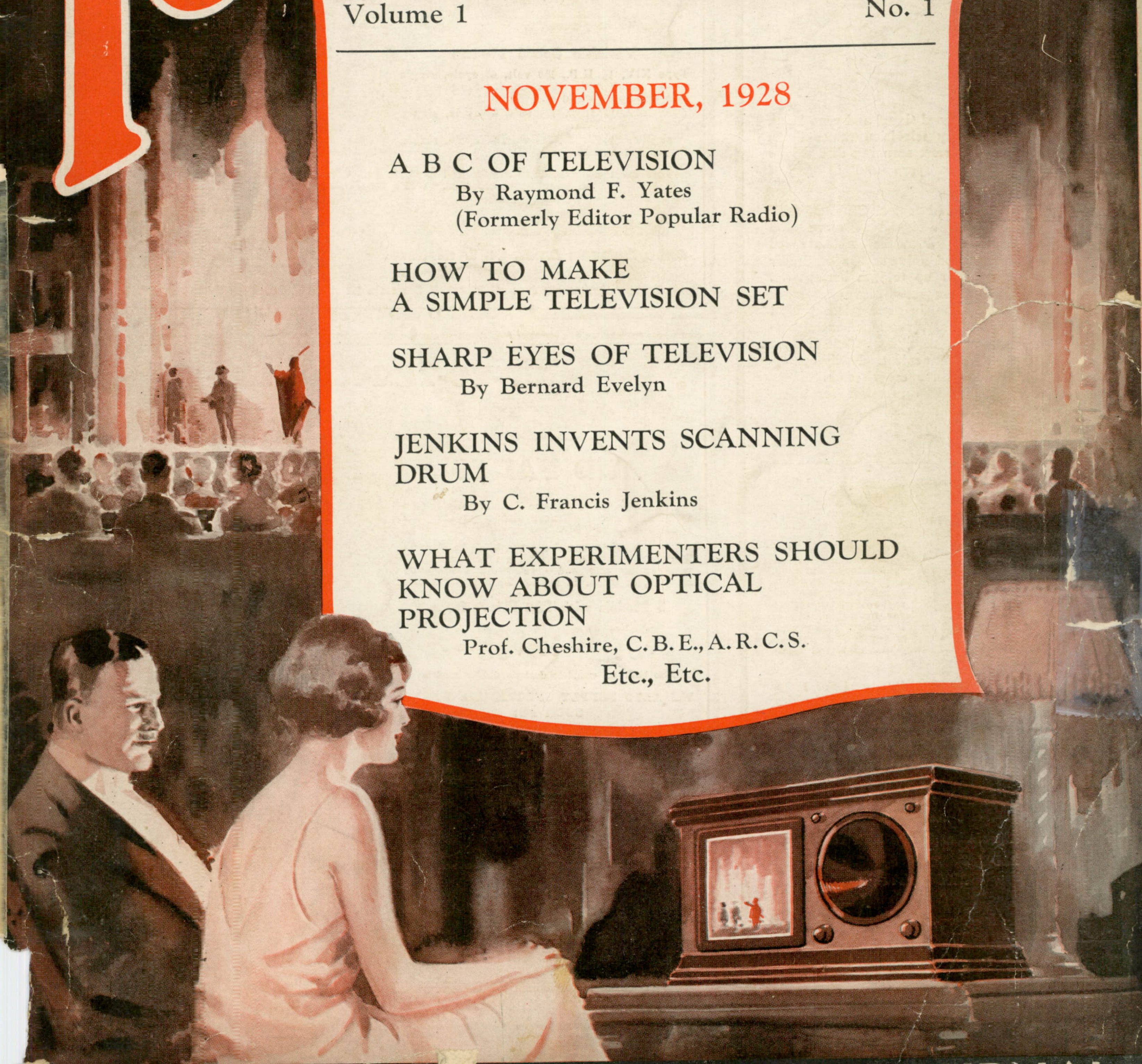
NOVEMBER, 1928





AMERICA'S FIRST TELEVISION JOURNAL

## Thru the Editor's Spectacles

THE man who says "It can't be done," is confronted by the man who says, "Here it is!"

A writer claiming to be an authority on all things pertaining to Radio, editorially stated in 1927 that Television was something far in the future. He indicated that a decade or more would probably be required to advance the reception of Television to the stage where it would be practical in the home.

In the intervening months from several sources have come developments in Television, which must confound that writer.

Both the Baird Laboratories in London and the Bell Laboratories in New York in July announced the transmission of men in action taken in daylight.

Baird followed with the transmission of action in natural colors.

The Carter Laboratories broadcast Television through an apparatus constructed by the young engineers. Sanabria and Hayes, and the stunt of receiving in an airplane 2,000 feet in the air and 10 miles from the sending station was successfully accomplished!

At the New York Radio World's Fair a constant stream of people visited the Carter exhibit, passed by the platform from which vision was broadcast, and also saw the result in the receiving apparatus at a distance from the sending station.

On September 11 WGY Schenectady, N. Y., by television and radio, broadcast a play: "The Queen's Messenger," synchronizing the action with the voice. This apparatus, constructed under the direction of Dr. E. F. W. Alexanderson was exhibited with voice

(*Continued on page* 38)


# Television

AMERICA'S
FIRST TELEVISION JOURNAL

*Official Organ of The Television Society*

VOLUME ONE NUMBER TWO


## Contents for November, 1928




TELEVISION

AMERICA'S FIRST TELEVISION JOURNAL

*Published by*

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*To Encourage the Development of Television Join the*

# TELEVISION SOCIETY, Inc.

417 Fifth Avenue, New York City

## DO IT NOW!

OBJECTS

To encourage experiments in the transmission and reception of vision by evincing a lively interest and sympathy therein:

To spread the knowledge of the means and processes by which such transmission is made possible, and by any and all legitimate means furthering the progress of visualization by electrical impulses:

To afford a center where all who are interested in the Science of Television may meet and interchange their knowledge and experience.

*Members.* Any reputable person who is in sympathy with the objects of this Society may become a member when duly nominated and accepted, upon the payment of the annual dues; and as long as such members remain in good standing, they shall receive all the benefits which the Society affords for the study of the Science of Television, including the special literature which the Society may, from time to time, produce for members, including the Official Monthly Journal of the Society.

*Certificate of Membership.* There shall be issued to each Member a membership identification card, designating the class of the membership.

DUES

The Annual Dues shall be Five ($5.00) Dollars, payable in advance; which shall include an annual subscription to the official monthly publication of the Society.

*"To Encourage The Development of Television"*

TELEVISION SOCIETY OF AMERICA
417 FIFTH AVENUE, NEW YORK, N. Y.

The undersigned desires to be enrolled as a member of The Television Society of America. Herewith find remittance covering the annual dues, which include one year's subscription to TELEVISION, the Official Monthly Publication of the Society.

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Television

AMERICA'S
FIRST TELEVISION JOURNAL

OFFICIAL ORGAN OF THE TELEVISION SOCIETY, INC.

Volume I. NOVEMBER, 1928 Number 2

# *Now You Can*
# BE A LOOKER-IN

*If you have not already experienced the thrill of tuning to pictures, get out the soldering iron, the screwdriver, the hook-up wire and build this Television Receiver.*

*by* JAMES MILLEN, E.E.

ONE cannot yet press a button and cause to appear on the screen of his television receiver a view of a ball game, a yacht race, or a political campaign. All these things are bound to come in time, but they are not here yet. Television as we have it now is something for the amateur, rather than the layman who is interested solely in the image received and not in the fun of experimenting with a new science.

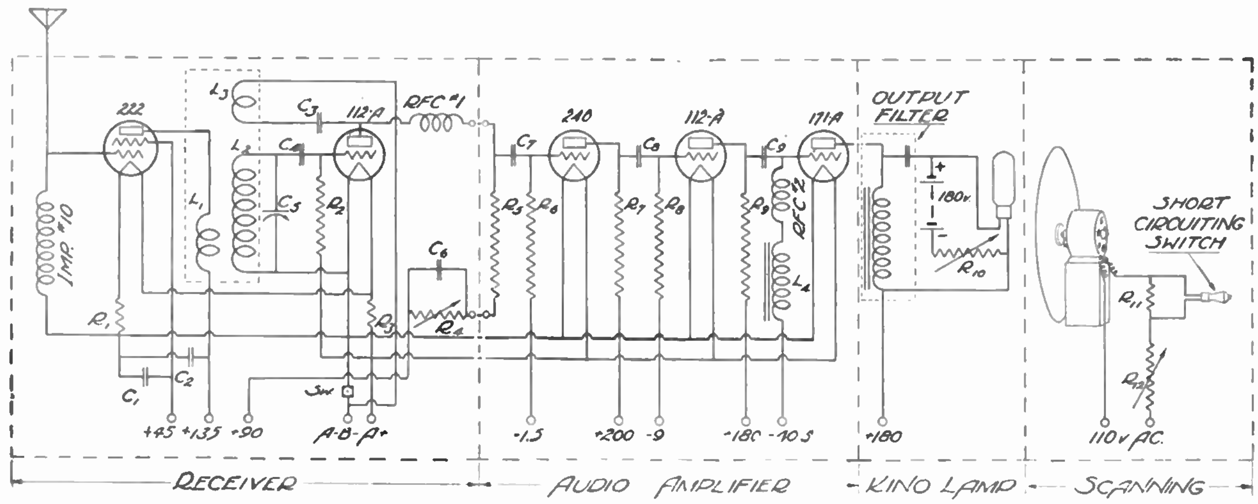
The most certain method of hastening the problems of television is to have as many experimenters as possible working on the problem. Turn television loose among the amateurs or those who love scientific experimentation and watch the important developments take place, just as in radio broadcasting.

As the receipt of a bit of badly distorted phonograph music from a well-worn record was considered quite an event only seven or eight years ago, equally thrilling now to the constructor of a home television receiver is the reception of a recognizable profile of one of the technicians of a television broadcast station in Boston, Schenectady or Chicago, the silhouette of a small girl skipping rope and bouncing a ball in Washington, or a page from some magazine held up before the "eye" of a station in California. While there are several different television systems being employed at present, they all have many points in common, and an outfit designed to receive images from one source may readily be altered to work from other transmitting stations.

*Distant Reception Possible*

The receiver described in this article was designed for receiving the half-tone broadcasts from station WLEX of Boston and the silhouette "movies" from 3XK the Jenkins Laboratories, in Washington, D. C. Outfits made to these specifications have given very satisfactory results. Station 3XK is over 500 miles from Boston yet its thrice weekly program was consistently received throughout August, even during local thunder showers and other handicaps. The same outfit, except for the substitution of a 24 aperture, 12 inch diameter disk for the larger 48 aperture disk, was successfully used at Long Beach, Cal., last July to receive the television broadcasts of station WGY, Schenectady.

These instances show that while




Imp. No. 10—Short-wave Antenna Impedance
R. F. C. No. 1—90 M.H. R.F. Choke
R. F. C. No. 2—500 M.H. R.F. Choke
L1-L2-L3 Short wave plug-in coils
L4—A.F. Grid Impedance
C1— .5 mfd.
C2— .5 mfd.
C3— .001 mfd.
C4— .00025 mfd.
C5— .000125 mfd.
C6—1.0 mfd.
C7— .5 mfd.
C8— .5 mfd.
C9— .5 mfd.
R1—15 ohms
R2—6 megohms
R3—2 ohms
R4—0 to 500,000 ohms
R5—50,000 ohms
R6—500,000 ohms
R7—300,000 ohms
R8—500,000 ohms
R9—25,000 ohms
R10—0-10,000 ohms
R11—5 to 10 ohms—40 watts
R12—0 to 100 ohms—75 watts

*Fig. 1. Fundamental Schematic Circuit described in this article. The National short-wave kit was used in this circuit.*

there are few television stations on the air in the country at present, the lack of great numbers need prove no serious handicap to the determined experimenter. There is hardly a location in which, if there is no local transmitter, the signals for a distant television transmitter cannot be received with sufficient intensity to give satisfactory experimental results.

For sake of discussion a dotted outline has been used to divide the schematic diagram of the complete receiver into its components in Figure 1 They are: Short Receiver; Audio Frequency Amplifier: Kino lamp and Scanning device. While any good radio frequency receiver capable of being tuned to the wave length of the transmitting station may be used, it has been found that a receiver employing a stage of untuned RF using the 222 high amplication tube is general preferable.

### *Standard Set Used*

The receiver illustrated is one we have been using and is a standard kit set. All of the parts are available in the open market.

It comprises several rather unique features. One is the single tuning control. Another is the foundation unit design which permits an efficient layout of parts with but few connections to be made by the assembler. As a result of the 222 tube in the first stage the sensitivity of the receiver in general is materially better than that of the plain regenerative detector type of set formerly much in use.

### *Circuit Non-Radiating*

Furthermore, the use of the 222 tube ahead of the essential regenerative detector prevents radiation —a problem which would soon become quite serious if all short wave receivers were of the radiating variety.

Another important advantage secured by the use of the 222 tube in this receiver is the elimination of tuning "holes," or dead spots commonly encountered with plain regenerator receivers. Heretofore rather carefully placed shielding has been considered essential to a receiver using the 222 tube, but the use of the untuned antenna circuit has been found to make shielding unnecessary. Elimination of shielding not only reduces cost and simplifies construction work but also makes it a simple matter to change coils when going from one wave band to another.

In constructing any type receiver, especially for short waves, and more particularly one for television where a motor and scanning disc are located in the same room, considerable attention must be given to rigidity of construction. This applies to the coils and their mountings, as well as the wiring and other parts of the set. The radio frequency choke coil used in the detector plate lead is of the multisection slot wound variety having very low distributed capacity over a wide band of frequencies. The other RF Choke, or grid circuit impedance is one especially designed for the purpose and has an inductance of approximately 2 millihenries.

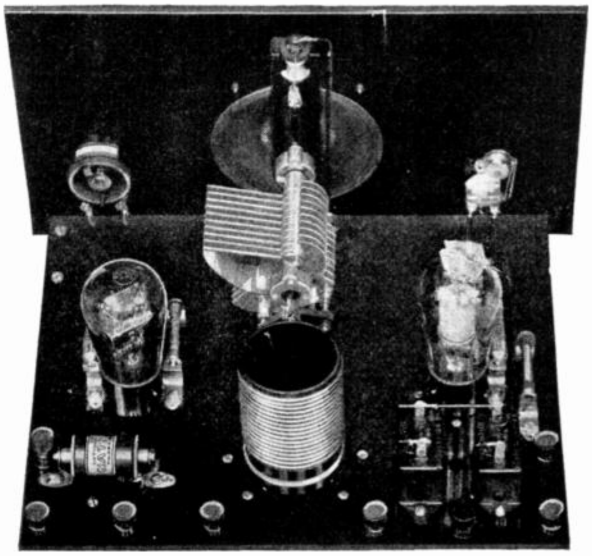
### *Audio System Important*

The perfection of the picture received depends upon how good a signal is transmitted in the first place and upon how well it is reproduced at the receiving end. Here the amplifier used following the detector plays the important part. If the signal to be received contains frequencies of from 18 to 20,000 cycles, then it is important that the audio amplifier be able to amplify all frequencies within these limits. The diagram of the audio amplifier in Figure 1 is one that has a much higher frequency range than the average, giving picture reproduction with ample detail for recognizability of persons.

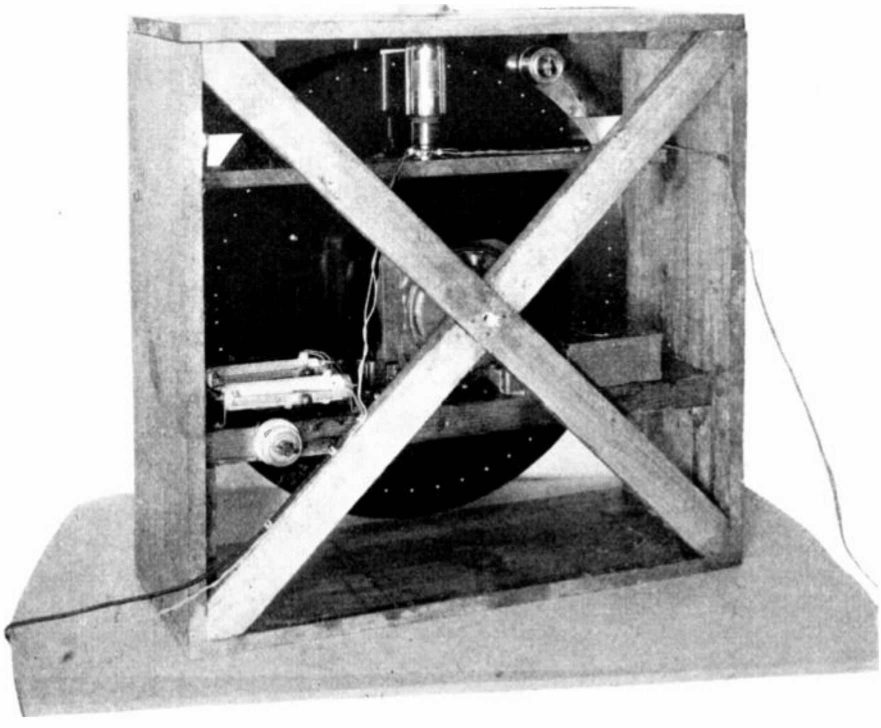
This amplifier is essentially resistance coupled. The first tube is a 240 or 340, high-mu tube. The second is a 112, and the third a 171. The values of the coupling resistors, grid leaks and coupling condensers are marked on the diagram. The grid leak is replaced in the case of the 171 by an audio frequency choke in series with a radio frequency choke. In the output circuit two 3-henry choke coils are connected in series. Spring suspended sockets should preferably be used in building the amplifier to reduce the possibilities of microphonic tube noises when motor and disc are located close by. An important point to keep in mind is the necessity for employing high-grade resistors in the grid and plate circuits.

Noise does not present the same limitations in a television receiver that it does in a broadcast receiver. Any noise is bothersome if you must listen to it, but in a picture it is represented by black spots and streaks that appear in a continually shifting position unless it is a periodic noise. Poor coupling resistors and vibration are the two most common sources of noise in the receiving amplifier. If in an early stage of an amplifier a plate coupling resistor is defective it will introduce noise that is amplified. A pair of ear phones connected to the output terminal will reveal this noise. Some noise is to be expected in a high gain amplifier but one can easily judge the amount of noise permissible by tapping the tubes and comparing the microphonic noise with the amplifier noise.

In three stages of amplification, as a rule, the amplifier noise will not be appreciable. Unless there is a poor or defective resistor in one of the plate circuits the amplifier will be quiet. Vibration from the receiving disk or its motor, transmitted to the amplifier or detector tube, will introduce periodic noise which will cause a black streak across the field of the picture. Other periodic interference such as sixty cycle hum may get into the signal and cause streaks across the picture. These will not remain stationary but will move upward or downward across the field of the picture.



*The short wave receiver used for picking up the television signals.*



*A temporary housing set-up of a scanning disk, driving motor, neon tube and regulating apparatus.*

### *Neon Lamp in Output*

The Output Circuit is so arranged that the neon or Kino-Lamp is always illuminated. When a signal is received the brilliancy of illumination merely varies in accordance with the signal. The construction of the tube is quite simple. There are two flat metal plates placed parallel and very close together. The plates are one and one-half inches square, and present an area of two and a quarter square inches. Either plate can be used as the anode. The plates are in a space containing neon gas, hence the name, neon tube.

When the current through the tube is changed, due to a change in impressed voltage, the amount of light emitted is changed. This fact is made use of to reproduce the picture. A resistance must be connected in series with the tube because, like all gas conductors, it has a negative resistance coefficient.

A good picture background will be obtained if the current through the neon tube is limited to 10 or 20 milliamperes. More current will cause the lamp to glow brighter and brighter, but there is no advantage in this so far as the picture is concerned and it only serves to shorten the life of the lamp. Accordingly, care should be taken to adjust the current to the minimum satisfactory value. A Clarostat has been found just right for such use and may be conveniently mounted on the front of the frame supporting the scanning apparatus.

For illuminating the kino lamp either a standard high grade "B" eliminator, using a filament type rectifier tube such as the UX280, or heavy duty "B" batteries may be used. If the back plate glows instead of the front one when the lamp is turned on the difficulty may be corrected by reversing the leads to the power supply.

### *Accurate Disk Is Necessary*

Several different concerns are manufacturing scanning disks suitable for use with signals now on the air. The better grade disks are well made mechanically, so as to run true and require little power. The holes in the disks must be punched to the necessary degree of accuracy if the received image is to be free from black lines and streaks. A feature of the National disk is radially shaped holes, rather than round. By making the holes this shape the "lines" across the image are much less obvious than the use of a disk with round openings.

Successful results have been obtained with a number of different types of small motors for driving the scanning disk, but the one being used at present is the Baldor 1/8 horsepower, YIV variable speed condenser type, for operation on 110 volts (single phase) 60 cycles AC. This is a ball-bearing motor that operates very smoothly and quietly. The swish of the disk through the air, constituting the major portion of the noise, is quite insignificant. Special rubber vibration absorbers are supplied with the motor for mounting purposes.

The diagram, Fig. 1, shows the method for speed control. For the variable resistor "R12," a 75-watt, 4 to 100 ohm wire wound resistor with sliding contact is used. The other resistor may be a 10 ohm 10 watt resistance. This is labeled "R11" in the diagram and is shunted by the push button speed control leads.

### *Push Button Controls Speed*

The resistance "R12" is so adjusted that with the push button released the motor runs at slightly below proper synchronous speed. When the push button is depressed the disk tends to speed up.

Do not mount the television receiver in the same cabinet with the disk. Vibrating of the motor will introduce a synchronous noise that will result in a series of horizontal lines being drawn across the picture. Keep the receiver and amplifier on a support separate from that for the disk.

The following convention has been adopted by the Raytheon Company in regard to neon tube mountings. The tube is fitted with a standard UX base. The plates inside the tube are placed in a plane at right angles to the axis of the "Pin" of the base. If the pin, therefore, is pointed toward the disk when inserted in the socket, the plates inside the tube will be parallel to the disk. Mount the tube at the proper height to cover the inch and a half square scanned by the revolving disk. The tube plates are connected to the "plate" and "filament" prongs of the base.

### *Phones Used to Tune in Signal*

The first step in the reception of a television is the locating of the signal on the receiver dials. This is best done with the aid of headphones or a loud speaker connected in place of the neon lamp. However, do not fail to have a fixed condenser of about one microfarad capacity in series with the phones when connecting it in place of the neon lamp or across the neon lamp terminals.

