TELEVISION News

HUGO GERNSBACK Editor

FEATURES:

- AN EXPERIMENTAL CATHODE RAY SCANNER
- COLOR TELEVISION
- NEW TYPES OF PHOTO-ELECTRIC CELLS
- HOW TO BUILD A SCANNING UNIT
- MAKING AND TESTING NIPKOW DISCS
- THE NEW JENKINS TELEVISION STATION
- IMPROVED SYNCHRONIZING METHODS

August

50¢

Baird TELEVISION KITS

Build your own Baird at home!

—get world-wide shortwave reception!
—see clear, distortionless Television Pictures!

Never before a set so practical—simple to operate —easy to assemble—at anywhere near these prices!

Build your own Receivers from these Baird-built kits—quickly and at lowest cost! Enjoy the thrills of tuning in shortwave stations from all over the world! See and enjoy pictures and programs from your favorite Television stations! Amaze your friends with this newest, most thrilling form of radio entertainment! Baird-built kits are complete. You can quickly assemble them—complete your Television Receiver in an hour—your Shortwave Set in a few hours. Charts and wiring diagrams furnished with each kit.

We have no connection with any company using a similar name.

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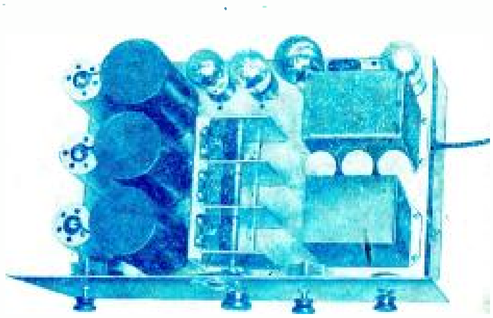
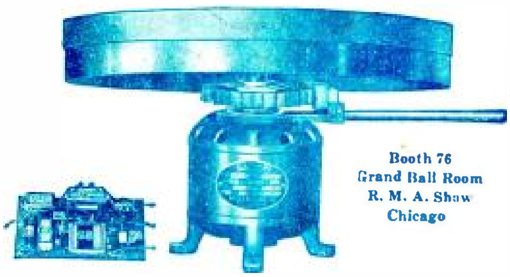
Ear phone jack; phonograph pick-up; all aluminum chassis; coils and screen grid tubes individually shielded; carefully shielded variable condensers; two shielded stages of screen grid radio frequency; shielded screen grid detector; uses famous OCTOCOILS; highest quality resistance coupled amplification; 245 power tube; wave length range 15 to 520 meters; single dial control; operates dynamic or magnetic speaker. Quality equal to any high class broadcast receiver!





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Jumped from $35 to $100 a week

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Get your copy today. It tells you where Radio's good jobs are, what they pay, tells you about my course, what others who have taken it are doing and making. Find out what Radio offers you, without the slightest obligation. ACT NOW.

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National Radio Institute Dept., 1GC4
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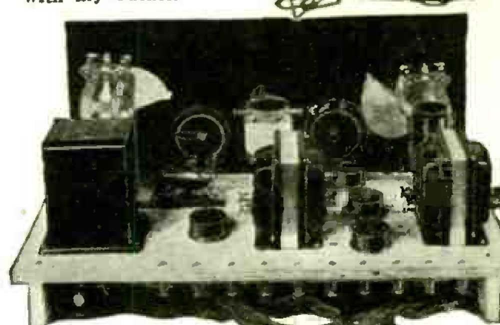
Back view of 5 tube Screen Grid A. C. tuned Radio frequency set—only one of many circuits you can build with my outfits.



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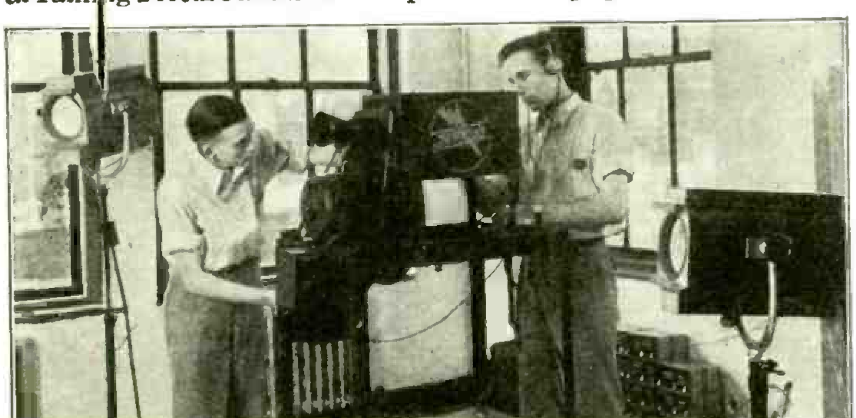

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Vol. 1

TELEVISION News

No. 3

HUGO GERNSBACK, Editor

H. WINFIELD SECOR, Managing Editor

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JULY - AUGUST, 1931, ISSUE

In This Issue: Prominent Television Authors

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FOR THE FIRST TIME, a standard brand of radio tubes is sold at extraordinarily low prices, yet each and every one of the tubes is guaranteed in all respects for 6 months.

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2-Inch Photo-Electric Cell, $3.90

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TYPE	CAT. No.	YOUR PRICE
UX-201A—Amplifier or Detector—Standard for all purposes	No. 600	$ .50
UX-226 —Used as amplifier tube for A.C. operation	No. 601	.60
UY-227 —Used as detector amplifier for A.C. operation	No. 602	.65
UX-171A—Power output amplifier for A.C. or D.C. operation, ¼ amp.	No. 603	.65
UX-171 —Same characteristics as the 171A on tungsten filament, ½ amp.	No. 604	.70
UX-240 —Designed for impedance and resistance coupling	No. 605	.70
UX-120 —Power amplifier used in last stage of audio frequency of battery set using dry cells	No. 606	.70
UX-199 —Detector and amplifier tube, long prongs	No. 607	.70
UV 199 —Same characteristics as UX-199 only short prongs	No. 608	.70
UX-112 —Power amplifier tube, ½ amp.	No. 609	.70
UX-112A—Power amplifier tube for low current consumption, ¼ amp.	No. 610	.70
UX-200A—Detector tube recommended for weak signals and good reception	No. 611	.70
UY-224 —Screen grid, four-element, used as frequency amplifier and linear power detector in special circuits	No. 612	.70
UX-245 —Power amplifier tube used in last audio stage—for low plate voltage	No. 613	.85
201A—Quadrode 5-prong, for special circuits	No. 614	.85
200A—Special detector tube, a supersensitive detector	No. 615	.85
201A—Special radio frequency, a supersensitive detector	No. 616	.85
201A—Special audio frequency, a supersensitive detector	No. 617	.85
171 —Special A.C. ½ amp. extra coated filament—good for electric sets	No. 618	.85
T-11 (201A High Mu), high emission	No. 619	.85
Switch tube, 201A or 112 or 171, double life	No. 620	.85
226, 227, 171A—Adapter tubes, to convert battery sets into A.C., each	No. 621	.85
NEW UX-230 Detector—Amplifier for use with dry cells or storage battery	No. 635	1.10
NEW UX-231—Power Amplifier—for dry cells or storage battery	No. 636	1.10
NEW UX-232 Screen grid R.F. amplifier for dry cells or storage battery	No. 637	1.10
NEW UY-235—Variable Mu, screen grid heater, 2½-volt	No. 638	1.50
NEW UY-247—Pentode Power tube, 2½-volt filament	No. 639	1.50
UX 210—For power amplifier, high voltage	No. 622	1.60
UX-250—Power amplifier used in last stage of audio frequency	No. 623	1.60
201A—All bakelite shield tube	No. 621	1.60
UX-222—Screen grid tube for D.C. operation. Radio frequency amplifier	No. 625	1.60
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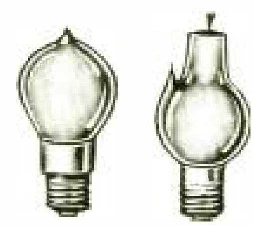
UX-280—Used as a fullwave rectifier tube for high emission	No. 631	.75
UX-281—Characteristics similar to the 280, but used as half-wave rectifier of high emission	No. 632	1.60
Freshman rectifying tube, especially designed for use with Freshman Master "B" Eliminators, UV brass base, limited quantity	No. 633	.60

Order by Our Catalog Number Preceding Price.



2-Ampere Charger Bulbs. $2.95

5-Prong 201A $.85

5 and 6-Amp. Charger Bulbs. $4.85

RADIO TRADING CO., 25T West Broadway NEW YORK

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

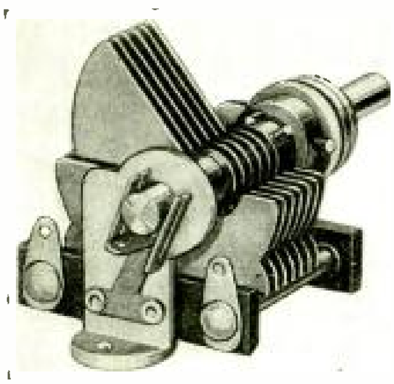
The converter illustrated is model PR-3FS and has a filament transformer built in. There are only four external connections to make, and one of these is to a positive B voltage, 50 to 180 volts, taken from the receiver. If you have a screen grid set you may take this voltage from the screen of a radio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

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

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

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

▽ ▽



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

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

▽ ▽

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

▽ ▽

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RADIO WORLD, now in its *ninth* year, is the first and only national radio weekly, and publishes the latest, up-to-the-second news of circuits, both of kit types and of 1931 commercial receivers, as well as news of happenings in the broadcasting field. Lists of broadcast and short-wave stations, including television stations, are published regularly. You get your information weekly—which means quickly—and you get it accurately, so be sure to become or remain a subscriber for RADIO WORLD. We are able to offer now premiums especially attractive to television experimenters, and ask you to make your choice from the parts offered on this page. When ordering, please use coupon.

The regular subscription rates are: $6 for one year, 52 issues, one each week; $3 for 6 months, (26 weeks); $1.50 for three months, (13 weeks); $1 for 8 weeks; 15c per single copy.

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Enclosed please find:

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☐ $3.00 for six months' subscription (26 issues). Please send the Hammarlund Condenser, PR-H-20.

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JULY - AUG., 1931

TELEVISION News

VOLUME I
NUMBER 3

HUGO GERNSBACK, EDITOR
H. WINFIELD SECOR, MANAGING EDITOR

TELEVISION TECHNIQUE

By HUGO GERNSBACK

AS the television art advances and tends to become popularized, so the technique of television presentation will advance as well. Radio people will appreciate this fact when they think back how broadcasting first started, and how crude the transmitting technique was.

At the transmitter, somebody spoke into a poor-grade microphone which, like as not, often suddenly went out of commission. It took several years to discover that you should have two independent microphone transmitters, with two independent lines; so that, when one went out of commission, the station was not cut off the air. Then, at the radio transmitter itself, neither the high nor the low notes passed through; and the result at the listening end was consequently poor.

Also, too, there were often long waits, whenever one program went off the air, before another came on. Broadcasters started with a single studio and, when an orchestra went off the air, it took some time to get out of the studio, and there was an interval before the next performer could go on the air. Of course, these things sound ludicrous now; but in those days, when each station had only a single studio, and there was no switching arrangement from one studio to a multiplicity of others, as there is today, the problem did not appear so simple.

When television finally gets running along the lines of broadcasting, we will have all the refinements that we find in audible radio today, plus a good many additional contributions which the television art demands.

Just as we used to have a single microphone in the old days, so we now have a single transmitting scanning mechanism which, as like as not, in the midst of the program, becomes defective; and the image vanishes from the television receiver. In the future, of course, we shall have double and even triple scanning transmitting apparatus, which will overcome possible failure of one of them; and, secondly, this will also give us more intensity, a thing which—in television particularly—is highly desirable.

The other day we were listening in and viewing a television performance from one of the local television stations. After the singing team got through, we were greeted with an announcement that we should stand by for some five minutes, until the carbons were changed on the television transmitter! Of course, such crudities as this will not happen in the future. The "listening" and "seeing" audience will not stand for this in the future; while today, of course, they are glad to see anything.

Then, as we have in present broadcasting, the so-called fade-in and fade-out (that is, where we first hear the music or voice in the background and then hear it come up to full volume) so we will have one screen image merge into another in television. We will have the "fade-out," as we have today in motion pictures. We will have superimposed scenes, and even a multiplicity of scenes at the same time.

We will have all sorts of novelties, once television gets under way; and some enterprising network will soon show us one ship in the Atlantic Ocean and one in the Pacific, both at the same time, side by side. Then, of course, we will have trick television, just as we have trick motion pictures today. It will be possible even to have two well-known actors appear on two different stages in different parts of the country; while, by television, the audience will see the two actors (actually separated by hundreds of miles) together on the television screen, going through their act as if they were actually side by side. Of course, it would not be possible, for instance, for them to shake hands; but they could go through a performance; speak their lines, and act the parts just as if they were together. This naturally would be accomplished by televising the two scenes independently, and bringing them together on one screen.

Quite a good many tricks which are now being accomplished in motion pictures can be adapted to television as well. We can have the usual close-up; we can have the heroine shedding glycerine tears, while the audience is none the wiser.

We will have our thrillers (like, for instance, Harold Lloyd doing his "impossible" stunts on the face of a skyscraper) because most of these effects can be easily enacted in the studio, without the television audience seeing the technique, any more than the motion-picture audience knows the "inside" of the movie trickery.

We will see pre-view "ticklers" of important motion pictures, giving us a few snatches here and there; similar to what we see in motion picture houses now. The difference, however, is that the enterprising motion-picture directors will have the scenes actually enacted for the benefit of the *visionists* right at the location, while the sets in Hollywood or elsewhere are still intact; since it will cost very little to have a television transmitter *on location* and take a few "shots" for the edification of the television "audience" who will wish to see the motion picture in its entirety later on, if the few televised snatches are sufficiently interesting.

Then, of course, we shall have almost immediately the good old *sponsored* program. We will see Amos 'n' Andy in person; we will see the Cliquot Eskimos doing their stuff; we will see the Armstrong Quakers; the Empire Builders and many others. The television programs enacted by the *scenists* at the television transmitter are going to be vastly more expensive than the mere aural programs are today. You can fake a train and a galloping horse to perfection by sound alone, at practically no cost, but, when television comes in in earnestness, you can't fake a horse, and you can't fake a collision between trains (except by transmitting motion pictures, which would probably be detected by the audience).

It will be necessary, in other words, for the television broadcasting companies of the future to become practically motion-picture producers on a vast scale, where everything that is thrown on the receiving screen will be backed up by the actual happening at the transmitter.

TELEVISION NEWS IS PUBLISHED ON THE 15th OF EVERY OTHER MONTH

THE NEXT ISSUE COMES OUT AUGUST 15TH

SANABRIA Produces

By H. WINFIELD SECOR

Giant television image is made possible, thanks to a new neon arc tube perfected by Dr. W. G. Taylor. The neon arc tube excited by a 250 watt amplifier output tube, yielded an image of surprising brilliancy.

Mr. Sanabria, the youthful television inventor, is here seen holding the new Taylor neon arc tube.

THE biggest television pictures ever to be reproduced flashes across a ten-foot screen in the laboratory of Ulysses A. Sanabria, 24-year-old engineer. The radio pictures, beautifully clear, perfectly defined and possessing the illusion of depth, danced across the big screen like super-movies, while young Sanabria described modestly the achievements which have made him one of the world's most important contributors to television.

"I couldn't get a light bright enough," Sanabria said. "And then my friend, W. G. Taylor, invented a revolutionary new lamp, utilizing a neon arc, which makes these brilliant, large-size pictures possible."

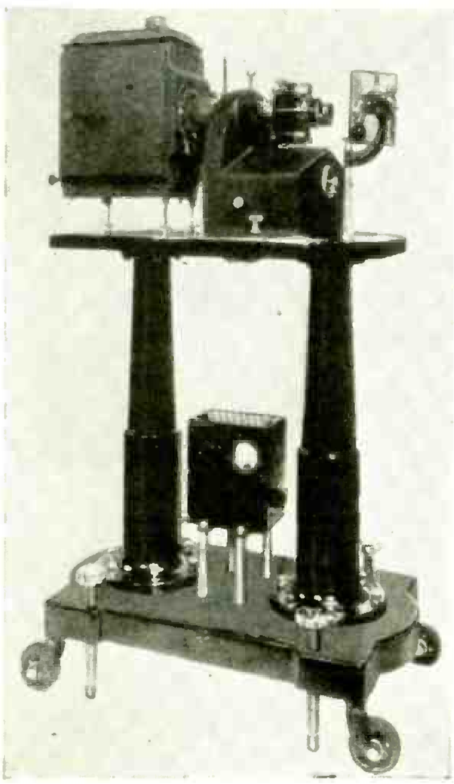
Taylor, himself barely 30, also was present at the demonstration in Sanabria's tool-littered laboratory in an obscure west side Chicago machine shop. "The pictures have a slightly pinkish tinge," he said. "That's the fault of the lamp. I think I can build another which will project pictures of pure black and white."

Largest Lens Disc Ever Built

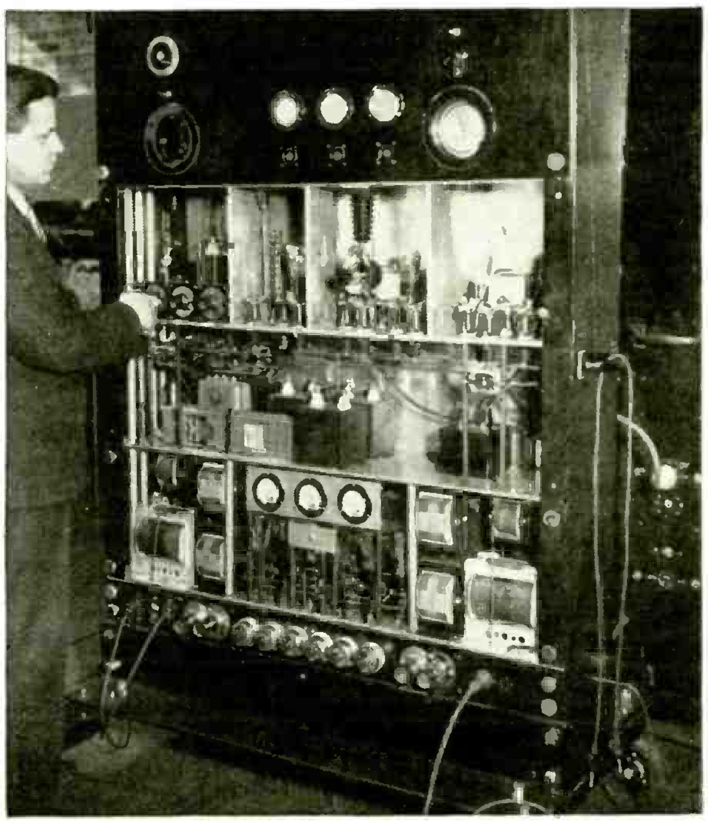
The lamp glows in a brass tube behind the largest *lens disc* in the world, perfected by Sanabria. The disc is a solid aluminum wheel with forty-five lenses sunk in it. An electric motor drives the disc at a speed of 120 miles per hour on its outer edge, so that the whirling lenses distribute the light over the ten-foot square screen in front of the device. The light races so rapidly over the screen and its intensity varies so accurately that the human eye sees actual motion pictures, instead of a zipping daub of light. The apparatus is much too ponderous and expensive for home use, but Mr. Sanabria is now manufacturing similar equipment for an advertising concern which intends to use the giant television pictures to draw crowds to display rooms in most of the big cities.

Neon Arc Similar to Crater Tube

The new neon arc tube used by Mr. Sanabria and which was developed by Dr. W. G. Taylor, is somewhat similar in principle to the neon crater tube, the development of which has been eagerly watched by television fans everywhere, for the very good reason



Left: Sanabria projection lamp and scanner used at transmitter.

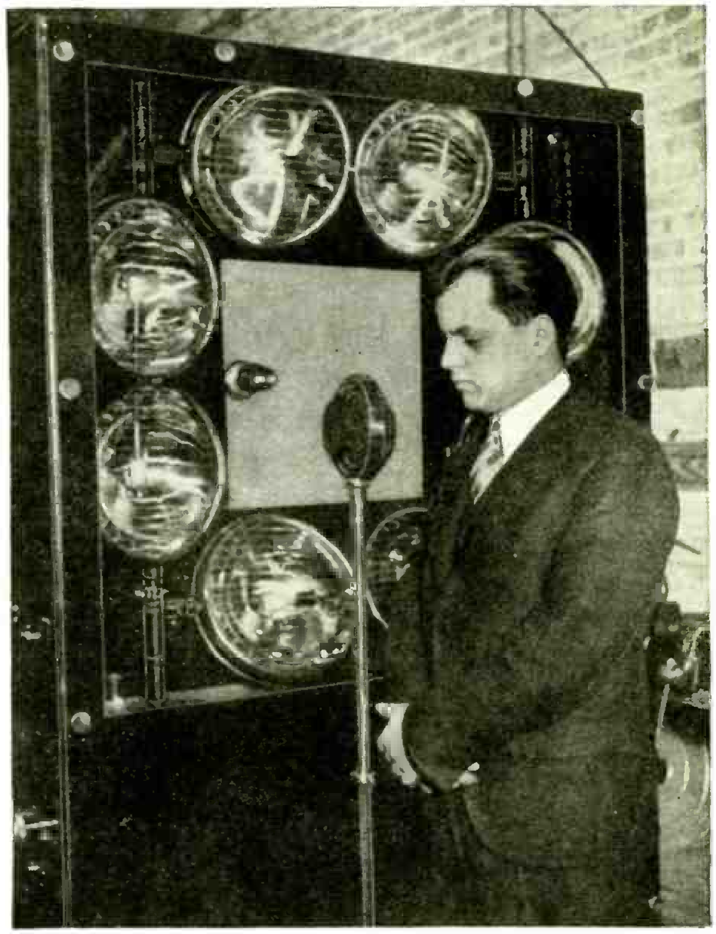


Right: The elaborate television control switchboard used in operating the new Sanabria transmitter. The amplifier stages, amplify the minute photo cell currents over 2,000,000 times.

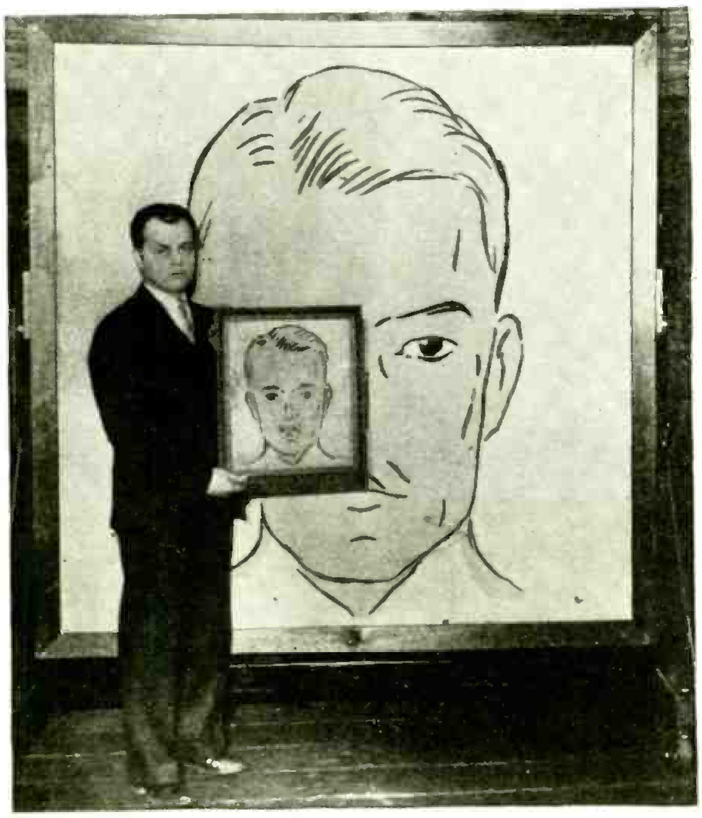
10 by 10 Ft. Image

that a new and powerful illuminant for lighting the television screen has been sorely needed. The original neon crater tube excited by an amplifier tube no larger than a '50 and possibly having 800 volts on the plate, has produced a brilliant television image about two feet square.

The tremendous difference between this size and one 10 ft. x 10 ft. square is made readily apparent, by a study of one of the accompanying illustrations, which shows Mr. Sanabria holding a screen of the two foot size. The larger screen has twenty-five times the area in square feet, of that exposed to the eye by the smaller screen. Certainly we could not hope to brightly illuminate a screen 10 ft. x 10 ft. with the ordinary television means so far known, except perhaps with a powerful arc lamp and a Kerr cell, such as used by Alexanderson, in his 6 x 8 ft. screen demonstrations in a theatre about a year and a half ago. Therefore it was up to Dr. Taylor and his co-worker, Mr. Sanabria, to devise an efficient and quick-acting or easily modulated source of illumination for the television reproducer; this has been evolved in the form of a neon arc.



Mr. Sanabria is here seen standing in front of his television transmitter — note the bank of photo-electric cells which pick up reflected light rays falling on his face when being scanned.



This picture shows the relative size of the former largest television screen used in connection with a neon glow tube as compared with the latest screen, recently illuminated in a demonstration at Chicago by Messrs. Sanabria and Taylor, utilizing Mr. Taylor's neon arc tube.