Television signals have a very distinctive sound but unfortunately the short waves contain signals which may easily be mistaken for television. For instance, the high speed code and picture transmission of such stations as WIZ and WQO are much like a television signal because of a flutter, or what may be called a group frequency. A good wave meter will be of great help in tuning television signals. It will prevent mistaking an automatic code station for the picture station.

The television experimenter may be puzzled to find his received picture either turned upside down or else reversed, as looking through a photographic negative the wrong way. Both of these faults can be corrected quite easily.

### *Image May Be Inverted*

When an image is upside down and the correction of this fault is obvious. The subject before the transmitter at WLEX is scanned from top to bottom during one revolution of the disk. Accordingly, if you rotate your receiving disk so that the plate of the neon lamp is scanned from bottom to top the picture will be inverted. To reverse the manner in which the neon lamp plate is scanned vertically, it is necessary to reverse the direction of rotation of the disk or remove the disk from the shaft of the driving motor and turn it around. The latter operation may involve the removal of the hub and remounting on the opposite side of the disk.

The received image may be reversed horizontally. For example, one of the objects often placed before the transmitter is a microphone stand with the microphone and the station letters mounted on it. If you receive this object erect, but reversed, so that the letters are backwards your disk is so rotated that the holes pass the neon plate in the wrong direction.

The correction of this fault is not so obvious. It is plain that whether you scan the plate from top to bottom or from bottom to top makes the difference between

(*Continued on page* 27.)

*The complete television receiver used for the WRNY demonstration. The operator is adjusting the disk to "hold" the image after the signal is tuned in.*

# Can You Solve These *Television Problems?*

*Amateurs have succeeded in solving many perplexing radio problems. The problems of Television are none the less fascinating and many of them will be conquered by novices whose imaginative faculties often perform feats that balk slide rules.*

*by* EDGAR H. FELIX, I. R. E.

THE experimenter is attracted to new fields of scientific endeavor by their unsolved problems.

Television, the most alluring field of experiment now in the focus of public attention, is a comparatively old science. The methods of today have been known for more than a generation. Scanning discs, neon tubes and synchronous motors are older than tone broadcasting. The technical stabilization of broadcasting and its recognized importance as a medium of entertainment and education have forced us to realize the potential value of television and to attack its problems anew. The improved technical facilities of modern laboratories and the feverish energy recently concentrated upon visual broadcasting promise to bring the rapid solution of its many problems. By taking advantage of normal progress in synchronous motor design and by using the improved systems of amplification, of radio telephone transmission and reception, and the latest neon tubes now available, television, though following entirely conventional and timeworn principles, is ready to step from the laboratory of the scientist to that of the home experimenter. That step, experience has proved, is but little short of general public acceptance.

The first objective of the experimenter in television is to reproduce a moving image by radio. The attraction of animation gives television an advantage over the reception of fixed visual images (namely, still photographs) although, from the standpoint of service value, still picture reception is in a far more advanced stage than television. With a simple, three tube device, attached to a standard broadcast receiver, and a recording unit, a four by five picture, consisting of 110,000 image points, can be received. Transmission of such pictures can be


*Scanning is still another perplexing problem of television. What is needed is a scanning mechanism that does not need mechanical power and that does not destroy the picture value with lines.*

undertaken—on the broadcasting band without the remotest risk of infringing outside the ten kilocycle channel upon which broadcast allocations are based. No great skill is required for still picture reception.

Observing these channel limitations, the most detailed moving or television image, which may be sent at the rate of sixteen reproductions a second, is a 24-line picture with a maximum of 576 image points. The superiority of three-minute still picture reception detail is therefore some two hundred times that of television, while its area is twentyfold.

The experimenter, however, does not select his field of activity for the advanced status in which he finds it, but for its unsolved problems and the reward which awaits their solution. A genius will solve the problem of bridging the gap betwen the attained detail and quality of the three-minute still picture and the speed requirement of television, calling for repetition of the complete image each sixteenth of a second.

### *Fruitful Field for Study*

It is the unsolved problems of television that make it a fruitful field of experiment. By a study of the known, we will ultimately conquer the unknown. The 24-line picture is interesting scientifically but, to the layman, it is decidedly lacking in entertainment or educational value. A close-up of a face is clearly recognizable in a good 24-line television transmission, but if the subject moves away from the television transmitter so that his whole body is reproduced at full length, the face is then reduced to three or four sweeps of the scanning disc and hence is no longer recognizable. The general public will not support a television which gives them only a full front view of faces and depends upon a wink or the turning of a head for its maximum thrill. It wants to see the full-sized figure in action and with sufficient detail so that the action is clearly recognizable and appreciated. But the experimenter, appreciating the scientific value of the crude television of today, will work with scanning discs, neon tubes and corona discharges in the hope of improving the quality and detail of reproduction attainable.

The standard of picture reception, sufficient to make the activities of two persons, such as two wrestlers, fencers or boxers, sufficiently clear to be entertaining, is perhaps two hundred lines. This will give the face of a person in full figure as much detail as we now secure from a close-up of a 24-line picture of the face alone. No disinterested prospective purchaser, approached with a view to being sold a television device for its entertainment value, will contradict the statement that any less than the amount of detail attainable in two hundred lines is sufficient to warrant a substantial investment. The experimenter must bridge the gap between 24- and 200-line television broadcasting.

To jump from 24 to 200 lines appears to be a simple problem, but it is the great problem of television. Twenty-four lines, properly transmitted, can be accommodated on the broadcast band in a ten kilocycle channel. Two hundred line pictures require 320,000 cycle modulation and (assuming the conventional double side band modulation) at least 750,000 cycles of ether space, an amount equivalent to three-quarters of the entire broadcast band, would be required to transmit 200-line television images. The value of these channels is so much greater than the most exalted valuation placed on television that there is not the slightest likelihood of the establishment of such a service. Likewise, on short waves, congestion makes impossible such a lavish use of our ether resources to accommodate such a service. We must find a way of reducing the ether space required by television.

### *Band Varies as Lines Squared*

The ether space required for television transmission increases as the square of the number of lines rather than as the number of lines. The use of single side band transmission is not the answer to the problem because the saving in ether space effected is only a maximum of 50 per cent and because the reception of a single side band signal is so difficult and costly that this feature would be a detriment to the growth of television.

It is easy to calculate the frequency band required by a transmitter under the present methods which we are using. It is the product of the number of lines multiplied by half the number of lines, times the number of pictures per second. Stating this as a formula:

$$f = li \times \frac{li}{2} \times p$$

where "$f$" is the modulation in cycles, "$li$" the number of lines and "$p$" the number of times per second that the image is repeated. The latter figure is usually presumed to be sixteen per second, following motion picture practice, although, ultimately, if television continues to be transmitted by the method which we now use, probably twenty pictures per second will be used rather than sixteen.

The transmission of ten pictures per second is really not television because the subject is discernible only when at rest. With motion picture reproduction the entire screen is illuminated for half the time, while with television transmission, illumination of any given point continues only for a very minute fraction of the time it takes to reproduce the complete image. At the rate of sixteen pictures per second, any one particular spot at the reproducing point of a 24-line picture is illuminated for something *less than one-eighth-thousandth of a second.* Because of the brief period of illumination, high grade television will require more images per second than motion picture transmission so long as we retain the present method of illuminating one area at a time in succession.

It is easy enough to demonstrate a 200-line picture in the laboratory and, no doubt, some affluent company will do it one of these days and proclaim itself the leader and the "inventor" of television. The 200-line picture system, made along the conventional lines, is as useless as a giant automobile truck, two hundred feet wide. There are no streets upon which it may operate. It is a laboratory curiosity and not a useful device until we learn how to transmit such a picture without requiring the excessive ether space now necessary for it. A number of obvious solutions occur at once to the student who has but a surface knowledge of the problem, but these obvious solutions come so far from meeting the problem that they cannot be considered seriously.

### *Synchronization Is Problem*

The second, great, unsolved problem is practical synchronization. There is a great reward awaiting the inventor who solves synchronization in a practical way. Reliance upon the synchronization of power lines is an obvious solution of the problem for synchronizing the speed of the transmitter with that of the reproducer. However, not all areas within the range of a broadcasting station are served by the same power system. In New York, for instance, there are seven independent sixty-cycle systems within fifty miles, as well as two important direct current districts. Alternating current power is far from universal and television limited to homes equipped with sixty-cycle A. C. excludes important farm areas and direct current districts.

Non-interconnected A. C. lines differ quite considerably in frequency. Frequency variations occur from day to day and hour to hour on the best regulated power systems. Dr. J. H. Dellinger, former Chief of the Radio Laboratory of the Bureau of Standards, recently stated, before the Institute of Radio Engineers, that his measurements of the power system at Washington, D. C., showed frequency variations ranging between plus and minus 0.15 per cent. A discrepancy of that magnitude in the frequency at the receiver and transmitter of a television system is certain to make the reproduced image wholly unrecognizable.

Reliance upon direct current motors regulated by fine vernier rheostats may satisfy the experimenter but it will never appeal to the consumer.

The accuracy of regulation required to hold an image for a matter of a second is so much greater than the skill and balance required to walk a tight rope that only those possessed of an excessive bump of curiosity and unlimited patience will long be lured to a television reproducer depending upon that method for synchronization. You would consider yourself skilful if you could manipulate a rheostat so that it would maintain a motor, at one point, in synchrony with another, at a distant point, to the accuracy of one per cent. Even assuming that you are a super-skilful regulator and so manipulate your vernier rheostat that you are even more accurate than within one per cent and actually maintain it within one hundredth of one per cent, the deviation would still be sufficient

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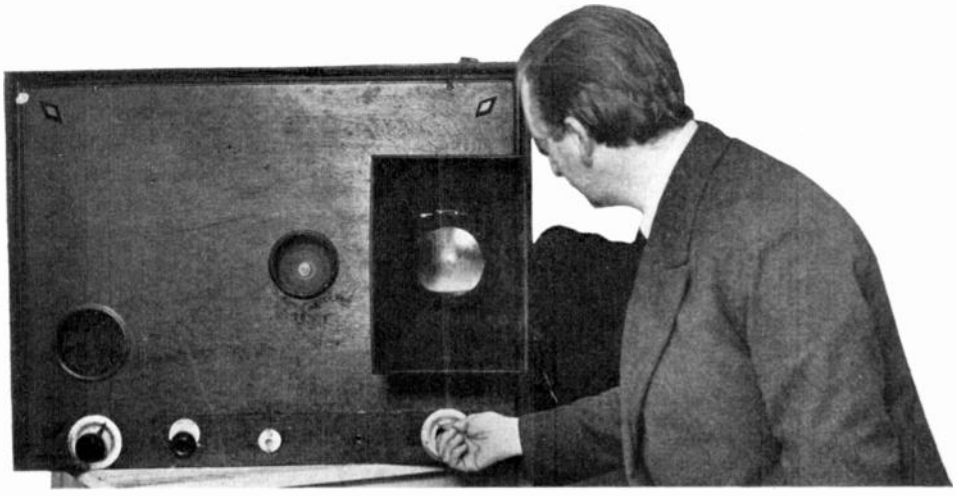


*One of the outstanding problems of the television art is that of projecting the received image without the use of powerful sources of illumination. The maximum entertainment value of television will be derived only when more than one person at a time will be able to view the transmitted scene.*

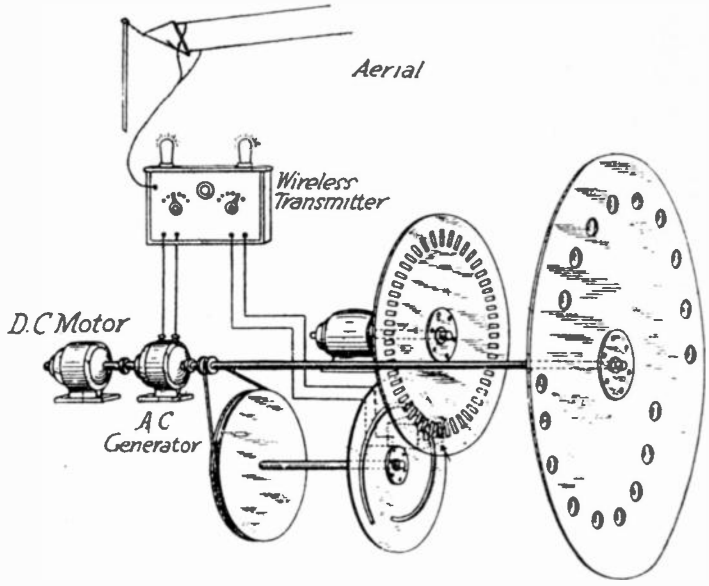
to give you only one accurately framed image each one and one-third of a second, namely, one out of twenty reproductions.

The ultimate answer to television synchronization is a reliable means of operating a synchronous motor from a power source, the frequency of which is locally determined at the receiver, with an accuracy of at least one part in one hundred thousand. He who solves the problem of maintaining broadcasting stations within carrier range of each other, that safely, continuously and reliably operate upon the same channel, will also, by the same means and at the same time, solve the problem of television synchronization.

### *Television Like Wireless in 1908*

Formidable as these problems may seem to the informed experimenter, they will also be solved within a very short time. Some of those close to the problems of television, who understand the magnitude of the unsolved problems, frequently predict that five to twenty-five years may elapse before they are solved. The status of television today is but little different from that in which we found radio telephony two decades ago. The first demonstrations of radio telephony were made before the year 1900. The method of modulation employed was to put a microphone in series with the ground lead of a continuous wave arc transmitter. This method was used experimentally for two decades. All kinds of microphones were devised to increase the current carrying capacity to a point sufficient that radio telephone transmissions of reasonable power could be conducted.

As early as 1904 Professor Reginald Fessenden transmitted radio telephony from Brant Rock, Mass., to Wilmington, Del., but radio broadcasting and long-distance radio telephony did not come until an entirely new conception of modulation was evolved. Dr. E. F. W. Alexanderson pointed to the vacuum tube as a means of modulating continuous waves and successfully evolved a system of modulation which made possible the first experiments in reliable high-power radio telephony. R. A. Heising evolved the first practical method of high-power modulation which promptly brought us radio broadcasting. Instead of trying to change the resistance of the aerial by a microphone, we now vary the plate potential of the oscillator system according to the speech currents to be transmitted.

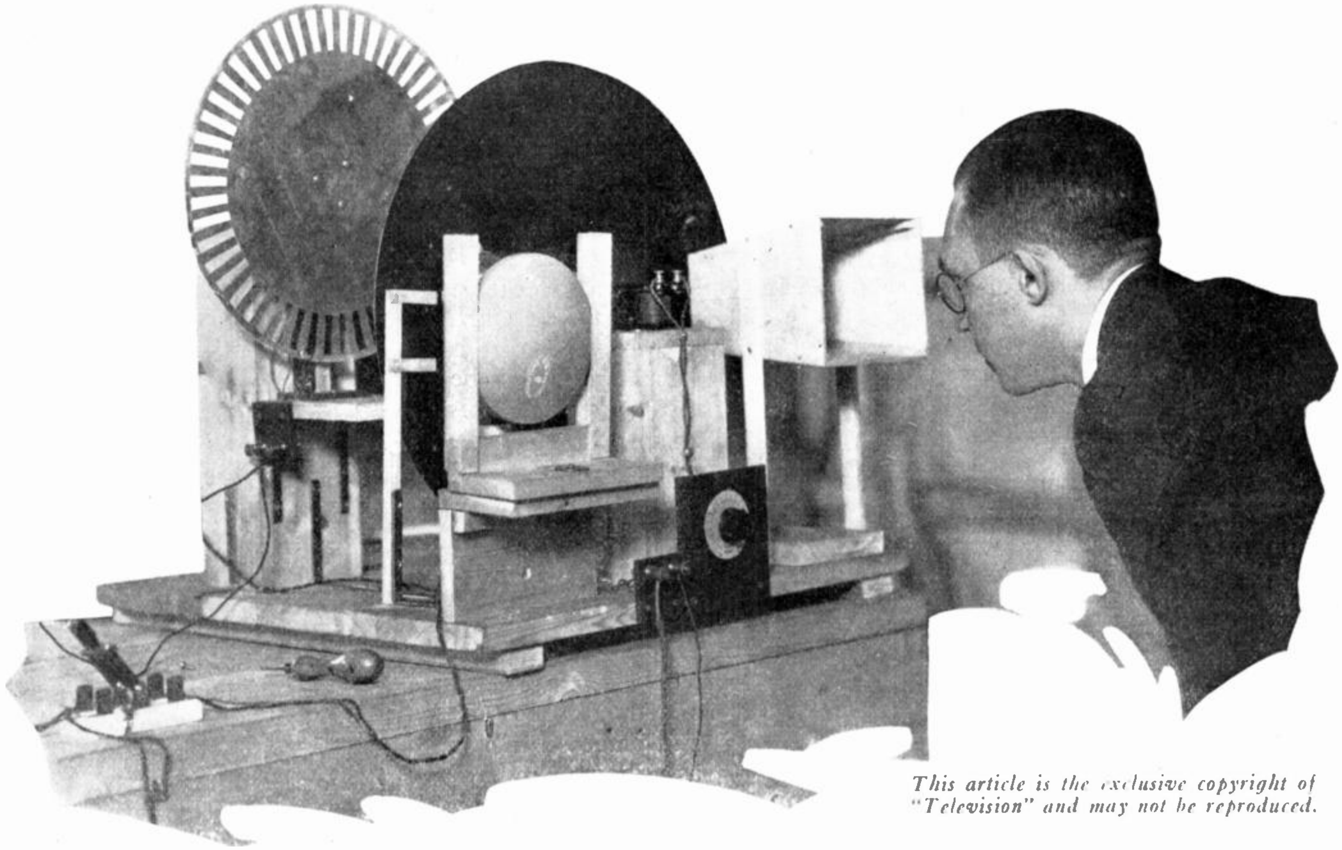


*One of the early scanning systems devised by Baird, the English experimenter. This has been superseded by later types.*

### *New Wonders Will Come*

An invention as simple and basic will enable us to tremendously increase the number of images which we send simultaneously as a television transmission. When the invention is made, it will be so simple that we will all wonder why it did not occur to us before. Many of the elements of that system are already here and in daily use. We have sensitive photoelectric cells, which enable us to scan a subject for several feet. We have a new photoelectric cell which actually generates electric current in proportion to the light reflected on it, the Wein cell. We have the Nipkow disc and have all manner of trick discs, departures from the conventional spiral construction. We have simple and reliable vacuum tube amplifiers. We know how to receive the images, amplify them and convert them into light. We have the neon tube, which responds to all light frequency variations with no apparent lag. And, more recently, we have Cooley's corona discharge, which, instead of giving us a red glow, now gives us brilliant, ultra-violet light with less amplification, less power, than we required to secure the neon tube glow.

He who devotes himself intelligently to the crude television of today, the 24-line picture which will soon be radiated from coast to coast, can do so with the assurance that there are two great, unsolved problems which may bring him a magnificent reward, that of combining images so that not such an enormous frequency space is required to transmit an image of adequate detail and entertainment value, and, second, the evolution of a system of synchronization which will be independent of power systems, sixty-cycle supply and skillful manipulation. These problems, instead of acting as a deterrent to the experimenter, should be definitely and clearly realized as the goal of his work. The sooner these inventions are made, the sooner television will spread into the home and become a new and lasting boon to our present-day civilization.





# HOW *to make a* SIMPLE TELEVISION SET

*Specially described and tested for* TELEVISION *by our Technical Staff*

AMATEURS must have read the numerous accounts of the demonstrations given to television during the past two years, but although much has been published on this work nothing whatsoever appears to have been done to give practical assistance to the amateur in carrying out research work in his own home. This at first seems surprising, as the very large part played by the amateur in the development of wireless is well known and appreciated.

Television, however, is a much more complex subject than radio, and requires a knowledge of science which is not usually within the grasp of the man in the street. The subject, however, has been greatly developed within the past two years, and in the South Kensington Museum, London, open to the view of the public, is a quite simple apparatus with which "television" of shadows was first achieved.

There would seem to be no outstanding reason why the ordinary amateur should not build for himself a similar device and enjoy the unparalleled pleasure of exploring for himself this new branch of science. There is always something infinitely fascinating in exploring a completely novel field, and we purpose to give in this article constructional details which will enable the amateur to build for himself a simple machine which will show the transmission of outlines in a crude form.

In subsequent issues we shall publish further devices and improvements, and also assist in any way we can amateur constructors in solving and elucidating the problems which they are bound to meet.

The mechanical part of the apparatus consists essentially of a simple disc perforated by two spiral sets of holes. We have purposely reduced the device to its simplest possible form, and in this first machine the same disc will be used both for transmitting and receiving, so that there will be no synchronizing problems to deal with. Synchronizing devices will be dealt with in a subsequent issue.

We will begin by giving the details of this disc. Cardboard may be used and forms a fairly satisfactory medium, and one very easy to handle. It may be obtained from any stationer's, and

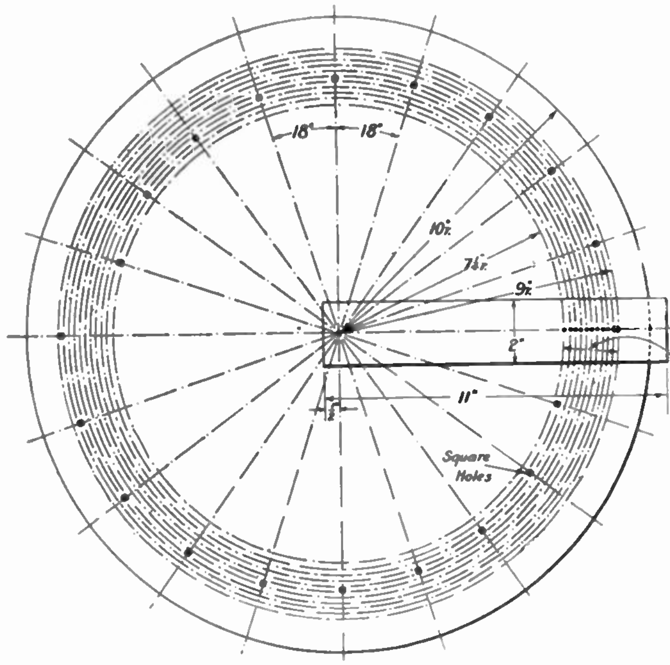



*Fig. 1*

should, preferably, have one side covered in black. There is considerable latitude in the thickness of the card, but it must be sufficiently substantial to give rigidity. The first step is to cut from this card a circle 20 inches in diameter, then mark off eleven circles, the first with a radius of 9 inches, the second with a radius of 8 10/12 inches, and so on until the final one with a radius of 7 4/12 inches. The circumference must then be divided up into twenty equal segments and radii drawn. Where the radii intersect these circles the squares are cut, as shown in diagram, Fig. 1.

In place of cardboard thin sheet metal, such as tin-plate, may be used. A very suitable tin-plate is the material known as Taggart. This is almost as thin as paper, being, in fact, the same material out of which biscuit tins and similar light tinware are made. It is very easily handled, and can readily be cut with an ordinary pair of scissors. It is sold in sheets of 22 inches by 30 inches.

A heavier grade of tin may, of course, be used, but it is not so easily handled.

In marking off the circles the proper instrument to use is a large protractor, but this may not be available, in which case a strip of cardboard 11 inches long by 2 inches wide may be employed. This is used in a similar way to a draftsman's trammels.

With the point of a pair of dividers pierce the cardboard at one end and place on the tin as shown in the sketch, Fig. 1.

Using the point of the dividers as a pivot, mark off the radii along the card, and at the end of each radius pierce a hole with another pair of dividers. Then using the cardboard as a link swing a circle round on the tinplate, this being repeated for each radius.

Where thick tin is used it may be more convenient to drill the holes in place of cutting them with a chisel or knife. Round holes must then, of course, be used. A round hole does not give such good results as a square hole, but if it is desired to get the best results the circular hole can be fieled square with a rat-tail file.

If you are using cardboard there is a tendency to warp which makes the use of tin or other metal preferable. In place of tin an aluminum plate gives a more satisfactory disc, and can be recommended in preference, although, of course, in cutting it entails a greater amount of mechanical skill and labor.

The marking off of the disc is done as follows: First of all, using either a sufficiently large protractor, a pair of dividers or, if you have not any of these, a piece of cardboard as previously described, mark off a circle with a 10-inch radius, then with the same centre mark off a second circle with a radius of 9 inches, then a third circle as shown in the drawing, and so on until you come to the tenth circle with a radius of 7¼ inches. Now divide the circumference of your disc into twenty parts. To do this you will require a large pair of dividers. First of all draw two diameters at right angles to each other, thus dividing the disc into four equal parts, then divide each of these four equal parts into five equal sections, using your dividers to do this, or, of course, you may divide

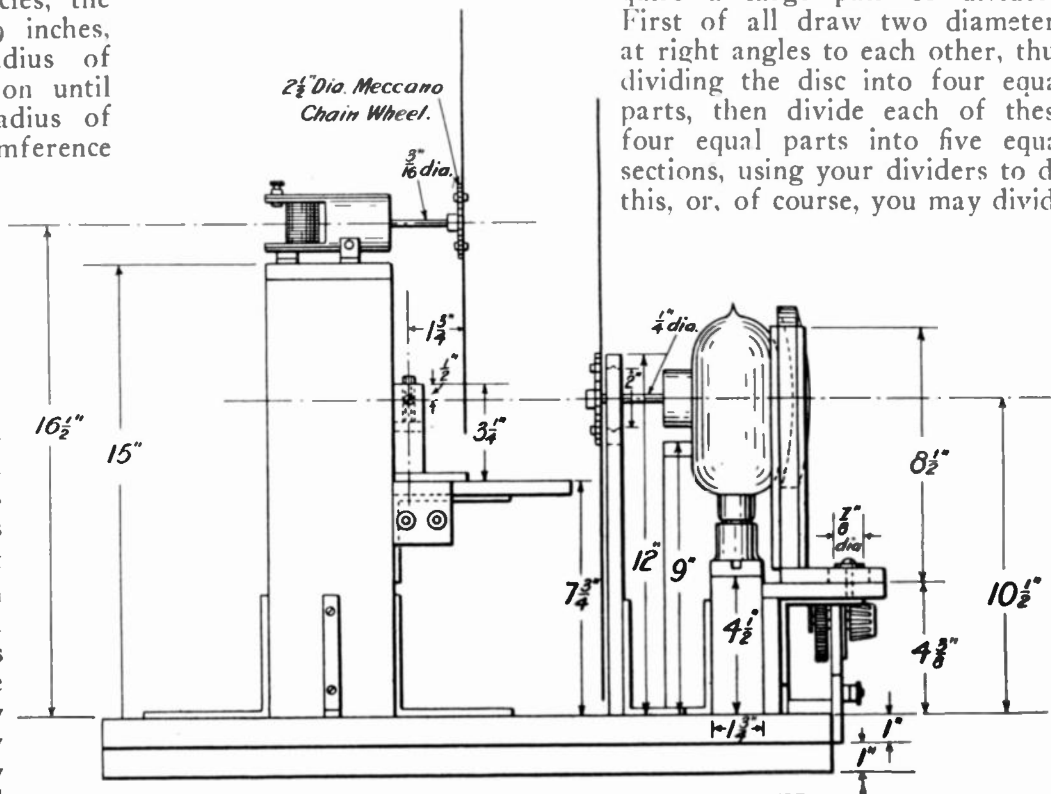



*Fig. 2*

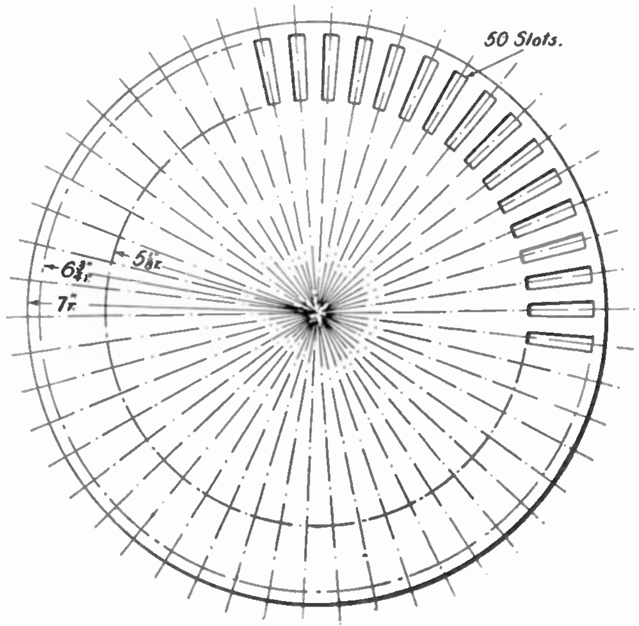



*Fig. 4*

the disc by using a protractor and drawing radii at angles of 360 degrees divided by 20, that is 18 degrees.

You will now have your disc divided into twenty segments, and at the point where the radii cut the concentric circles square holes should be cut, as shown in the sketch, Fig. 1; or, of course, as previously stated, round holes may be used. The centre of the disc must be bored with a hole to fix on the spindle of the driving motor.

Any simple little 4-volt motor may be used. A Meccano pulley was used for fixing. Three bolts (3/16 inch diameter) were used to fix the disc to the pulley, as shown in the sketch, Fig. 9.

The motor carrying its disc is then fixed to a pedestal, the dimensions of which are given in Fig. 2. This pedestal is simply a wooden box, ½-inch wood being used, and is attached to a baseboard made of the same material.

We have now a revolving disc suitably mounted, and this constitutes the first and most essential part of our "televisor."

The next step is to construct our light interrupter disc. The light interrupter disc is 10 inches in diameter, and has fifty holes arranged round its circumference, the holes and spaces between being equal. Two alternative constructions of this disc are shown in Figs. 3 and 4. To make the disc the most suitable material is thin tin, but aluminum may be used, and makes a more rigid job, although it is not perhaps so easy to handle. This second disc is fitted to the shaft of a little electric motor of the same type as that used for the exploring disc and the whole is mounted upon another pedestal, as shown in sketches, Figs. 2 and 3. We come now to what may be considered the heart of the whole apparatus, that is the selenium cell, and this is a snag which has destroyed the hopes of many amateurs who started along the road towards television.

In the first issue of this journal an account appears upon "How to Make a Selenium Cell." But some readers may not wish to go to this trouble, and while it is highly advisable for those who are taking up the study of television to construct their own cells, it may be preferable to buy at least one commercial cell to enable results to be achieved without delay. Experimenters may then commence to construct their own cells, having by them the standard article with which to compare results. The amateur should not grudge the price of a good cell,

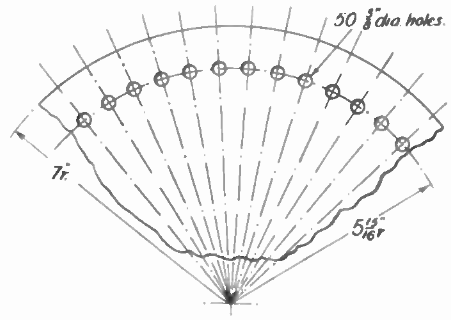



*Fig. 3*

as apart from the apparatus being described at present, these cells will be of the greatest use in future experiments, the same applying to the little motors, reflectors and lamps which he will also be called upon to purchase.

The selenium cell, of whatever type he decides upon, is fixed be-

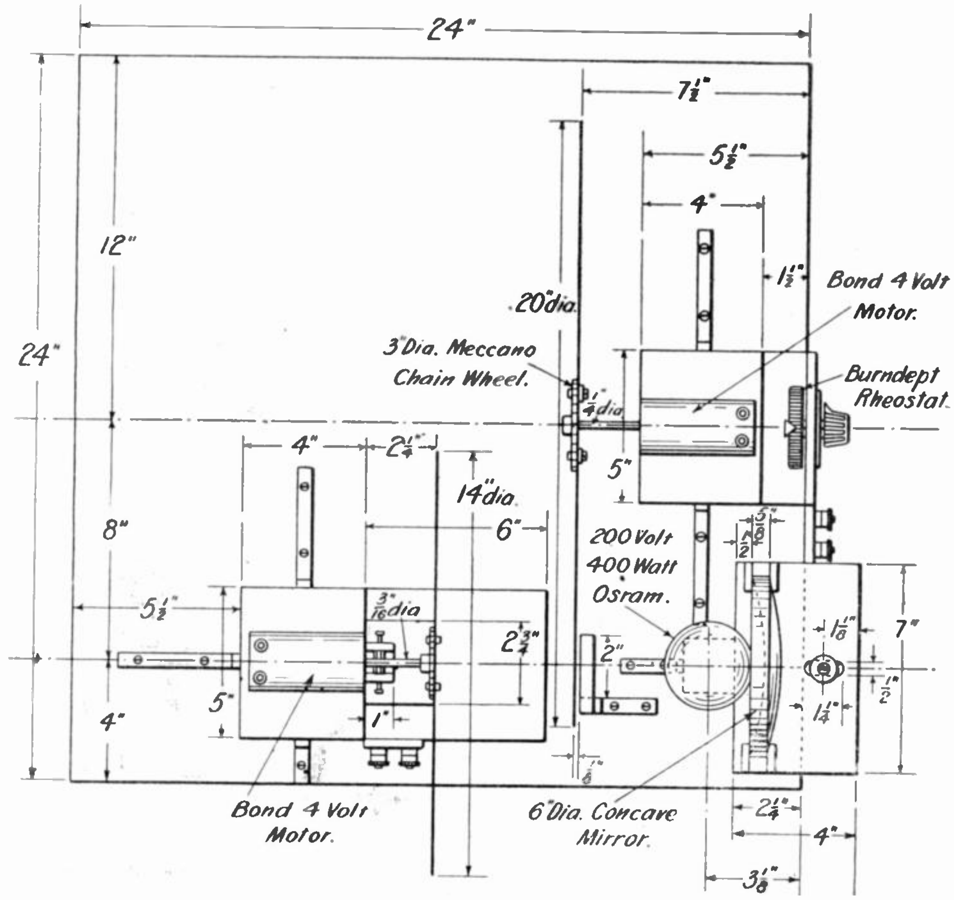



*Fig. 5*

hind the disc and in line with the perforations and slots, as shown in sketches, Figs. 2 and 5. The next item then is the lamp. A projection type lamp, such as a Mazda 400 watt, is suitable, or an ordinary 100-watt lamp may be used. Behind the lamp is the reflector. This is a Mangin mirror 6 inches in diameter, and can be purchased from any optical supply house. The object of the mirror is to concentrate the light of the lamp upon the cell. In operation the light from the lamp is focused upon the holes in the disc, so that an image of the lamp filament falls upon the cell.

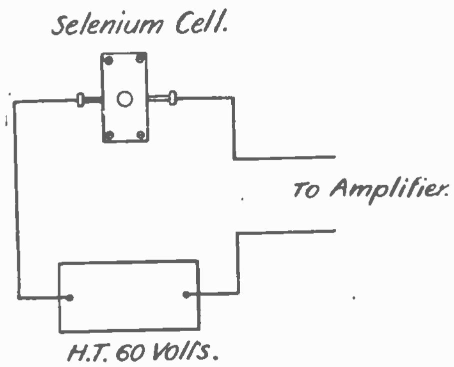



*Fig. 6*

Now for the first test of the apparatus. The first thing to do is to find if the cell is functioning properly, and this requires a three-tube audio-frequency amplifier. Any good three-tube amplifier will serve the purpose.

There are on the market a number of three-tube amplifiers which can be purchased very cheaply, and these are quite suitable. The circuit of the cell is shown in Fig. 6 and the motor circuits in Fig. 7

The arrangement of the cell fixing is shown in Fig. 8. The voltage required for the cell varies from 20 to 100 volts, depending upon the type used. It is safest to start with a voltage of not more than 20, as there is a danger of burning out the cells if too high a voltage is used. The makers will give you what they consider a safe maximum voltage, and this should not be exceeded.

Having connected the cell as

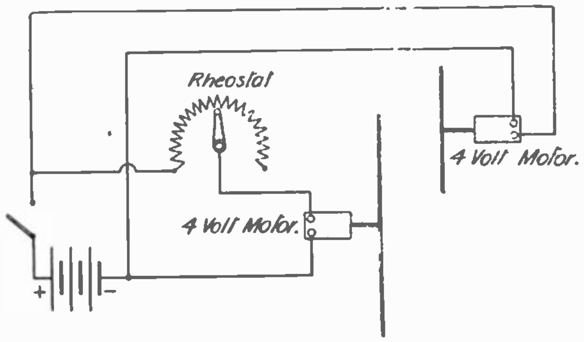



*Fig. 7*

shown in the diagram (Fig. 6), start up the motor driving the radially perforated disc; see that the light from the lamp is coming through one or other of the perforations of the spirally-perforated disc and is falling on the cell. If now a pair of headphones is connected to the output of the amplifier a clear note should be heard, this note being caused by the interrupted light falling upon the cell. When a hand is interposed between the light and the cell the note should stop.

If you find that this is the case then we can proceed to the next step. If you cannot get a clear note from the amplifier then there is a fault either in the cell or in the amplifier itself. If the cell is a purchased one there is not much likelihood of it being faulty, and it would be as well to make sure that the amplifier is in order.

Once having got the sound we have to amplify it sufficiently to give a fairly brilliant light in a neon tube. An ordinary neon tube may be used. These can be purchased from any radio supply dealer. They have in the base a little coil of resistance wire, and it is advisable to remove this or to purchase a tube from which the resistance has been omitted.

It is, however, not essential that the resistance should be removed, the only difference being that the results are somewhat brighter with no resistance.

An ordinary transformer coupling may be used, but difficulty will probably be experienced in preventing "howling." The easiest way to overcome this tendency is by spacing the tubes widely apart. The final tube, which should be of the transmitting type, must be kept well away from the input of the first tube, a distance of 4 or 5 feet being advisable, or shielding may be resorted to. The potential on the final tube must be high; the higher the potential, of course, the brighter the Neon

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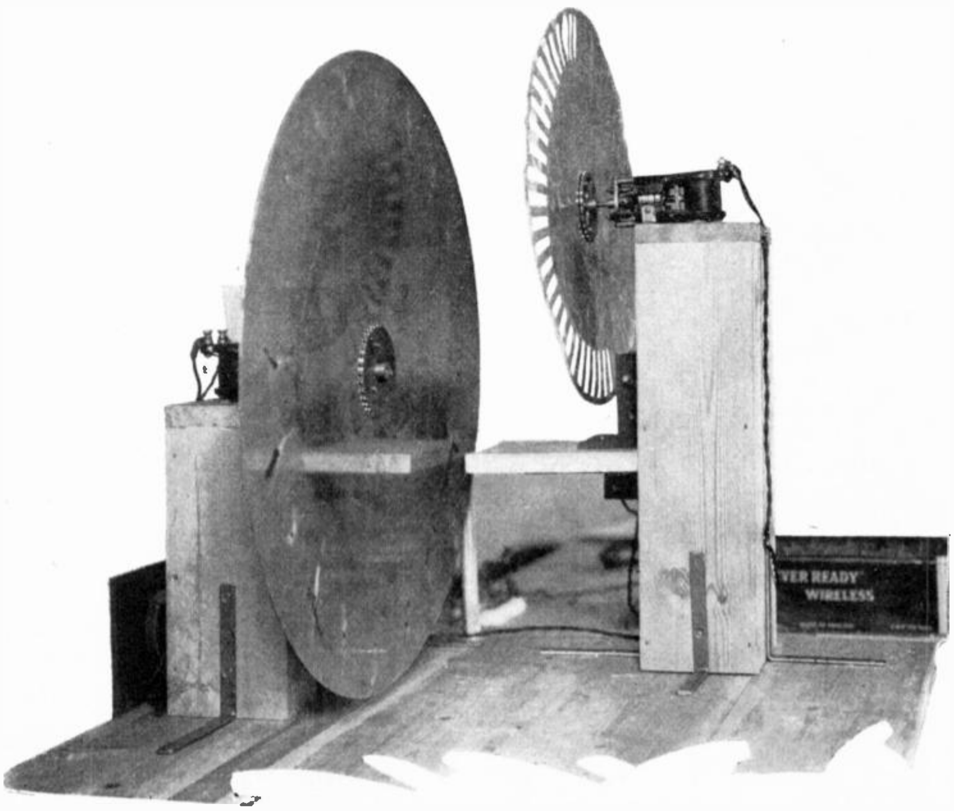


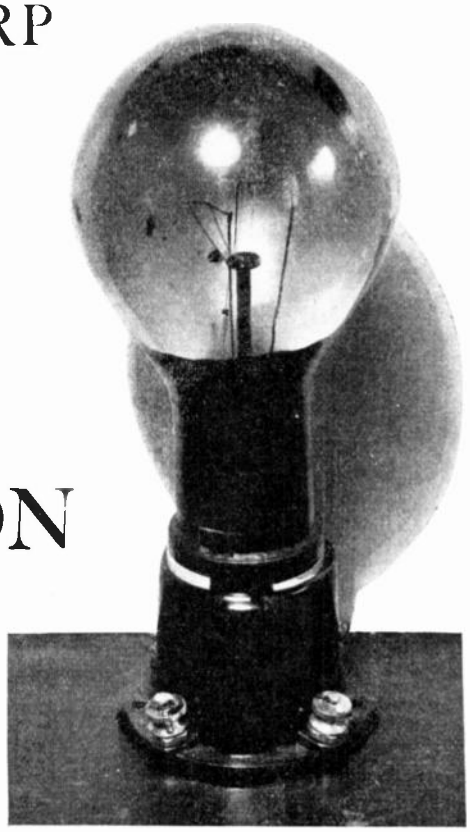

*Side Elevation of Apparatus, Showing Arrangement of Spirally Perforated Disc*

# PHOTO-ELECTRIC CELLS

## THE SHARP EYES of TELEVISION

by

*Bernard Evelyn*



***ELECTRIC eyes now sort beans, count automobiles and measure sunburn as well as perform the miracle of television. These "eyes" never make an oversight and no flash, no matter how infinitesimal in its duration, can succeed in eluding them. The absorbing experiments that led up to the development of this marvelous device are here outlined for the benefit of the student.***

ONE of the main factors in the success of the Sanabria television transmitting set is the improved type of photo-electric cell used. These cells were built by Lloyd Preston Garner of Illinois University. To appreciate the nature of this improvement it is necessary to have a general idea of photo-electric phenomena and the stage of a development reached up to the introduction of the Garner cell.

The term photo-electricity is employed to designate any electrical effect due to the influence of light. As a result of many experiments in photo-electricity modern physicists have built up the theory that light is an electro-magnetic disturbance and that a change in electrification is caused by the addition or subtraction of negative electrons.

### *Early History Cited*

Before Professor Hertz performed his now classic experiments it was known that certain "semi-metals" such as selenium, thalium, strontium and barium, when under the influence of light, decreased in resistance to the passage of an electric current. In 1873 while conducting some experiments in which selenium was used as a resistance Willoughby Smith was annoyed by the peculiar instability of this metallic form of resistance. He investigated the phenomenon and discovered that selenium had the property of varying its electrical conductivity with the intensity of the light to which it was exposed. Light-sensitive cells made of these rare substances have been used in the past in telephoto experiments but had to be abandoned because of their inertia and their inconvenient property of "lag" or fatigue. Moreover, they are only at their maximum sensitivity when kept at very low temperatures.

In 1887 Hertz noted that the electric discharge of a spark gap took place more easily when light fell upon it than when it was in darkness. The light given by another spark gap discharged simultaneously was sufficient, but other sources of light were tried and it was found that the greater the actinic power of the source of light the greater the spark produced. He investigated this by inserting in the primaries of two induction coils a common interrupter (Fig. 1). One coil produced the spark SA and the other, a smaller coil, the spark SP. SA was about 1cm. long and SP about 1mm. long. With this arrangement Hertz was able to increase or decrease the distance between his two spark gaps. Whenever he diminished the distance the intensity of action increased.

Then he proceeded to introduce between his two spark gaps a plate of metal or glass. The spark SP ceased. When the plate was removed the spark immediately reappeared. This result was puzzling to Hertz and seemed to indicate that the action was not due to light as he had at first surmised. On the other hand neither could he attribute it to some form of electrical - action - at-a-distance because of a cessation of action with a metal plate as screen.

Having arrived at this point Hertz proceeded in a way which is a beautiful example of the inductive scientific method. He tried interposing a sheet of rock-crystal between his spark gaps. Spark SP

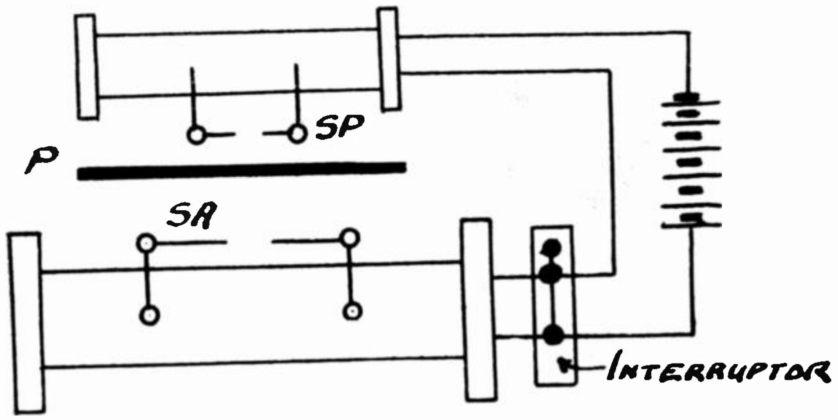



FIG. 1.

once more reappeared. He then had the certain knowledge that he was dealing with a phenomenon of light, particularly of the ultra-violet rays of the light spectrum, rays which are stopped by ordinary sheet glass but which can pass through rock-crystal or quartz. The spark SA he called the active agent, the spark SP the passive.