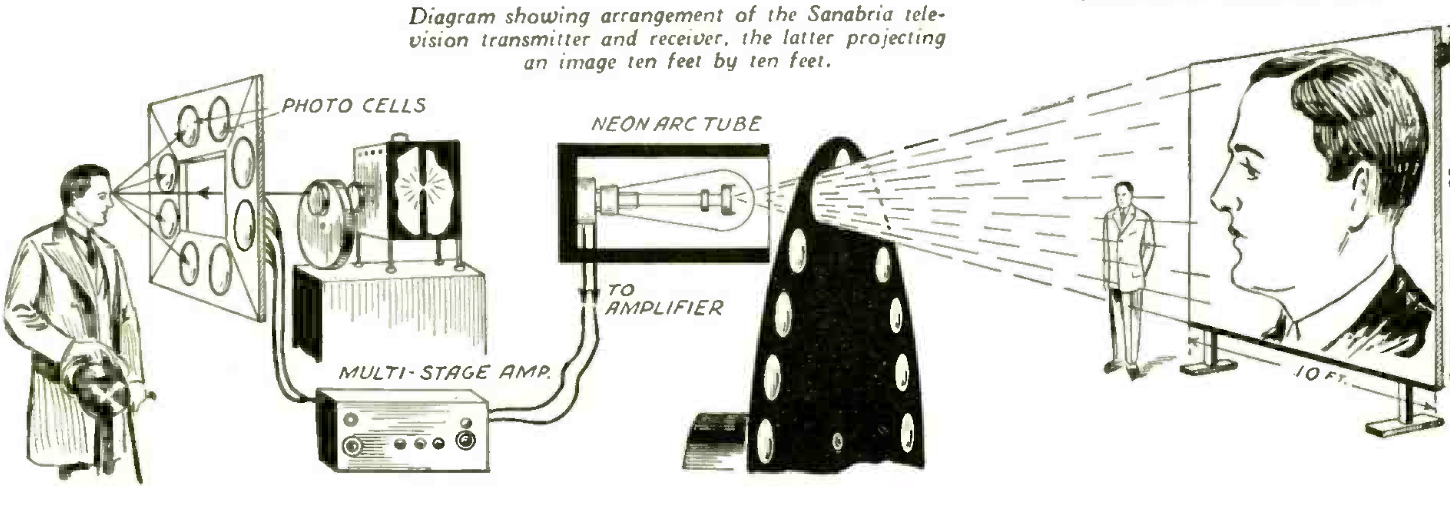
How Neon Arc Tube Is Used

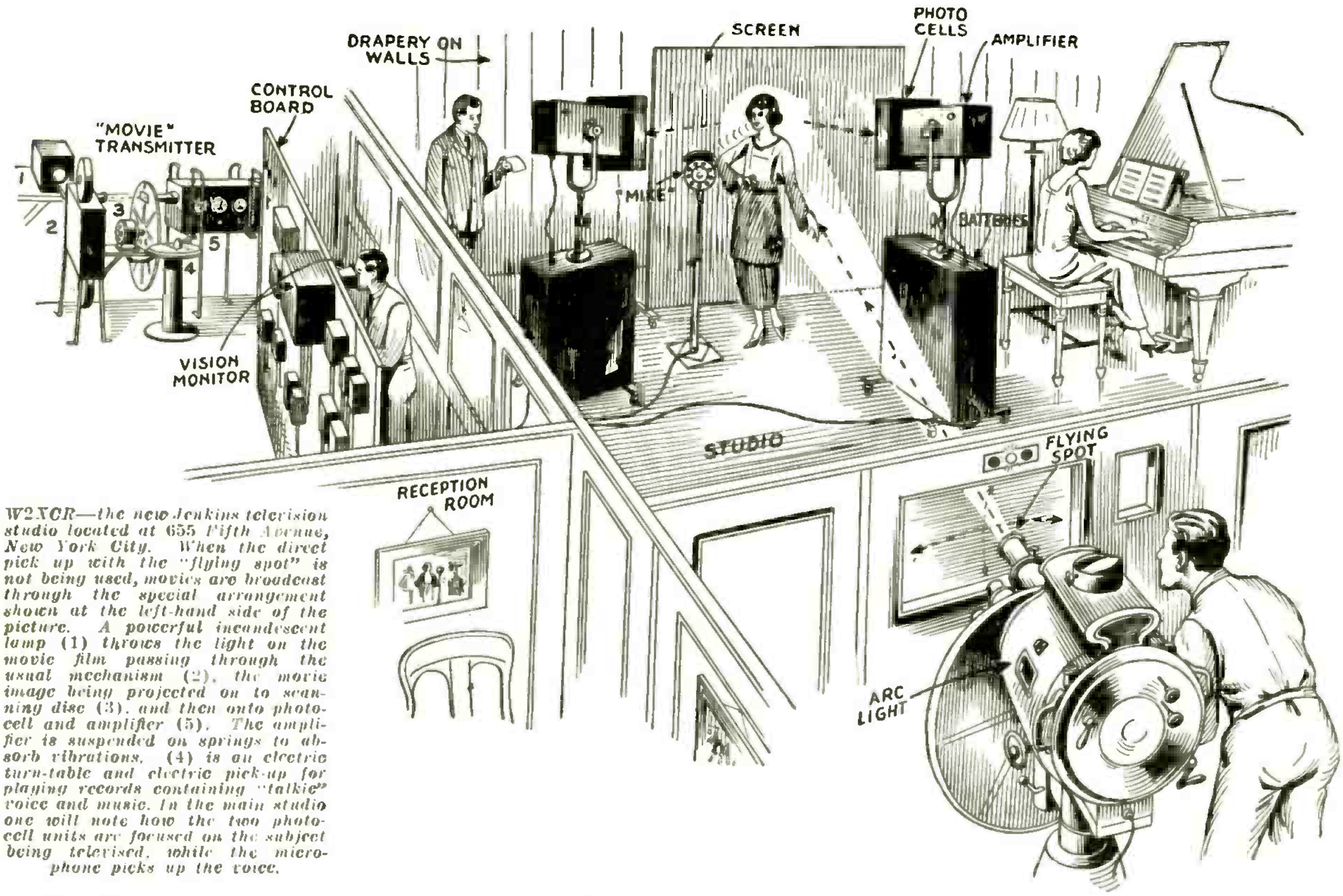
The brilliant and highly concentrated spot of light in the neon arc tube is created partly in virtue of the utilization of a heated cathode, so one report states. The same source of information discloses the fact that a power tube as large as one-quarter kilowatt, was employed to excite the neon arc tube.

The new neon arc tube is placed behind a large scanning disc fitted with a series of lenses arranged in a spiral, in a similar manner to those used in the Jenkins 2 ft. x 2 ft. image projector, which utilizes a neon crater tube. (*This is described elsewhere in this issue and is also shown on the front cover.*)

One of the accompanying photographs shows the elaborate amplifying (*Continued on page* 231)

Diagram showing arrangement of the Sanabria television transmitter and receiver, the latter projecting an image ten feet by ten feet.





W2XCR—the new Jenkins television studio located at 655 Fifth Avenue, New York City. When the direct pick up with the "flying spot" is not being used, movies are broadcast through the special arrangement shown at the left-hand side of the picture. A powerful incandescent lamp (1) throws the light on the movie film passing through the usual mechanism (2), the movie image being projected on to scanning disc (3), and then onto photo-cell and amplifier (5). The amplifier is suspended on springs to absorb vibrations. (4) is an electric turn-table and electric pick-up for playing records containing "talkie" voice and music. In the main studio one will note how the two photo-cell units are focused on the subject being televised, while the microphone picks up the voice.

The Jenkins New York Studio

Excellent reception has been reported by hundreds of "lookers-in" from the new Jenkins transmitting station, W2XCR. Accompanying voice and music are simultaneously transmitted over the broadcast station WGBS.

By D. E. REPLOGLE
Vice-President of Jenkins Television Corp.

Specially prepared for TELEVISION NEWS

SHOWMANSHIP — the magic wand that converted the radiotelephone experiment into the mighty broadcasting institution of today—is being applied to the television situation. However, instead of being merely waved, it is actually being prodded into the television art; thereby causing the latter to break into a brisk trot towards the early realization of a real television industry.

The latest, and no doubt the most ambitious, introduction of showmanship into the television situation takes the form of complete sight and sound studios at 655 Fifth Avenue, New York City, with television and sound broadcasters joining hands in providing the necessary outlets. Located in the very heart of a great cultural center, the new television studios are assured of endless talent of all kinds, in addition to the handy film pick-ups that serve to plug the holes in the television program.

Miss Dorothy Altman, pianist and singer, in the Jenkins television studio W2XCR, in New York City.

How the Subject Is Scanned

The new studios of the Jenkins Television Corporation contain complete equipment for sight and sound broadcast pickups. The *direct pick-up* studio has the general atmosphere of the usual sound broadcasting studio, with the noticeable draperies for acoustic treatment, and with the necessary microphones. In addition, however, there is the flying-spot scanning system, comprising the beam projector and the photo-electric cell banks. The former is a powerful arc lamp in a large housing, provided with an enclosed scanning disc and with three lenses of different focal lengths; the assembly being mounted on a swivel pedestal resembling the usual barber's chair base. The operator can readily aim the flying-spot beam at the subject and, by using the proper lens, cover the desired area for a close-up, half length or long shot, without changing the relative positions of either subject or scanner. The scanner operates on the standard system of 60 lines, 20 pictures per second.

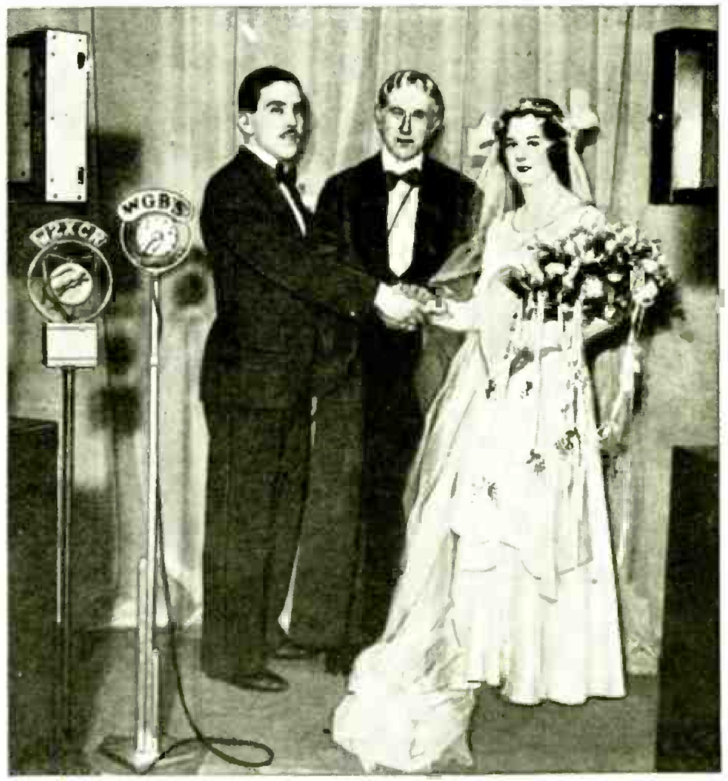
Light Reflected Onto Photo Cells

The beam of light that sweeps the subject is reflected in greater or less degree by the subject. The reflected light actuates the banks of photoelectric cells, which translate the varying light values into corresponding electrical terms. Amplified millions of times, these latent pictorial values are sent by wire to the 5,000-watt transmitter, located in the same building, for broadcasting.

Meanwhile, the microphone placed close to the subject serves to pick up the sound accompaniment, which may be voice or music. Properly amplified, the sound accompaniment is sent over a direct wire to the transmitter of Station WGBS at Astoria, Long Island, across the East River.

How Movies Are Televised

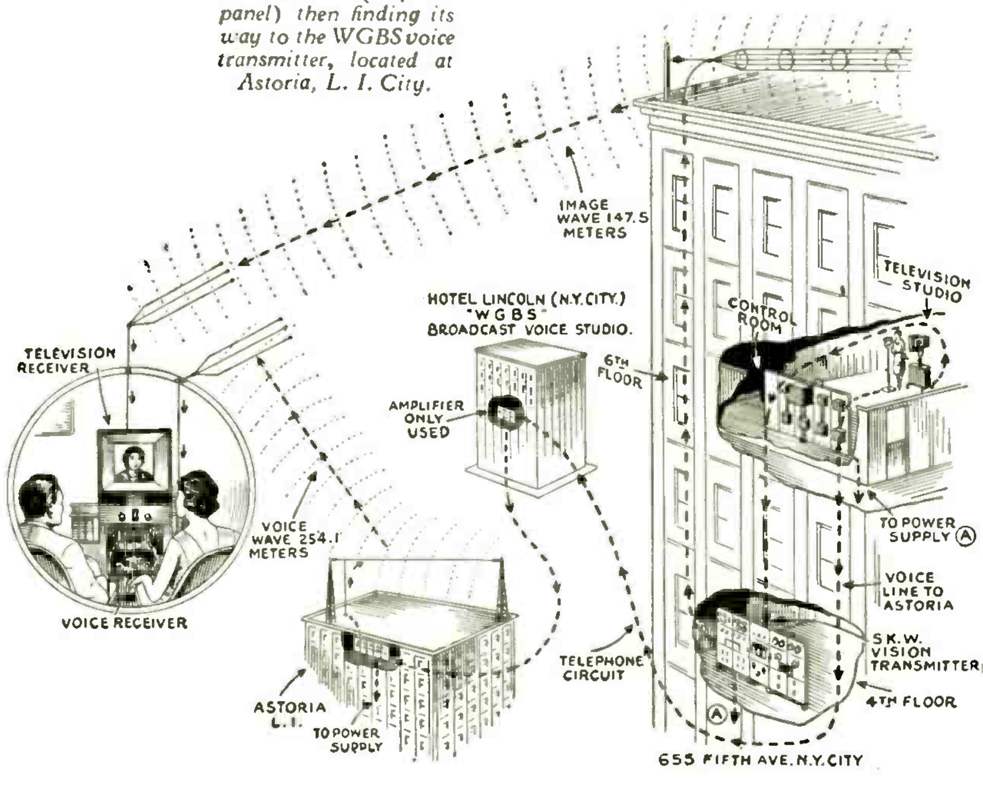
The *film pickup* studio contains equipment not unlike the conventional film projector. As a reel of film passes through the machine, it is scanned line by line with a powerful beam of light.

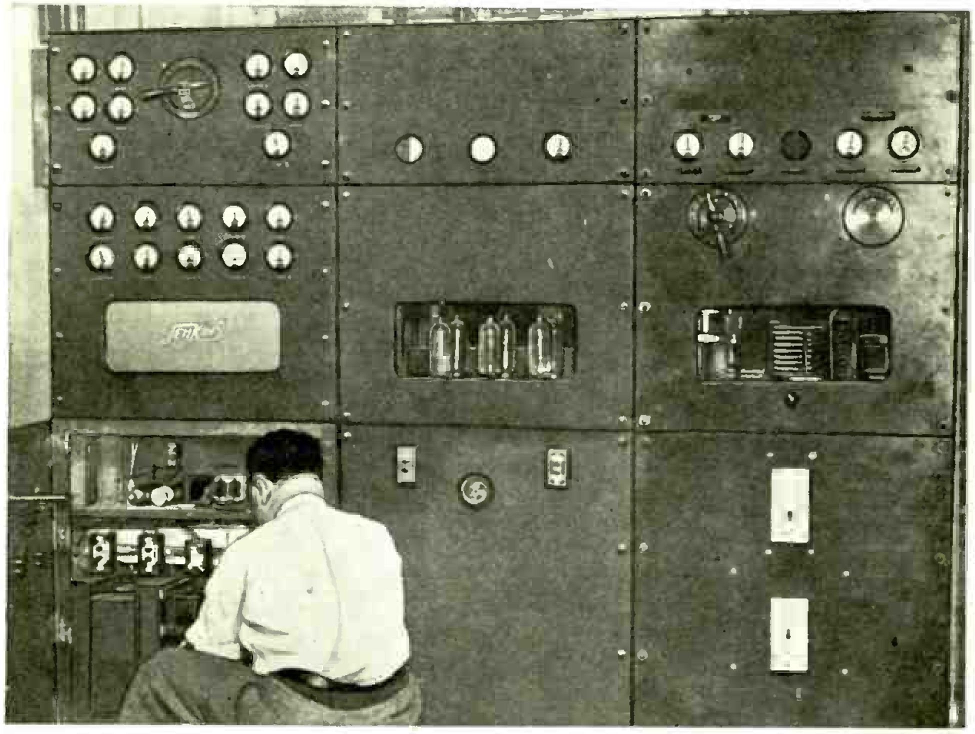


Frank Du Vall and Grace Jones being made man and wife by Dr. A. Edwin Keigwin (center), at station W2XCR-WGBS in the first television ceremony. The television "eye" broadcast the sight of the bride and groom while the radio voice channel broadcast the synchronized "I do's" to thousands of visualists who were thrilled by this marvel of modern science.

Photo at left shows Mortimer Stewart, television program director of W2XCR-WGBS and Miss Patricia Bowman, premiére ballerina of the Roxy ensemble, as she appeared before the "television eye" of station W2XCR.

Below we have diagramatic view showing how the image and voice are transmitted from W2XCR, the voice circuit passing through the Hotel Lincoln, WGBS (amplifier panel) then finding its way to the WGBS voice transmitter, located at Astoria, L. I. City.





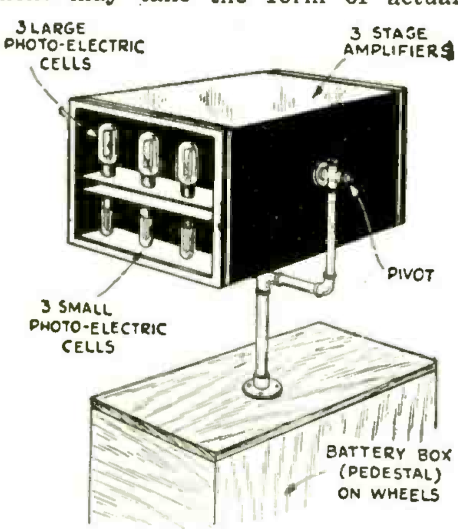
Above we have a view of the Jenkins 5 k.w. "television" transmitter unit, located at 655 Fifth Avenue, New York City. The full 5,000 watts power has been in use for several weeks.

The varying amount of light reaching the photoelectric cell is similarly translated into electrical terms, greatly amplified and impressed on the outgoing carrier wave.

Adjoining the studios is the control room. Here the operators monitor both sight and sound channels, to obtain the necessary signal level at all times. The pictorial signals are checked by looking into a monitor televisor, which shows the pictures exactly as they are being sent to the transmitter; while a second monitor televisor indicates how they are being sent over the air. The sound signals are monitored by means of a loud speaker connected with the speech amplifier of the studio.

Sound May Be Broadcast Many Ways

The synchronized sound accompaniment may take the form of actual speech or music for either direct pickup or film pickup, or sound recordings. It is interesting to note that, in the broadcasting of film, the sound accompaniment may be a verbal description given by an announcer or lecturer actually looking in. The announcer or lecturer may be at a remote point, if desired, looking in on the pictures being received from the station. Again, the television pickup may be a sporting event, fashion show or any other feature, with the description broadcast from some remote point. An entirely independent broadcast transmitter may be employed to broadcast the descriptive accompaniment, if so desired, so long as the speaker is looking in and following the pictorial action.



One of the photo-cell transmitter units.

The new studios are made possible by the collaboration of the Jenkins Television Corporation and the General Broadcasting System. The Jenkins organization has provided the television transmitter, W2XCR, located in the same building as the studios. The General Broadcasting System has provided time on its daily schedule for Station WGBS; so that sight and sound programs may be broadcast to the radio audience of metropolitan New York and a considerable section of surrounding territory. The television equipment has been constructed by the De Forest Radio Company, which is associated with the Jenkins organization in the commercial development of the television art.

Fashions By Television

The first television fashion parade in the WGBS-W2XCR sound and image broadcasting studio was staged recently before the microphone and the electric "eye". Six manikins from Sak's Fifth Avenue store, paraded before the sensitive apparatus which picks light rays and converts them into electrical impulses for broadcasting.

Here we have the control board of W2XCR, located two floors above the 5 k.w. "power transmitter" shown above. The television image is also monitored at this board.

Seventeen costumes were shown under the direction of H. L. Redman, of the store. As each manikin passed before the electric eye, displaying a hat, a pair of gloves, a coat, stockings or shoes, purses, necklaces and earrings, a representative of the store described the apparel before the microphone.

TELEVISION
Here and There

Fannie Hurst Sees Hubby Via Television

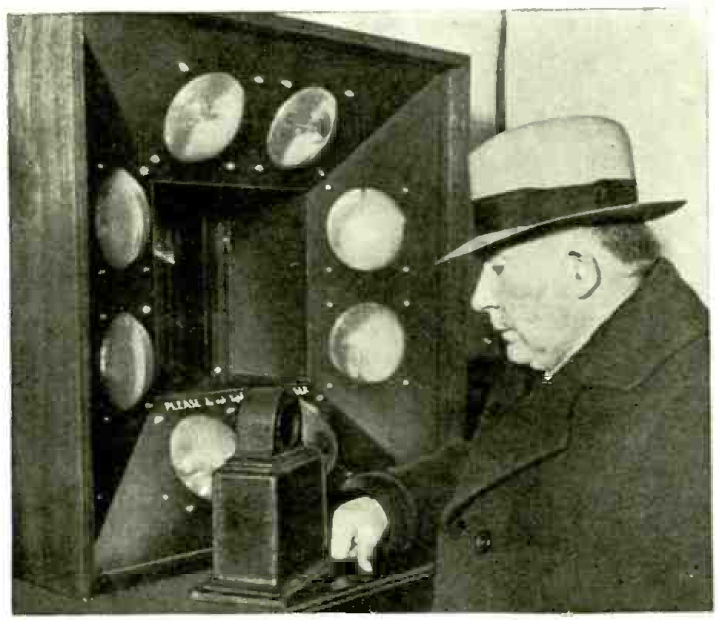
Fannie Hurst, well-known and celebrated woman novelist, is seen in the television booth in the A. T. & T. Co. building, New York City, getting what she confessed to be "the greatest thrill of an eventful life." She talked with her husband and saw him laugh, smile, and move his lips, although he was located at the Bell Laboratories, five miles away. Hubby was having the same thrilling experience at his end of the circuit. In each case the party at the receiving end appeared as if they were only nine feet away.

Television Enters the Movies

One of the most interesting photoplays of the present season is "Just Imagine", featuring the famous comedian, El Brendel. Television is featured among many other scientific devices in "Just Imagine" and one of the television screens is shown on the wall toward the left of the picture with an image on it. Note the "artificial sunlight" window and the flash of light in front of the actor, which announces that someone is at the door. A fearful and wonderful "rocket plane" is also a feature of the photoplay.

"Electric Eye" Gets Oculist's Test

What is believed to be the first test of the "sight" of an electric eye is being made at the Westinghouse Research Laboratories at East Pittsburgh, Pa. The electric eye—which sees many different objects—is put in a queer reflecting egg-shaped box. A special electric light bulb is placed alongside. As day after day passes, various degrees of "fatigue" are recorded on a chart which resembles somewhat a patient's fever chart at a hospital. By means of this new instrument, invented by C. C. Hein, Jr., of the Westinghouse Laboratories, it is hoped to find out exactly how much more reliable the electric eye is than the human eye.



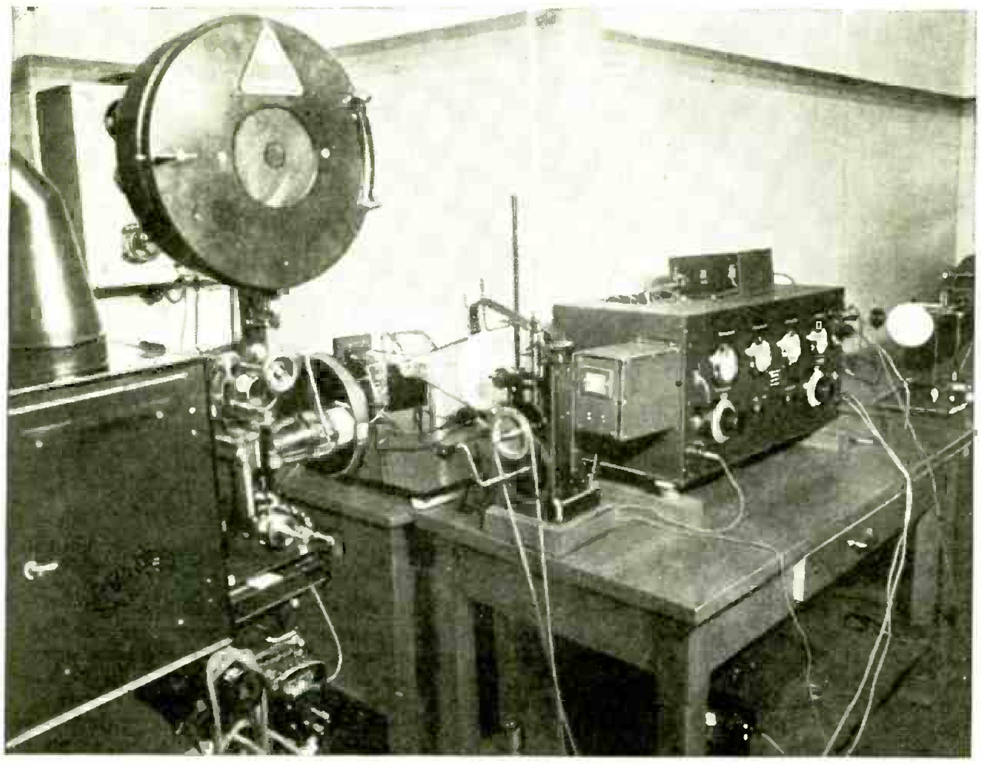
Look Out Crooks! Televisor 'll Get You!

Some time ago in Chicago, Police Commissioner John A. Alcock, tried out Television, in order to ascertain its merits toward broadening the activities and usefulness of the Police Department. Our grandchildren will probably see the "cop on the corner" observing the face of a wanted criminal as reproduced on the dial of his pocket televisor. With the aid of television, the list of automobile thieves will be greatly reduced.

Von Ardenne Sends and Receives Motion Pictures By

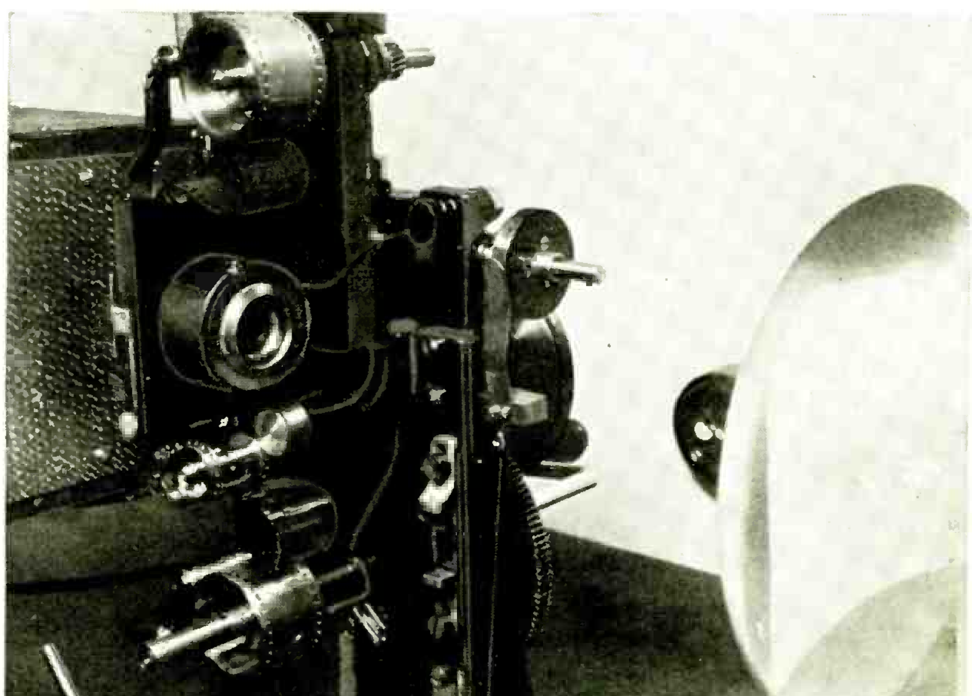
TELEVISION WITH THE BRAUN TUBE

By DR. FRITZ NOACK (Berlin)



Baron Von Ardenne's laboratory, with motion picture and Braun tube television transmitter apparatus set up. The film passes between the Braun tube and a photoelectric cell, followed by a multi-stage amplifier.