Experiments with slit screens and reflectors showed that the effect of the active spark was propagated in straight lines in accordance with the laws of light. Then the action of various other illuminants was investigated. Sunlight, the flames of wood, gas, benzine, magnesium, limelight and so on were used. Hertz found that the electric arc was the most effective source of light and tested its action as regards rectilinear propagation, reflection and absorption. In every case the results justified his hypotheses.

*Birth of Electron Theory*

The next important step in photo-electric development was the discovery in 1888 by Hallwachs that bodies carrying negative charges of electricity readily lost that charge when they were exposed to ultra-violet light. If, however, the bodies had a positive charge then they were not discharged by the light rays. When Hallwachs made this discovery he was seeking for other phenomena due to the effect of the ultra-violet rays which would lead toward an explanation of Hertz's discoveries. He connected a polished zinc plate to an electroscope. The plate was charged and then illuminated by an arc light. When the charge was positive nothing happened; but when the charge was negative the gold leaves of the electroscope collapsed. By using tarnished plates instead of polished it was shown that the phenomenon was due to the action of light on the *surface* of the charged body.

From this was built up the hypothesis that electrical particles traveled away from the negatively charged plate and followed the lines of force of the electric field. This theory was to have a great bearing on the electron theory and led other experimenters to devise methods for studying the electrical discharge of bodies.

*Early Photo-Electric Cell*

One of these experimenters, Stoletow, placed a metal net a few centimeters away from the polished metal plate which was connected to the negative pole of a Volta cell. The net or grid was connected to the positive pole and a galvanometer was inserted to measure the current (Fig. 2). Then a light shining on the plate caused a deflection of the sensitive galvanometer needle. From this it was concluded that the light liberating the negative charge gave the plate a positive potential. A sufficient rise in this potential would overcome the difference of potential and a current of negative electricity would flow from the metal, the more electro-positive the metal used the greater the flow. Eisler and Geitel in 1889 showed that sodium, potassium, and rubidium, all electro-positive metals, manifested photo-electric effects when exposed to light.

*Vacuum and Gas Filled Cells*

As a result of this preliminary work a host of scientists made a study of photo-electric phenomena and carried out experiments in vacuum and in low pressure gases instead of as formerly in ordinary air. They found that negative electrons were liberated from illuminated polished plates in these mediums and a number of experiments and calculations determined approximately the velocity of this emission and the number of electrons emitted. Then the effect of the nature of the medium used was

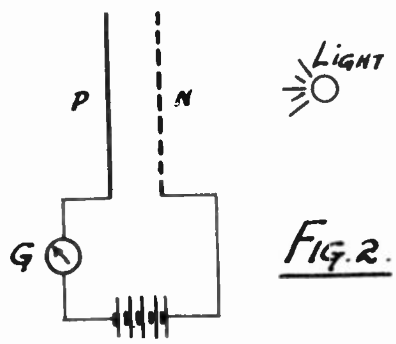



FIG. 2.

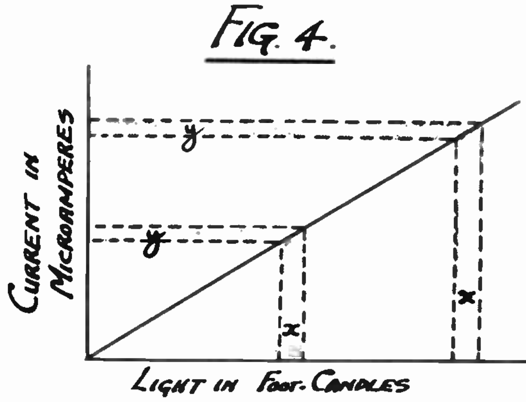
studied. The use of high vacuum found many partisans but it was also shown that when certain gases were used with certain metals the photo-electric effect was increased. This was due, not as at first surmised to chemical action, but to the production of ions in the gas by adhesion and collision. Condensation of gas on the surface of the plate did not affect the emission of electrons or form a surface film which would impair their active emission. Tests made with potassium showed that the photo-electric current was substantially the same whether the metal was distilled seven times or only once. If condensed gases had been affecting the plate the repeated heating would have liberated this condensation and increased the current.

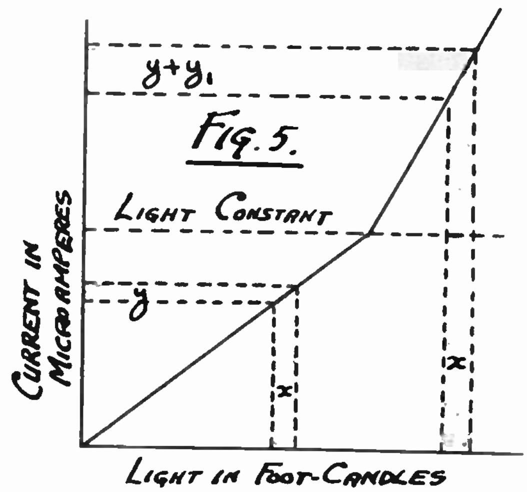
### *Modern Cell Described*

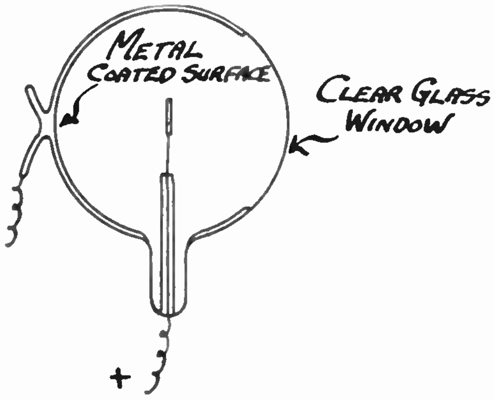
Photo-electric cells of the type built by Mr. Garner for the Sanabria television system are extremely complicated to make. After the sphere has been blown the various connections on it have to be raised and the cathode positioned. The glass used is Pyrex and requires a terrific heat to become malleable. The cell is sealed and is exhausted for over 24 hours by means of a mercury vacuum pump. After that the solid potassium, which is introduced in one of the cell's connecting tubes before it is emptied of all air, is melted with a blow lamp so that it forms an even deposit all over the inside surface with specially thick deposits at the base of each electrode. Further heating on only one side clears the window of the cell through which the light is to shine (Fig. 3). While this is done every part of the cell which is to remain coated is immersed in water. The cell is then filled with hydrogen gas and an electric current is passed through. This forms a hydride of the alkali metal, this having been found to be more sensitive, more electro-positive, than the pure metal. After the new sensitive surface is formed the hydrogen gas is drawn out and replaced with a gas. In the Garner cell argon gas at low pressure is used. Potassium hydride forms the plate deposit but it appears to be more crystalline than in any cell made hitherto.

### *Sensitivity and Law of Proportion*

Since 1913 a good deal of investigation has been made as to the relation of magnitude of the photo-electric current to the intensity of light used on the cell. Generally speaking the result of these investigations have led to the conclusion that the current produced is proportional to the light, that is to say that every unit light change gives the same current change. Deviations from strict proportionality were not considered desirable and were put down to faulty construction. The proportion law is illustrated diagrammatically in figure 4 where the increase in light produces a strictly proportional current increase. Kunz of Chicago in 1919 found, however, that when the potential, pressure, and light intensity were so adjusted that a glow was visible in the photo electric cell then the current produced was not proportional to the light intensity. The current was enormously increased over the value attained without the glow. This characteristic was not desirable in photo-electric cells used up to the advent of television. For astronomical measurements, unless an exact proportion existed astronomers would have to deal with logarithmic functions of the light intensity value.



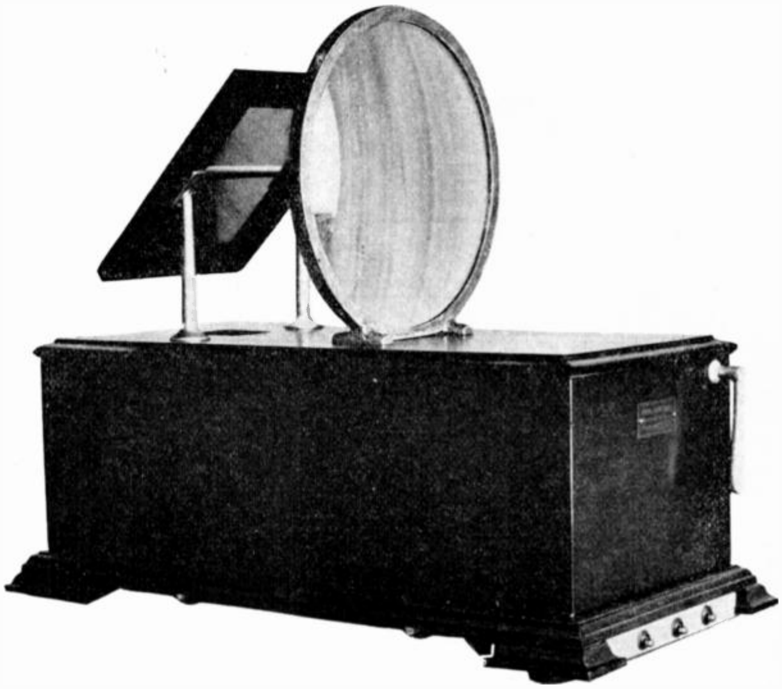

### *Faults Changed to Assets*

Until Mr. Garner became interested in television, none of the experimenters in this new science thought of applying the undesirable characteristics of a certain type of cell into advantages. Mr. Garner first of all returned to the spherical type of cell with illuminated central electrode, a type which had been shown to give a marked departure from the proportionality law. He then developed what he calls the "light-level system." This can best be understood by reference to figure 5, which represents diagrammatically the relation between the photo-electric current in microamperes and the light intensity in foot candle-power for the Garner cell.

Up to a certain point the cell obeys the proportional law. In figure 5, an increase of "x" foot-candles leads to an increase of "y" microamperes in the same relation as the cell shown in figure 4—but *only up to the light constant*. After a certain intensity is reached each small increase in light intensity

(*Continued on page 41*)

# Jenkins Invents



*The complete Jenkins Radiovision Receiver: The framing lever is manipulated to keep the image in the center of the lens on the side. The mirror turns the rays so the image can be viewed in a perpendicular position. Switches for controlling the receiver are at the front.*

RADIOMOVIES is not visionary, or even a very difficult thing to do. Speech and music are carried by radio, and sight can just as easily be so carried. Radio is not a noise, it is a carrier, comparable to copper wires extending in every conceivable direction from the broadcast station.

To get music by radio, a microphone converts sound into electrical modulation, which carried by radio to a distant place, is there changed back into sound and we hear the music.

To get pictures by radio the photo-electric cell converts light into electrical currents, and at a distance these currents are changed back into light values and we see the distant scene, for light is the "thing" pictures are made of. As with all other attainments, the engineer progressed slowly as he studied the fundamentals of his new mechanism, so still pictures were undertaken first.

### *But Two Receiving Schemes*

There would seem to be but two practical schemes to receive pictures electrically; one is on a flat surface, like a photographic negative, for example, and the other on a cylindrical surface, like a sheet of paper wrapped around a rotating drum. Because a picture by the cylinder method is easiest to do, and is entirely adequate for "stills," this method has been employed by all workers at some time or another.

However, whatever type of machine is used, the only method employed to the present time consists in a linear analysis of the picture, scene, or object, and the instantaneous synthesis of each line on a distantly located receiving surface. At the transmitter the lights and darks of each successive line are changed into electrical current of corresponding strengths, which, carried to distant receivers, is there changed back into like light intensities and assembled on a suitable surface, for example a sheet of paper, a photo film, or a flat picture screen.

### *Weather Maps Broadcast*

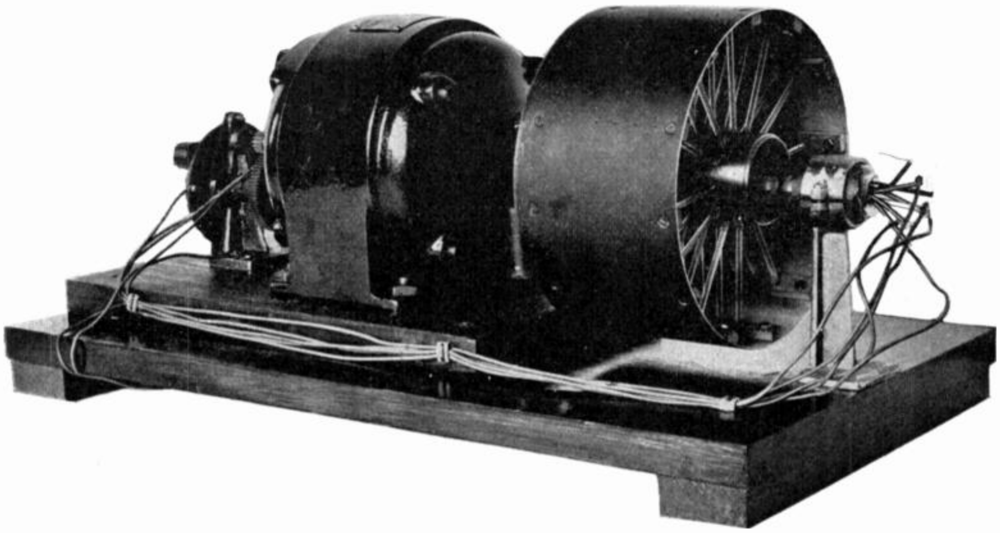
In the weather map transmitter, which structure is typical of all cylinder transmitters, the weather map is wrapped around a glass cylinder. Inside the cylinder is a source of light, and outside opposite the lamp a light-sensitive cell is mounted. As the cylinder rotates a screw moves the lamp and light-cell along together. The result is that every part of the weather map passes between the lamp and the cell. The transparent lines of the weather map let the light through and an electric impulse sent out from the cell is amplified and broadcast.

The receiving machine consists of a similar cylinder or drum rotated by a motor. An ink pen is carried along the surface of the cylinder by a screw as the cylinder rotates and marks the base map wrapped around the cylinder. The incoming radio signals make the pen touch the paper, applying ink at places corresponding to the lines on the map at the transmitting station. A duplicate map is thus built up on the map receiver.

### *Prismatic Plates Used*

In the prismatic ring machine, a typical plate method, the transmitter consists of a projection lantern, in front of the lens of which "prismatic plates" rotate. The rotation of these prisms causes the picture to sweep across a light-sensitive cell in successive journeys, each slightly displaced with respect to the last, until the whole of the picture has crossed the cell. The cell changes the picture characteristics into electrical characteristics.

# the Scanning Drum



Mechanism of the Radiovisor showing the driving motor, the seven-inch scanning motor, the quartz rods which look like spokes in the drum, and the neon lamp in place in the standard which holds it inside the drum hub.

*One of television's pioneers tells how and why he invented the scanning drum to replace the cumbersome disc. Jenkins conducts light to the periphery of a drum through tiny rods of quartz. This simple device gives better delineation and a brighter picture.*

These are put on a radio carrier wave and broadcast.

At the receiving station duplicate prismatic plates in a radio camera changes these varying electrical values back into light values which are recorded on a photographic plate to make up a negative. When developed prints of the negative can be made which are like the picture at the distant station. To the present time the fundamentals in all systems are the same—only the mechanisms differ.

### *Radio-vision Seen Directly*

Radiomovies or radio-vision, like the words radiogram and radiophone, refer to radio service. We say telegram, telephone, and television when referring to wire service. In radiovision the time of completion of each elementary picture is one-fifteenth of a second, so recording means is not necessary. The picture in action can be looked at directly as it comes in.

As you may already know, the general scheme is to analyze the object or scene by a rotating scanning disc at the transmitter which permits light reflected from the subject to fall on a light-sensitive cell. Just as in still pictures these light values are changed into like current values, which at the receiver permits light from a given source to be seen, directly or by reflection from a screen. It is a very old scheme, patented in 1884. A disc has tiny holes arranged in a spiral. If the holes are an inch apart in the spiral, then the ends of the spiral have an inch offset; and the picture is an inch square, made up of fifty lines, let us say.

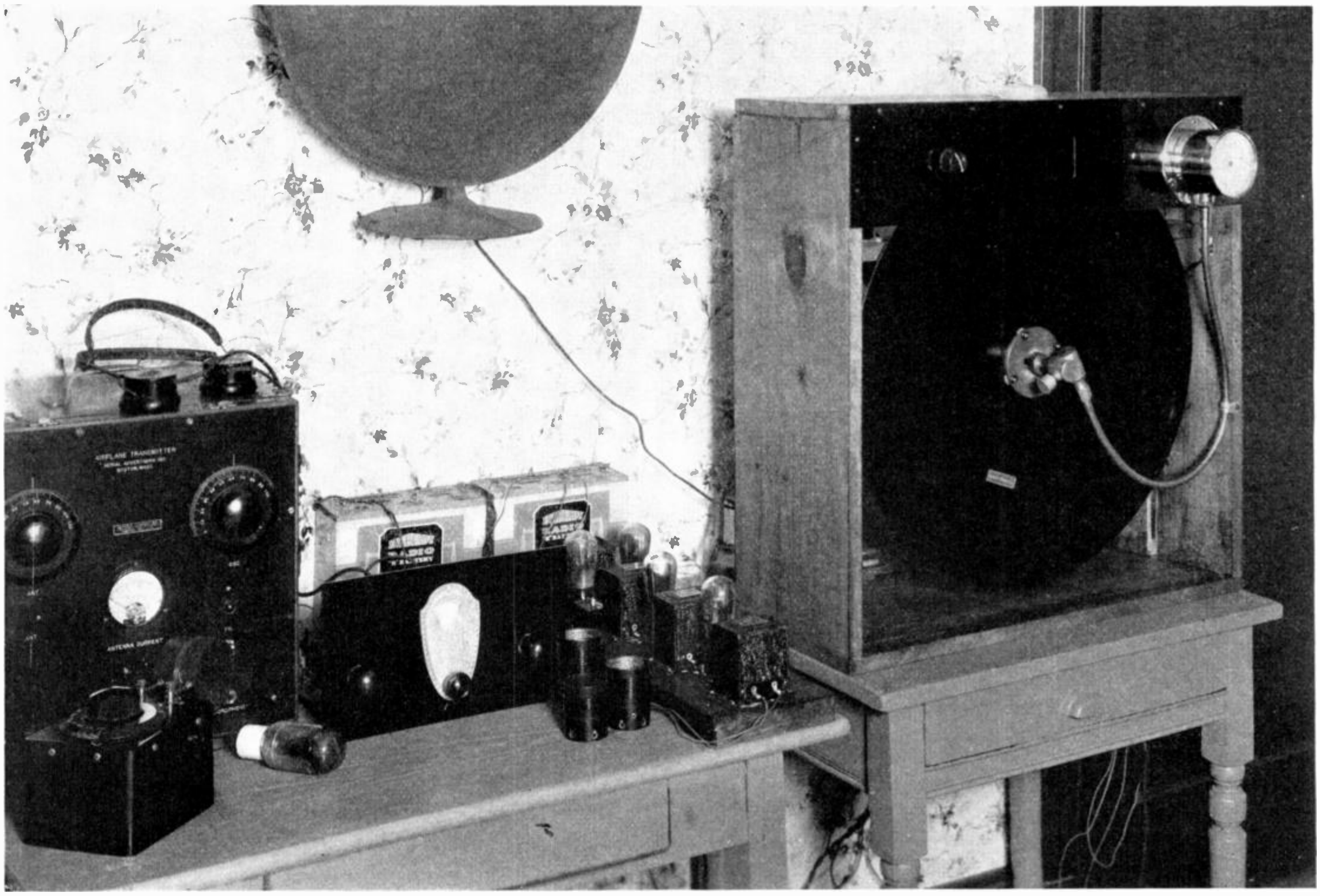
### *Light Limited by Disc*

The handicap of this method is that the light intensity, as in a pin-hole camera, is limited to the light which can pass through this minute aperture, which in this case is only 1/2500th part of the whole light. To overcome the blinding light on the person whose image is transmitted, it was proposed by Rineoux that an arc lamp of high-intensity be focused on these minute apertures, after passing which the spot of light is swept across the subject by the rapid rotation of the scanning disc, thus avoiding the discomfort of the old method.

At my laboratory we think that limiting the light by passing it through these apertures is not the best plan; the resultant available light is too weak. To get greater use of the light we made the openings in the scanning disc 1.5 inches in diameter and put lenses over the openings. The required concentration is secured by focusing the light-source, as a tiny flying spot of light on the receiving screen, to build up the moving picture. The other drawback to the disc method is the bulkiness of the mechanism. A scanning disc three feet in diameter makes but a 2-inch picture which can be viewed by no more than one or two persons simultaneously. Because of physical limitations in the apparatus the picture cannot be made much larger than the present 2-inch picture.

Months ago we abandoned the disc and invented the unique drum method now used in the Radiovisor. A 7-inch diameter drum serves eight or ten persons with motion picture entertainment by radio. The picture appears about 6 x 6 inches square. In its essential working parts the receiver consists of a 7-inch aluminum drum, mounted on the shaft of a small motor. A multiple glow-spot lamp is mounted in the hollow hub of

(*Continued on page 28*)



# THE *POWER* Behind the

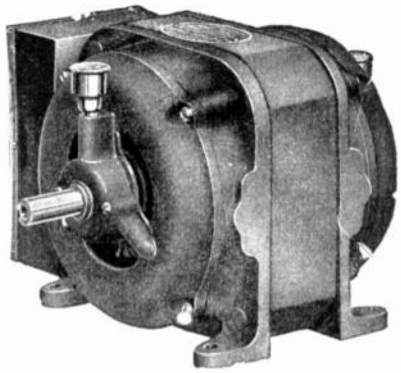
TELEVISION receivers and transmitters in their present popular form require the use of some convenient form of power, such as an electric motor, to operate the rotating elment known as a scanning disc. The scanning disc rotor as either transmitter or receiver of television impulses, is the "window" placed between the light source and the observer, as in the television receiver, or the light-sensitive cell and the subject to be televised, as in the television transmitter. In either case what the scanning disc accomplishes once every revolution, for every section of the televisor receiver screen or subject being transmitted, is the opening and closing of the light path to the light-sensitive or light-emitting cell.

When the transmitter and receiver discs are exactly in synchronism and in step the result is perfectly "framed" television reception. The operator at the television receiver, in other words, sees the reconstructed image located within the frame of the observing section or opening of the receiver cabinet. If the scanning disc at the receiver falls out of step with the transmitting disc the result will be a drift of the image towards one side or the other of the frame. Unless brought back into frame by an immediate adjustment of speed of disc through manipulation of the motor speed control the entire image will drift out of frame, be replaced by another image going faster than the first, and so on until the images fly across the field of the frame and the observer beholds what appears to be a display of rotating pyrotechnics.

It is of the utmost importance, therefore, to hold the scanning device to a speed at once synchronous and in step with its counterpart at the transmitting station. Synchronism can be approximated, perhaps closely enough for the amateur and experimenter, by the use of a motor controlled by an adjustable resistance, which must be continually manipulated by the observer. This control is likened to the steering of an automobile by the driver. Constant attention is required. In the case of the alternating current motor attached to the same electric lines which operate the motor which drives the

# Television Motors

*A new accessory is added to radio —the synchronous and universal motors. These motors purring in tune with those used at the picture broadcaster, build the picture up from a meaningless series of flashes. This article tells you what kind of a motor to buy and how to control its speed so that it will remain "in step" with the motor at the transmitter.*



# Scanning Disc

*By* RUTHERFORD KENNEDY

transmitter scanning disc automatic synchronization can be attained. With the seven or more large power companies supplying alternating current power in the New York area, none of which are permanently synchronized with each other, the synchronous alternating current motor will offer no solution. However, the specially designed alternating current motor has been proved by trial to be highly satisfactory motor power for televisor scanning discs.

One of the noteworthy products in the field of television today are the Baldor motors. They are built especially for adjustable speed or absolute synchronous operation. They have been found by experimenters to be quiet in operation and cause no interference to the receiving set. They have no short-circuiting mechanism to cut out starting coils as in various other types, and utilize no brushes.

The special Baldor television motors are of the induction condenser type. They use no commutator for either starting or running, avoiding the small spark which might occur in commutating motors and cause interference in the nearby television receiver or amplifier. Such interference more or less fogs the received image. While the magnetic action within the motor which causes it to rotate is similar to a poly-phase or "many phase motor, there is an absence of hum often found in the single phase type. The rotor turns in ball bearings so that it responds rapidly to rheostat or inductor speed regulation. The starting current is also very low, causing no appreciable flicker in the lights when starting.

The type "V" adjustable varying speed motor is made in three sizes. It is so designed that, following the usual on and off switch, speed control mechanism in the form of a variable resistor, reactance, or a combination of the aforegoing may be used. While many television broadcasters are using the adjustable speed type of motor for rotating the transmitter scanning disc, engineers believe the solution of synchronism of motors used on non-synchronous alternating current power systems will be a synchronous type motor at the transmitter and a variable speed AC motor at the television receiver, controlled by an adjustment in the hands of the observer. The Baldor variable speed type was designed for such service, and can be controlled so that any speed between 100 revolutions per minute and synchronous speed can be attained with suitable resistors in series with the line. The circuit diagram shows how the wires to the resistance and the condenser box are connected.

A flat scanning disc is practically a frictionless load on the motor. If it can be loaded slightly, causing it to work somewhat harder, much better operation will be secured. This loading can be accomplished by attaching small blades at right angles to the disc, making a sort of fan which will catch the air and create a load. Small pieces of tin, one by two inches in size, with a small flange turned over for the purpose of bolting to the disc, will accomplish the purpose. They should be cut exactly the same size and each attached to the disc at exactly the same distance from the motor shaft so that the balance will not be disturbed when the motor and disc are in operation. On the other hand, many experimenters advocate the placing of a small flywheel on the motor shaft in addition to the disc, but this will be left to the particular findings of the individual experimenter.

The variable speed type M2-V is of 1/15 horse power, 110 volt-60 cycle single phase AC, and operates a 9- to 18-inch diameter aluminum scanning disc between 750 and 1,750 R.P.M. with a 150-ohm rheostat connected in series with one of the power wires to the motor terminals. The necessary condenser is supplied as part of the motor equipment. The rheostat should be capable of carrying at least one-half ampere of current without heating.

## *Who Is Broadcasting Television And When*

EASTERN DAYLIGHT TIME

| *Station* | *Location* | *Broadcasting Time* | *Waves in Meters* | *Disk Holes* | *Motor R.P.M.* |
|---|---|---|---|---|---|
| WRNY and 2-XAL | New York | On the hour during program periods — 5 minutes each, also Monday 6:40 to 7 P.M.; Tuesdays 12 M. to 12:20 A.M., and Saturdays 3:40 to 4 P.M. | 326 and 30.9 | 48 | 550 |
| WGY | Schenectady | Tuesdays, Thursdays, and Fridays—1:30 to 2 P.M. | 380 | 24 | 1,200 |
| WGY and 2-XAF | Schenectady | Tuesdays, 11:30 to 12 P.M. | 380 and 31.4 | 24 | 1,200 |
| WGY and 2-XAD | Schenectady | Sundays, 10:15 to 10:30 P.M. | 380 and 21.96 | 24 | 1,200 |
| WLEX and 1-XAY | Lexington, Mass | Nightly — Irregular hours. | 61.5 | 48 | 1,080 |
| 3-XK | Washington, D. C. | Mondays, Wednesdays and Fridays—9 to 10 P.M. (Silhouettes). | 46.7 | 48 | 900 |
| WIBO | Chicago | Several nights weekly at 2 A.M. | 306 | 45 Special | 1,080 |
| KDKA | Pittsburgh | Irregular-experimental (Radio Motion-pictures). | 62.5 | 60 | 960 |
| 4-XA | Memphis | Irregular-experimental | 120 to 125 | 24 | 900 |

NOTE: 9 o'clock, Eastern Daylight Time=8 o'clock, Eastern Standard Time=7 o'clock, Central Standard Time=6 o'clock, Mountain Standard Time=5 o'clock, Pacific Standard Time.

The variable speed type Y1-V is 1/8 horse power, 110 volt-60 cycle single phase AC, and operates a 24-inch scanning disc between the same speeds with the same rheostat resistance as the MV-2 type of motor with the exception that the 150 ohm rheostat for 1/8 H.P. motor should be capable of carrying at least one ampere without overheating.

The variable speed type Y2-V 1/8 horse power, 110 volts-60 cycle single phase AC motor for television sending stations, will operate at constant speed at slightly less than synchronism, or 1,200 R.P.M. However, with a 60 ohm rheostat, of not less than one ampere current carrying capacity, speeds of between 500 and 1,100 R.P.M. can be attained.

The synchronous or constant speed Y2-S motor of 1/8 horse power, 110 volt-60 cycle single phase AC is for sending and receiving apparatus where absolute synchronous operating is desired and can be attained automatically, as television transmitter and receivers operated from the same alternating current circuits. The speed is 1,200 R.P.M. and will not vary with slight voltage or load changes. It is similar in size to the Y2-V type.

In most cases the 1,200 speed of rotation of transmitter discs is most satisfactory for this allows condenser variable speed motors of the 4-pole 1,800 R.P.M. A very satisfactory form of variable resistance is one made of wire which has negligible temperature coefficient, arranged with definite steps, with a pushbutton hand control arranged to short circuit about 15 per cent of the total resistance. This will allow the motor, when

(*Continued on page 27*)

# *What Experimenters Should Know About* OPTICAL PROJECTION

*by* PROFESSOR CHESHIRE, C.B.E., A.R.C.S., F.I.P.

*Late Director of Optical Engineering Department of the Imperial College of Science and Technology*

*Do you know how to trace rays of light? Do you know what refraction popularization or "black light" is? Could you calculate the index of refraction for a piece of glass? This article tells you how to do these things, how to fathom the fascinating mysteries of light behavior.*

"WHY is it that during an eclipse of the sun the patches of light which are found on the ground beneath a plane tree, and which are formed by rays which have passed through the spaces between the leaves, take the shape of the eclipse sun?" In these words Aristotle, about 350 B.C. propound his famous problem concerning the optical projection of pictures. Nearly 2,000 years, however, elapsed before a satisfactory solution of this problem was given by Maurolycus. This solution we shall refer to later when considering the action of a lens.

Fig. 1 illustrates Aristotle's problem. It is a photograph taken some years ago of the pictures of the eclipsed sun projected through the leaves of a (plane) tree on to the pavement of a street in Bombay.

Now the telescope for astronomical purposes was not invented until the year 1608, but for many years before this date eclipses of the sun had been observed and studied by the method described—a method now generally referred to as the "pinhole camera" method.

Fig. 2 is a facsimile of a quaint diagram which occurs in a book written by Gemma-Frisius in the year 1545. It shows an astronomical observatory fitted up as a large pin-hole camera for the observation of an eclipse of the sun which was visible at Louvain in the year 1544. An image of the eclipsed sun was projected, through an aperture in a shutter on one side of the room, on to a wall which acted as a screen on the other side, and upon which the various phases were drawn in by the observer. To facilitate this operation fiducial lines were drawn upon the screen, thus anticipating in some way the reticules and micrometers which were later fitted to the eye-pieces of telescopes.

*Fig. I. Images of Eclipsed Sun on Pavement at Bombay*

Paradoxical as it may seem, the astronomer had in the arrangement shown by Fig. 2, although without lenses, the optical equivalent of a telescope magnifying system. To an observer stationed at the pin-hole the sun seen directly would have subtended an angle of half a degree, as would also have done the image on the screen as seen from the same place. From a position, however, midway between the pinhole and the picture on the screen, the latter would have been seen as subtending an angle of one degree, i.e., under a linear magnification of two! Nearer still the magnification would have been correspondingly greater. This interesting method, however, was in practice very limited in its application. The pinhole could not be enlarged for obtaining more light, because of the falling off in definition of the pictures which resulted. Later it was discovered that the pinhole could be enlarged to any size if then filled up with a lens of such a power as to give a focused image on the screen. This image could then be examined with a second lens, used as a hand-magnifier. The astronomical telescope in use today is essentially such an optical arrangement. The value of the pinhole camera for obtaining distortionless pictures of architectural subjects is well known, but the possibilities of the method for landscape work is perhaps less known. In the hands of an expert like the late Sir William Abney, beautiful work has been done.

In Fig. 3 we have an example of his work taken through an aperture of O/I mm. diameter, and with an exposure of one minute.

It is a remarkable fact that we have in the Pearly Nautilus an animal with a pinhole camera type of eye. Fig. 4 is a section.

Of this eye, for a description of which we cannot do better than quote from Sir Ray Lankester's article on "Mollusca" in the ninth edition of the Encyclopedia Britannica. He says there: "The eye of Nautilus is among the most interesting structures of that remarkable animal. No other animal which has the same bulk and general elaboration of organization has so simple an eye as that of Nautilus. When looked at from the surface no metallic lustre, no transparent coverings, are presented by it. It is simply a slightly projecting hemispherical box like a kettle-drum, half an inch in diameter, its surface looking like that of the surrounding integument, whilst in the middle of the drum membrane is a minute hole. Owen, very naturally, thought that some membrane had covered this hole in life, and had been ruptured in the specimen studied by him. It, however, appears from the researches of Hensen that the hole is a normal aperture leading into the globe of the eye, which is accordingly filled by seawater during life. There is no dioptric apparatus in Nautilus, and in place of refracting lens and cornea we have actually here an arrangement for forming an image on the principle of the "pin-hole camera." There is no other eye known in the whole animal kingdom which is so constructed.

*Fig. 3.—Pinhole Photograph of Landscape.*

A fundamental property of wave-motion, first enunciated by Huygens, is that every little bit or element of a wave surface is propagated in the direction of a normal to that surface. A spherical wave propagated in a homeogeneous medium, for example, remains spherical throughout its travel, each little element of its surface being continuously propagated along a radius of the sphere. Fig. 5 is taken from Huygens' treatise on light, published in 1690.

We are now in a position to pass on to the consideration of optical projection by means of lenses and lens systems, but first we must understand the relationship between a "wave" diagram, and a "ray" diagram as used for explaining the action of a lens. Suppose that in Fig. 6 A represents a source of light so small that for our present purpose it can be treated as a point. The spherical light-waves given out by this

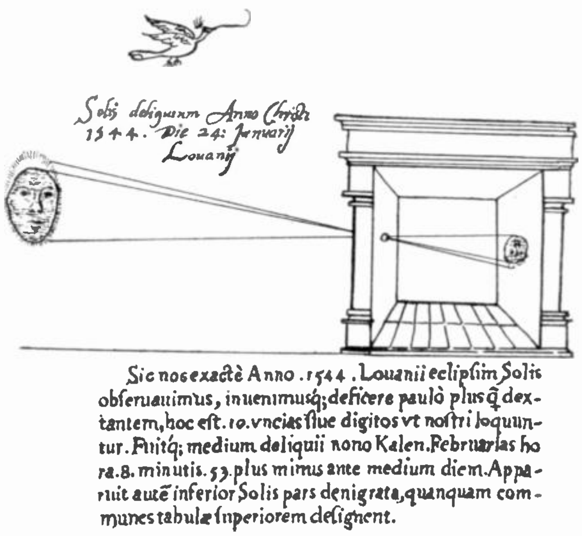



*Fig. 2.—Ancient Method of Observing Eclipses.*

source can be represented diagrammatically by a number of equidistant concentric circles spreading out from the point A.

In one direction, suppose that these waves fall upon a lens which cuts out of each successive spherical wave, as it reaches and passes through it, a circular watch-glass-shaped disc, or "calotte," as it is sometimes called, and since the center of this calotte has to pass through a greater thickness of glass in which light waves travel more slowly than its circular edge, this center will be relatively retarded and thus fall behind, with the result that if the lens is sufficiently thick at the middle all the calottes passing into the lens, with convex-front surfaces, will emerge as concave-fronted ones. Thus whilst the normals of the incident waves, in the direction of travel diverge outwards from a point (the source A), those of the emergent waves converge to a point (focus C). As a consequence the waves emerging from the lens B, whilst passing onwards, contract continuously into smaller and smaller calottes, with greater and greater curvatures, until they come finally to a point or focus and pro- through which they pass and proceed once more as convex-fronted, diverging waves, similar to those proceeding from A.

In the second, or ray diagram, Fig. 6, the waves have been left out and replaced by a number of normals, drawn to the wave-surface on the one side starting from A, and on the other side to the wave-surfaces converging to C. The waves therefore are real; rays are simply straight lines which show the directions along which waves travel. Thinking and visualizing should be done in terms of waves—mathematical calculations are generally better done in terms of rays.

A charming experiment for demonstrating the action of a lens, in picture projection, can be carried out as follows (see Fig. 7). Take a converging lens of as great a diameter as possible and arrange it in a well-darkened room to project an image of a candle or other light source (better an arc) on to a screen. Conveniently the size of the image should be approximately equal to that of the object.

Having done this remove the lens and fill up its place with a stretched sheet of tinfoil. Now take a stout pin and prick a hole in the foil. An inverted image of the candle will appear on the screen. Prick a second hole, when a similar image to the first, but on

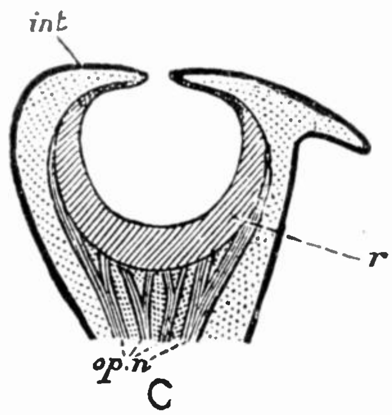



*Fig. 4.—Section of the Eye of Nautilus.*

a different part of the screen, will make its appearance. Prick away until a dozen or more images are seen, each, of course, in the continuation of the straight line joining the object and the aperture producing it. Note that if two apertures are made fairly close together the corresponding images on the screen more or less overlap


*Fig. 5.—Radiation of Light from a Candle, according to Huygens.*

one another. Now, without disturbing the perforated tinfoil, slide the lens back carefully in its own plane to its original position. As this is done and the rays passing through the various apertures picked up by the lens, one by one, the corresponding images on the screen will fall together in the most striking way, until, finally, when the lens comes to its final position covering all the apertures, only one central image will be found on the screen. Now prick more holes until the whole of the tinfoil in front of the lens has been removed. Nothing further happens except that the single image becomes brighter and brighter. This experiment shows us then,

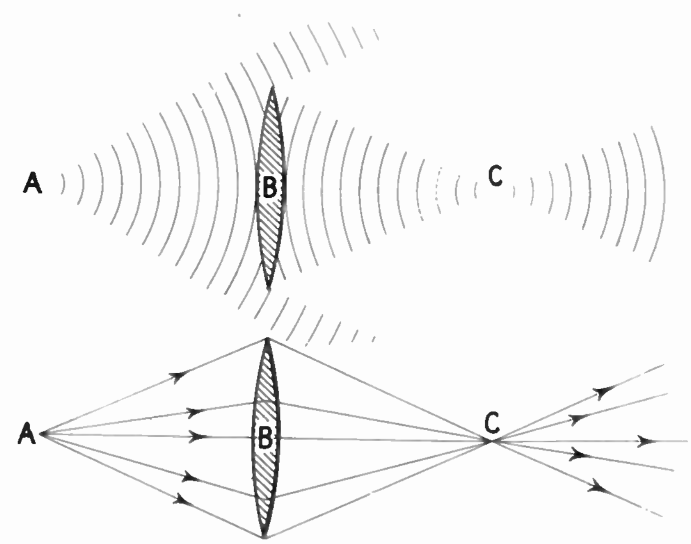



*Fig. 6.—Wave and Ray Diagrams for a Lens.*

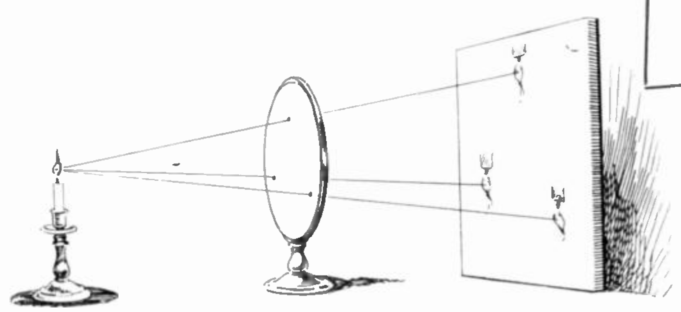


*Fig. 7.—Showing Perforated Tinfoil in Action.*

that one of the primary functions of a lens is to allow of the use of a large aperture with its great light-collecting power for imaging purposes. Later we shall find that this larger aperture is also necessary for the definition of detail structure in the image.

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(*Continued from page 8*)

the picture being right side up and upside down. Similarly, whether you scan the plate from left to right or from right to left makes the difference between seeing the image correctly or reversed.

How can we make the holes pass the plate in the opposite direction and still progress from top to bottom? Reversing the rotation of the disk alone will turn the image upside down. You must also turn the disk around on the shaft of the motor. Thus, if your image is right side up but reversed, you must reverse the direction of the rotation of the disk and also remove the disk from the shaft and turn it around with the other side out. These factors make several incorrect combinations and only one correct one, but the incorrect combinations provide perfectly recognizable images whose worst fault is to be upside down. Should the image obtained be a negative instead of a positive AC connections to the Kino lamp. Interchanging these connections will correct the trouble.

## TELEVISION MOTORS

(*Continued from page 24*)

running just under synchronous speed to be slightly accelerated by pressing the button. When the receiver scanning disc is just in step the image will appear to stand still on the screen. A moment longer of pushbutton depression and the image moves slowly off the screen due to the motor running a little too fast. By releasing the button the motor slows down slightly, and so the image is kept "framed."

A rheostat of 160 ohms divided into ten steps, and a separate 25 ohm resistor shunted by the pushbutton will be found ideal. The two resistors are connected in series. Both should be capable of carrying the required current without undue heating. If the motor is running too slow for the short-circuited resistance of the hand resistor to overcome, move the adjustable arm on the ten-step resistor one step further in advance. The motor will then speed up slightly and can be brought "down" to synchronism, instead of "up" to a state of perfect step with the transmitter scanning disc.

(*Continued from page* 21)

the drum. Between the lamp and the periphery of the drum are tiny quartz rods, each rod ending under its particular minute aperture in the drum surface.

*Quartz Rods Carry Light*

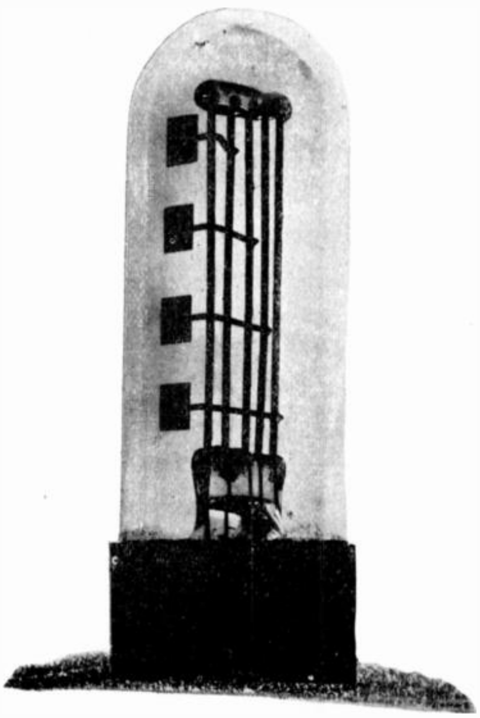
A quartz rod has the peculiar property that light flows through it like water flows through a pipe. The use of quartz rods avoids light loss. The tiny holes in the drum are arranged in a plurality of helical turns like a coarse-threaded screw. The number of helices determines the size of the picture with a given size drum. Increasing the size of the drum also increases the size of the picture. The number of glow-spots in the lamp correspond to the number of hole helices in the drum. The glow-spots in the lamp are lighted one at a time by the current from the plate of the last tube of the amplifier of the radio set.

The adoption of quartz rods for conserving the light, and dividing the neon glow target into small sections, lighted one at a time, has enabled us to obtain a large picture with a relatively small current. The receiver is not bulky and its operation is simple. The motor cord is attached to the house current and the lamp cord to the radio set.

*Simple Device Gets Images*

To get the pictures attach a correctly made picture receiver to a suitable radio set, and tune in the station broadcasting the pictures.