Appearance of image reproduced on the end of Von Ardenne's cathode ray tube (unretouched photo).



Close-up of film movement mechanism placed between end of cathode ray tube (right) and photo-cell (left).

MANFRED VON ARDENNE has recently attained extraordinary success justifying the assumption that the Braun tube may in fact be regarded as the television receiver of the future! At the transmitting end also, M. Von Ardenne has recently been using the Braun tube for scanning, and here too he reports progress. The great advantage of the Braun tube for television lies, as is well known, in the lack of mass or inertia in the scanning apparatus, as well as in the absence of sound, control with very small power, and the easy transition from a system with one number of pictorial lines to another.

The lack of inertia is produced by the fact that the scanning is accomplished by means of a weightless cathode ray. The absence of sound might also play a special part, if pictures and sound are simultaneously sent and received. We are actually not so far removed from that; now that the experiments testing the possibility of using ultra-short waves, undertaken in Berlin by the Telefunken and Lorenz Companies and the Reichspostzentralamt (German Post Office Department), have proved favorable, at least within a certain range of distances. The introduction of ultra-short-wave radio will probably take place soon.

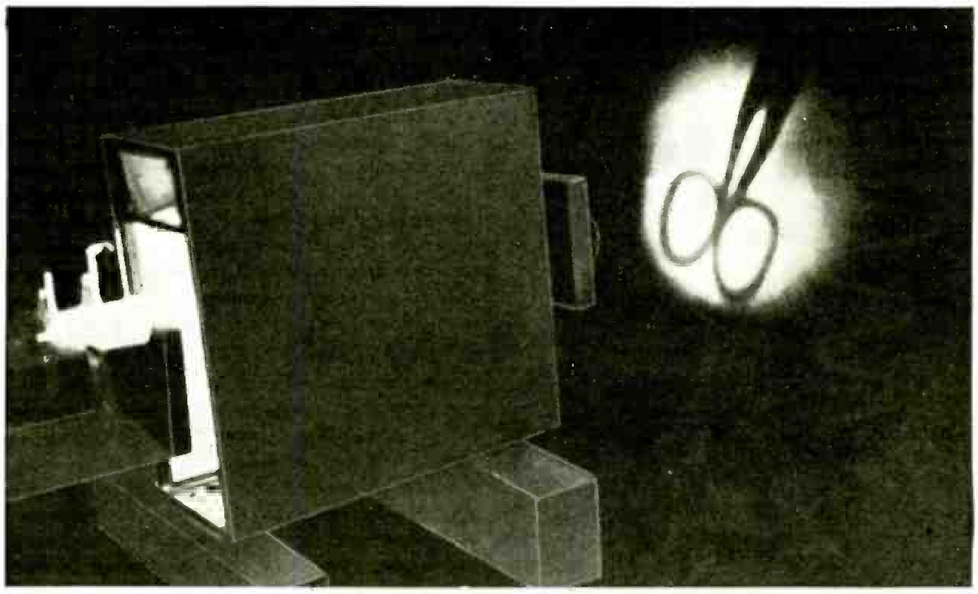
Advantage Over All Other Systems

A very important advantage of the Braun tube over all other television systems lies in the extremely low power required for controlling the scanning ray. The power is made up of the *control potential* to be given the tube and the slight *capacitative current*. This capacitative current is extraordinarily small, because the control capacities amount to only a few micromicrofarads.

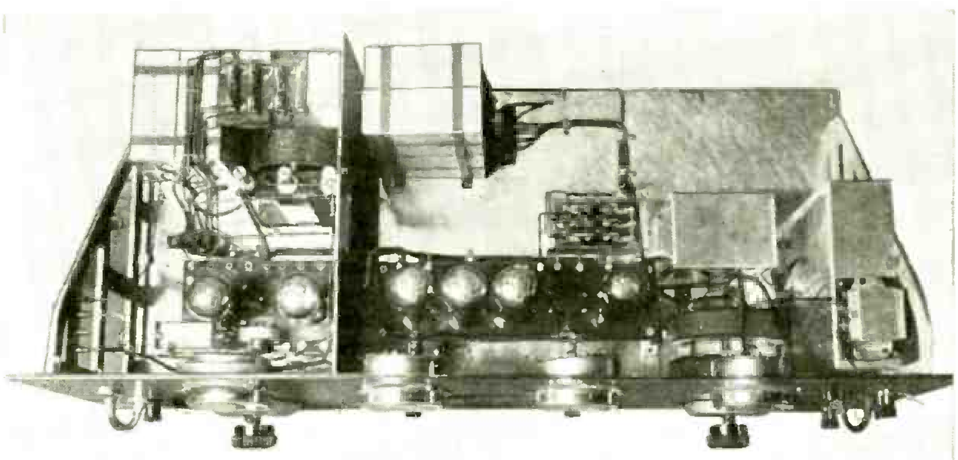
The Braun tube also possesses the further advantage that one can conveniently shift from one number of pictorial lines to another, and even from one size of picture to another. We shall afterwards see why this is possible.

For a number of years people have been experimenting with the Braun tube as a television instrument, not only in Germany but elsewhere. One experimenter governs the light ray according to the familiar control principle in Braun tubes, by putting inside the tube small electrostatic condensers between which the cathode ray is allowed to pass and on which one applies the control potential.

To be sure, these condensers, whose fields are perpendicular to each other, are used to make the cathode ray describe pictorial lines. The pictorial lines' intensity must be obtained through special devices operating electrostatically. Inventors had to rack their brains to perfect a scheme for controlling the pictorial element's intensity so perfectly that the control of pictorial line would in no way be unfavorably influenced.



Remarkably clear image of a pair of scissors "projected" beyond the fluorescent screen end of the cathode ray tube. The image is thus enlarged—the key to "large pictures" from a "small tube".



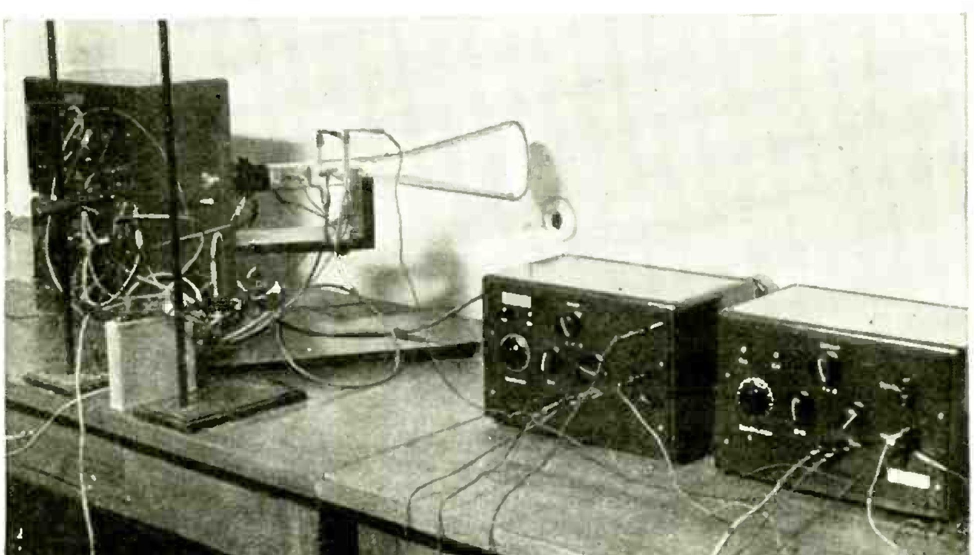
Television receiver used in Von Ardenne's experiments with transmission and reception of "movies a la television".

Manfred Von Ardenne has succeeded in evolving a control process which circumvents these difficulties. For this purpose the main point is that the filament cathode is surrounded by a small cylinder, and a screen is placed before this cylinder. Thus Von Ardenne succeeded in constructing a tube which, as lately demonstrated, allows an output of 20,000 pictorial elements a second to be achieved perfectly.

"Saw-Tooth" Line Control Current Necessary

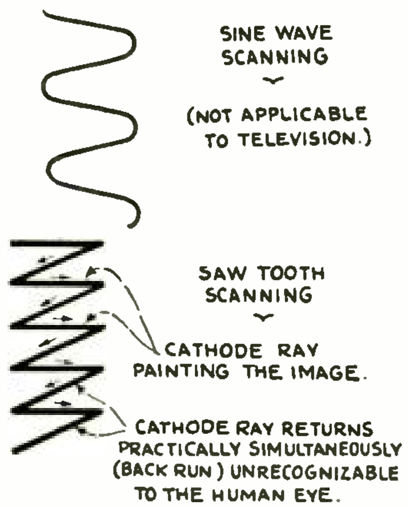
The pictorial line control has likewise been essentially improved by Von Ardenne. He does not use the so-called "sine-curve" scanning, but instead a *"saw-tooth"* scanning movement. While with the former, the scanning ray describes on the fluorescent screen a sort of helical (cork-screw) line, in such a way that the light ray produces a line both in going and in returning, with the saw-tooth scanning a line is described in but one direction. This is because the beam when returning is carried back extraordinarily fast; *so fast that it is not recognizable by the human eye.*

The saw-tooth line is, technically, not so easy to produce as the sine curve; but, on the other hand, it has the advantage that it is uniformly bright over its entire length, while the sine curve naturally shows greater brightness at its turning points. Thus it is that pictures with sine-curve scanning are darker in the middle (which is just the point most intently regarded by the human eye), than they are at the edge. One can get around this disadvantage by screening down the pictorial surface. This, however, decreases the size of the picture, and the total brightness of the picture is then naturally less, than when one



One of the cathode ray television image receivers, with tuning cabinets at right.

uses the sharply jagged saw-tooth line. The sine-curve scanning has the further disadvantage that, because of the scanning in two directions, splitting of the picture occurs. This effect forces the user to be satisfied with low line-frequencies and low pictorial numbers.



At top—the sine wave movement of ordinary cathode ray (not suitable for television); below—the "saw-tooth" movement (exaggerated) now used for television scanning.

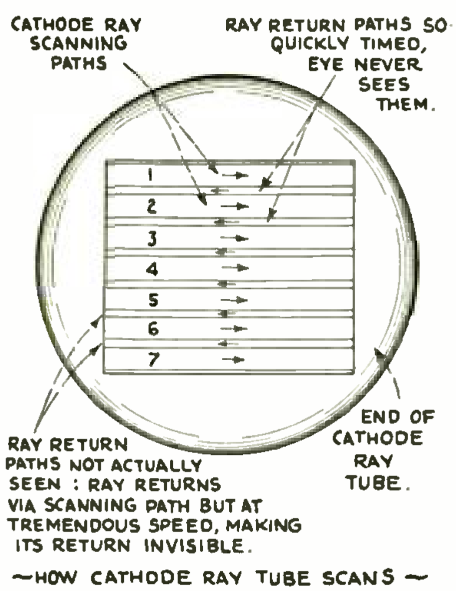
Producing the "Saw-Tooth" Current

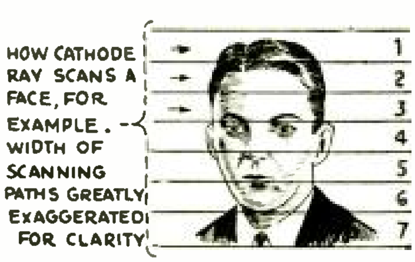
The saw-tooth potentials are produced by Von Ardenne in a familiar fashion; charging condensers by virtue of the saturation current of an electron tube, and discharging them through suitable glow tubes. As already stated, the *return* period of the beam must be kept extremely low. Accordingly, the glow-lamp must discharge the condenser as quickly as possible. *If the return of the beam is too slow, interfering lines of light will appear across the pictorial surface.* Now, it is possible to combine the line and the pictorial potentials, that the return stroke would take place in a corner of the picture. It is more satisfactory, however, to make the return movement as rapid as possible, and simply cause the ray of light to run back over the pictorial surface itself.

Von Ardenne has been able to make the return movement extraordinarily rapid at the transmitter (in which he likewise uses a Braun tube for scanning) by connecting a contact mechanically to the motion-picture apparatus, when sending film images. This contact mechanically discharges the saw-tooth condenser of the transmitter suddenly. In this way, he has succeeded in keeping the return time so short that disturbances can no longer be observed.

For producing pictures of any desired size, it is necessary to have ready several sets of glow-tubes, which show various ranges of potential between the ignition voltage and the extinguishing voltage (within the desired limits) and which, after being put in the saw-tooth receivers, furnish corresponding jagged wave-form potentials. Now it is to be remembered, with Von Ardenne's latest invention that there are available such saw-tooth oscillographs using Braun tubes for measuring purposes; the tubes for which were also developed by Von Ardenne. Therefore all those having such measuring instruments at their disposal can use these directly for television reception.

It is possible so to regulate saw-tooth wave-form potentials that, even on large fluorescent screens, perfectly-illuminated rectangles are formed.



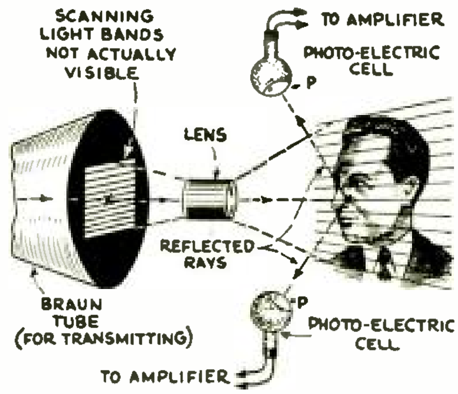


Left:—Simplified diagram showing action of Braun or cathode ray tube during process of scanning. Actually there is no space between scanning paths: they may even over-lap, and thus present a very perfect image.

Right:—Diagram showing how the Braun tube is used for scanning "film" image at transmitter and reproducing it at the receiver.

Rôle of Fluorescent Screen

Very important, for the maximum attainable picture- and line-frequencies, is the *fluorescent screen.* It is not a matter of indifference whether the screen has a long or short period of afterglow. With screens having a

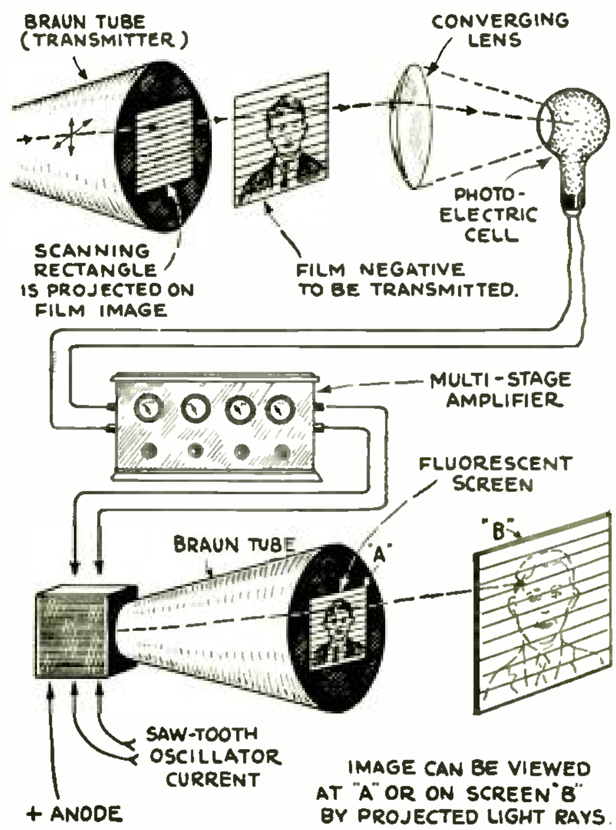


How cathode ray tube cas be used for scanning subject at "transmitter".

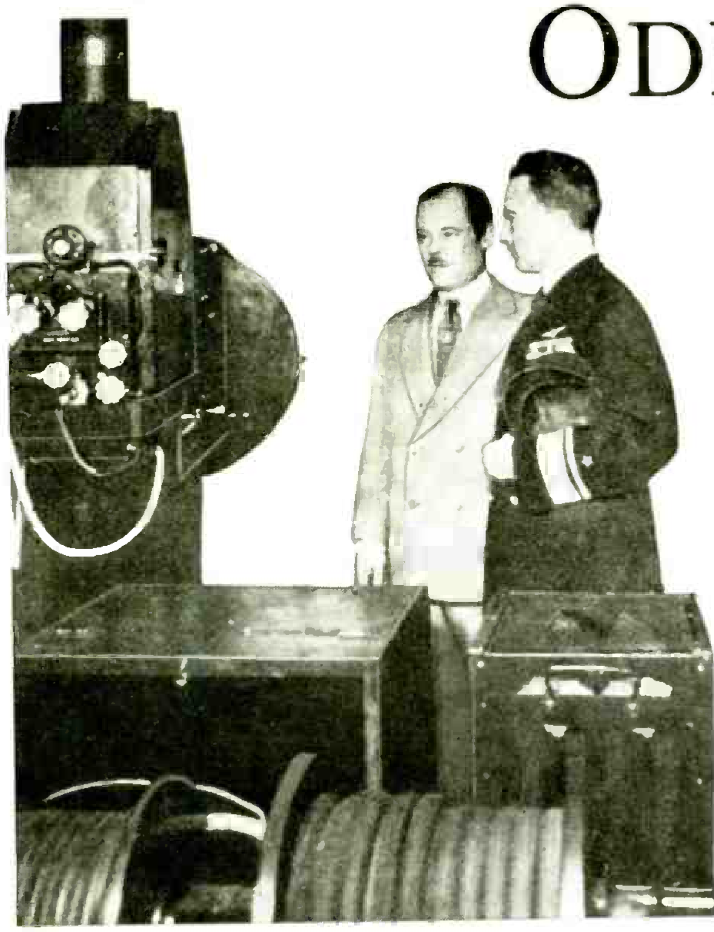
suitable afterglow, one can go down to 5 to 8 pictures per second, without the flickering being unendurable. *In this respect the Braun tube has an incontestable advantage over all other television systems.* Yet it is to be considered that the flickering is the more unpleasant, the brighter the picture becomes. For this reason, it is advisable not to operate with too low picture frequencies; in view of the great brightness of the pictures produced by the Braun tube.

The same statement holds for the reproduction of quick movements; as, for example, the transmission of mov-

(*Continued on page* 228)

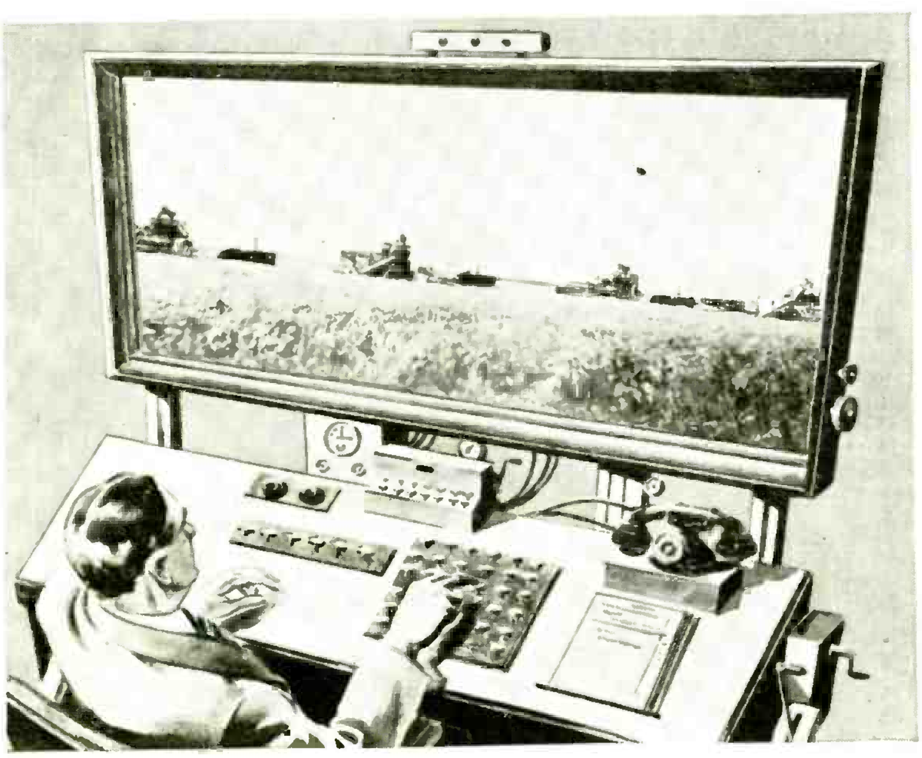


ODDITIES in TELEVISION



Byrd and Alexanderson Inspect Televisor

ON a visit to the General Electric Research Laboratory in Schenectady recently, Rear Admiral Richard E. Byrd saw television and was himself televised for the first time. In the photograph he is being shown the theatre television projector by Dr. E. F. W. Alexanderson, who developed this machine which is capable of projecting a television picture on a screen seven feet square. The Alexanderson system of producing large television images involves the use of a Kerr cell and a powerful source of light such as that from an arc, the light being modulated by the television impulses from the transmitter by virtue of the Kerr cell, which reacts on the polarized beam.



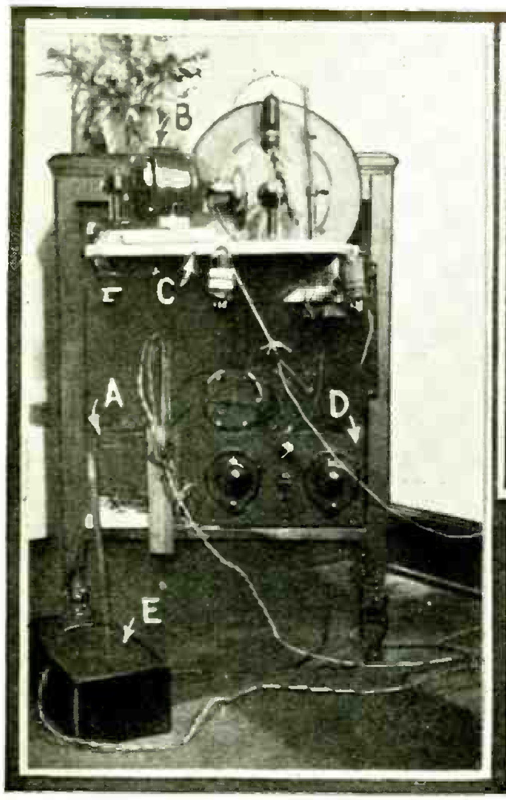
What Is It? View 10 Ft. Away

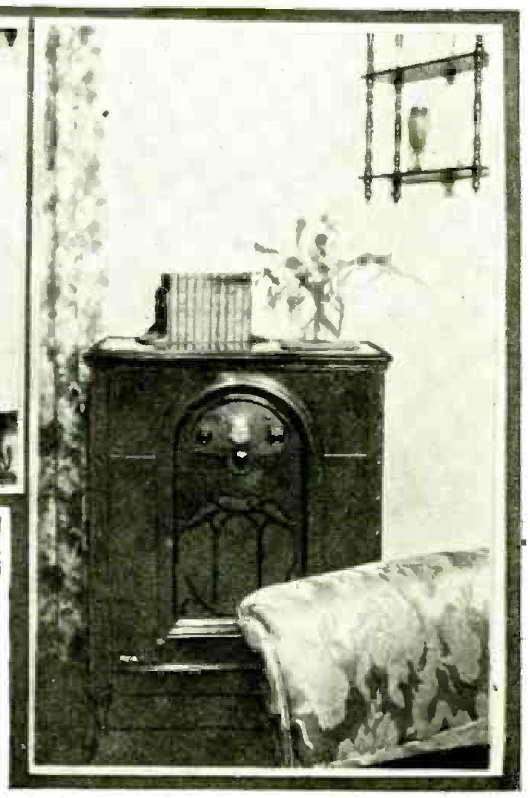
YES, this is a television image of a pretty coarse pattern to be sure, and the Bell Laboratory Record informs us that this represents a synthetic television image, and made up of about 1,100 elements. This may be compared to the present television image now being broadcast by N. B. C. and other stations with a 60 hole disc. Here the image measures 60 elements high by 72 elements wide, or it is made up of a total of 4,320 elements. This picture represents an image scanned by a disc containing 33 holes.

Harvesting by Television

THE scientific farmer of tomorrow may indeed run his business by television, as is the gentleman shown in the accompanying picture. Where large farms, thousands of acres in area, are to be harvested or planted, the superintendent or owner will be able to obtain a clear idea of just what is going on, when television apparatus becomes a little more common than it is today.

Courtesy of The Timken Roller Bearing Company.





Above we see Mr. Cowan with his Atwater Kent receiver and the lens of the television receiver appearing at the rear of the cabinet. Photo at left shows rear of Mr. Cowan's converted A.K. receiver with short-wave adapter at D; scanner motor at B; shelf supporting scanner at C; also power supply at E.

Photograph at right shows how set of books conceal television scanner when not in use.

HOW I GET TELEVISION ON A BROADCAST RECEIVER

By EDWARD L. COWAN

The author describes the simple yet effective scheme he uses for receiving television images with his Atwater Kent broadcast receiver, plus a short-wave adapter and a scanner.

IN my location at Athens, Georgia, I have been successful in picking up television images from transmitting stations, the nearest one of which is located several hundred miles away. The accompanying photographs show my Atwater Kent, Model 60, standard broadcast receiver to which I have added a short-wave super-adapter.

To obtain good television images, as we all know, it is very desirable that a resistance-coupled amplifier be employed in the audio end of the circuit and this I have arranged for.

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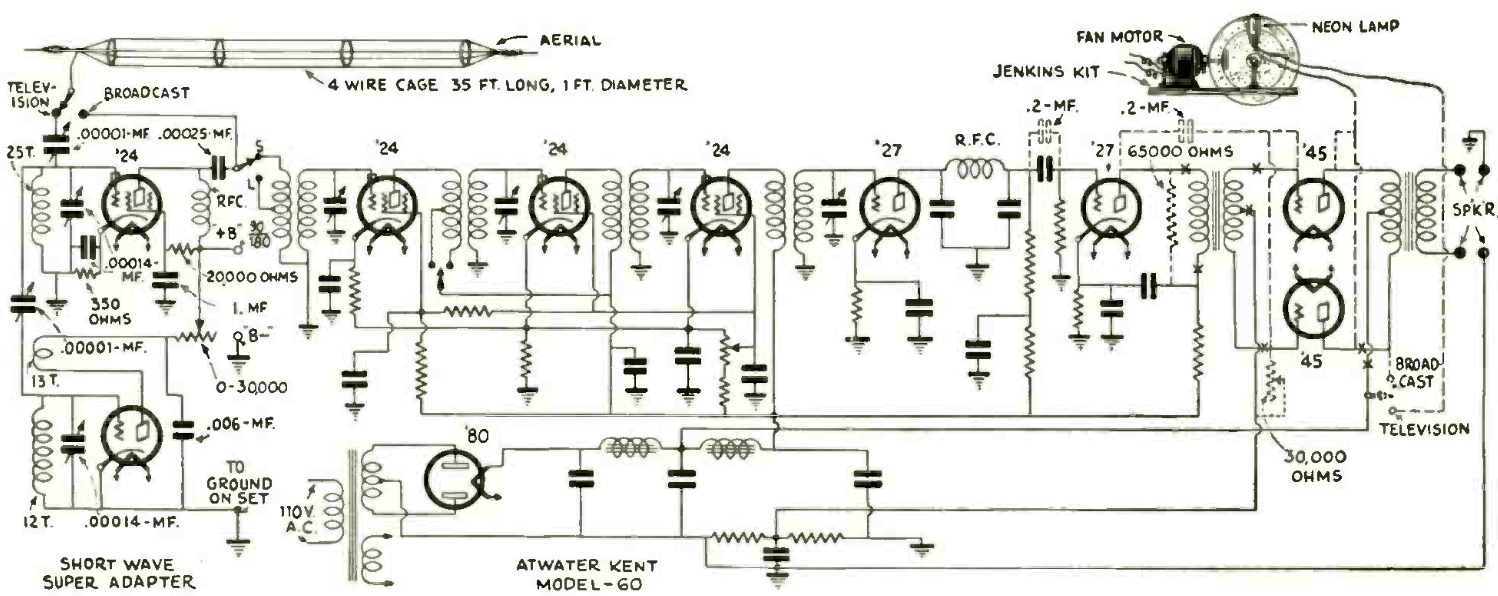

Diagram showing how Mr. Cowan fitted his Atwater Kent receiver with a short-wave super-adapter, in order to tune in the television wavelengths of approximately 150 meters, and also how he converted the second audio stage into a resistance-coupled type.

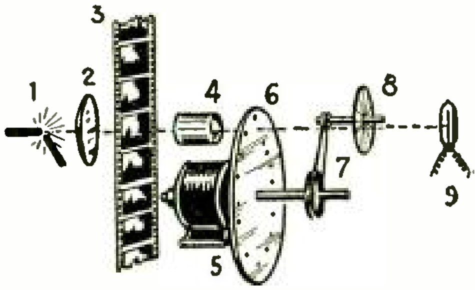

Fig. 1—Basic arrangement of the transmitter of the Ahronheim color "telekino" system with color filter. 1, arc light; 2, condenser; 3, colored film; 4, objective; 5, motor; 6, scanning disk; 7, transmission drive; 8, twelve-part color filter; 9, photo-cell.

COLOR TELEVISION

By DR. FRITZ NOACK (Berlin)

The Ahronheim system here described employs a color filter or analyzer, each color acting upon a different photo-cell; at the receiver the image is viewed through a synchronously driven color filter, placed between the scanning disc and the eye.

THE Ahronheim system of color television, which was mentioned in the first issue of TELEVISION NEWS (page 52, March-April) is now published in greater detail, as a result of the inventor's having made patent arrangements which permit the release of information. As previously explained, the Ahronheim system contemplates the use of several distinct colors of the spectrum (more than the red, blue and green of other color television systems) in order to give the image a more natural appearance.

The fundamental principle is shown in the illustrations, which show the Ahronheim scheme applied to the transmission by television of colored film, such as used in a number of motion-picture theatres. To transmit these by ordinary television methods would require an excessively high waveband; too high for radio broadcast limitations. In addition to this, the superposition of two or three differently-colored pictures does not give an absolutely natural appearance; and the fading which is inseparable from short waves is discriminatory as to different modulation frequencies, and would cause entire details to be lost.

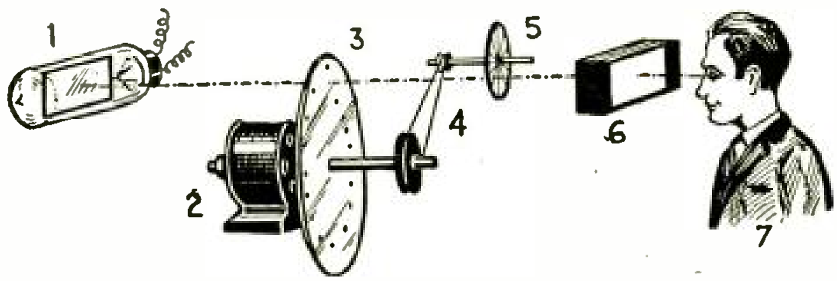

Fig. 2—Basic arrangement of the receiver of the Ahronheim color "telekino" system with color filter. 1, glow lamp; 2, motor; 3, scanning disk; 4, transmission drive; 5, twelve-part color filter; 6, observation window; 7, observer.

Transmission

The idea which is applied here is that the color elements of such a picture are different, not in intensity but in the color (frequency) of the light. The apparatus therefore filters the light, in order to determine its true color value; for instance, if a point of the image is dark red, a suitable filter will allow the light to pass; while the ray will penetrate through no other filter. In Fig. 1 the method is shown, as it is applied at the transmitter to the transmission of colored film.

We have at the left the usual light-source (1) which is sending a ray through the film (3) by means of the lens system (2, 4) upon a revolving Nipkow disc (6). Connected directly to the shaft of the scanning disc by belting (7) or gearing is the color-filter disc (8) which is divided into as many sections as there are colors to be reproduced. (The inventor has suggested twelve, as sufficient to reproduce all the hues of the chromatic spectrum.) This color disc must revolve at a rate of speed sufficiently high to present a filter section of each color to every pictorial element. However, the photo-cell is excited only once for each pictorial element; because only one light ray can penetrate the revolving filter for each point. Furthermore, the filters may be so regulated, as regards transparency, that the cell receives an impulse of equal strength for each element, of whatever color. The impulses received by the cell are amplified and transmitted in the method usual with all television processes.

The Receiving System

At the receivi..g end, the method of reproducing the image may be any of the standard systems; a Nipkow disc is again shown for simplicity. Again a color-filter disc is interposed, between the scanner and the eye which takes the place of the photo-electric cell (Fig. 2). If the filter disc is run in exact synchronism with

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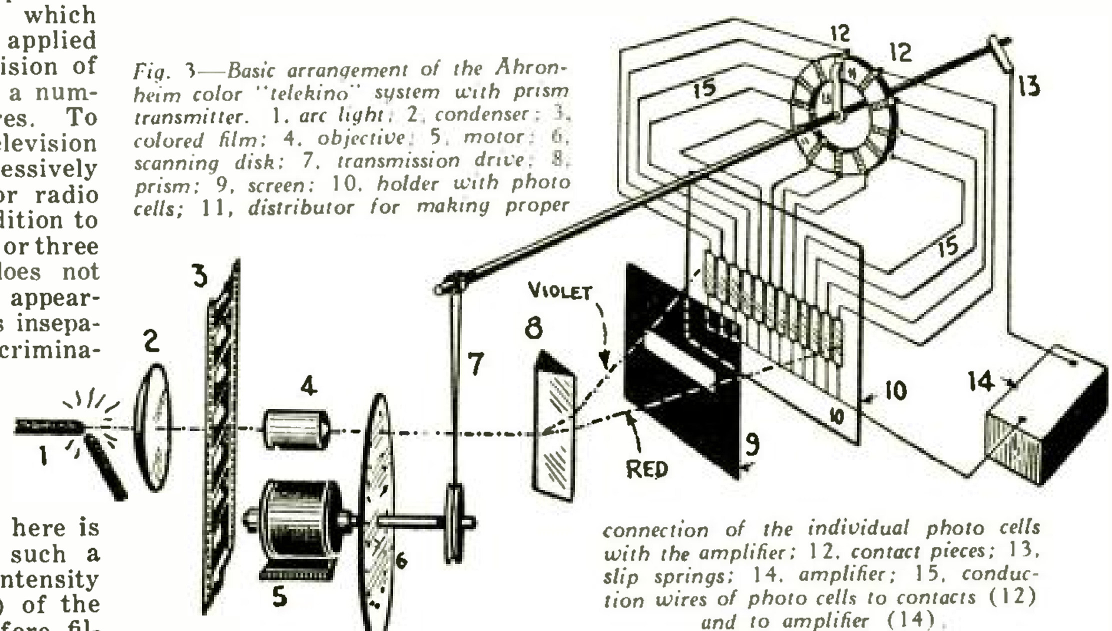


Fig. 3—Basic arrangement of the Ahronheim color "telekino" system with prism transmitter. 1, arc light; 2, condenser; 3, colored film; 4, objective; 5, motor; 6, scanning disk; 7, transmission drive; 8, prism; 9, screen; 10, holder with photo cells; 11, distributor for making proper connection of the individual photo cells with the amplifier; 12, contact pieces; 13, slip springs; 14, amplifier; 15, conduction wires of photo cells to contacts (12) and to amplifier (14).

The GLOW-TUBE
PROBLEM in the TELEVISOR

By K. NENTWIG

The author explains the nature and construction of the Neon glow lamp, as used in present-day television systems for reproducing the image. Several interesting output circuits, showing the best connection of a Neon tube, are shown and discussed by the author.

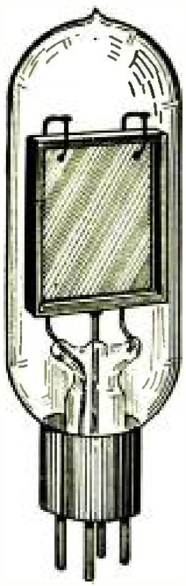


Fig. 1—Usual type of neon television receiving tube, familiar to American experimenters, containing a flat plate.

SINCE, in most instructions for building a televisor, the glow-lamp used is treated briefly, such a short account is not sufficient to give a clear idea of the construction and the different ways of connecting it. Therefore I have tried, in the following article, to deal with this theme in rather more detail.

Let us first consider the construction of such a lamp. The first glow lamps appeared some twenty years ago; for about ten years they have been used for electric signs, as voltage indicators, etc. In those types used for advertising display, etc., there are inside a glass bulb two wire spirals, which are wound together but insulated from each other.

This design, originated on the basis of experiments by Dr. F. Schröter and O. Schaller in the years 1916-17, has lasted until today; Fig. 2 shows such a type. The glass bulb is evacuated of air and contains a quantity of neon gas. If we put a sufficient voltage across the two spirals, there forms between them an orange-colored light, emanating from the spiral which has the negative potential. This spiral is therefore called the cathode, while the other is termed the anode. Hence it follows that only direct current can be used, if the glow is to form at only one electrode. If we also apply an alternating-current potential (which may be relatively weak), the intensity of the glow oscillates in synchronism with the latter. These oscillations occur practically without inertia; that is, instantaneously. The absence of inertia is so great that the glow-lamp is able to reproduce over 100,000 voltage oscillations per second as oscillations in brightness. It is this lack of inertia which makes the glow-lamp suitable as the light-relay for television; since here it is a question of having the source of light follow instantly every fluctuation in potential.

The special lamps used in the televisor have no spirals; but they employ as *cathode* a thin metal plate (that is, its surface), and as *anode* a frame which goes around the surface of the cathode. Fig. 1 shows such a type. By the arrangement or construction of the electrodes the glow is spread evenly over the whole pictorial surface; which is, of course, absolutely necessary for the illumination of the image.

Two Critical Voltages of Glow-Lamp

Now we may make brief mention of the following peculiarity of such glow-lamps. In the case of these lamps with two electrodes the glow discharge forms at a voltage of about 175, which is called the lighting voltage. The potential may then be lowered to 150 volts before the glow goes out; therefore this lower potential is called the extinguishing voltage.

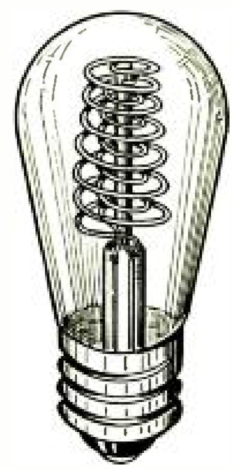


Fig. 2—German type of neon scanning tube, containing two wire spirals inside the bulb, the space between them becoming filled with a luminous glow. A lens in front of the tube gives the same optical effect as a flat plate.

The fact that the glow does not go out at the same potential at which it forms (that is, the lighting and extinguishing potentials do not coincide) is unfavorable, to this extent, that not a uniform, but a "jumpy" changing of brightness is possible. In order that both potential value may coincide, there has lately been brought out a glow lamp which has, besides the cathode and anode, a third electrode or "auxiliary-ion" electrode. In operation, this is connected with the positive pole of the voltage source through a resistance of about 0.1-megohm and effects a practical coincidence of the two potentials. Thereby a uniform changing of brightness is attained; which is, of course, important for the reproduction of images.

The lamp must be so selected that the surface of the cathode is always somewhat larger than the size of the image. In the case of the standard size of the R. P. Z. (*German National Postal Service*), 30 x 40 mm., for example, one uses a lamp whose cathode surface is about 35 x 45 mm. (1.4 x 1.8 inches). I should like to say something about the selection of the proper type. In fact, it is frequently advised, in constructional articles, to use ordinary spiral glow-lamps, which are then to be somewhat changed. But these lamps are only fairly suitable for rather small images.

For larger sizes—even for the 30 x 40 mm. image—these lamps are not particularly suitable, for the reasons given below. First, the illumination of the pictorial field is not even; and, secondly, the brightness is also rather mediocre. These disadvantages must be taken into account, because of the inevitably weak lighting of the image received. This is due to the fact, that for every pictorial element, only about one thousandth of the total illumination of the glow lamp is available. Therefore, in all my articles, I have stressed this point, to protect the amateur builder from needless vexation. Likewise these lamps have the added disadvantage of needing a higher lighting potential than the special lamps. The voltage must therefore be made higher. It is there-

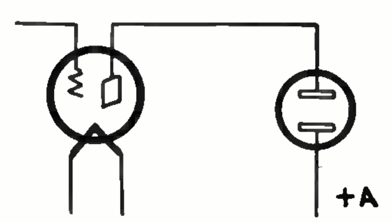


Fig. 3—Shows direct coupling of neon tube to plate of last amplifier tube, plus A indicating B plus. (A meaning anode.)

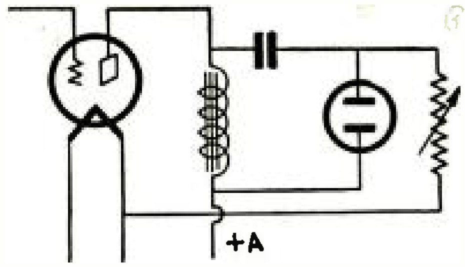


Fig. 4—Here the neon tube is coupled by means of a choke coil and condenser to the last amplifier stage.

fore always well to use only special lamps, unless one is willing to put up with the disadvantages described here.

Methods of Connecting Lamp to Receiver

This should suffice for the construction of the glow-lamps; therefore we will proceed to the consideration of the different possibilities in the way of circuit connections. We need, as was seen above, besides the oscillations of voltage, which produce the image and are furnished by the amplifier, also a direct-current potential for the glow-lamp, so that it may operate at all. Only a glowing lamp can be modulated by voltage oscillations, which it then converts into light oscillations. Of the many existing possibilities, only the most important will be pointed out and briefly discussed. All other modes of connection represent only variations of those described here.

In principle, one can connect the glow-lamp exactly like the loud speaker. The simplest way is undoubtedly that of Fig. 3. As we see, the glow-lamp is placed directly in the plate circuit of the last tube. At the same time, the cathode of the glow-lamp is connected with the plate of the power tube, and its anode with the positive pole of the plate-voltage supply. It is very easy to see, that by such a connection, the glow-lamp's potential is furnished by the plate-current supply of the set, the potential of which must therefore be about 200 volts. Even if this hook-up is the simplest, it also has various disadvantages.

The most important disadvantage is this, that the plate potential for the power tube cannot be regulated, apart from the potential requisite for the glow-lamp. Therefore the connection shown in Fig. 6 is better. In this hook-up, the glow lamp is coupled to the power tube through the two blocking condensers and the choke. Then there must certainly be a special source of current for the glow lamp, which will be spoken of below.

As to the choke or condensers to be used, the following may be said. We may use any output choke; as they are frequently used also for the loud speaker connection. The same service is rendered by any good filter choke, in which case it must be, above all, of large current capacity; since otherwise saturation will cause distortion, to which the glow lamp is very sensitive. The condensers are from 2 to 4 microfarads. The variable resistor shown in Fig. 6 is to have a maximum of about 10,000 ohms and must stand a load of about 2 watts without much heating. With most lamps, a potential of about 180 volts is ample.

Still another method is shown in Fig. 5, in which the connecting is

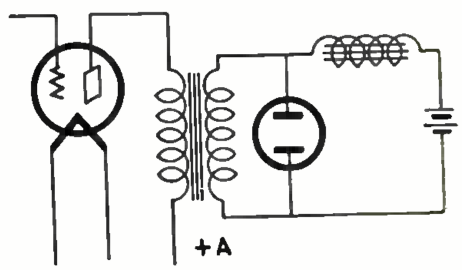


Fig. 5—Neon tube coupled inductively, through a transformer, to last amplifier stage.

done through an output transformer. In this hook-up, the voltage of the glow lamp is fed, not through a regular resistor, but through a filter choke. The rule given above holds for the dimensions of the choke, as well as the transformer. This means as large an iron core as possible; so that there may be no saturation by the current passing through the glow-lamp.

Current-Supply Problems

Now, a few words about the sources of potential for the glow-lamp operating current: In Figs. 5 and 6 a special source of potential is used to produce the current. It can be taken from either a storage plate battery or a power pack. Because of the higher cost of operation, dry-cell batteries are out of the question. As mentioned above, a potential of about 180 volts is sufficient for many special lamps. If this is taken from a socket power unit, care must be taken that the direct current obtained is as free as possible from modulating alternating (or ripple) current. If this is not the case, then there will be almost always in the pictorial field dark lines which are due only to this alternating current and do not belong to the picture itself. With a "B" storage battery or a filter unit to supply plate potential for the receiver, it can at the same time be used for producing the glow-lamp current. The necessary hook-up is shown in Fig. 4. The elements shown in this diagram (choke, blocking condenser, and variable resistor) have the same values as in Fig. 6; so there is no need of going into details.

In conclusion, let us consider the regulation of the operating current. To adjust for the right amount of current, one proceeds as follows: Start the entire apparatus during a television broadcast, and give the glow-lamp the potential indicated by the manufacturer. Now, if black spots (not belonging to the picture transmitted) whisk through the pictorial field during reception. the glow-lamp potential is too low and the glow-light is being extinguished occasionally by too high an alternating current potential provided by the amplifier. Matters are remedied either by raising the potential applied to the lamp or reducing the output of the amplifier.

But, if the potential applied to the glow lamp is too great, then, to be sure, the picture appears with all the image values, but it is, as they say in photography, too dull. Lessening the operating potential is the right thing here.—*Das Funkmagazin.*

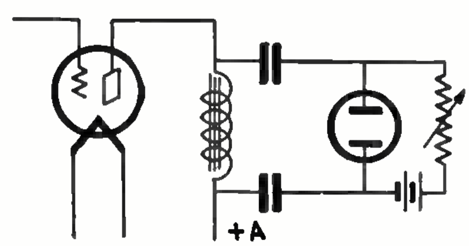


Fig. 6—Here the neon tube is coupled through condensers and a choke coil to the output stage of television amplifier.

HOW YOU CAN Experiment *With the* Cathode Ray Scanner

By C. H. W. NASON

Details of control circuits for cathode ray scanners.

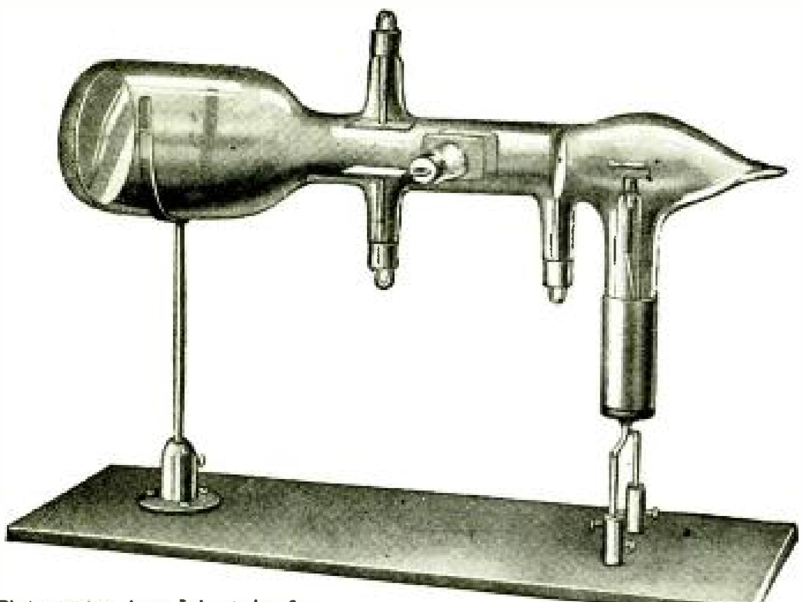
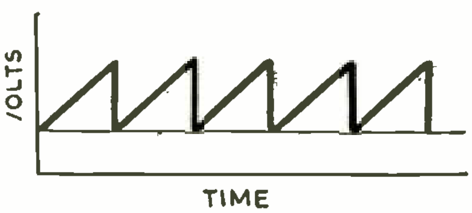
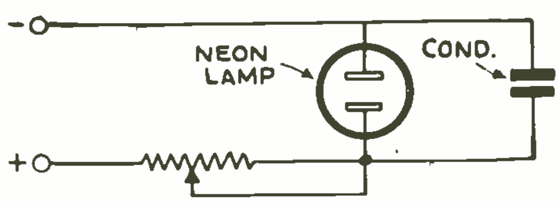


Photo courtesy Argco Laboratories, Inc.

Experimental cathode ray tube suitable for television experiments described by the author.

MOST of those interested in the present-day advances in television have heard of the work of Zworykin at Pittsburgh and of Farnsworth on the West coast. These gentlemen have dropped the clumsy mechanical devices employed





by other investigators and have turned their attention to the cathode-ray or inertialess electron beam for the answer to the problem. Whether or not the answer truly lies in that direction, the writer cannot satisfactorily answer; but he can say that the courage of these gentlemen in so departing from the beaten track is admirable. The Farnsworth system has been described in elementary detail in numerous journals and should be familiar enough to the serious investigator to require little repetition here; the same holds true for the Zworykin system. Unfortunately those desiring to experiment with the cathode ray as a means of transmitting and receiving television images are limited, for the most part, as the financial means and the tubes necessary for the transmission of images in this manner are outside their monetary abilities.

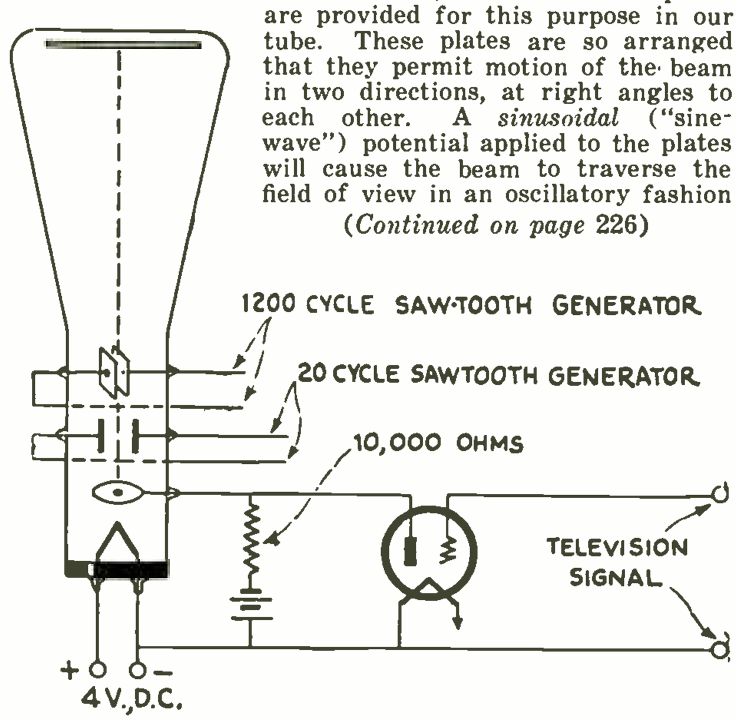
For that matter, but few experimenters are able to afford the necessary apparatus for transmitting test images of any kind and must rely upon the signals available from the television transmitters now on the air—all of which are now translations of a disc-scanned scene.

The writer intends in this paper to describe a system for the employment of the "Braun" or cathode-ray oscillograph tube of ordinary type in the reception of disc-scanned scenes; so that the amateur and the minor experimenter may have the opportunity

Volt-time curve, above at left, shows "saw-tooth" wave form required of oscillator that develops control current for cathode ray scanner.

Left: Neon tube oscillator circuit: the neon tube is shunted with a condenser and connected to a D.C. supply.

Right: Hook-up of experimental cathode ray scanner to oscillators supplying "saw-tooth" oscillators of 1.200 and 20 cycles periodicity. The saw-tooth oscillator currents move the cathode ray up and down and sidewise.



of working with the most advanced equipment.

The tube shown in the first figure is of German origin and well suited to this purpose. The parts of the tube are easily identified in the illustration, and their operation will be taken up in the next paragraph. The price of this tube compares favorably with that of a scanning disc and synchronous motor.

What the Tube Consists of

The cathode-ray oscillograph comprises an electron-emitting source; a means of accelerating the electron stream and concentrating it into a uniform beam; and a fluorescent screen or target, which gives a visible indication of the motion of the beam. This series of elements is encased in a tube or envelope, either highly-evacuated or filled with gas at a low pressure. The beam of electrons may be moved about the screen under the influence of an electromagnetic or electrostatic field; and two sets of plates are provided for this purpose in our tube. These plates are so arranged that they permit motion of the beam in two directions, at right angles to each other. A *sinusoidal* ("sine-wave") potential applied to the plates will cause the beam to traverse the field of view in an oscillatory fashion

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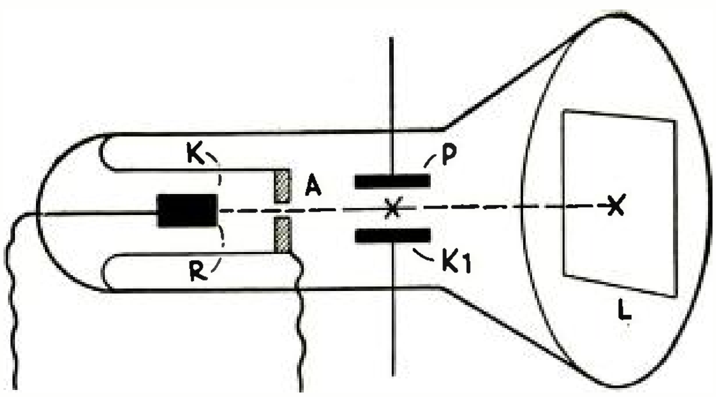

Fig. 1—Here we have a diagrammatic view of the Cathode Ray tube, sometimes called a Braun tube, as used for television.