Surprisingly simple apparatus can be put together to get the pictures, namely, a neon lamp, a scanning disc, and a small motor to rotate the disc. A 12-inch scanning disc with 48 scanning apertures gives splendid definition. The disc may be made of card-



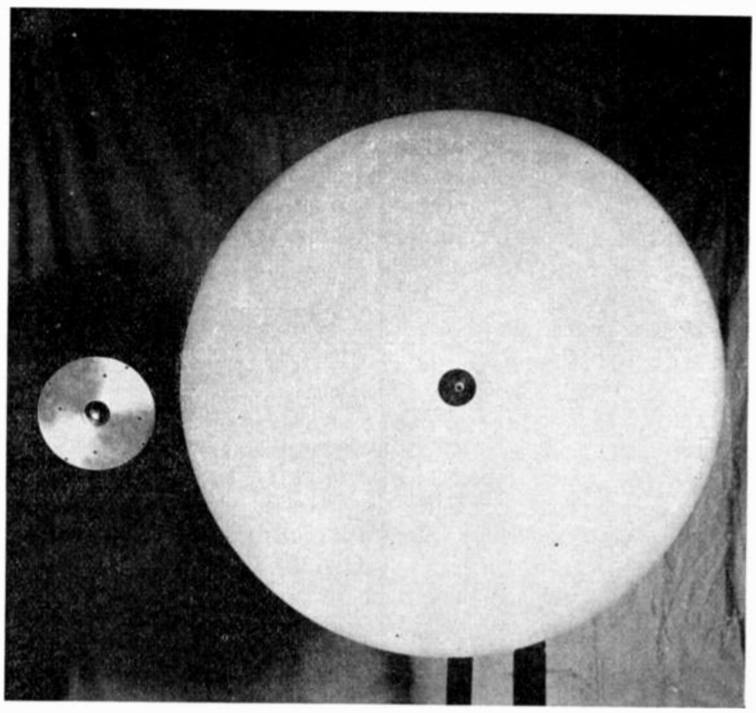
*The Neon lamp, equipped with base. The black spots are targets which give off light.*

board, bakelite, iron or aluminum. The only real difficulty is getting the tiny holes correctly laid off in a spiral. A Neon lamp suited to this 12-inch disc costs one dollar.

Mount the scanning disc in a bearing so that it turns freely. Rotate it by any small A. C. induction or D. C. motor of 1/20th, 1/16th, or 1/18th h.p., mounted on a board between guide strips so that it may move to and fro, parallel to the scanning disc. Cut from the inner tube of an automobile tire a disc 2½ to 3 inches in diameter. Put this disc between 2-inch flanges on a hub to go on the motor shaft. Locate the motor so that the rubber driving disc bears against the back of the scanning disc.

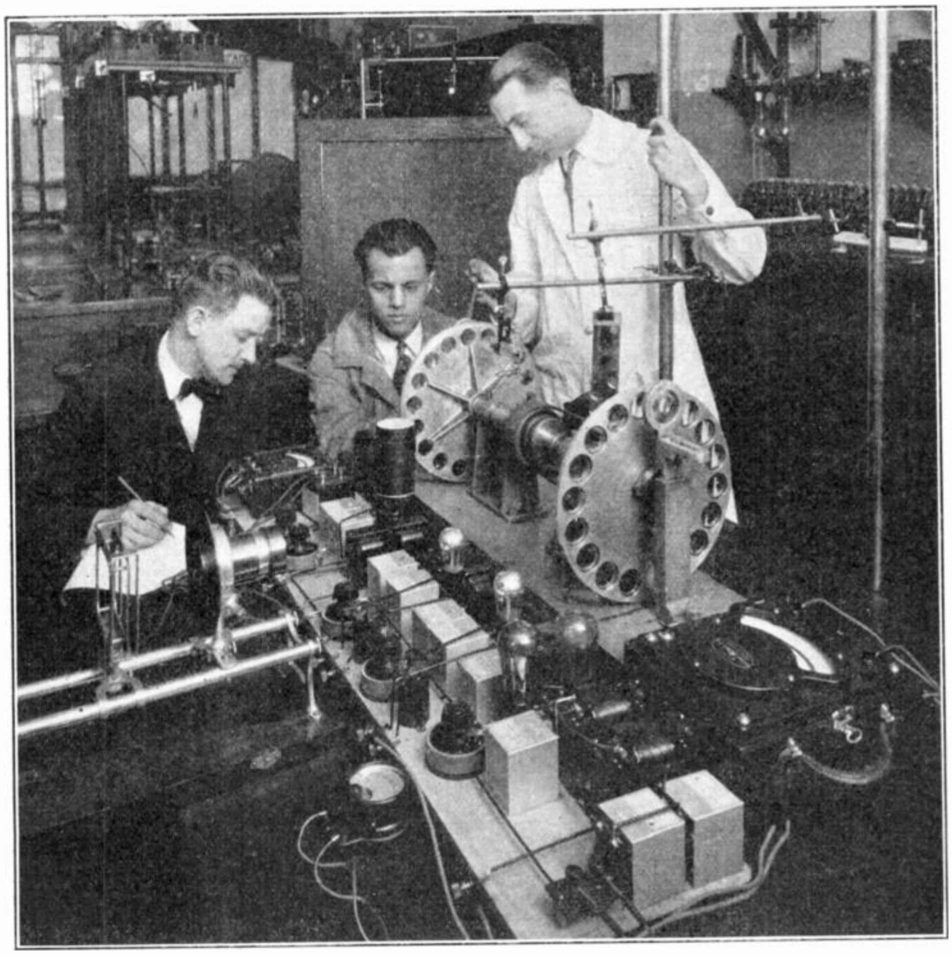
To bring in the picture synchronism is attained by shifting the location of the motor with respect to the disc axis. Support the lamp behind the top of scanning disc so that you can look at it through the flying holes in the whirling disc, and the picture receiver is ready. The motor wires are attached to the house current and the lamp leads to the output of your radio set, like a loudspeaker is attached. A resistance-coupled audio amplifier set produces the best and sharpest pictures. The picture is about the size of a picture on a movie film, but appears larger through a reading glass.

Tune in the station, adjust the position of the motor, and out flashes a picture in all its mysterious fascination.



*The Jenkins drum (left) and the disc scanner (right) make the same size picture.*

# Chicago Goes On the Air With Pictures



*how*

***a brilliant Chicago amateur, U. A. Sanabria, and his collaborator, M. L. Hayes, succeeded in putting Chicago on the television map. A glowing example of the unbounded opportunity for accomplishment that exists for amateurs who have mastered this new art. Everywhere the television expert is "the man of the hour."***

*Left to right. Robert Armstrong, U. A. Sanabria, M. L. Green.*

WITH the recent inauguration of television broadcasts from WIBO, Chicago, the new science passed from the experimental stage. The transmitter used was built by the Carter Radio Company under the direction of U. A. Sanabria, with the cooperation of M. L. Hayes.

Although the principle of the system demonstrated is the same as the one used by the Bell Telephone Laboratories recently it is much less complicated and differs in several important points. The modifications entitle it to be christened the Sanabria Televisor.

Regular broadcasting on 305.9 meters goes on at WIBO three nights a week at one o'clock. Shortly another station, WMAQ, will have a regular schedule.

### *Images Intercepted on a Plane*

A few weeks before the installation of the regular transmitter at WIBO, while flying over Chicago, Sanabria and Hayes picked up images broadcast from the station at the Navy Pier, which juts out into Lake Michigan. An outwardly simple box installed in the cabin on the tri-motored plane "Chicago" was the receiver.

All that could be seen on the front panel was a large lens and a small control knob. The most rigorous tests were made and the images recorded on the lens were picked up from all angles in a radius of 25 miles at all altitudes from 500 to 2000 feet. Those who witnessed this historical achievement became convinced that television had arrived. The next and logical step was to establish a regular transmission service. One of the makers of the device remarked after the test, "Of course there must be television broadcasting equipment installed at given points before the 'ultimate consumer' may enjoy the full benefits of the invention."

### *Permanently Placed at WIBO*

The equipment in the flying test was not fully perfected. Hand-

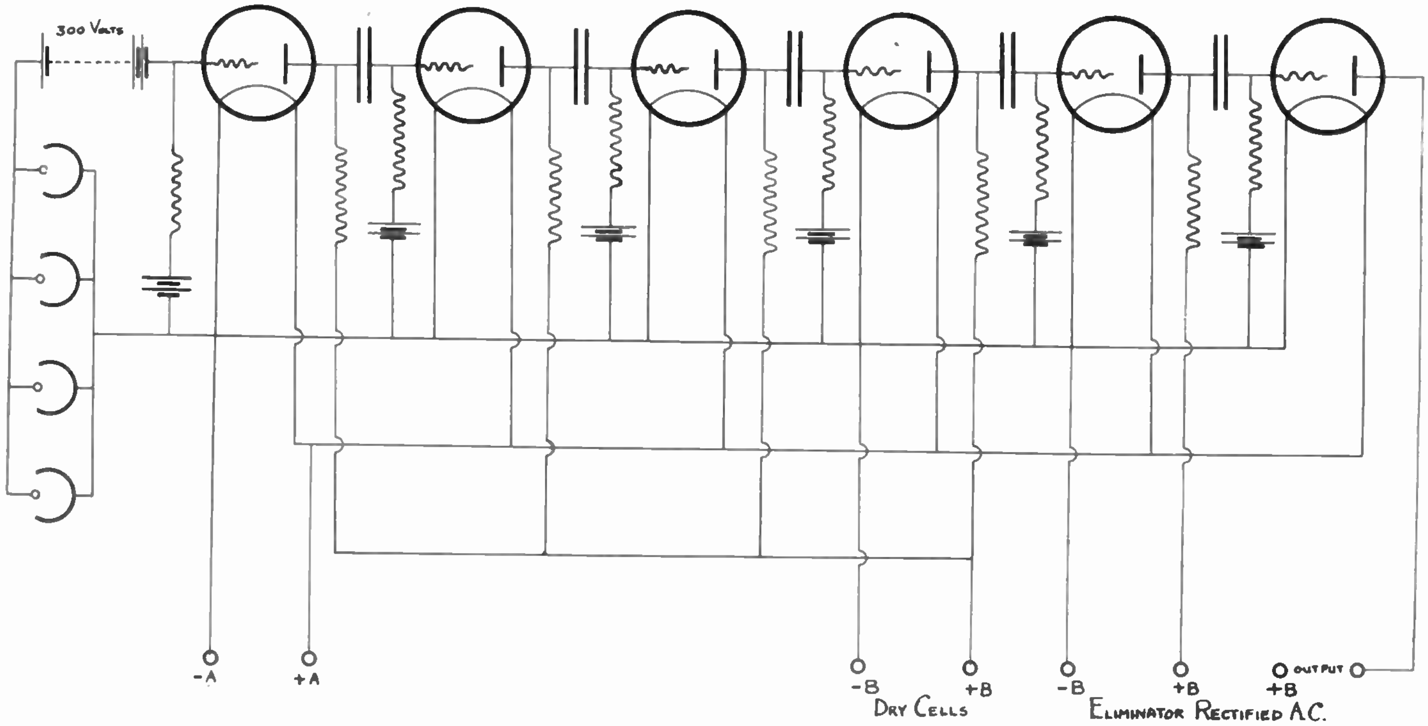



*Diagram showing wiring of transmitter amplifier to bank of photo-cells*

power was used to operate the receiving disk. The ground station was almost as rudimentary, having been "thrown together" for experimental purposes only. It did not take very long. However, Sanabria designed a transmitter which was an improvement on the one used at the Navy Pier. On the night of August 14-15, the transmitter being completely set up in a permanent form in a metal frame at the Nelson Bros. station W I B O, regular nightly broadcast began. M. L. Green, engineer of WIBO, assisted Sanabria and Hayes in building the set. The preliminary tests were held at one o'clock in the morning.

As Sanabria explained his transmitter he reviewed the major problems faced by the experimenter in television. These come under five heads: (1) Pictures must be resolved into a number of small elements; (2) the elements must be translated from light values into equivalent electric impulses or variations of current strength: (3) the impulses must be transmitted to a distant point; (4) received impulses must be reconverted into light and shade values; (5) finally the recomposition of the transmitted signals must be made in their correct relative positions.

### *Four Photo-Electric Cells Used*

The image to be televised is broken up into elements by means of a powerful beam of light shining through a perforated whirling disk. These bands of light are reflected into the photo-electric cells which produce an electric current corresponding in strength to the varying light intensities. Such electric signals are very weak and must be amplified. From the amplifier they pass to the aerial by the regular channel.

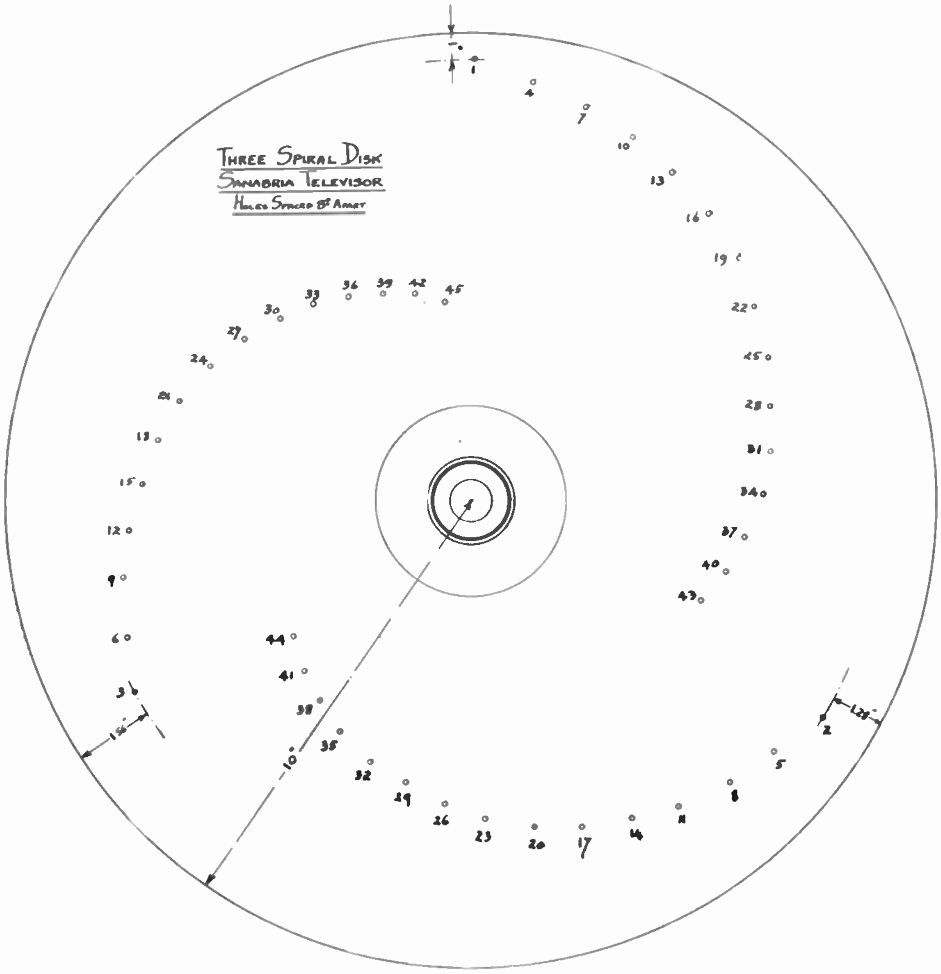
The person being televised sits or stands in front of a battery of four huge photo-electric cells arranged on each side of an opening about a foot square, cut in the center of a panel. The clear glass portion of the cells projects from the panel and the alkali metal coated portion comes flush with the panel edge. The cells, as a protection against vibration, are held tightly in position on the panel by means of elastic webbing. The subject being televised is illuminated by the scanning light that comes through the panel aperture. On the panel are a number of small electric lights which add to the illumination of the object and help regulate the light intensity of the cells.

The photo-electric cells are made of pyrex glass, filled with argon gas at a low pressure, and coated with potassium-hydride which makes them slightly blue in color. This surface sparkles. Close examination reveals that the potassium is deposited in tiny crystals. This surface is called the "cathode." The cells are probably the largest made for television purpose, being 12 inches in diameter and spherical in shape. At their center is a nickel alloy ring "anode" about 1½ inches in diameter. The anode is connected to an outside nickel wire by means of tungsten wire sealed in the glass.

### *More Sensitive Than the Eye*

These cells, more sensitive than the human eye, more sensitive than any cells made heretofore, were built especially for the Sanabria transmitter by Lloyd Preston Garner of the Television Tube Corporation, Chicago, with the assistance of Mr. Waggoner at the rooms of Dr. C. T. Knipp, Physics Laboratory, University of Illinois. They were completed on July 27th.

The huge cells were entirely hand-made. Besides the care required in their making a deal of personal danger is entailed. In one part of the construction, a por-




*Sanabria Triple Spiral Disc which the inventor claims gives better definition and less Flicker*

tion of the cell must be kept immersed in water while the balance is being subjected to terrific heat. The slightest blunder might cause the cell to break, with disastrous results. Potassium possesses a strong chemical affinity for oxygen. If the potassium in the cell was touched by water it would immediately combine with the oxygen, releasing hydrogen with such violence that the hydrogen would ignite and explode.

### *Light-Level Principle Used*

Special characteristics built into Mr. Garner's cells for the basis of his "light-level" system. A very small increase in light above the light constant causes a great increase in their electric action. He has demonstrated that his cells show no practical fatigue. This marks a great advance, being in direct contradiction to the experience of all other cell builders to date. At present not much data is available on this interesting feature of the Garner cells as they have only been in use for a comparatively short time. One thing, however, is known, and that is that they have a life of fully eighteen months, at the end of which period they can be renewed.

Behind the cell panel is a large type E Powers Projector inside of which is a powerful automatic searchlight. A motor turns the carbons of the light to keep them burning at the same rate on all sides, else the light cast through the projector lens would have shadows. In front of the projector lens is the 20-inch diameter scanning disk made of thin aluminum but protected from whipping by aluminum flanges extending from the hub. This disk is rotated at 900 revolutions per minute by a 60 cycle A.C. synchronous motor connected to its shaft by means of a perforated fabric belt. Holes in the belt run over sprockets. This insures constant tracking and also prevents the slipping that would occur if smooth pulleys were used. In front of the scanning disk is a Bausch & Lomb 8-inch focal length lens which condenses the beams of light that pass from the electric arc, through the disk perforations, onto the object being televised through the rectangular opening in the photo chamber panel. The disk is about five feet away from the person sitting in front of the cells, and the lens is so arranged that the subject is in perfect focus with a latitude of two feet. A person can be seated at the minimum distance from the cells, move back two feet and still be in focus.

### *Three Spirals Multiply Definition*

Sanabria has invented a novel method of perforation for the disks used at the transmitting and receiving ends of his system. He calls the new disk a Definition Multiplication disk. Instead of being arranged in a single spiral as in other systems the holes are arranged in three spirals, each covering 120 degrees. There is a total of 45 holes. The effect of this special grouping is that the picture being televised is swept three times each revolution and flicker is practically banished. It also makes possible the transmission of much faster movement than hitherto. The rapid motion of an eyelid for example can be seen.

The theory of the Sanabria disk is still a subject for debate, however, the inventor considers the following explanation acceptable: In a television line frequency repeated periodically with the usual scanning method the repetition might endure for 1/32 second and would set up appreciable interference because the "impedance" of the receiving circuit would be low for that type of signal. With the definition multiplication system repetition occurs in a fractional quantity of the above, endures only for about 1/1,000th part of a second, and therefore sets up no more apparent interference than the fundamental line-frequency.

The three sets of spirals are arranged in a 45-line image, so as to scan the first, fourth, seventh lines, and so on; then the second, fifth, eighth lines, etc.; then the third, sixth, ninth, and every third line thereafter until with the three spirals all the lines of the image have been scanned. The endurance of frequency of the images is thus a fraction of what it would be if the lines were scanned in the regular order from left to right and down. With three spirals sweeping the image at 900 revolutions per minute 45 images per second are being given. Though those images consist of 15 lines, persistence of vision gives an apparent image of 45 lines. The disk now employed for transmission is 20 inches in diameter but experiments are still being carried out to determine the best and most convenient size. In another transmitter being erected at WMAQ 48 holes will be used.

*New System Being Evolved*

Mr. Sanabria is working on a new system to utilize the principle of definition multiplication but it will not employ disks or cylinders. He said it will produce images with a detail of apparently 400 lines, and show pictures eight times as large as those of today, which can be projected on a screen. However, he thinks it will take a year to perfect this method.

If an image of 400 lines was attempted with the present systems frequency of 3,200,000 cycles would be required. This would necessitate a wave of 400 meters with at least 100 meters separation. In that case only one station, or two at the outside, could operate on the wave bands. Radio engineers have been working in a restricted audio-frequency band of about 10,000 sycles, but the band where light instead of sound is employed goes up into millions of cycles. Mr. Sanabria will use these higher cycle bands but instead of the wide separation band needed at present he will use, just as for a 45-line image, two or three kilocycles on each side of the carrier. This will make possible a vast number of television stations.

*Special Amplifier Used*

The resistance amplifier used was specially designed by Sanabria for television work. A potential of 300 volts is used on the cells. The success had in transmitting in a 5 kilocycle band is due to breaking up the periodic frequencies and alternating them, with relatively great time between the alternations. The system is not as complicated to operate as might be thought, from looking at a photograph of the amplifier. The row of knobs in the picture do not all have to be twirled. Once the circuit has been balanced to the required modulation, absolute control is effected by the use of only the first and last of these knobs.

*Duplicate Disk Checks Image*

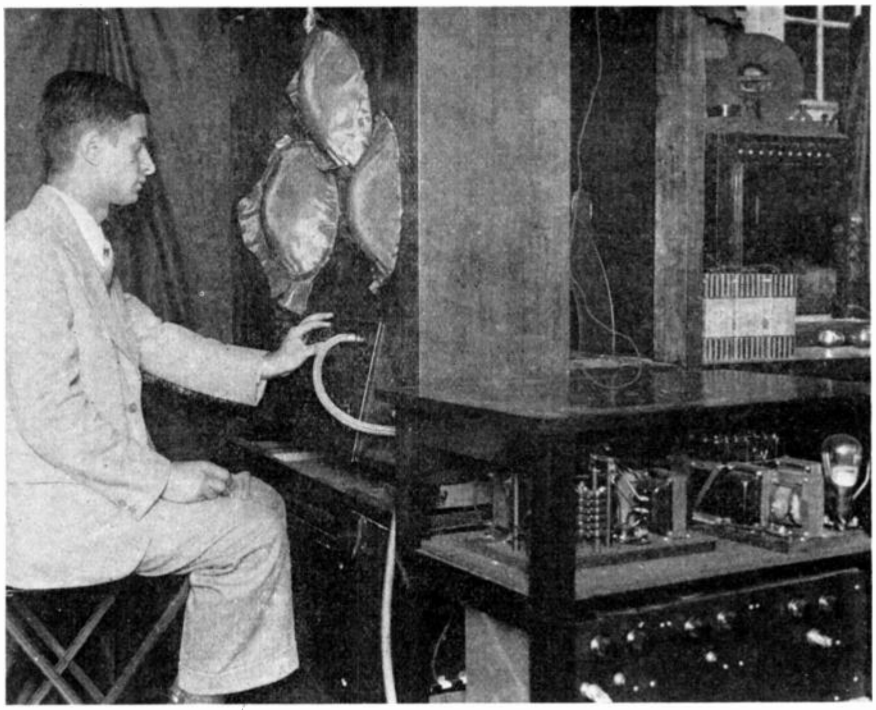
As in broadcast studios and stations there is receiving apparatus to check the broadcast; so also in television work. At the back of the amplifier and immediately to the right of the light source is a receiving disk mounted in front of a neon tube. The disk, which is a duplicate of the one used for scanning the image being televised, is rotated at 900 r.p.m. and its apertures are viewed through a small lens enclosed in a hood. Without the lens one sees a picture about 1¼" wide and about 1½" deep. The use of the lens enlarges this slightly. The output of the amplifier, at the same time that it is being passed to the antenna, is passed to the Raytheon Kinolamp at the back of the rotating disk. This glow tube converts the constantly changing picture current into simultaneous light variations.

*Synchronizing Easy in Chicago*

Good reception was obtained at distant points from standard high-quality neutrodyne receivers with a neon tube in its output where the speaker would ordinarily be placed. The same type of motor was used to drive the disk as that at the transmitter. To frame the

(Continued on page 41)

*Second from right, Mr. A. J. Carter showing the Sanabria Televisor to executives of the Oak Park Kiwanis Club preparatory to flight in which Television signals were received in the air for the first time. At extreme left representative of the H. F. L. Laboratories, Chicago, holding the Osotone set used for reception.*



*General view of the WRNY television transmitter. The arc light is at the extreme right, facing the scanning disc and the person being televised. The edge of the disc is just visible beyond the wooden framework. The three lens-like surfaces are photoelectric cells covered with copper gauze for shielding. The inside of the cell box is lined with thick sheet copper. In the right foreground, part of the cell amplifiers is shown.*

# TELEVISING AT WRNY

*Some of the prodigious problems in radio engineering that must be solved before living pictures can be put on the air. Microphones that "see" rather than "hear" make possible the new science of television. If you would be a television engineer read this illuminating article.*

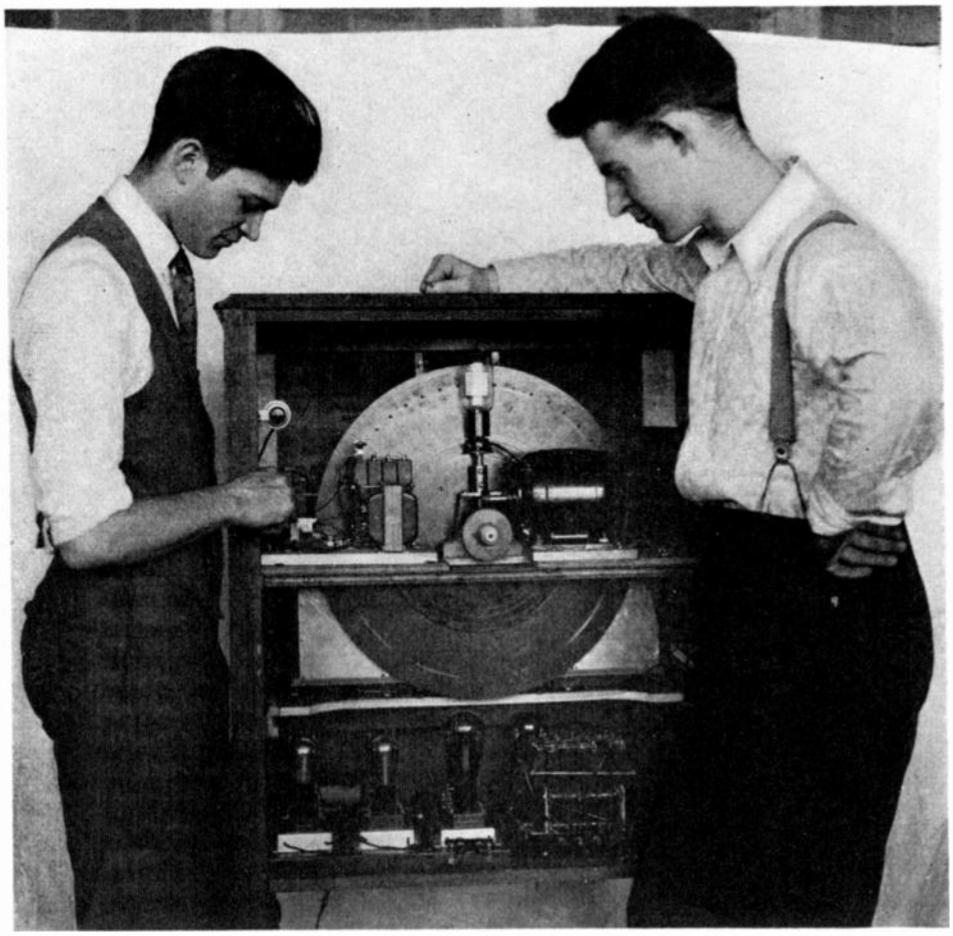
TELEVISION broadcasts have been on the air from WRNY for some weeks and the indications are for indefinite continuation for the benefit of amateur experimenters and station engineers who wish to further perfect their apparatus and the methods of transmission employed. The impulses are confined to a wave band 5,000 cycles in width, that being the width of speech or music channels to which stations are limited by law. The television impulses are also sent out simultaneously by the station's short-wave transmitter, 2-XAL, on 30.91 meters. The television schedule consists of a five or ten-minute period of television at the beginning of each hour of the station's time on the air.

At the WRNY transmitting station at Coytesville, N. J., atop the Palisades from 181st Street, Manhattan, the person to be televised sits in a booth facing three large photo-electric cells, arranged in a triangle in a wooden frame, through the center of which is an opening about six inches square. On the other side of this frame is a scanning disc 24 inches in diameter, but with a spiral of 44 tiny holes, which revolves at the rate of 450 revolutions per minute in front of a powerful electric arc, the light of which passes through the holes and falls on the face of the subject.

These rays of light are reflected into the photo-electric cells, which produce electrical currents corresponding in intensity to the light and dark portions of the subject. The impulses generated by the cells are amplified by a series of specially shielded resistance-coupled amplifiers, which in turn feed the broadcast transmitter. The latter sends out a signal which is plainly audible in any ordinary broadcast receiver.

A television receiver to best intercept the WRNY signals must have the same number of holes in its scanning disc, and the disc must be revolved by a motor at precisely the same speed as the disc at the transmitting station. However, WRNY engineers say the 48-hole standard disc has been found to give good results. Such discs can be procured on the market, or constructed according to the specifications, of suitable material. This material may be flat cardboard impregnated with a stiffening compound. The disc must be accurately made for it is the medium which directs the ray of light from the neon tube, causing the image to be correctly or incorrectly assembled. All other things being good, it is the disc which is responsible for the success of the experiment.

The first demonstration of WRNY television broadcasts was held a few weeks ago at Philosophy Hall, New York University. A group of engineers, scientists and newspaper men viewed the results, not the best television ever seen, but good for the narrow transmission channel facilities to be had. At that demonstration Hugo Gernsback, President of the station, said he hopes to have achieved television for the public within six months but "so far we have not got it." He made it clear that WRNY broadcasts were being put on the air for the good of amateur experimenters who wish to "play with the new art." He characterized television as still in the "spark-gap" and "coherer" days of wireless, doubting that it was even yet to the "crystal set" period of the old days.



*Inside view of the complete radio broadcast and television receiver. The receiver proper occupies the lower section of the cabinet and the television apparatus, Nipkow disk, driving motor and neon lamp are in the upper compartment.*

The transmitting and receiving apparatus for the tests and subsequent demonstration was constructed in the laboratories of the Pilot Electric Manufacturing Company of Brooklyn, and set up at WRNY by John Geloso, Chief Engineer of the Pilot Company.

In the rear view of the receiver on the upper shelf are the television disc, beveled Bakelite gears, synchronous motor, and the two 2 mfd. condensers. Below, at the front is the receiver, shielded from the amplifier and power equipment at the rear. The last three tubes and the resistance coupling units when in operation are enclosed in three cans for shielding. To the right is a 250 type power pack, used to provide plate voltage for the audio amplifier and neon tube. About 90 volts of "B" battery gave good results on the R.F. and detector tubes. The radio tuner end is a standard receiver to which the special audio amplifier has been added.

For a scanning disc it was found necessary to use sheet aluminum 3/32 inch thick, reinforced by a

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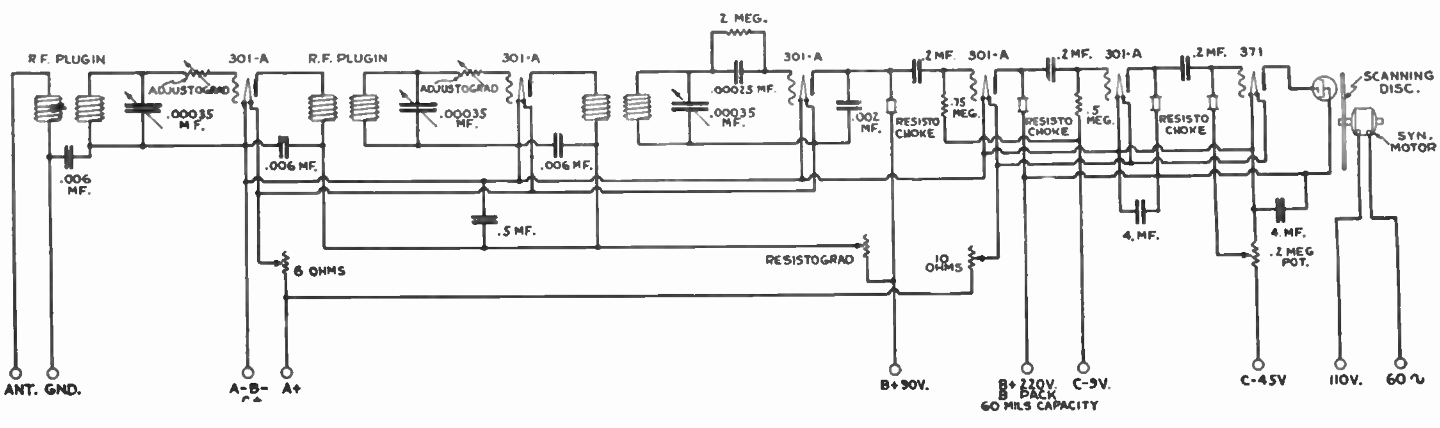


*Circuit diagram of the assembled television receiver used for the WRNY demonstration on August 20 between Coytesville, N. J., and New York University.*

# With the TELEVISION INVENTORS

*What the inventors are doing to improve the transmission of living and still pictures and how they propose to do it. The Television magazine does not in any case hold itself responsible for the technical correctness of the ideas proposed. A resume of each patent issued is given solely for the purpose of permitting the reader to keep abreast of the art.*

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Patent No. 289,416. Convention date, April 26, 1927. C. Chilowsky and A. Guerbilsky claim protection for a system of transmitting images by varying the amplitude of the transmitted wave in accordance with the light intensity of successive elements of the image, and the position of the individual picture elements is determined by the frequency of the same or another transmitted wave. One method of accomplishing this is shown on Fig. 1, where an exploring device consisting of a rotating wheel (R) carrying mirrors projects the image on to a photoelectric cell (P), thus controlling

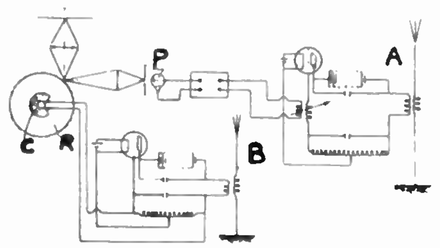


*Fig. 1*

the amplitude of the oscillations radiated by the aerial (A). A condenser (C) on the wheel (R) continuously varies the frequency of the oscillations radiated by the aerial (B). So that for each complete revolution of the exploring mechanism, the frequency generated is varied through a corresponding cycle, or alternatively it is claimed that two frequencies may be used, one varying slowly to determine a group of picture elements, the other varying quickly to determine a particular element in that group.

At the receiving end, the current of varying frequency may render operative in succession a series of piezo-electric crystals, the number of crystals being equal to the number of elements comprising the image. A piezo-electric device may be controlled by one frequency, and a rotating mirror or other mechanical device may be controlled by the other frequency, the mirror being motor-driven and the motor kept in synchronism by piezo-electric means.

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Patent No. 291,634. Patent granted to J. L. Baird. This invention provides an improved form of light valve or means for producing a varying light or illumination of the type in which gratings are employed.

Two gratings are used, each consisting of thin glass plates ruled with finely-spaced black lines (50 to 500 lines to the inch). Fig. 2 shows a front, and Fig. 3 a side view of the arrangement. In Fig. 2 the micrometer screws (13, 14) allow of fine adjustment of the non-moving plate (10). The other plate, which is mounted close behind the first, is given parallel

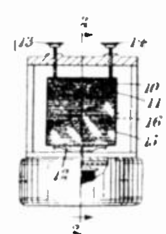

*Fig. 2*

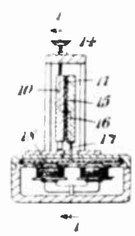

*Fig. 3*

motion, i.e., motion vertically in its own plane, being actuated by the telephone diaphragm. In a modified form, both plates may be made to move by means of electromagnets.

Suppose that in their initial positions the plates are arranged so that the ruled lines or gratings on one are inclined at a very small angle relatively to the lines on the other, and the two plates are then made to move behind one another. Transmitted light will appear in the form of transparent spaces alternating with black or opaque bands. In use the two plates are set to provide comparatively broad black bands and the movement of the black bands is used to cover and uncover the source of light and thereby provide the varying illumination required.

A further modification utilizes a glass cell with vertical and parallel sides, opposite sides being ruled at gratings as before. This glass cell is filled with nitro-benzine, so that on applying an electro-magnetic or electro-static stress the refractive index of the liquid is varied. Thus the beam of light falling on one wall of the cell is bent or refracted in accordance with the electric field applied to the cell and a varying quantity of light is delivered from the opposite wall of the cell.

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Patent No. 290,245. Westinghouse Electric & Manufacturing Co. Convention date, May 11, 1927. In an exploring device for television transmitters and receivers, the exploring pencil passes through two prisms which rotate at different speeds, so that the beam traces out a spiral path.

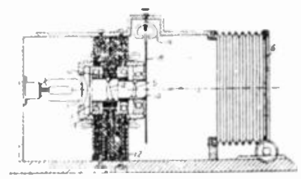


*Fig. 4*

Fig. 4 shows the receiver in which the fluctuating light from a lamp (1) is collimated by a lens (2), and passes through a mask (3) and prisms (4, 5) to a viewing screen (6), the position of which is adjustable. The prisms (4, 5)

(*Continued on page 41*)

(*Continued from page* 16)

tube. As much as 600 to 700 volts may be necessary on the circuit shown to give a bright image.

It will, of course, be obvious that other systems of amplification may equally well be used, and there lies here an excellent field for the experimenter. We have purposely shown a perfectly straight method of amplification, but the number of tubes and the quantity of plate voltage might possibly be reduced by using other and more powerful circuit arrangements.

Having got the neon tube to obey the light impulses we have finished the first part of our "televisor," and the most difficult part. The remaining construction details enabling us to show an image will be given in the next issue. The present article is the first of the series describing television in its very simplest form. Articles in subsequent issues will be published, using this first elementary "televisor" as a basis for further improvements and devices, always having the object in view to make each step progressive and as cheap as possible. With this in view an endeavor will be made to incorporate, in the next televisor to be described, all parts purchased for the first set, so that the expense incurred may be looked upon as an investment of permanent value.

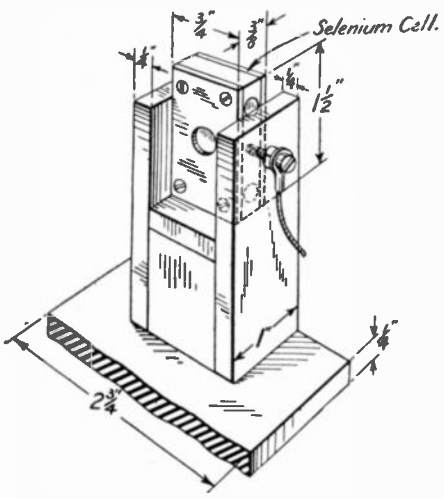
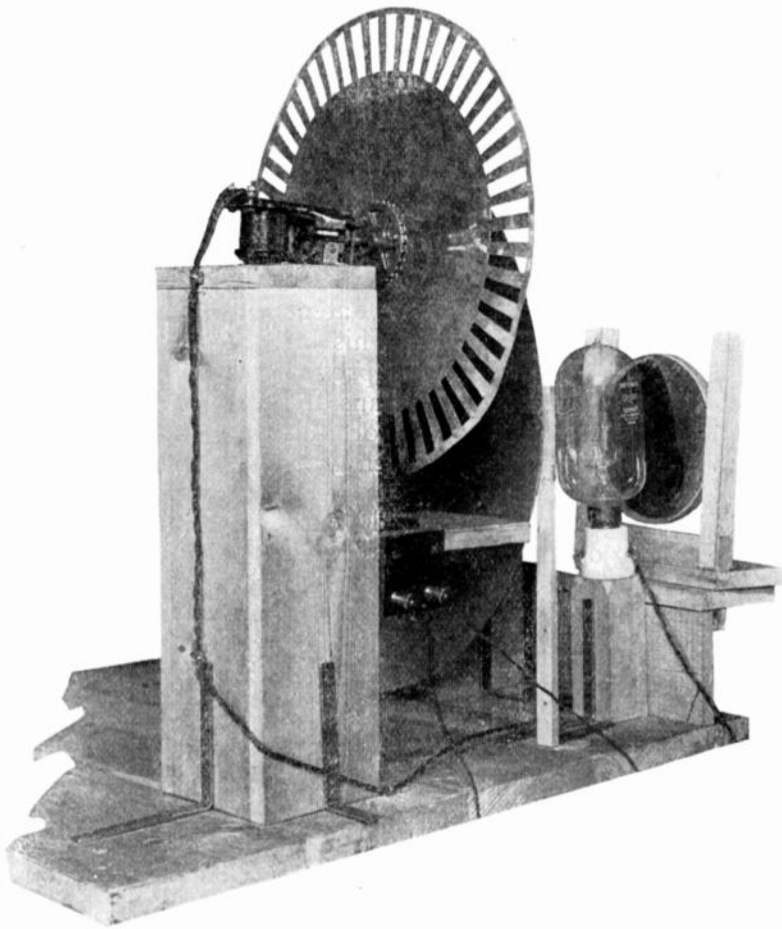



*Fig.* 8



*Side Elevation of Apparatus Showing Light Interrupter Disc With Motor, Projector Lamp and Mirror.*

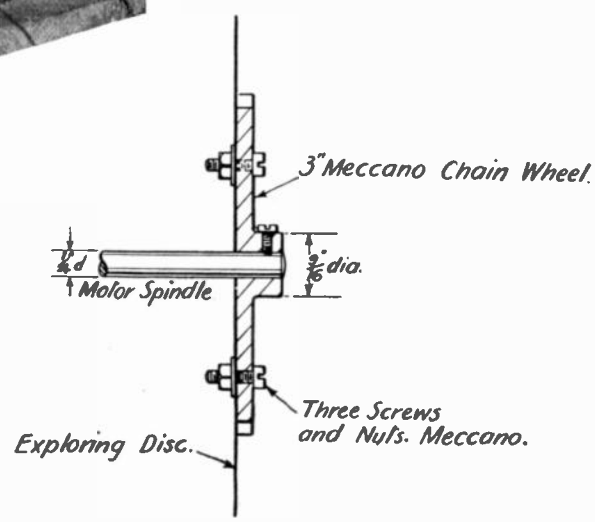



*Fig.* 9

# *What's New in* TELEVISION

*This department is devoted to the new products of manufacturers of radio and television equipment suitable for amateur use. Those who wish more details concerning the apparatus herein described will be accommodated if they will send a self-addressed envelope to the technical editor of this publication. Manufacturers of new devices are also invited to send samples of their new products to the laboratory maintained by "Television." If such equipment meets with the approval of the laboratory, the editors of "Television" will prepare descriptive matter for publication in this department*

## TELEVISION CLAROSTAT

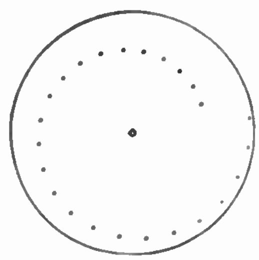
A precision control for the scanning disk of the television receiver, developed by the Clarostat Mfg. Co., Inc., of Brooklyn, N. Y.

It comprises a special power type clarostat, together with a short-circuiting push-button, contained in a sturdy, ventilated, metal housing with mounting feet. The device

has a resistance range of from 25 to 500 ohms, or sufficient for the required range of speed. It dissipates up to 80 watts, and is capable of controlling either a universal or a condenser type motor, on A. C. or D. C., up to 1/8th horsepower. Connections are made to screw terminals at one end, which are protected by a removable end plate.

## DAVEN SCANNING DISKS

Daven Scanning Disks are designed to afford the best possible quality of image. Holes are laid out mathematically correct, so the field will be evenly illuminated avoiding the appearance of dark lines in the image. A standard of one and one-half inch square picture has been adopted in order to take advantage of all the illumination that is obtainable from the neon Lamp. Pictures of this size require varying diameters of disk with different numbers of scanning lines; i.e., 24 scanning lines, a twelve inch disk; 36 scanning lines,



an eighteen inch disk; and one having 48 lines, a 24 inch disk.

The Daven Combination Television Scanning Disk type T-468 is designed to receive 24, 36 and 48 line pictures. In using this type of disk, all that is necessary is to change the position of the neon lamp, and pictures may be received from various stations without the necessity of having individual disks.

Regular disk types are: T-24 with 24 apertures; T-36 with 36 apertures; T-45 with 45 apertures, and T-48 with 48 apertures.