HOW THE CATHODE TUBE SCANS in TELEVISION

By HANS BOURQUIN

Many students of the subject often wonder just how the Cathode Ray scans the image and Mr. Bourquin explains this action very clearly in the accompanying article.

TELEVISION reception today is obtained principally by means of the Nipkow spirally perforated disc and the Weiller mirror-wheel. In both cases the formation of the picture is accomplished only by fairly large and complicated revolving mechanisms. Therefore, science is greatly interested in the use of the extremely simple Braun cathode tube for television. (For the optical process of forming the picture with this is accomplished, not by large movable apparatus, but by the movement of tiny inertia-less electrons.) The cathode-ray tube has already undergone extensive development for television and Von Ardenne, as well as Zworykin and others have obtained images with it.

This tube is shown in the diagram Fig. 1. In a somewhat trumpet-shaped tube there is (at the left) the real Braun tube R, whose cathode K is heated in the usual manner, to ensure from the start a steady flow of negative electrons. The anode A at the right end of R is shaped like a section of pipe. If one gives both electrodes an accelerating voltage of

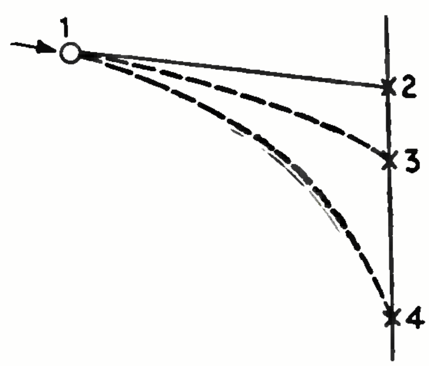

Fig. 3—Diagrams used by the author in explaining the action of the Cathode Ray.

from 300 to 400, the cathode sends out a powerful thin pencil of rays, as indicated by the horizontal central line in the diagram. Then the radiation strikes a luminous screen L, visible at the extreme right, in which cupriferous zinc sulphide is brought to luminescence. In the given case, the eye sees, in an otherwise dark room, a more or less luminous spot in the middle of the rectangle forming the surface to be illuminated for producing the picture.

Between the anode A and the screen L, are the two plates of a condenser K1, which can be charged from the outside, and between which the abovementioned cathode ray passes. If this condenser is charged to one polarity the ray is diverged, for example, upward; if the charge is of the reverse kind, the divergence is downward. Charging and discharging can be attended to by a local alternating-current machine; if a relatively high number of alterations per second occur, then the dot of light is rapidly moved *up and down* within the limits of the rectangle on L. Now, in the tube, there is also another condenser (which was not sketched, lest the clarity be affected). Its axis lies in a horizontal plane and therefore passes perpendicularly through the plane of the paper. The axes of the two condensers intersect at point P. This second condenser is operated by a second generator; if the alternation is slow, the dot of light moves slowly back and forth on the screen—*i.e.*, in a *horizontal* direction.

Fig. 2 shows roughly how the luminous dot moves in its assigned rectangle under the simultaneous effect of the two condensers. At a certain time point 1 is illuminated, and the first condenser will try to direct the dot from 1 to 2, while the second condenser tries to move it to the right by the distance 2-3; consequently the luminous dot takes the route 1-3 and it is quite evident that a zigzag motion results. It is also plain that the picture is illuminated alternately from left to right (from front to back, in Fig. 1) and from right to left. The illumination will be the more thorough, the shorter the distance 2-3 is in relation to 1-2.

In these processes, however, the surface would everywhere appear of uniform brightness. If a picture is to become visible, *the pictorial elements must differ in brightness;* this is to be effected by the arriving television waves. For this purpose there is connected in the Braun tube, between the anode and cathode, a grid on which the electric waves so fall that the number of electrons reaching the screen decreases or increases again; at the same time there occurs an undesirable phenomenon, which is shown in Fig. 3.

Somebody throws a stone, from point 1, at a wall in the direction of point 2. Then the stone will not strike

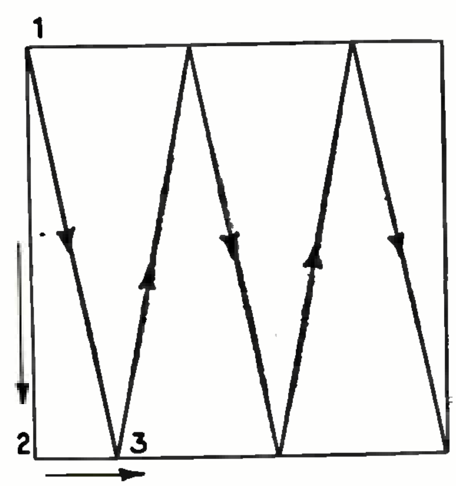

Fig. 2—Shows typical path followed by Cathode Ray in scanning an image.

at 2 but about at 3; because during the time of its travel it is subject to the pull of gravity. If one lessens the initial velocity in a second attempt, then the stone lands at the point 4 for example. The deviation from path 1-2 is greater, the lower the velocity of projection. Now, if the number of effective electrons in the tube is reduced by passing through the grid, then their velocity also becomes less; and the divergence increases. The result is that the path of the dot of light varies more or less from what it should have been, according to Fig. 2; and this leads to a slight distortion of the picture.

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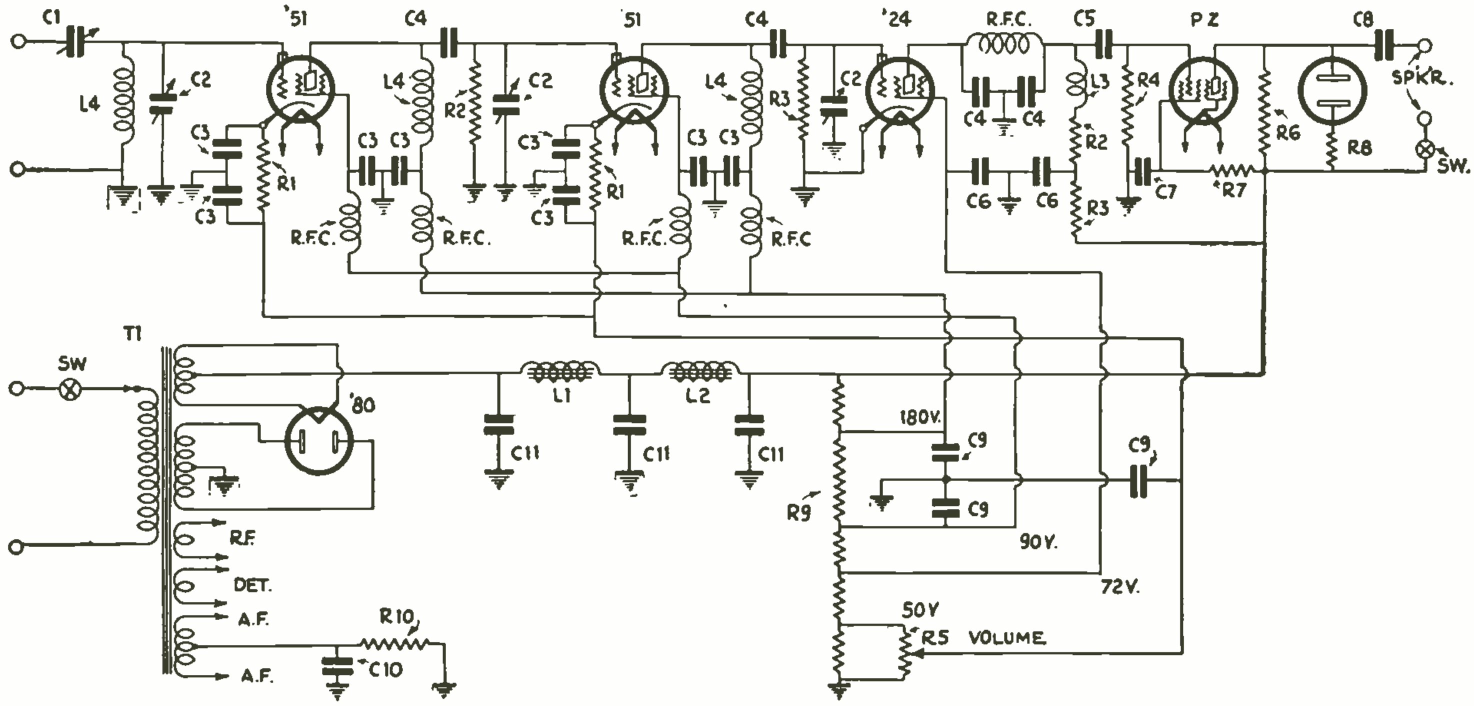


The diagram above shows a circuit employing two new vacuum tubes, the variable-Mu type '51 tubes and the new Pentodes (PZ). This television receiver will provide an output sufficient for all ordinary requirements.

TWO NEW TUBES *For* *the* Television RECEIVER

The author describes a new television receiver circuit in which he tested the Variable-Mu '51 and the new PZ Pentode tubes with gratifying results. A very strong output current is obtained.

THROUGH the courtesy of the manufacturer, the writer has recently had the rare privilege of trying out two new tubes for television. These tubes—the last word in broadcast equipment—are so ideally suited to the problem of television reception, that they seem almost as though designed with this specific purpose in mind. They are the new '51 variable-mu tetrode and the PZ pentode output tube.

Elimination of Cross-Modulation

The value of the first is found in its freedom from the effects of *cross-talk*, which has been the bugaboo of television reception. In most television receivers the band has been filled, not with television signals, but with the harmonics of broadcast transmitters. Poor design has laid these receivers open to *cross-modulation* in the grid circuit of the first tube, due to strong local broadcast transmitters. This interference is caused by the fundamental wave of the broadcaster, and *not* by a strong harmonic component from the station. The harmonic component has been manufactured to order in the plate circuit of the first tube.

The use of the '51 tube entirely removes this difficulty, and leaves us with the circuit-design problems limited to those considerations affecting the width of the received band.

Grid Circuit Detection Improved

New data on grid-circuit detection, recently made public, have shown us where the faults lay in our original detectors, and have pointed the way to improved frequency-response in this end of the channel. Grid-leak detectors, properly proportioned, have been devised and are far superior to the plate-circuit or "bias" detectors, heretofore considered the last word in design. Utilizing the screen-grid tube as a grid-circuit detector, we are able to remove the last traces of distortion which proved so troublesome at the early stages of the game.

Grid-circuit detection introduces a *phase reversal*, in the detector stage, which demands the use of an odd number of A.F. stages following, if a *positive* image is to result. Heretofore this called for the use of three A.F. stages following the detector, and three stages of transformer coupling are troublesome enough to get going—let alone three stages of resistance coupling, where a frequency-response flat over the entire range, from 15 cycles to 40,000 cycles, is demanded.

Enter the Pentode

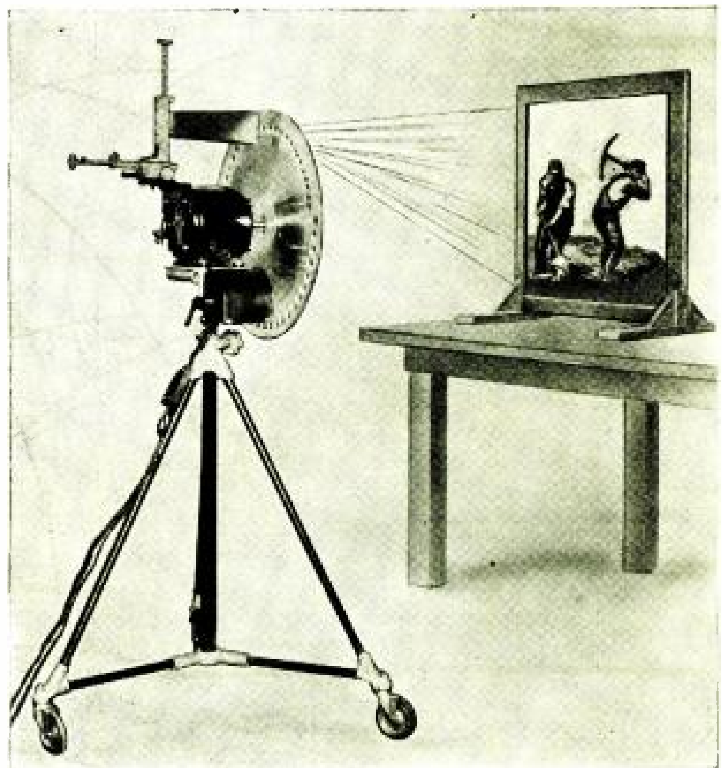
Utilizing the screen-grid tube as a high-level detector, we are able to obtain the required number of subsequent phase reversals through the use in a single A.F. stage of a pentode tube, which requires much less input to its grid for the same power output obtained before with a three-electrode tube. Not only is the pentode superior in its theoretical considerations, but it seems more easily fitted into the television picture than the three-electrode tube, so far as the use of the neon tube as a *load* is concerned.

The receiver shown in the schematic circuit is devised for extreme simplification of the operating problem. It is the designer's intent to do away with all tricky control gadgets, and evolve a receiver as simple in operation as the usual broadcast set. A glance will indicate that the volume control and a single tuning control are the only adjustments permitted. As a third adjustment, a method of varying the initial brilliancy of the neon tube might have been provided; but this was thought unnecessary, inasmuch as the preliminary adjustment of the current through the neon tube to approximately 20 milliamperes (by

(*Continued on page* 234)

A TELEVISION PROJECTOR *for* *Screen Pictures*

The crater lamp television projector here described is the one shown on our front cover. With this remarkable, yet simple, machine a picture as large as two feet square can be projected, with no greater signal output than that obtained with two '50 amplifier tubes in the last stage of the receiving set.



The Jenkins "crater tube" television projector, suitable for home and small auditorium use. A picture as large as two feet square can be obtained with this simple mechanism, which comprises a neon "crater tube," which yields a small point of light of great intensity, the modulations of which are passed through lenses in the revolving scanning disc, on to the screen.

FOLLOWING rapidly in the footsteps of the motion-picture art, the television technique is ready to step out of the peephole stage. The latest developments make possible the projecting of a television picture on a screen for the entertainment of a small theatre audience, compared with the one to six persons who heretofore might be served by the usual televisor for home use.

The projector-type televisor developed by the DeForest Radio Company's engineering staff, in collaboration with the Jenkins Television Corporation (both of Passaic, N. J.) comprises a special form of neon "crater" lamp, in combination with a lens scanning disc. The lamp is arranged for ready adjustment in order to focus the extremely small source of light with proper relation to the lenses of the scanning disc. The lenses serve to project individual spots of light on a screen, one following another; forming the horizontal lines with which the incoming pictures are woven. The lens disc is driven by a large synchronous motor, which keeps in step with the television transmitter when both are employed on a common A.C. system. The entire assembly is mounted on an adjustable tripod, carried on rubber tired wheels.

It is possible with this television projector to project pictures measuring two feet square. The pictures are most pleasing; since the lens scanning disc provides sufficient diffusion to "fade" adjacent lines into each other, thereby getting away from the angular effects of the usual scanning system. Ample illumination is provided, for good pictures in a darkened room.

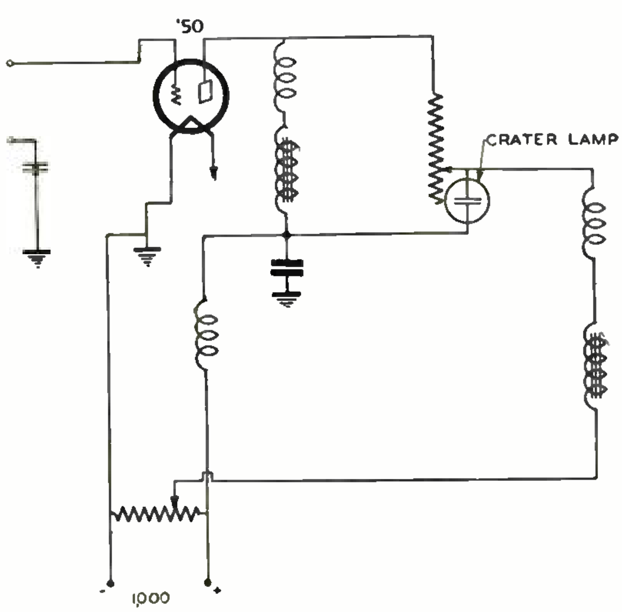
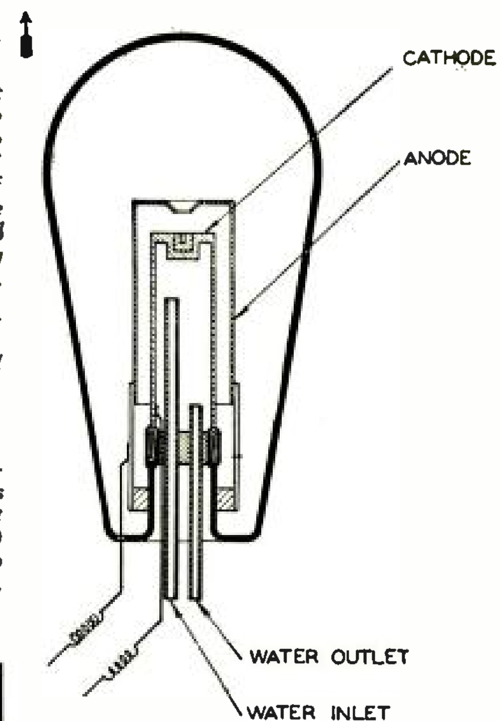
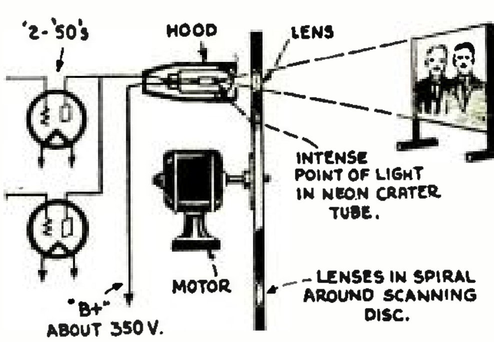


Diagram of connections showing how neon crater tube is hooked up with 1,000 volt D.C. plate supply and '50 amplifier output tube. (Two '50 tubes are generally used, connected in parallel as below.)



Sectional view of water-cooled neon crater tube.



WHAT PRICE IMAGE QUALITY?

By D. K. GANNETT
American Telephone and Telegraph Company

No matter how perfect the television transmitter and receiver may be, we must be able, technically and legally, to transmit the desired frequency of picture impulses over the circuit. Some of the present limitations, so far as quality of the image is concerned, as occasioned by having to limit the frequency within certain bands, are here forcibly presented by photographic evidence.

IN THE processes usually employed in telephotography, the picture may be considered to be divided into a large number of small, equal-sized elements like a mosaic. Unlike the human eye, which sees the whole picture at once, the electrical eye of the transmitting machine is focussed on only one element at a time; passing rapidly along row after row of elements until the whole picture has been scanned. As each element is viewed in turn, an electrical signal is sent out whose strength corresponds to the average shade of that element. Upon reception of the signals, the receiving apparatus recreates the picture elements one at a time, painting each dark or light as directed by the electric signals, and arranges them in the proper order to form a picture similar to that viewed by the transmitter.

Fig. 1—Pictures transmitted over the commercial telephotograph system, containing 250,000 elements. Compare with image at right.

It is apparent that, in such a system, picture details smaller or closer together than the size of one picture element cannot be properly transmitted. The finest details which may be sent are such as would make alternate picture elements dark and light. The electric signals which would be sent out as these elements are transmitted would be alternately strong and weak, a cycle being sent for each two elements. The frequency of this current would therefore be the number of picture elements being sent per second, divided by two. Where the detail is coarser, the frequency would be lower.

It is necessary, therefore, to be able to transmit from the sending to the receiving apparatus all frequencies up to that corresponding to the finest detail—a frequency equal to the number

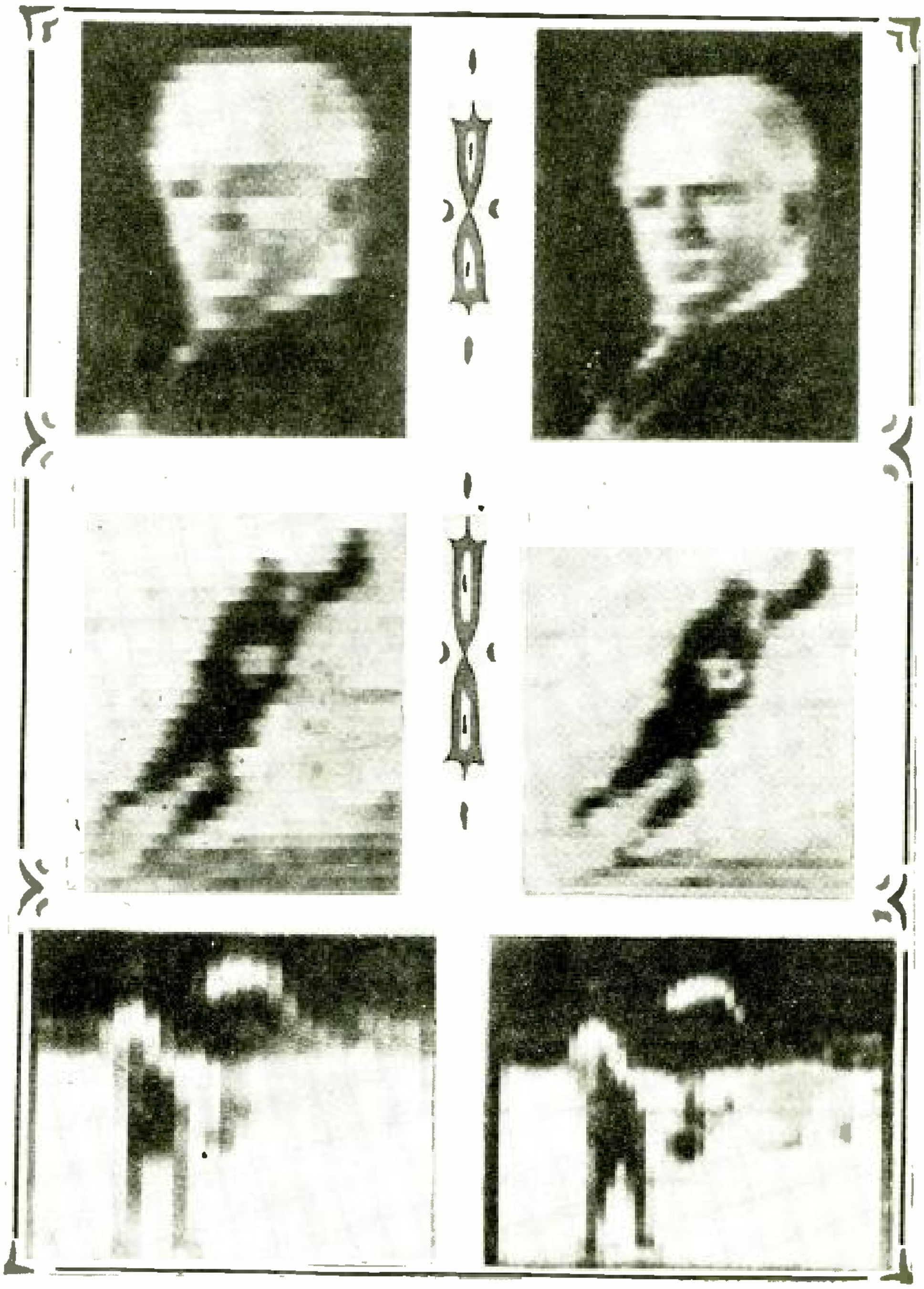


Fig. 2—Television images as they would appear if transmitted by usual methods over an ordinary broadcast band.

Fig. 3—With two ordinary broadcast channels, 1,250 elements could be transmitted. The gain over Fig. 2 is obvious.

of picture elements per second divided by two. If the wire line or the radio channel over which the currents are sent cannot transmit as high a frequency as this, the received picture will appear coarser, just as though the picture had been divided into larger elements in the first place. No matter how nearly perfect the sending and receiving apparatus, therefore, no better picture can be received than that permitted by the frequency-band which can be sent from the sending to the receiving point.

This is true equally of telephotography and of television. The principal difference between the two is in the speed of transmission. In telephotography, several minutes may be taken to transmit a picture, but in television, as in moving-picture projection, it is necessary to present to the observer about 16 complete pictures per second, in order to give the illusion of motion. This means that each picture can contain only the detail which can be transmitted in 1/16 of a second.

Suppose, for example, that an ordinary 10-kc. radio broadcast channel is to be used for television purposes. With the usual broadcasting methods, the total channel width is divided between two sidebands which are transmitted from the radio transmitter; so that the highest frequency which would be transmitted to the television receiving apparatus from the radio receiving set is determined by the width of one sideband, which is 5,000 cycles. Since each cycle represents two picture elements, the number of picture elements which could be received is 10,000 in a second, or 625 in 1/16 of a second. No matter how good the television apparatus, therefore, no better quality picture could be obtained than one containing 625 elements, or about 22 by 28 elements.

Television pictures of about this quality are illustrated in the pictures in Fig. 2, showing a portrait, a single figure and a group of figures as they would appear when sent over an ordinary radio broadcast channel. These may be compared with the photographs of Fig. 1, which show how the portrait and the group in the prize-fight ring appear when divided into 250,000 elements instead of only some 625. To broadcast such pictures as television images would require a frequency-band 4,000,000 cycles wide—equivalent to 400 ordinary broadcast channels. It will be seen that the pictures in Fig. 2 are so lacking in detail that they are no more than barely recognizable.

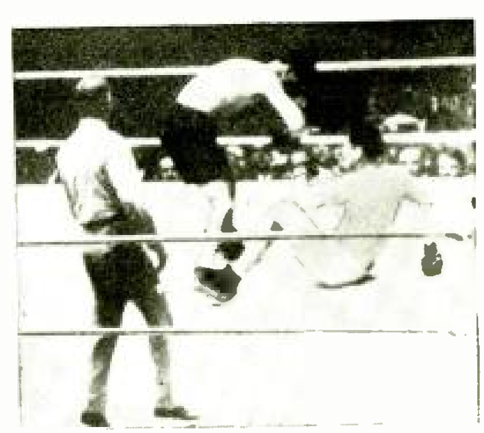
Figs. 3, 4, and 5 show the same pictures as they appear when divided into greater numbers of elements than Fig. 2, to have more detail. The pictures in Fig. 3 have 1,250 elements each and would require 20,000 cycles or two broadcast channels with ordinary broadcast methods. By special methods of broadcasting, whereby only one of the sidebands is transmitted from the radio transmitter, the necessary frequency band could be cut in half; so that Fig. 3 could be sent over a single broadcast channel. Figs. 4 and 5 have 6,250 and 12,500 elements, and would require 10 and 20 broadcast channels, respectively, when ordinary broadcast methods are employed. By using the special single sideband method of broadcasting, the same results could be obtained over a channel equal to five broadcast channels in the case of Fig. 4 and 10 broadcast channels in the case of Fig. 5.

These pictures may be compared with the images transmitted by the television apparatus demonstrated

(*Continued on page* 225)

Fig. 4—By using ten (present limit) ordinary B.C. channels, and transmitting 6,250 elements, the image looks like this.

Fig. 5—By employing twenty ordinary broadcast channels greater detail is gained as indicated in the group above.



Compare this picture with Fig. 5. The image above is composed of 250,000 elements, like Fig. 1, requiring 400 10-K.C. channels.

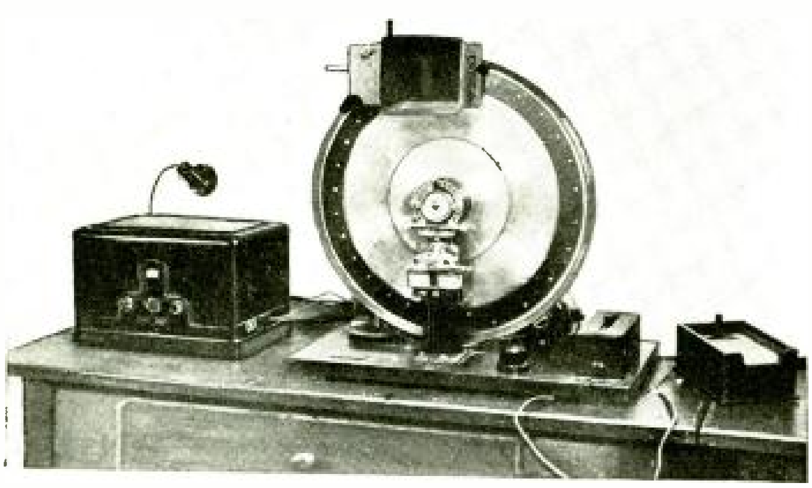
How To Build a

TELEVISION SCANNER

with "Constant Speed" Brake

By BRUNO WIENECKE
Member of the Berlin Radio Club

A description of the image receiver awarded the first prize in German television construction competition.

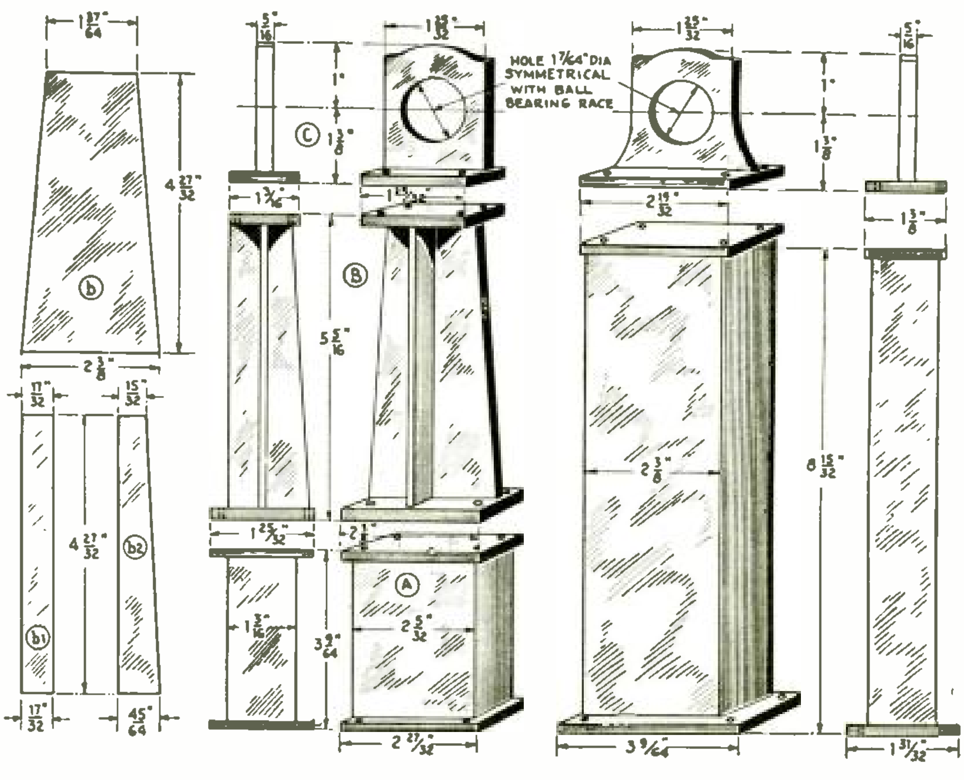


A view of Mr. Wienecke's prize-winning television scanner, with the tuner cabinet at extreme left.

In accordance with our intention to inform our readers, with as much detail as possible, about the prize-winning sets in the last construction competition of the Reichs-Rundfunk-Gesellschaft (National Radio Society of Germany), we are giving herewith the instructions for building this television set. We believe that, even with a fair expenditure of precise machine and hand work, approximately equal results to those obtained with the original, may be attained.

THE following specifications for the mechanical part of a television receiver are intended for those amateurs who are accustomed to work for the result intended with endurance and steadfastness and to attain it. Although the construction of the set is not unduly difficult (particularly if the directions are quite exactly followed) yet it is very desirable for the amateur in mechanical tasks to possess manual dexterity. Matters are specially simplified by the presence of a lathe; since without it exact work might not be possible. Of course one can also have the lathe-turned parts made by a local machinist. I should like to give an urgent warning against careless work; since it is then impossible to get a smoothly-running set which will furnish good pictures. The set described here may seem at first very complicated; it is, however, the result of many experiments, in which it appeared that with more primitive devices it was not possible to get the result attained with this model.

The principle of the set is the use of a Nipkow scanning disc, which is brought by a motor to approximately the right number of revolutions (1,200 per minute), and is regulated by an electromagnetically-actuated brake during observation; this being done continuously to produce a steady picture.



Figs. 1 and 2—Details for cutting out and assembling scanning disc support pedestals.

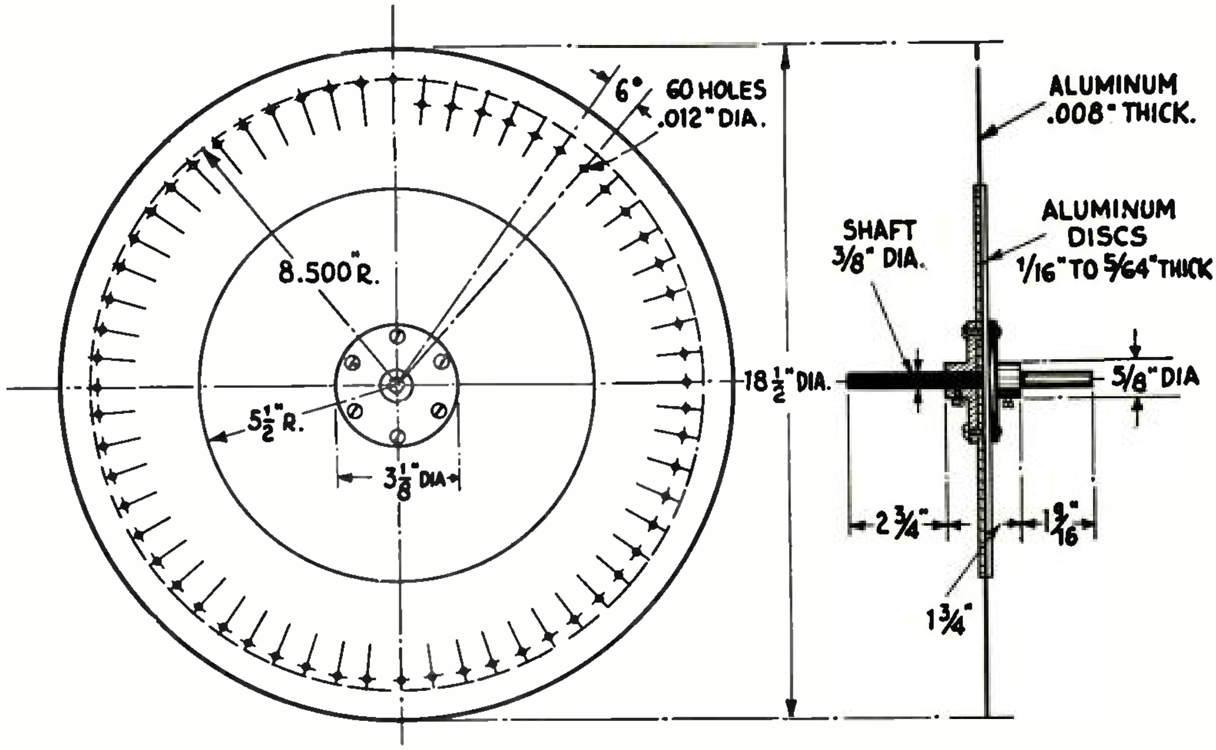


Fig. 3—Dimensions of the Wienecke scanning disc converted from 30 holes (German) to 60 holes (American—60 by 72 elements, latest standard ratio).

Mounting the Scanning Disc

The axle of the disc runs in ball bearings, which are fitted into two pedestals. Because of the relatively large diameter of the perforated disc, the pedestal bearings have to be very high and therefore must be of rigid construction. The author has used much labor and care on this. In Figs. 1 and 2 two different shapes for them are drawn, between which the amateur can choose; the latter of these may take somewhat less work.

In Fig. 1, A represents the lower part, which consists of sheet iron .04-inch thick, which is bent over a piece of joist 1¼x2¼ inches to make a little box, and is soldered together. The two surfaces forming the ends of the box consist of .08-inch sheet iron. If ordinary black iron plate is used for A, it is advisable to do the soldering with hard solder or brass. The middle piece B is composed of five sections. Three of these parts are represented at the left side of the drawing, separately; namely the middle section *b*, to which are attached behind and in front the side sections *b*1 and *b*2. These three parts consist of 0.12-inch sheet iron or iron plate. The middle piece, consisting of these three parts, is provided at top and bottom with rectangular plates 0.24-inch thick. It is very advisable to fasten all five parts together provisionally with little clips and to give them to an oxy-acetylene welder, who will weld them together into a very stable support. It is especially to be insured that both part A and part B shall have exactly parallel end surfaces; for otherwise the completed pedestal bearing looks very crooked.

Fig. 4—Graving tool used to finish edge of disc while being spun on motor, as in Fig. 5.

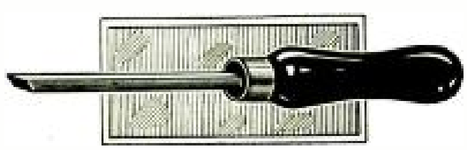
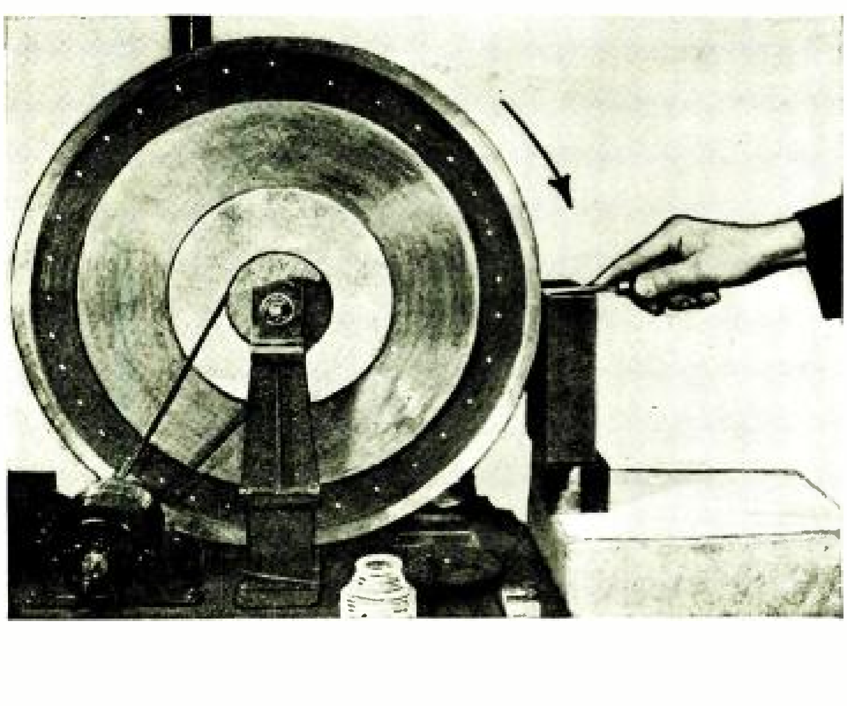


Fig. 5—Truing up edge of scanning disc with graving tool, the disc being driven by motor as shown.



Part C (Fig. 1) represents the actual pedestal bearing, into which the ball bearing is fitted. It consists of two pieces of 0.32-inch flat iron which, as the illustration shows, are set at right angles to each other. It is advisable to hold the two parts together by two .16-inch thick screws, and then use hard solder or weld them together. The size of the hole in the upright piece depends on the external diameter of the ball bearing. The bearings used by the writer had a diameter of 1.10-inch, a hole 0.36-inch and a breadth of 0.32-inch. The hole works best if it is neatly drilled; in any case make it only large enough for the ball bearing to be pushed through indeed easily but still with friction.

To hold the ball bearing fast in it, part C has on one side a slot running from the edge to the hole; this slot can be pressed together by a screw coming from above, and clamps the ball bearing fast. After all three parts, A, B, C, are ready, they must be screwed together. The necessary holes for the 0.16-inch screws marked in the illustration are not bored until now. Start with the uppermost part, C; this is then set on part B and the holes are marked on the lower plate with a sharp needle. The same thing is done with B and A.

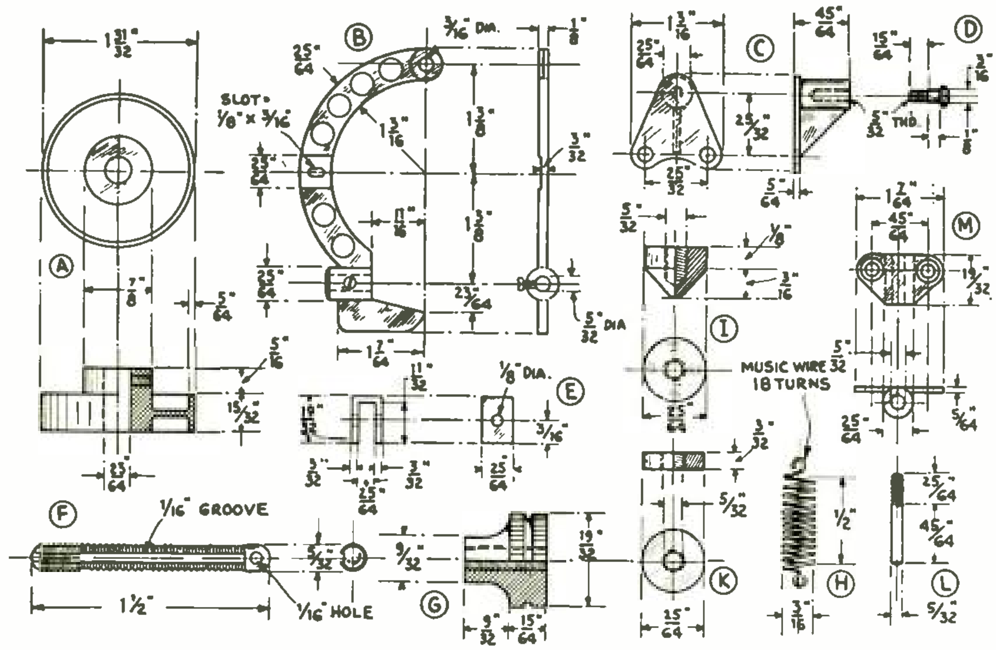
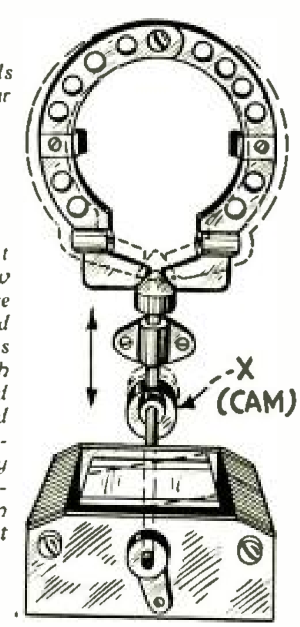


Fig. 6—Details of brake gear and drum.

Fig. 6A, right—Shows how brake arms are moved in and out, by means of the cam which moves pin and button up and down; cam being turned by magnetic mechanism shown in photographs at O-N.



The making of the pedestal bearings according to Fig. 2, in which only two parts are needed for each pedestal, should be clear from the illustration.

To increase their stability, the two pedestal bearings are screwed, not directly on the wooden baseboard but on a piece of flat iron 8 inches long and 0.32-inch wide, with a thickness of 0.16 to 0.24-inch. The ball bearings are put into the pedestals, and the axle is put through; this consists of a piece of silver steel 0.36-inch thick and 6.2 inches long. Both pedestals are now set up on the above-mentioned piece of flat iron, in the positions they are to take afterward; and they are so arranged that the axle, viewed from above, runs parallel with the long edges of the iron plate. If the pedestals are too crooked, this cannot be done; and one loosens the screws at proper places and puts in a sheet iron shim on one side. When everything is right, the fastening holes are bored in the iron plate, proceeding from the holes in the pedestals. After tightening all the screws, the axle must be able to turn freely in its bearings.

The Nipkow Disc

On the perfect production of the Nipkow disc depends, to an extreme degree, the quality of the pictures obtained. Therefore we shall describe herewith a method of manufacture, the exact pursuance of which should certainly result in good accurate discs.

First the material: the writer used hard-rolled sheet aluminum .008-inch thick. When purchasing it, be careful to see that it lies as flat as possible. By using such thin metal one ensures that the never-entirely-flat plate draws itself into a flat plane when revolving. Thicker metal, on the other hand, must be made flat beforehand with a well-polished hammer. One proceeds very carefully with the plate and avoids any dents. The round disc, drawn a 0.1-inch or more larger than necessary, is cut out with shears. For holding this disc we use two somewhat smaller aluminum discs .06-inch thick, which must also be good flat and true surfaces.

All three discs are held together by means of six screws, with the aid of a hub made in two halves, which is shown in Fig. 3. When screwing the assembly together, pass the axle through the two halves of the hub and the discs. The hub is fastened to the axle by two screws. A smaller grooved disc, made as is expedient, is then screwed fast to the axle, and the entire arrangement is set up by means of the two pedestal bearings on a fairly large board, ready to rotate. It is then connected with the driving motor (see Fig. 5), which is also fastened upon the board, by a suitable leather, spiral, or rubber belt.

Balancing the Disc

Now we will turn the disc round and make it perfectly balanced. For turning off the outer edge, use a hand tool, such as that shown in Fig. 4. This consists of a tempered piece of steel of square cross-section, whose surface, as shown, is smoothly ground off *obliquely*. In a pinch, a screwdriver may be ground sharp for this purpose. Before beginning the work we fasten, as a support for the tool, a block of wood, a box, or something

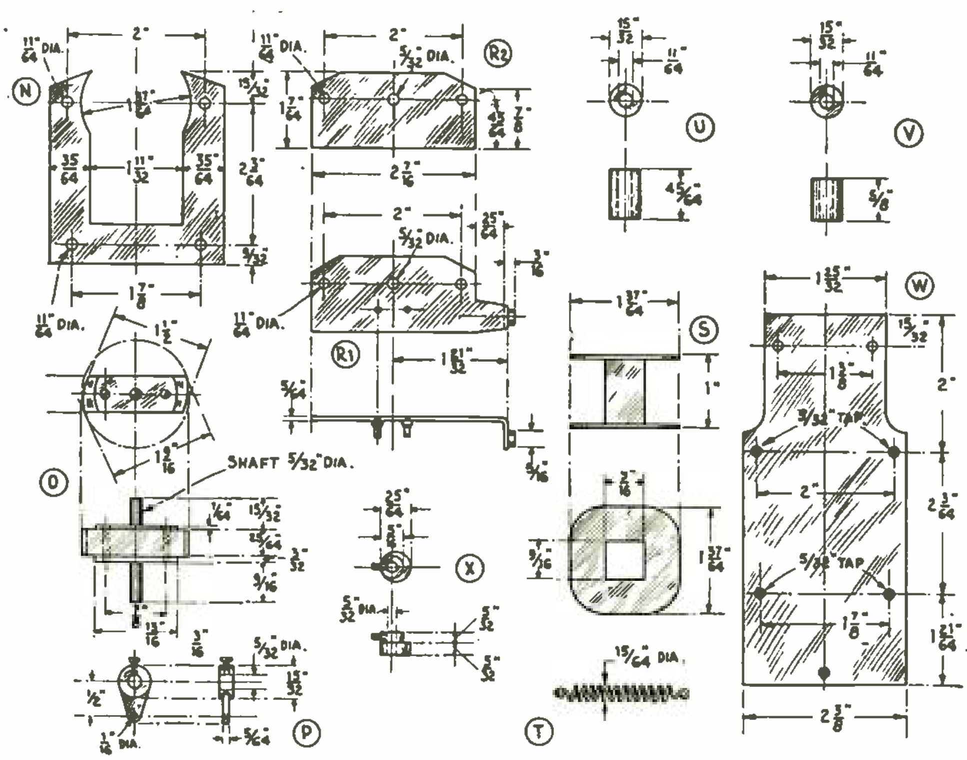


Fig. 7—Details of the various parts used in building the magnetic brake mechanism, which acts to steady the speed by alternately releasing and applying friction brakes to the brake drum attached to the scanning disc shaft.

similar sideways toward the disc in such a way that the support is as nearly as possible at the height of the axle and is only a few hundredths of an inch away from the edge of the disc. The whole arrangement is shown in Fig. 5.

By means of the motor the disc is now made to revolve as rapidly as possible, in such a way that the edge of the disc runs from above toward the edge of the tool. Now one brings the tool nearer to the disc in a radial direction, holding it very firmly and pressing it somewhat against the support. As the tool touches the disc, long turnings or curls of metal fly up; while at the same time the velocity of revolution of the disc is greatly reduced. After a short pause, during which the speed of revolution again increases, the tool is again moved against it, until the edge has become uniformly smooth. Then, with the motor at rest, we remove with a file the pronounced "wire edge" from both edges and polish these round, with the motor running, by means of emery paper.

Now our disc presents a very neat appearance, but probably at a rather high number of revolutions it will show very great unsteadiness; because the center of gravity lies outside the axis of rotation. We must balance it. For this we leave on the axle only such parts as will in any case remain there; thus, perhaps, the grooved disc but not the driving belt on it. If the disc is left to itself, it will adjust itself to some position; and in fact one place will probably always be at the top. This we must find accurately, and weight the disc there by fastening on little pieces of sheet metal by means of paper clips or similar means which are at hand; until the disc, revolving easily, comes to rest in any position. Near the edge of the side discs of thicker sheet metal, there is bored along the same radius an 0.16-inch hole and in it is fastened a screw which, in case its own weight is not sufficient, holds some little discs of metal. The total weight of the screw must (because of the smaller radius) be greater than the balancing weights used at the outer edge of the large disc; and the disc must again be balanced by turning off or filing off parts, until it again stands still in all positions.

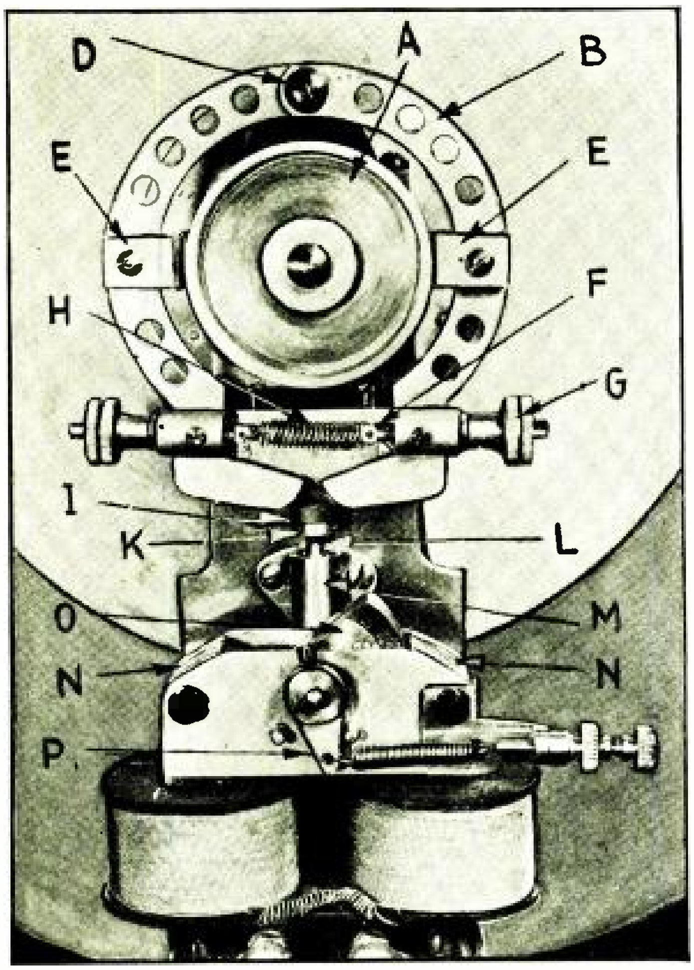
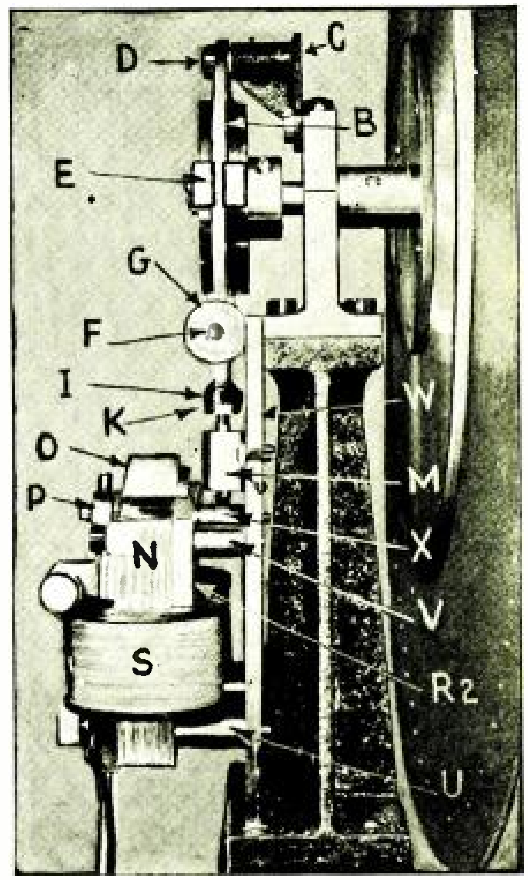


Fig. 8 — Close-up view of the magnetically operated brake system, which tends to "brake" the scanning disc shaft whenever the speed rises above the prescribed limit.