## BALDOR TELEVISION MOTORS

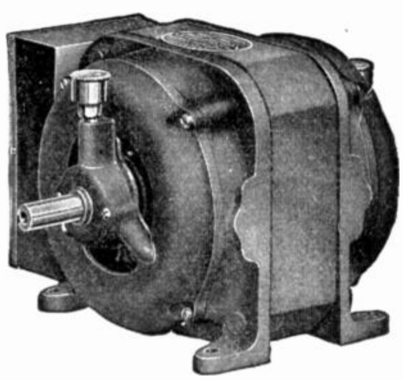
*Adjustable Varying Speed and Synchronous Types*

Alternating current motors used in Television equipment, both in transmitting and receiving, must be built in accordance with very rigid specifications in order that satisfactory results are obtained.

The motor must be of the induction type, not relying upon a commutator either for starting or running. Because of the fact that the motor is placed in close proximity to the Television Amplifier, tiny sparks such as are produced by brushes sliding over the surface of a commutator while the motor is running would create disturbing electrical waves, which if picked up by the amplifier may cause distortion or fogging to such a degree that the sought for picture would be an utter failure.

The ideal motor must be silent in operation and free from hum, either of which affects the amplifier to cause distortion and lack of clearness.

All the characteristics mentioned



above for Television work are incorporated in the design of the Baldor V and S condenser type single phase ball-bearing motor.

The magnetic action is similar to a polyphase motor, the usual single phase hum is absent.

The important advantages of the Baldor Condenser Motor may be summarized as follows.

1. V type. Constant or variable speed with ease of control.
2. S type. Absolutely synchronous.

3. High efficiency and cool running.
4. Quiet and Clean.
5. No Radio interference.
6. Practically unity power factor in operation.
7. Low starting current.
8. Statically and Dynamically balanced.

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### RAYTHEON KINO-LAMP

The Raytheon Kino-Lamp is primarily designed to be employed as a light valve for use in television receiving sets. The Kino-Lamp consists of two metallic electrodes in a gas under low pressure. These electrodes, which are separated about 1 mm. are flat plates 1½ inches on a side. When operating, one plate is covered with a uniform pinkish glow; and when suitably amplified television signals are impressed on this tube, the intensity of the glow fluctuates in direct proportion to the fluctuation of the impressed voltage. When this glow is scanned thru a suitably perforated rotating disk, the broadcast images are reconstructed. The glow may be caused to appear on either plate by connecting it to the minus d.c. terminal.

The Kino-Lamp has a dynamic resistance of about 1200 ohms. The current thru the tube should never exceed 20 M.A., d.c. The Lamp is provided with the UX or long-prong type of base, and may be used in the Navy standard socket or in the UX or Universal socket. One electrode is connected to the prong which is normally used for plate connection, and the other electrode is connected to the filament prong diagonally opposite the plate prong.

In common with practically all gaseous conduction devices, the Kino-Lamp has a negative coefficient of resistance. Hence, if this tube were connected directly across a constant potential source, the current thru the tube would increase until a short circuit condition might be reached, the current becoming so high that the tube would be seriously damaged. It is important, therefore, that an external resistance of from 500 to 2000 ohms be connected in series with the tube.

Although primarily intended as a light valve in television receiving sets, this tube may be used wherever a low-pressure gaseous discharge tube is required. The tube may be used as a low-frequency oscillator, and when suitably connected may be used to give a saw-tooth wave form, the current thru the tube increasing linearly up to a certain point, and dropping back to its original value practically instantaneously. The current then increases linearly again to the same point as before, and drops suddenly back to its original position, etc. Advantage may be taken of this saw-tooth wave form to furnish a linear time axis on a cathode ray oscillograph. Undoubtedly, many interesting and useful applications of this tube will suggest themselves to the experimenter.

### RAYTHEON FOTO-CELL

The Raytheon Foto-Cell is of the hard vacuum type, and, as now constructed, is a custom-built article. As soon as we have received sufficient data from experimenters


in regard to the requirements which this cell must meet, we will standardize its production, and furnish complete technical data in regard to the Raytheon Foto-Cell. The hard vacuum type of photo-electric cell is particularly suited for television signal transmission because of its linear characteristic.

A gaseous type of Foto-Cell which is more sensitive than the hard vacuum type, and which should have a wide application in other fields is being developed by the Raytheon engineers.

### Thru the Editor's Spectacles

(*Continued from page 3*)

and view synchronized for the wonder of thousands at the Radio World's Fair in New York.

What tomorrow's accomplishment will be is an open question. That Television will make strides toward perfection is not to be doubted. The rapid development of automobiles from the one-lunger was considered a remarkable record of progress—and it was. But the progress of Radio and Broadcasting was swifter by far.

With all the experience, with all the intensive study and constant experimentation one need not be surprised should it be possible to sit comfortably at home and see and hear Grand Opera ere the season closes, for more than two thousand electrical engineers are devoting themselves ardently to Television development every day!

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### AMONG THE INVENTORS

#### Radio Engineers Meet in Chicago

Television was the subject discussed at a meeting of Radio Engineers at the University Club, Chicago, Thursday night, September 27th.

The adoption of a code of terms and definitions standardizing Television phraseology was discussed and a list prepared to be submitted to all of the engineers. These lists are to be returned to the Secretary with corrections and suggestions.

The use of gears or synchronous motors was also discussed.

The fact that stations broadcasting use discs with different numbers of holes was condemned and a solution of this problem sought.

Sanabria of the Carter Radio Company was introduced and illustrated his method with diagrams. To someone who questioned the technically correct methods used, Mr. Sanabria said, "No amount of technical objections will weigh with me, for the system works, which is conclusive proof that it is right." He stated that an engineer told him he would be able to broadcast on a narrower wave band than other systems. He explained that with a triple spiral a clearer picture with less flicker and much better definition was obtained.

# A B C of TELEVISION

*By* RAYMOND FRANCIS YATES
*Former Editor of Popular Science Monthly, Member Institute of Radio Engineers and American Physical Society.*

## CHAPTER I

### TELEVISION—THE NEW CONQUEST OF SPACE

*An elementary treatment of the basic principles of one of the newest and most fascinating technical arts. Includes instruction for the construction and manipulation of home-made television and photo-telegraphic equipment.*

In 1884, many years before Henry Ford succeeded in clogging our national highways with the familiar "Lizzie" and while the odoriferous kerosene lamp still illuminated the great American home, Paul Nipkow, a more or less obscure German experimenter, applied for a patent on what he very aptly called an "electric telescope." Nipkow was no idle dreamer, for his patent specification, No. 30105, which is still available at the German patent office, did something more than merely anticipate an approximation of contemporary television equipment; he prescribed it with precision. Minus a few modern conveniences and scientific refinements that were quite unknown in Nipkow's day, the present television receiver and transmitter is built, bolt for bolt and gadjet for gadjet, as this sanguine, hard-headed Jules Verne would have built it, at that time, so long ago that cigar store Indians were still a curious innovation of American merchandising. Any treatise on the subject written without an acknowledgment of Nipkow's fundamental contributions would amount almost to a blasphemy, for it was in his penetrating mind that the daring conception was born, and the realization as well.

It is true that many of our greatest inventions are more adjuncts to our senses; mechanisms that provide sensory projection or extension into realms beyond natural limitations. The telephone and radio, permit us to hear over appalling distances. A man in New York conceivably may listen to the drone of a bee in Shanghai. Roentgen's X-ray and the microscope permit a marvelously intimate examination of matter; the ray makes opaque, matter hitherto impenetrable to vision. Television equips our eyes with a magic telescope, so to speak. Television is but another accessory for our most important sense, providing a practical realization of that age-old yearning to see over distances that defy our optical powers. How long the race has yearned to see loved ones from afar, to steal even a transitory glance that would satisfy the heart and set the mind at ease. Indeed, television is the realization of what must have been a primitive urge.

Although the fundamentals of seeing electrically were known to the writer, seeing his first practical demonstration held a fascination that almost bordered on awe. Here was the laughing face of a man whose actual physical being was located in an obscure room of a great factory several miles distant. Not a single movement eluded the keen, watchful eye of the mechanism before which he sat while the electrical equivalents of his likeness were flung into the great amphitheatre of space. His voice, perfectly synchronized with the movement of his lips, added a touch of realism—and there was the smoke from his cigarette!

The picture, measuring about 4 by 5 inches, was in tones of pinkish-red, a color which represents the spectrum of the gas, neon, contained in a special electric lamp capable of jumping all the way from total darkness to full brilliancy as many as 100,000 times per second. The picture was divided up into 48 thin strips, each strip being separated by a very thick line of black.

Much like the movies of old, the reproduction at times stubbornly drifted from the field of vision only to be coaxed back into position by the operator. Judged by the high standards of present-day photography, this illusion was unmistakably crude but the fact that television had reached even such an immature state of perfection was in itself a significant happening. At least the man could be easily recognized and even such a slightly tangible thing as the smoke from his cigarette was sufficient to cause registration. Surely one could not help but be sanguine over the staggering possibilities of this new art.

Due to the highly imaginative and at times flagrantly speculative musings of the Sunday newspaper writers, television is at the moment, however, too enthusiastically appraised by the lay public. Already the public is talking of the imminence of home television perfected to a degree where it will be possible to enjoy a football game or a presidential inauguration from the vantage point of a luxurious living-room chair. While the patriarchs of engineering admit the possibilities, they seriously question the imminence, unless some unforseen development completely revolutionizes present practice. It must be conceded that appalling technical difficulties at present stand between football games and living-room walls. *In the same breath it must be maintained that, even with the modest development that has taken place, television is practically ready for domestic application.* Although the scope of the scenes scanned cannot include anything more pretentious or sizeable than intimate likenesses of broadcasting performers, the lure, the novelty and captivating fascination of the feat brings it within the possibilities of immediate commercial exploitation. Television is, by way of comparison, in its earphone stage of development. Perhaps before this volume reaches the hands of the public, a large number of homes in the republic will be equipped with the new marvel of the age.

The least that may be said is that television is ready to court the attention of that vast army of radio experimenters who so enthusiastically mastered the mystery of communication without wires. To the legion of amateur pioneers, television falls as a rightful heritage; it needs their patient hands and ingenious minds. Broadcasting received its original impetus from the inquisitive dabblers of 1920, who, through their activity in the fabrication of home-made receivers, brought the manufacturers rushing to the public with merchandise to satisfy a theretofore undreamed of demand.

Contrary to what appears to be the public notion, television is neither involved nor complicated. Some are inclined to measure the intricacy of a machine by the marvel of its product. This analysis does not always hold. It certainly does not hold in television. Living pictures are available to an ordinary radio receiver, the only accessory apparatus at present needed being a metal disc, an electric motor horsepower, and a neon lamp, which may now be purchased from a dozen different radio manufacturers. The only remaining requisite is the zeal and love for adventure in science-land possessed by millions of scientifically and mechanically inclined Americans.

Television gives man still another advantage in his fight to annihilate space and mitigate the importance of time as a factor in the life of the world. Phototelegraphy, the art of sending "still" pictures by wire and wireless, has already facilitated the intercourse of many corporations and individuals. The facsimile of a legal document filed in a telegraph office in London, is wafted across the Atlantic in a matter of minutes and delivered to its destination before three hours have elapsed.

There is a ten-million dollar bond issue to float. The public announcement from San Francisco must be released on a given day simultaneously in New York, San Francisco, Chicago and Boston. Copy is late, due to last minute changes and revisions. Facing this emergency, the agent representing the corporation issuing the bonds, turned to the phototelegraph. The announcement was published in the four corners of the United States as per schedule! This speed, by comparison, makes a snail out of the fastest airplane.

The Standard Oil Company of California now sends its annual statement to the press of the country by phototelegraph. Rogues gallery photographs and fingerprints are exchanged between the police departments of all of our large cities. Banks send signature cards and signature verifications. A doctor in Cleveland sends an X-ray photograph to a specialist in New York for diagnosis and saves a man's life. Such are the services rendered by the picture transmitter.

Every invention changes to some extent the habits of life. Some even effect profound economic adjustments. How television will effect our mode of living or the intercourse of the world, only time will tell. Today, the order of things calls for centralization. New York is a colossus born of the need for the centralization of finance. Centralization is in itself a potent weapon against time, it cuts down the need for transportation. Today, working Manhattan gets on the subway at 5 P.M. and rides to upper Manhattan. Tomorrow it may fly to Adirondack villages in aerial argosies or on a five-hundred-mile-an-hour monorail.

There are two things that tend to defeat the need for this centralization. One is high speed transportation at low cost and the other is the now infant television. Most of our business, to say nothing of our social intercourse, is done by sight and speech. The extension of both of these faculties over vast distances should obviate the need of transportation of human beings at least. We may, without much stretching of the imagination, look forward to a time when a board of directors may meet electrically, see and talk with each other and discuss quite privately the affairs of their enterprise. As a matter of fact, that is something that could be accomplished today in a limited way so we are not taking flight to imaginative regions when we list it with the possibilities. Much of our business intercourse that today requires the physical presence of the parties concerned might well be done by television. We might extend our speculation to include a meeting of the League of Nations or a session of the United States Senate.

Soon the phantom images of television will be as large, as real and as perfectly delineated as those that amuse us with their tragic and humorous antics on the motion picture screen. Indeed, those who read this book may live to see them in color with a third dimensional effect—not only length and breadth, but depth. These scanty, jumpy and ragged forms of the present art will doubtlessly grow to live in an illusion so highly perfected that we can only dimly appreciate its realism at the present time.

It is wholly conceivable that we shall be able to feel by radio—touch transmitting. If we can produce an illusion that satisfied one sense, there is really no reason why we cannot trick the remaining senses. Just as we now employ a scanning device at a television transmitter so we might devise some sort of an exploring "feeler" that would, for instance, electrically register or impress equivalent impulses upon an electromagnetic wave. At the re-

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## EYES OF TELEVISION

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leads to a large increase in current, a much larger increase than would have resulted for the same light increase in an ordinary cell. In order to obtain as large an increase in current in the old cell a vastly greater light intensity would have to be used. The responsiveness of the Garner cell to small increases in light is of paramount importance inasmuch at it takes television out of the realm of fancy into that of practical commercial application. The old type of cell required such powerful lights to operate that a human being could not stand the glare or the heat and only inanimate objects could be televised. With the Garner cell the sitter may be as close as two feet from the cells without discomfort.

In the Garner cell the portion of the sensitivity curve about the light-level takes a sharp upward sweep which he hopes to make even steeper, so that less light will have to be used than ever before. In the operation of the Garner light-level method for television a certain amount of light is sent directly into the cells, and a certain amount is reflected from the sitter. This represents the light constant. Increases in light occur by means of the play of the arc light shining through the revolving metal disk.

## CHICAGO GOES ON THE AIR

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picture a push-button controlled cut-out was attached to one of the motor leads. By its use the motor was brought into perfect step with that at WIBO. Once the picture was framed no further control had to be used. The 60-cycle alternating current in Chicago is remarkably constant and is used to operate automatic clocks.

Predictions for the future of television are easy. Nearly every field of human endeavor will be able to make use of it. Television will enable man to explore wave bands at present untouched but it will require a much more precise science. In television, improvements will always be feasible.

Many steps were taken in the development of mechanical reproduction of pictures and finer results are continually being obtained. One need only be reminded of the recent announcement of colored films for the home to recognize how true this is for just one branch of picture reproduction.

A tremendous demand for television sets and broadcast service is sure to arise. This demand will make possible larger appropriations for experimental purposes. The large photo-electric cells, for instance such as are used by Sanabria, cost $500 apiece. If it had not been for the generous support of several firms the obstacles he and his assistants overcame might still be considered insuperable. Weston provided all the meters necessary to making the essential measurements. Further donations were made by Raytheon, Sonatron, Benjamin, Starko and Willard. The rest of the material, together with the use of machine tools and expert technicians, were supplied by the Carter Radio Company.

Neither Sanabria nor Hayes is a product of technical school or college. They became interested in radio and the problem of television, but soon found that no data was available, so began working from first principles. In the course of experiments they discovered what appeared to be important facts and made out patent applications. The applications were returned as invalid, having been previously patented. Having re-invented all the things their predecessors had invented they went on to original ideas on which patents were granted, many of which form part of the system described.

The WMAQ television transmitter, an improvement over the one used at WIBO, is being erected at present. The *Daily News* will be the first newspaper in the Middle-West to make a regular feature of television. Other stations have applied to Mr. Carter, who is affectionately known in radio as "Nick," for television transmitters.

## WRNY TELEVISING

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second disc of smaller diameter as a stiffener. The engineers advise, to guard against eccentricity and ruining the received picture, that it has been found most satisfactory to employ discs permanently fitted with shafts which run in ball-bearings of the finest type to guard against end-thrust movement. A specially developed Pilot neon lamp was used, of low resistance type, which was operated from the output of the 171 power tube. The driving motor for the disc is 1/20 horse power. It plugs into the light socket and the speed of rotation is controlled by a small power rheostat.

The circuit diagram shows the parts employed in the receiver throughout. All three audio amplifier tube plates are supplied 220 volts "B" potential from the heavy duty power pack. The engineers found this high voltage best for the purpose if properly biased with "C" voltages.

The procedure of intercepting television signals is the same as tuning in an aural program. After the signal is loudest, as found by plugging in the speaker at the output, the telephones at the detector or first audio, the speaker or phones are disconnected and the motor started. When the motor is running at full speed retune the set slightly to the best advantage, then adjust the motor by means of the speed control to keep the picture centered or framed in the opening.

## WITH INVENTORS

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may have convex surfaces, as shown, or plane surfaces, additional lenses being used in the latter case. The prisms are rotated at high speed, the prism (4) being mounted inside the rotor (10) of an induction motor having a stator (12). The prism (5) is rotated at a slower speed by the magnetic drag exerted on the steel cylinder (14), which carries it, by the steel cylinder (13) forming part of the rotor; its speed being regulated by means of the adjustable magnetic brake (18, 19). The scanning pencil of light consequently traces out on the screen (6) a spiral path of varying luminosity.

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ceiver we simply need a membrane sensitive and pliable enough to be "modulated" with the received impulses of varying intensity. This may be a highly imaginative speculation, but, after all, imagination is the very essence of creative effort and invention.

The educational potentialities of television are so obvious that little need be said concerning this phase of the subject. The old Chinese adage "a picture is worth ten thousand words" is still a gem of wisdom. This one expression alone probably foretells as much about the educational future of television as can be written in many pages.

Some years ago when the writer was preparing a daily critique on broadcasting for the New York Herald Tribune, be published a short sketch which outlined as part of the narrative the television receiver of the future.

"The luxurious living-room in the apartment of Adam Gleek was quite dark save for the kindly, comforting glow that the fire in the hearth shed on the surroundings.

Adam, a nervous, gray-wiskered little old fellow, still dressed in the style of 1930, slapped on the knee his crony H. Budington Lyman, M.D. "Bud," he said, "you came in just in time to see a good evening's entertainment. I had the Television Times on the Wall directly after dinner. The radio program tonight will include a trip to Yosemite Valley by the camera reporter of the Station Ba14. Ba14, you know, Bud, is the station that reported the last Kentucky Derby so beautifullly. Doesn't sound bad, eh?"

H. Budington Lyman, M.D., although gray-haired and slightly wrinkled, had managed to preserve some of the athletic poise of earlier days. He was large in frame and had a deep, gruff voice that matched perfectly his physical greatness. He remained thoughtfully silent for several moments.

Adam looked at him, questioningly. "The program, Bud; do you think you will like it?"

H. Budington Lyman stirred himself. "Yes, Adam," he said "I believe that we shall both enjoy the program, but I was just thinking of some of my earlier experiences with the radio when I was an enthusiastic youth. You remember the old days, Adam, when we could receive nothing but wheezy voices and music thick with the mold of distortion. That was the time when I was practicing on Fifth Street and you lived around the corner. I will never forget that three-circuit tuning device that I had set up in the back of the office. Let me see, you had some kind of a dingbat—what was it? O, yes! an Armstrong set. You thought it was about the finest thing ever and we were constantly getting into arguments as to who could pull in the most distance. Remember, Adam?"

Adam Gleek gave a nervous little cough, slipped down further into the softness of the divan and gazed ceilingward. "Gad, Bud," he said, tapping his nose with his spectacles, "I should say I do remember those days, but you were wrong about the set I had. It was a neutrodyne if I remember correctly, and what a lot of sleepless nights that old thing brought to me and the whole family. But if you did not go to the office in the morning with a long list of stations that you had copied the night before you got the "razzberries" to use an expression of those days. What a sorry mess the radio sets were then? Remember the danged B batteries, the storage batteries and all the other contraptions that one had to use?"

"What provoked me most of all," H. Budington growled savagely biting the end of a new cigar, "was the interference that stations caused. My old three-circuit tuner used to be pretty selective, but even at that I had a great deal of trouble compared with the service that we get today. I lost a good patient at that time too; a fellow who used to be a radio-frequency fiend. I had treated him ever since the time I started to practice, but we got into a heated debate one day over the relative merits of radio frequency and the three-circuit tuner set, and do you know, he got so boiled up about it that he paid his bill before he left and I haven't seen hide nor hair of him since," Lyman chuckled.

Adam spoke, "I think the most disagreeable feature of the old-fashioned radio," he said, continuing to tap his nose with his silver-rimmed spectacles, "was the terribly annoying screeches and howls that one would innocently pick up from the neighbors who had radios. If my memory serves me correctly, it was not until the year 1928 that this nuisance disappeared. I remember too—"

The mellow sounding gong of the radio-controlled lock on the mantel struck eight. Mr. Gleek arose and walked briskly to the television receiver on the opposite side of the room. "Gracious," he said pressing the button that controlled the filamentless vacuum tubes, "I had no idea of the time. Ba14 begins at 8:05." He set the tuning control to a point which bore the mark of the station that was to be received from and returned to the divan.

There suddenly appeared on the wall at the side of the mantle a square of a soft green light. It was an odd green that contrasted strangely with the red tinge of the fire already present.

"Aha," said Mr. Gleek, "They are transmitting in green tonight. It fits the subject beautifully. Leave it to Ba14 for good judgment in choice of colors. I shall never forgive WZ27 for transmitting the funeral of President Fisher in orange."

"Television Ba14," said a soft voice coming from the direction of the radio on the opposite side of the room. It was deceivingly human in tone and quality. "Connections have just been established with our camera reporter in Yosemite Valley and we are now ready to present to our audience beautiful views of what are probably some of nature's grandest spectacles. Our reporter has succeeded in setting up sixteen cameras and consequently we shall see sixteen of what are considered the best scenes of the locality."

Before the last word of the announcer had melted into the stillness of the room, there appeared on the wall the picture of a beautiful waterfall. It was the Bridal Veil in all of its splendor. Simultaneously with the picture the room was filled with the sound of water dashing against rock.

(*To be continued*)