Fig. 9—Sideview of the magnetically operated brake, which serves to maintain the scanning disc speed at a constant value.



Making the Holes

Now comes the chief problem: *making the holes.* For this there are various methods, *i.e.*, one can first bore the holes much larger than they are to be finally, and reduce them correspondingly by covering them. The writer bored the holes the right size at first and this method is to be described here.

First we need a basic line, on which the division is then undertaken with compass and ruler. As basic line we use the circle described by the outermost hole; in our case, therefore, with a radius of 8.50 inches. We leave the disc on its pedestals, and move the support used in turning off the edge around, in such a way that it stands at the right in front of the disc as close as possible. We mark on the support the place which corresponds to the end of the radius. The disc is then again brought to rapid rotation, and a very sharp *brass* needle is placed exactly on the marked point on the support, as nearly as possible parallel to the axle, and is pressed quickly, accurately, and strongly against the disc. There results a rather thin but exact circle.

Checking the Holes

Now we take the disc out of its supports (without, however, unscrewing the hubs and side discs) and divide this circle into sixty (60) exactly equal parts.* Draw at each division point a short radius, and begin on these radii to mark the points for the holes, using for this a very exact scale (steel tape). The first center point comes on the previously-drawn circle: on the next radius it lies .012-inch further inward, etc. Measuring is always done from the circle. For marking use a sharp needle with good

* The dimensions given in the above data are for a 5 to 6 ratio, latest style scanning disc, the image being 0.890-inch long by 0.738-inch high, or 60 x 72 elements.

light; for great exactness is needed. The centered holes are bored with a .012-inch steel drill (small drill—No. 80—emery-papered down to size as measured by a micrometer). Then the burr is removed, so that the aperture is free. The disc is again tested in its supports and is rotated and looked through. (Put a bright lamp behind it, with as dull a ground glass as possible, and shut off the side light somewhat.)

Now we see the image of the lamp, with many dark streaks of greater or less width crossing it. If narrow bright streaks are visible between the holes, then our work was very inexact. By means of a small square needle file, we now begin to file the holes square, one at a time, using our steel support as a guide. Be careful in filing! Do not file out too much! Every time a hole is ready, we let the disc run to see whether the dark streak between this and the next hole has disappeared; then we go on to the next hole, etc. By this method one gets a uniform pictorial field, in spite of the hand work. Should bright streaks be present, they can (if they are not too wide) be removed by making the holes between which they occur slightly smaller by light hammering. When all the holes are done, we carefully remove the burr; in this process a cork with a small piece of emery paper glued to its flat surface does good service. With this one smoothes every hole on both sides. The disc is now completed and can be lacquered dull black on the band where the holes are located. After the lacquer is dry, do not forget to clean out the holes!

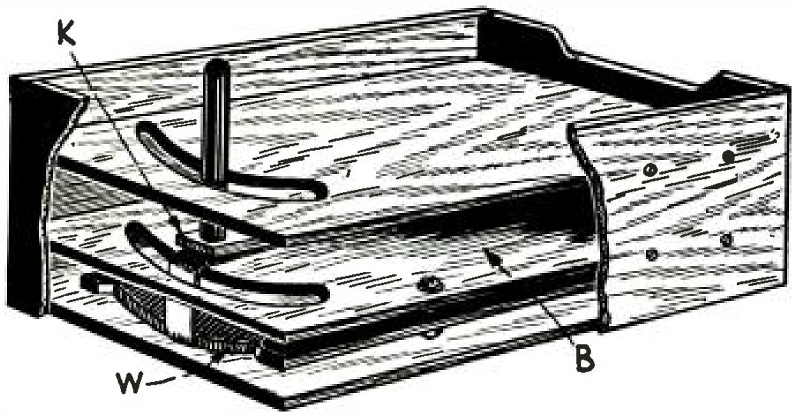


Fig. 10—View of the brake motor control rheostat, W.

The Speed Regulating Brake

The parts belonging to the brake are drawn in Fig. 6 and can be made according to this. At the same time, heed what follows: The braking drum A must have its circumference good and round. The braking levers B, which are made out of 0.12-inch sheet brass and have 6 holes each to lighten them, must be easily moveable radially but not at right angles to that direction; the neck screw D must therefore be well fitted. The part C, to which the braking levers are screwed by means of D, is fastened by two other screws to the upper part C of the forward pedestal bearing, in such a way that the distance from the center of the axle to the center of screw D is 1.4-inch. F is an 0.16-inch threaded pin with a small eye at one end, and a groove along its whole length; into which a small screw projects and thereby prevents the threaded pin from turning. The nut G belongs to it.

Part E represents the real brake shoes; they have glued on the upper side a little piece of chamois. Into each of the two levers B is screwed a braking shoe, slightly moveable radially. I is the brake cone with its counter nut K. Both are placed on pin L, which can be moved in the holding piece M.

The Braking Maget

Fig. 7 shows the parts belonging to the braking magnet. N is the sheet metal cut-out for the magnet core; it was cut out of an old transformer core.

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With a thickness of the individual sheets of say .014-inch, one then needs 38 pieces. The round part for the armature is, if possible, to be turned; the packet of previously worked sheets being tightly screwed together and fastened to the face-plate of a lathe. The coil body belonging to the core is shown in position S. Making such coil bodies might well be familiar to the amateur, so I shall not go into details. Each coil is wound with at least 2,000 turns of .0097-inch diameter (No. 30 B & S) enamelled copper magnet wire. At O is represented the armature, arranged in movable fashion in the curved part of the magnet core; it contains 27 pieces of sheet metal. It has also at the front side, an .04-inch brass end-plate and at the back side one of .10-inch. In the latter are also cut the threaded holes for holding the laminations together; while in the front .04-inch plate the screw-heads are countersunk. The axle of the armature is 0.16-inch thick and fastened very firmly and with very special care in the armature assembly. This might best be done with a .04-inch well-fitting conical pin, which is bored edgewise through the 0.10-inch end-plate.

The bearing plates are represented by R1 and R2; R2 is the rear plate and R1 the front one. The latter has also a small arm with a little socket, which contains a smooth 0.12-inch hole for receiving a screw 0.12-inch long (not shown) with a set screw. This screw has in front a small hole for receiving one end of spring **T**, which is then set by turning the set screw. Furthermore there are on the front plate R1 two little fixing pins, for lever P, which, however, are best drilled for at the end. Lever P is fastened to the axle by a little 0.12-inch steel screw. After one has found the right position for the lever, the axle must be drilled a little at the proper place; for this lever too must not come loose later.

Translating the rotary motion of the armature into the vertical motion (which pin L [Fig. 6] must accomplish) for moving the brake shoes, is done by means of the little eccentric X, which is fastened on the rear end of the armature shaft (*i.e.*, opposite to lever P) by means of an .08-inch steel screw on which one end of pin L lies. The entire magnet assembly described is screwed to plate W by four screws, 1.52-inch long and 0.16-inch thick. The spacing cylinders U and V being put between the assembly and the plate; V is for the upper holes and U for the lower ones. At the same time, the two bearing plates R1 and R2 are fastened by the two upper screws. Then plate W is screwed to the middle piece B of one of the pedestal bearings, on the side where the parallel piece *b*1 is located. This is done by two 0.14-inch screws at the top and one .08-inch screw at the bottom; the heads of the screws are countersunk. If the pedestal bearing is made as in Fig. 2, plate W can be dispensed with; since the parts can be screwed directly to the pedestal.

For the armature O it is specially to be noted that the end surfaces are not arcs of a circle but are *backed off*, as is shown in the drawing. Fit the armature first into the magnet core in the usual fashion, and then remove the material at the places in question with a file.

Figs. 8 and 9 contain details about assembling, etc. Fig. 8 shows the braking mechanism from the front and Fig. 9 from the side.

The Speed-Regulating Resistance

This is in the box drawn in Fig. 10; the upper part of which is covered with cloth (velvet, billiard cloth, etc.), and into which one can conveniently put the hand when operating the regulating resistance. The box has inside it an extra panel B, in which is fastened the bearing screw L for the crank (Fig. 11). The resistance W is screwed to the under side of B. This resistance consists of an insulating strip ¼-inch thick, shaped like W in Fig. 11. The plate is wound carefully with wire having enamel or other insulation. The total resistance is to be as great as possible. In using constantan wire (nickel alloy) of .006-inch thickness, there results a resistance of about 1,200 ohms.

Begin the winding at one side, wind to the middle, and fasten the end of the wire. Then wind the other half from the end to the middle, and connect the two wire ends there by soldering. The two outer ends are joined to the two screws R1 and R2. The individual windings must lie perfectly smoothly on the polished surface at H and are cautiously scraped bare at this place.

The parts belonging to the contact arm are seen in Fig. 11 also. See that the sliding spring F gives good contact, without pressing too hard on the windings. In screwing the resistance to the sub-panel, which is removable for this purpose, put some insulating washers between the actual bottom and the resistance; so that the winding lies perfectly free.

The Driving Motor

The choice of the right motor is of the greatest influence on the operation of the set. Detailed experiments have been made with various motors. In the competition, the set ran with a so-called "universal" motor (series motor, operating on A.C. or D.C.), such as is used for running sewing machines. It later became evident that this kind of motor is very unsuitable for this purpose; since the number of revolutions could not be kept constant. There proved to be pre-eminently suitable a small, single-phase, induction motor with short-circuited armature (repulsion type). These motors run synchronously with the network current but, in contrast to the ordinary synchronous motors, they start automatically. Unfortunately, they cannot be regulated by a rheostat resistance; which, however, in our case, does not mean much. One finds approximately the correct number of revolutions by trial, turning off one of the grooved discs used until, with the brake set loosely, about 1,200 revolutions a minute are reached.

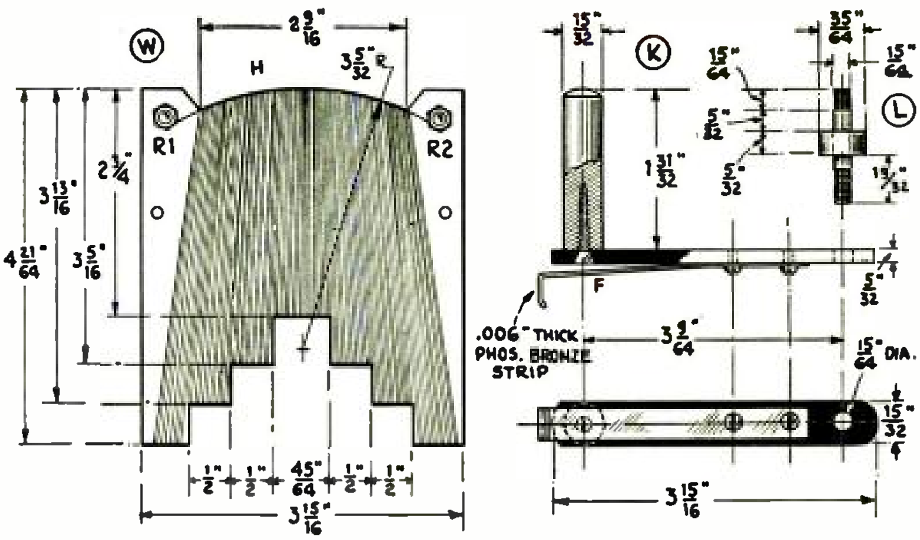


Fig. 11—Shows details of the magnetic brake control rheostat, W, the resistance wire being wound around the form "H".

Assembling

As a base-board for the set a board (wooden) 20 inches long and 12 inches wide, with a thickness of 1 inch, is used. On this we screw the iron plate with the two pedestal bearings and the Nipkow disc. How the braking device is fastened to the front pedestal may be seen from the first illustration (the unnumbered photograph). Behind the disc, the driving motor is screwed to the plate. In front at the right are the switch and a variable resistance, in case a commutator motor is used for operation.

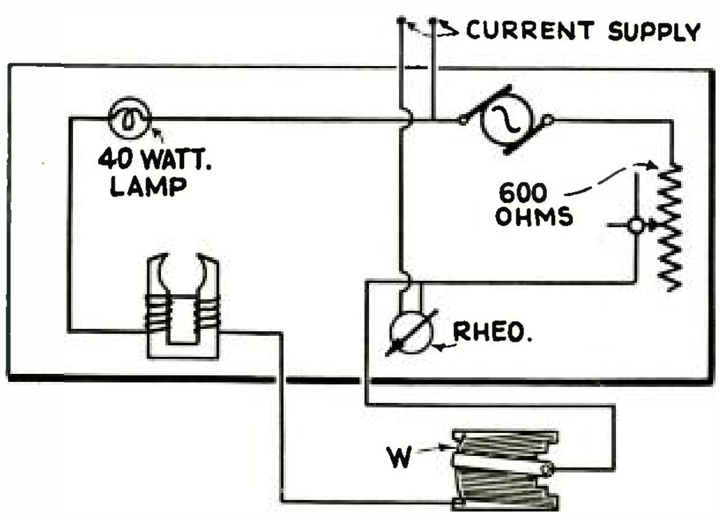


Fig. 12—Hook-up of the magnetic brake control rheostat. W, which is in series with the "magnetic brake" and a 40-watt lamp. A 600-ohm adjustable rheostat is connected in series with the main driving motor, while a third variable resistance (rheo.) of 100 ohms or so is connected in series with the second current supply wire.

Great stress is to be laid on a proper driving belt. Best is a rubber cord without any place to cause shock (*i.e.*, no rubber ring), 0.16 to 0.2-inch thick; also a spiral cord can be used. With the usual thin leather belts the joining of the two ends generally causes little shocks, which keep the picture from being steady; avoid making the belt too tight.

The hook-up is given in Fig. 12 and should be understandable without further comment. In the circuit of the braking magnet there is also a 40-watt rheostat lamp. The box with the regulating resistance is connected to the baseboard by a cord 3 to 6 feet long. At the side, close behind the disc is a 0.40 to 0.48-inch iron bar, fastened securely, which projects slightly above the disc. At the upper end of this bar, which serves as a stand, there are clamped by means of the usual supports a little picture window and the receiving neon lamp; as may be seen from the photograph. The pictorial window is 0.72 by .886-inch and is made out of a small board. To shut out light from the side, a black cardboard screen is placed around the window opening. The glow-lamp, which is close behind the perforated disc, has its two prongs inserted in a small socket, which is held by the support clamps.

Operating Adjustments

The spring T, which holds armature O fast by way of lever P, is so stretched that lever P lies firmly against the right contact pin. Now armature O, as is seen in Fig. 8, must be turned out of the magnet poles. Eccentric X is then so set that, on a turn of the armature to the right, it raises pin I and presses the brake levers outward. Now one switches the exciting current for the magnet on in full, so that the armature is drawn into the magnet poles, whereby the levers B are moved outward. In this position, the brake shoes are moved

(*Continued on page* 235)

TELEVISION DIGEST

David Sarnoff, President R.C.A., Discusses Television

At the annual meeting of the stockholders of the Radio Corporation of America, held May 5th, 1931, in New York City.

Any discussion of future opportunities in the radio field must naturally include *television*. In this connection I would call your attention to the full and frank statement of the situation made in our Annual Report. (*Published elsewhere in this department.—Editor.*)

Important forward strides are being made with television. In our development work now proceeding at Camden we are seeking to perfect television to a point where it is capable of rendering real service before offering it to the market. While the public was willing, and even eager, to experiment with radio in the early stages of broadcast development, it seems to us that it will desire a comparatively more advanced television receiver than the early crystal radios. There was no precedent for the taking of sound and music out of space, but the public has been educated by the motion picture i dustry to expect picture transmission of a high quality, and it is doubtful whether interest can be long sustained by inferior television images.

The progress we have made so far has given us the belief that ultimately a great service of television can and will be made available. Because of our present and past efforts in this field of research and development I feel that the position of the Radio Corporation both as to patent rights and technical facilities is promising. I do not believe that television will supersede sound broadcasting by radio. It will be a correlated industry. Television promises another great industrial development, but to assure this, we cannot disappoint the public and defeat the possibilities of a future great service by hasty and premature action at the present time.

Television Popular In 10 Years, Says Dr. Compton

In ten years television may have achieved the stage of popularity now enjoyed by the radio, Dr. Arthur H. Compton, Nobel Prize physicist, of the University of Chicago, said recently in an address before 2,000 persons at the College of the City of New York.

The distinguished physicist said that while there is nothing essentially impossible about the development of television, tremendous problems must be overcome before it is likely to provide public entertainment on a large scale.

A new principle is needed, Dr. Compton told his audience, and suggested that scientists now working on the problem might "utilize bands of different frequencies to get more detail in television pictures than by using a single wave or frequency, as is generally done at the present time."

The photo-electric cell is bound to play a leading part in any successful development of television, Dr. Compton said.

Barthelemy's Television Demonstrated

A French television system—that of M. Barthelemy—excited some interest when demonstrated a few days ago at the Electrical High School at Malakoff. According to our Paris correspondent, moving images from a studio at Montrouge, a mile and a quarter away, were picked up on an "Isodyne" receiver and gave a luminous picture 12 x 16 inches, in a well-lighted salon. The image was described as "jerky and uncertain," but plainly discernible to those immediately in front.—"*Wireless World.*"

French Television Rights

Pathe-Natan, interested in radio broadcasting, has now incorporated as a subsidiary the first French concern aiming at the use of television. The concern is named Baird-Pathe-Natan and holds the French rights to the English Baird processes.

The idea seems to provide for future developments in the new field, since from the announcement there is apparently no intention of operating immediately.—*From "Variety."*

First Television Tea

The first Television Tea in social history was held recently simultaneously at the Bell Telephone Laboratories, 463 West Street, and Telephone Headquarters at 195 Broadway. Appropriately, the guests were members of the Engineering Woman's Club, some forty of whom were present at each place. One by one, they were called from the tea-table to the television booth. Face to face, although some three miles apart, they could see each other clearly while they talked. Since the conversations had all the privacy of a telephone call, it could not be learned whethe the talk was of slide rules and cosines, or whether it was merely on such subjects as women usually discuss at afternoon functions.

Mrs. Frank B. Jewett was hostess at the downtown gathering, and Mrs. Harry P. Charlesworth was hostess at the Laboratories. Mrs. George D. Barron is president of the Club.

General Harbord Sees World Parleys by Television

A prediction that corporation boards of the next generation, members of which are in various parts of the world, will be holding meetings by *television* was made recently by General James G. Harbord, chairman of the board of the Radio Corporation of America, at a joint dinner of the Cleveland Engineering Society and the National Industrial Congress.

General Harbord, speaking on "In Years to Come," outlined the most recent progress in the field of electricity, particularly radio. "We often hear people speculating as to what men will do with electricity," he said. "I am looking at the other side of the question and making some suggestions as to what electricity will do to men during the next few years.

"As we now have the combination radio and phonograph, we shall eventually have a combined radio, phonograph, sound picture projector, facsimile and *television receiver*, a sound recorder and an electrical piano or other purely electrical musical instrument.

"Living rooms will soon be built with an eye —or perhaps I should say with an ear—to acoustics. Interior decoration will provide an effective but unobtrusive screen for the picture paneled in the wall, if this is desired. Architects in designing homes will specify the wiring to receive and carry the necessary currents.

"A great corporation, whose directorate is scattered across the continent, suddenly needs a meeting of its board of directors. Buzzers buzz, wires hum and bells ring in a dozen distant cities. The call goes out. The hour is named. Switches are thrown and at the appointed time, say perhaps an hour after the call was issued, a quorum is assembled by electricity and called to order by the chairman. To each man, as he sits in the quiet of his own office, comes in turn the voices of his fellow directors. Discussion is carried on with the same ease as if they were all gathered around the table in the same board room. The discussion ends, the motion is put and carried. The secretary types it, and a copy is flashed to every member involved. Each affixes his signature after verifying what he has heard and now sees. The facsimiles, with various signatures affixed, are flashed back to the chairman, and the board of directors adjourns."

Television—From the R.C.A. Annual Report

Television has been brought definitely nearer to commercial development by the research and technical progress made by your Corporation during 1930.

Public interest in the new service promised through sight transmission by radio, and the new industry which the manufacture of television sets for the home now brings into view, requires a precise statement with regard to these developments. It must be recognized at the outset that while intelligence may be transmitted through either the ear or the eye, the services which radio may render through sound and vision do not compete with one another. Each has its peculiar and distinct function.

Sound broadcasting, upon a continually rising scale of public interest, is still engaged in developing its major possibilities. Similarly, the sound equipment industry continues to be subject to further development technically and industrially. Sound broadcasting and sound reproducing equipment constitute a distinct division of the radio art.

While television during the past two years has been repeatedly demonstrated by wire and by wireless on a laboratory basis, it has remained the conviction of your own Corporation that further research and development must precede the manufacture and sale of television sets on a commercial basis. In order that the American public might not be misled by purely experimental equipment and that a service comparable to sound broadcasting should be available in support of the new art, your Corporation has devoted its efforts to intensive research into these problems, to the preparation of plant facilities and to the planning of studio arrangements whereby sight transmission could be installed as a separate service of nation-wide broadcasting.

It is felt that in the practical sense of the term, television must develop to the stage where broadcasting stations will be able to broadcast regularly visual objects in the studio, or scenes occurring at other places through remote control; where reception devices shall be developed that will make these objects and scenes clearly discernible in millions of homes; where such devices can be built upon a principle that will eliminate rotary scanning discs, delicate hand controls and other movable parts; and where research has made possible the utilization of wavelengths for sight transmission that would not interfere with the use of the already overcrowded channels in space.

It may be stated at the present time that your Corporation made further highly important progress in 1930 in scientific and research development along these lines. Radio Corporation of America will pursue this development aggressively in the laboratory during 1931, without attempting to market such equipment commercially this year. Progress already made gives evidence of the ultimate practicability of a service of television and the position of your Corporation in this new and promising field, both as regards patent rights and technical facilities, is such that it may anticipate new and broader service opportunities.

PILOT LAMPS As An Aid In Synchronizing

By CLYDE FITCH

This synchronizing aid utilizes a neon pilot lamp excited by a current having the scanning hole frequency; the pilot lamp is placed behind the disc.

WHERE automatic synchronization is not available, considerable difficulty is experienced in getting the scanning disc at the receiver to run in step with the one at the transmitter. Often, the image will flash into its full mystic brilliancy, only to disappear again and never be found for the rest of the evening. The operator does not know whether the set is operating properly or whether the disc is out of synchronism. And, in changing the motor's speed, synchronism may occur when they are changing scenes at the transmitter; and no image will be seen. Some experimenters have spent many hours adjusting the apparatus, only to see a single flash of the image gliding into and out of view.

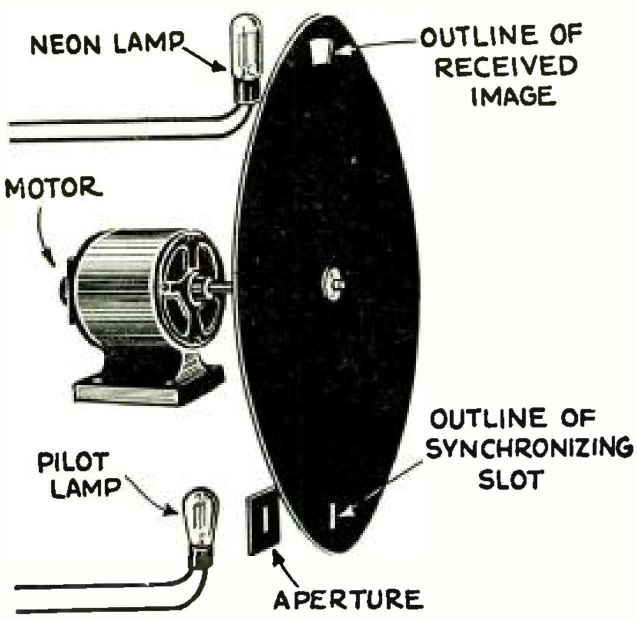
By means of the pilot lamp illustrated, it is possible to determine whether the disc is in or out of synchronism, and to make adjustments accordingly. Thus, one variable factor is eliminated. Knowing that the disc is in synchronism, if no image is received, further adjustments can be made on the set. This device does not hold the disc in synchronism; it merely indicates when synchronism is obtained, and is a great aid when manually holding the disc in proper speed.

In the received television signal, there is a predominant frequency, determined and produced by the scanning holes passing by the image. Thus. in a 48-15 disc, there would be 48 times 15, or 720 holes per second passing by the image. This produces a strong 720-cycle component in the television signal.

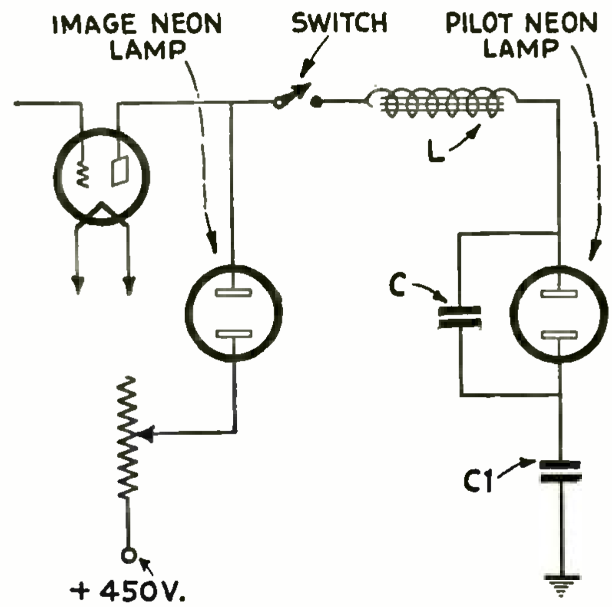
By means of a filter circuit, this frequency may be separated from the main signal and applied to a small neon pilot lamp; and the lamp will therefore flash 720 times per second.

On placing an aperture in front of the lamp, and placing the whole behind the scanning disc, in the position shown, every time a hole passes over the aperture, the lamp will flash, provided the disc is in synchronism. Thus the aperture, which should be as long as the height of the image, and not much wider than the scanning holes, will stand out in full brilliancy when the disc is in synchronism. When it is out of synchronism, the lamp will flash between two scanning holes, and the pilot light will not be visible. Thus, the operator should first adjust the speed of the motor until the pilot lamp is visible through the aperture, and then adjust the set for a clear image. It is possible that, with the discs running in step, the image will be out of frame. For this reason, the pilot lamp should be so mounted that it may be moved in the direction of rotation of the disc or in the opposite direction, and the speed of the motor slightly altered, until the image is in frame and the pilot lamp also visible.

There are various ways of connecting the pilot lamp. In the diagram, it is shown connected across the main neon lamp, through an inductance coil L, which allows the 720-cycle current to pass through but blocks out higher frequencies. The condenser C allows any higher-frequency currents that might get through the coil L to pass by the pilot lamp without affecting it. C1 is a stopping condenser.



Arrangement of neon pilot lamp behind scanning disc.



Circuit connections of neon image and pilot lamps.

It may be necessary to place a variable resistor across the pilot lamp also. When proper adjustment is obtained, the pilot lamp will light only on the 720-cycle component of the signal. Should any other component of the signal operate the pilot lamp, the lamp will be visible even though the disc is out of synchronism; varying the motor speed will not cause the pilot lamp to disappear, and the operator will immediately know that the pilot lamp is not connected or adjusted properly. When properly operated, the pilot lamp will be visible only when the disc is in synchronism, and a slight change in motor speed will cause it to disappear. A switch may be used to disconnect the pilot lamp after synchronism is obtained, if desired; then it will not rob the image lamp of any of its brilliancy.

MAKING and Testing Nipkow Discs

By R. SCHADOW

The scanning disc is a much abused part of the modern television apparatus—you will learn some new things concerning it from Mr. Schadow's informative article.

OF all present television scanning systems, the Nipkow disc and the glow-lamp on the receiving side undoubtedly offer the simplest and therefore cheapest arrangement. One can therefore expect that for the present, there will probably be no radical change from it; and it remains particularly for the young television amateur rather than the television industry to improve what we already have, instead of adding a new scanning device to the already considerable number of known and more complicated systems.

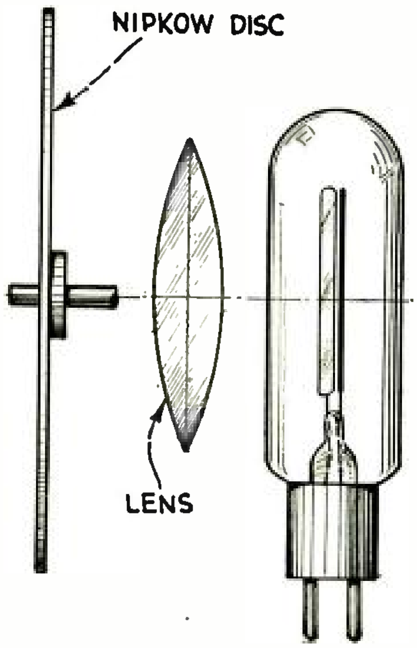


Fig. 1. Lens arrangement magnifying the plate of a glow-lamp, for disks of rather large diameter.

The Nipkow disc with its spiral of holes is the chief part of our televisor. At first sight, its manufacture seems the simplest conceivable thing; and the many instructions for making it, presented in the technical journals, show plainly that an effort is being made in every conceivable manner to obtain, on a convenient and cheap basis, what may be regarded as the ideal—with more or less success.

Let us consider what requirements we should demand of a good scanning disc, and how far these can be fulfilled with the means possessed by the average amateur:

(1) Exactness of the angular division;

(2) Uniform distance between the lines;

(3) Proportionate distances between the lines;

(4) Proportionately square holes;

(5) Slight depth of holes.

Size of Image Depends on Disc Diameter

In making a scanning disc its diameter is optional, if the holes are arranged in the proper relation; only the size of the image is governed by the diameter. Here there must be, unfortunately, a compromise. The desire for as large a television image as possible involves increasing the diameter of the disc, as well as the need of a glow-lamp with greater active lighting surface.

Then there is the added point, that a large pictorial field cannot be magnified so readily as a smaller one; *i.e.*, with a smaller disc and a proper lens, we can get the same image size as with a considerably larger disc and no lens. A disc diameter of 16 to 24 inches may be regarded as suitable; with the 24-inch diameter, there results, without the use of a lens, an image with an average breadth about 2.4 inches.

So far as I know, glow-lamps with such large electrodes are not manufactured. But one will easily get along by putting another magnifying lens between the glow-lamp and the disc (as in Fig. 1), when the illuminating surface will be correspondingly magnified. With ordinary spiral-electrode glow-lamps, the use of such a lens (or even two lenses) between the lamp and the transparency (sheet of ground glass, transparent tracing paper, or the like) is strongly urged, even with a smaller image. (See Fig. 2.) By this means, the light intensity of the glow-lamp, which is naturally not very luminous, is increased; while, above all, the transparency is illuminated with perfect uniformity! To be sure, the greater the surface to be illuminated, the less its illumination will be.

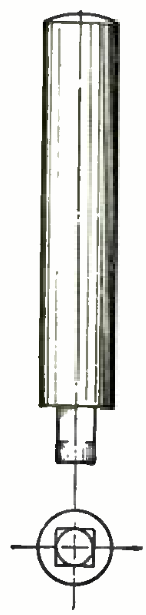


Fig. 3. Punch for square holes.

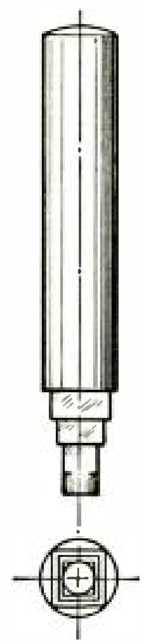


Fig. 4. Punch for square holes, with other punches each slightly larger (purposely exaggerated in the figure).

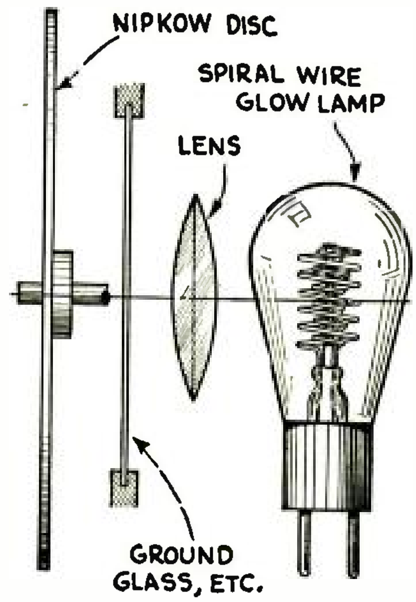


Fig. 2. Lens arrangement for ordinary spiral-electrode glow-lamp, making uniform the brightness on a transparent screen.

Not the least consideration determining the diameter of the disc will be the material used, especially its thickness. It must have the least possible weight; since, with a large diameter, both the friction and the centrifugal force will prove too great.

Exact Angular Division Important

The *exact angular division* of the disc is, unfortunately, not sufficiently heeded in most cases. But this is just as important, and perhaps more so, as the quadrangular form stressed in all disc drilling instructions. The more or less exact angular division determines the value of the whole disc. Inexact division spoils the impression of the entire image. But to divide a circle into 30 *exactly* equal parts with ordinary compasses is nearly a complete impossibility; for this one needs precision compasses with sufficient rigidity. And then a further error will arise in joining the points to the center point. How time-consuming this division actually is, at least when it is actually done with exactness, large discs causing more trouble than smaller ones, need be told only to those who have yet had no headaches about it. Most exact and dependable is division by means of a dividing apparatus. But, since this is seldom available for an amateur, he will do well, and inexpensively at that, to have the division performed in a mechanical workshop. Fairly large amateur organizations are perhaps in a position to get such a dividing apparatus and to put it at the disposal of their members.

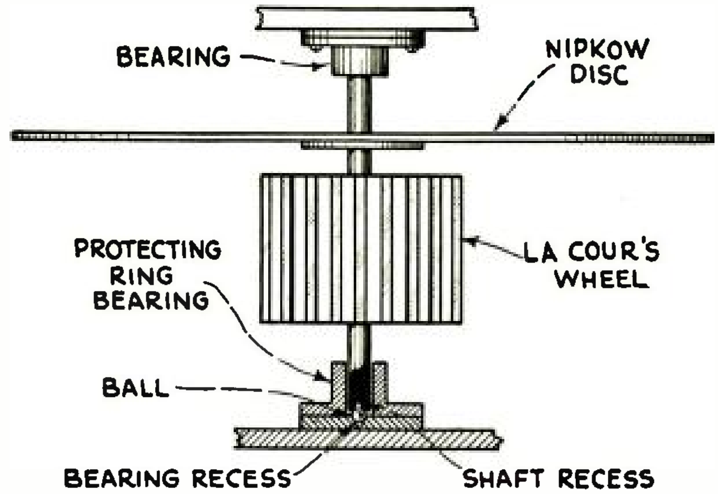


Fig. 5. Diagram of apparatus with Nipkow disc.

Laying Out and Boring Holes

I consider it similarly impossible to draw uniformly exact spaces between lines by means of a compass. But here a machinist's vernier scale is a great help; by using the vernier, it is not hard to get exact spaces and displacement during the drawing is also excluded.

The making of the holes themselves is apparently a delicate point. The circular shape certainly has a great disadvantage, especially with regard to the waste of light; but that this should cause parallel streaks in the pictorial field, as variously asserted, I have not been able to determine. In this case the holes must simply be bored just a trifle larger, to counterbalance somewhat, this failing produced by the incomplete touching of the scanning holes.

In practice this is best done by first boring all holes with a drill having the calculated diameter. With continued testing of the disc, in the usual manner, the holes can be now enlarged; using each time a drill .002-inch larger (the drills must be very finely ground, since otherwise they will push through), until there are no more parallel black lines in the pictorial field. Of course one cannot go too far; or bright lines will result instead.

Naturally, one cannot obtain the pictorial quality with circular holes that square holes give; but the former when well and neatly done will probably be better than the latter, if crude filing has produced holes of every shape but square. I certainly found it so, and I do not think anyone can make perfect holes by this method. Gluing on proper square holes on holes cut considerably larger indeed affords greater exactness and is convenient and cheap; but it limits one to cardboard as the material for the disc.

How to Make Holes With a Punch

To make a disc out of thin (.008-inch aluminum) sheet metal with perfect square holes, we make a stamp or punch (as in Fig. 3) of the exact size, and two or more slightly larger. For this we need several pieces of silver-steel wire about 2 inches long, on which are turned taps which go tightly into the holes previously bored. In addition to these, a four-sided piece exactly the size of the square holes or a few thousandths more, is filed. In Fig. 4, three punches combined in one are illustrated. Now the punch simply needs to be driven through, with a proper backing under the disc; with attention given to see that the sides of the square are parallel to the line of the angular division, or perpendicular to it. The wire-edge resulting is carefully removed with a fine file, and the punch is driven through until such an edge no longer forms. Then the disc is tested as above and, if need be, the holes are enlarged with the next larger punch.

The thickness of the disc (*i.e.*, the depth of the holes) has a not inconsiderable effect on the brightness of the picture; a deep hole will act like a chimney and cause a loss of light. Therefore, one should use only thin metal or countersink the holes as much as possible. Of course, this has to be done before using the quadrangular punch. One must also watch out to do perfectly even countersinking; since there will otherwise be an impression of pictorial elements of different sizes, and there will be a corresponding distortion of the image.

Testing the Nipkow Disc

Testing the Nipkow disc for exact linear spacing is sufficiently familiar. The holes in question must be worked on to eliminate single heavy black lines. To find faulty places more easily, one marks the height of the defect, when it is visible, during the quick rotation of the disc, with a narrow rigid piece of metal (.04-inch wide). Then, when the disc is motionless, it will be easy to find the hole in question.

Testing for equal angular spacing of the scanning holes is less familiar to the experimenter. It is done by putting a glow-lamp behind the disc, as in ordinary television, connecting to it an alternating-current source of constant frequency. One can use any regenerative receiver with two A.F. stages; this is brought into resonance with a second oscillating tube circuit. Or, still more simply, when (with the antenna shut off) the receiver produces a heterodyne whistle, of the lowest possible frequency, with a nearby station. With a definite high rate of revolutions of the Nipkow disc, a thick black vertical line becomes visible in the pictorial field. From this streak (presupposing *constant* frequency of the heterodyne and uniform speed of rotation) the exactness of the angular division can be directly judged. If it is exact, the streak will show an even straight boundary on both sides. If it is not exact, the boundary will be more or less jagged; then the pictorial lines are displaced.

Mounting the Disc

In conclusion, I should like to say a bit about the mounting of the disc. In general, only ball bearings (small) should be used; the difficulty for the amateur always lies in procuring suitable, rigid bearings, which must also have proper openings for the shaft. But, in a simple way, a number of rectangular boards of fair thickness could be fastened together to make a base. First, two rather small holes are bored opposite each other for inserting a bit; then a wide cut is made with the bit at the height of the ball bearing, slightly less than its diameter. Now the hole simply has to be bored out with a proper sized drill; and we have a base to which the ball bearing is firmly inserted.

There is still more stress to be laid on a stable bearing, if the televisor is to be synchronized with the alternating signal current by a La Cour or "phonic" wheel; here a horizontal position of the disc is usually preferable to the vertical, since it is easier to balance its center of gravity. In that case, it is possible to do without ball bearings, by making grooves (as in Fig. 5) in the shaft on both sides. Then the bearing consists simply of a ball between the grooved shaft and a groove in the pedestal bearing. To avoid the danger of the shafts jumping out, the bearing is provided with a protective ring.—(*Das Funkmagazin.*)

A NEW MODULATED ARC

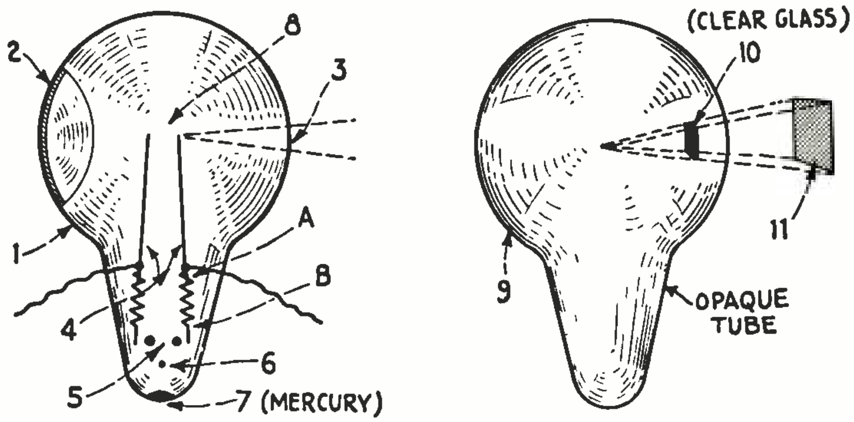
TELEVISION RECEIVER

By HENRI F. DALPAYRAT

A practical home television receiver giving a large image of great brilliancy is predicted by the author, thanks to his radical design of illuminant, involving a modulated mercury vapor arc.

IT may be safely assumed that, of all the scientific developments of our century, none have made such a tremendous appeal to the public's imagination as Television. To the average non-technical man the word "Television" gives the impression of an image reproduced upon a screen, like a moving picture. The scene is large, like a boxing match, for example; the details are clear and well defined; and a turn of a knob will "tune in" another station with a different picture.

Unfortunately, we are very far from having reached that stage of perfection with our present systems, and undoubtedly we would have to wait a few years more until this dream might become a reality. Unlike any other art, television can not be perfected rapidly. Knowledge, capital and skill are helpless to hurry the growth of this infant industry. The reasons are numerous as well as perplexing. Those stumbling blocks of television progress could be tackled in many ways or, possibly, entirely eliminated if the art were standardized; that is, if all improvements were successive developments of one original idea, which has been the case in radio. However, in television, nothing seems to have been standardized so far. The scanning disc (or drum) with neon lamp arrangement, on account of its simplicity and cheapness, has gained a wide popularity among experimenters who enjoy tinkering with this new, fascinating and interesting form of home entertainment. The results, however, are far from being satisfactory and are always a disappointment to the man who "looks in" for the first time.



New "Mercury Arc" television tube designed by Mr. Dalpayrat, the tube being opaque except for a clear glass window at 10. Fig. 1 at left; Fig. 2 at right.

The head-and-shoulders image produced by Neon lamp televisors are decidedly lacking in any entertainment value, especially when one has to sit for any length of time in front of the television, peeping through a hole and concentrating all his attention on a small, faint picture which lacks everything to make it interesting. The shadows are too dark and the details are very poor. The whitest person is reproduced as a full-blooded Ethiopian and, to make things worse, this picture usually vibrates up and down like the movies of twenty years ago; while a great number of dark lines continually shoot across the picture.

It is obvious that television in this present crude and undeveloped stage cannot be offered to the public who have been misled by exaggerated reports and prematured publicity. It is the firm belief of the writer that Neon tubes will be, to television, what the crystal detector has been to radio; just a stepping stone to be discarded as soon as something else superior is found.

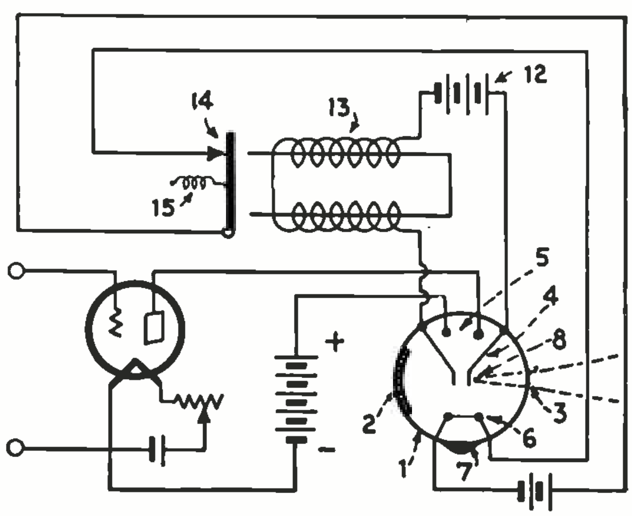


Fig. 3—This circuit shows special relay, 13, used to open the filament heating circuit when the "Mercury Arc" within the tube has been established.

Wanted—A Brilliant Light Source

The improvements badly needed at present are: First, a source of intense, brilliant modulated light to make possible the projection of a picture on a large translucent screen. Second, a scanning system as small and as rapid as possible, to scan, for example, at least 256 lines in one-twentieth of a second. In order to scan a 4x4-inch image, the size of the points or picture elements, in that case, would be 1/64-inch. The total number of points would be 256x256; and 65,536x20 (the picture frequency) = 1,310,720 or 2,621,440 modulated cycles per second at the transmitter.

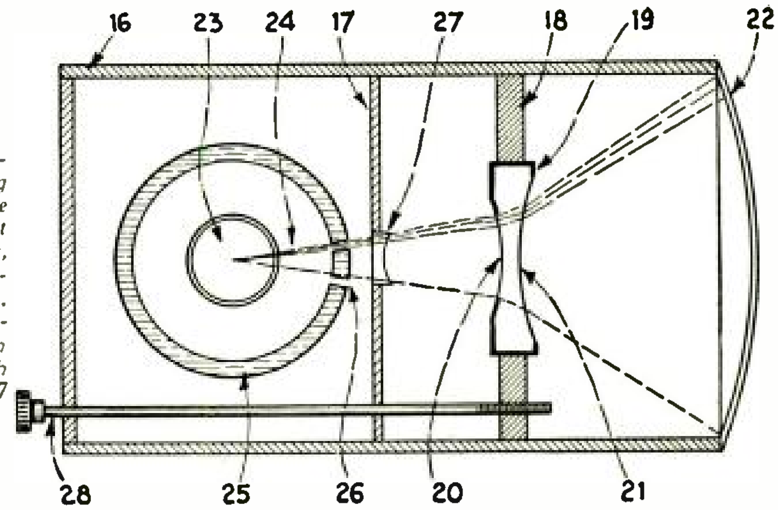
This 4x4 image could then be applied, by a magnifying lens arrangement, to reproduce an 8x8 picture on a ground-glass translucent screen. This signal frequency of 2,621,440 cycles could be transmitted on a wavelength of approximately 135 meters. This, however, cannot be accomplished by using the narrow channels now allowed and with our present transmitting systems, on account of the wide sidebands and their interfering action on other stations. (*Wavelengths be-*

low 10 *meters have been authorized for special wide-frequency band experiments.—Editor.*) According to the present Federal Radio Commission Regulations, wavelengths of 100 to 150 meters are allowed for television broadcasting; and it is the hope of the writer that shorter wavelengths will soon be allowed, in order to permit the transmission of larger images with finer details. This can only be accomplished by the use of more lines and therefore, more points, which can be accommodated by shorter wavelengths containing more cycles.

A Small, Fast Scanner Needed

The problem of a small and fast scanning device appears to be most important and difficult to solve. With a Neon lamp which has to be scanned line by line, with only one hole of the scanning device at a time crossing the surface of the lamp it is necessary to have a distance between each hole equal to the width of the Neon lamp. If 256 lines are to be scanned, as mentioned above, the scanning device ought to be 256x4 inches or approximately 85 feet in circumference, or over 27 feet in diameter! The absurdity of our present systems of scanning is evident. Fortunately, when a powerful, brilliant, modulated light is used, the beam itself can be scanned through a smaller angle; simplifying greatly the problem of the size of the scanning device as well as its speed, as will be shown later on in this article.

Fig. 4—One method of magnifying the scanning image in the Dalpayrat television receiver, employing a "Mercury Arc" tube, 23, scanned by a revolving perforated drum 25, together with special lenses 27 and 20.



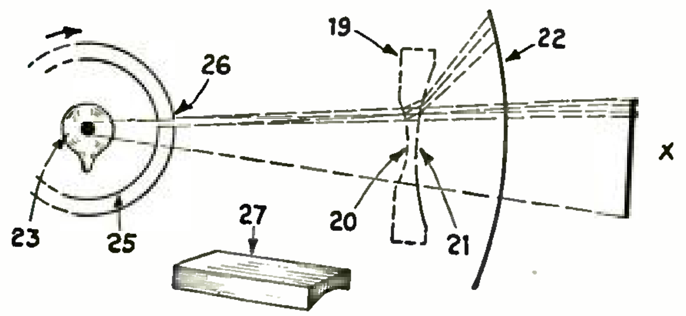


Fig. 5 — Diagram showing special bar lens, 27, and also method of enlarging the image through wide angle lens, 19.

A rapid recapitulation of the different well-known systems, up-to-date, will show, that at the transmitter end little indeed has been done in the form of improvement. The "flying spot" technique is still generally used. The scanning and illuminating are done at the same time by a narrow pencil of light, which covers thoroughly, line by line, the subject. The reflected light varies in intensity in proportion to the color or brightness (reflecting power) of each section of the subject which is covered successively by this moving spot of light. Those light variations are reflected upon enormous photo-electric cells which convert the light intensities into voltage variations; which are then amplified and transmitted. This system is often referred to as an "indirect transmission" system.

"Camera" Transmitters

In outdoors "camera transmitters" the subject is illuminated by daylight; the subject-picture is optically focussed on a scanning device, whose holes pass small beams of light which are directed into a single small photo-electric cell. This is known as the "direct transmission" system. Infra-red rays have also been used by Baird, in England, with good results; the subject being in complete darkness and scanned by those invisible "heat" rays.

In all those schemes, neon lamps and scanning devices are invariably used at the receiver and with such implements, the natural non-magnified size of the picture cannot be increased. This is due, first, to the small size of the Neon lamp; second, the limited number of holes in the scanning device, which cannot be increased without making it extremely large and therefore impractical.

As it has been shown in the above cases, we are then limited by so many uncontrollable factors that the future possibilities of the Neon tube and scanning-device arrangement are therefore very small, in spite of all the research work being done in this direction. It may be reasonably predicted that this system will become quite obsolete, as soon as a large source of intense modulated light is found.

Although several arc-light systems have been successfully demonstrated, from time to time, none of them could be practically used for home television reception. Mirror wheels are too large, too expensive and too delicate. The "light valve" or Karolus cell system of light modulation is complicated and inefficient; it has been found that the valve with its accompanying lenses and prisms absorbs and decreases the light intensity more than 45 per cent. The arc light itself is a great source of troubles such as flickering; it is unstable and needs constant care and adjustments, in addition to its consuming too much electrical power.

The Modulated Arc System

It is the opinion of the writer, that the new modulated-arc system, together with the new scanning device described below, will solve many of these difficulties and result, eventually, in the commercial production of a practical Home Televisor capable of showing a large image of fine details, wider view and greater brilliancy.

After a great amount of research and studies the writer has come to the conclusion that, in order to design a new system of light modulation, no mechanical motion was to be involved and that to reduce the losses of light, a very direct and short path had to be provided for the modulated beam of light.

In contrast to all the other systems previously used, the present system now described consists of modulating the arc itself. This is quite an innovation in the field of light modulation. Of course, it is well known that a magnetic field can deflect an arc, but in television, where the signal has to produce at the receiving end changes of light intensity, corresponding to voltage variations, at frequencies from perhaps 10 to 40,000 cycles or more, it is nearly impossible to design any form of electromagnet which will give an even response to all those frequencies. If an electrostatic field is to be used, extremely high voltages would be necessary and other serious complications would follow, without mentioning the poor results. The ordinary '45 power tube, as used now in the majority of radio receivers, does not deliver enough power output to oper-

(*Continued on page* 223)

A Mechanical Jig *for* LAYING OUT *and* PUNCHING DISC HOLES

A simple yet highly effective method of laying out the holes in a scanning disc is here described; also hints on how to construct a hole layout and punching jig.

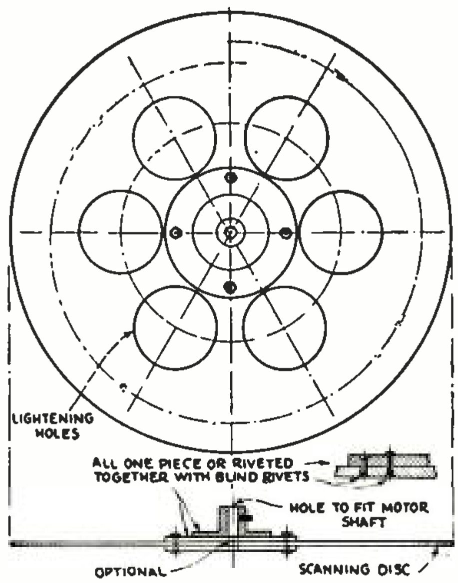
THE material best adapted to the construction of a disc is probably aluminum; but non-metallic materials such as hard rubber or opaque celluloid may be used. In this regard it is necessary to observe, that because the surface of the disc must be absolutely flat and uniform, it is necessary to utilize a resistant material of a certain thickness, which will not undergo a change of form while being worked. Otherwise, we must employ thin sheets of yielding material, such as ebonite or celluloid; in this case making use of the centrifugal force developed in the rotation to smooth it out into a perfect plane. Opaque celluloid (black) .016 to .020 inch thick would be preferable from that point of view; but it is very hard to work, especially as regards making the holes.

Thin aluminum is therefore preferable. There should be selected a sheet of crude aluminum .010- to .012-inch thick, very smooth, free from dents, and somewhat larger than the disc to be made; in order to use the central part of the sheet, which is usually freer than the edges of chance defects.

Marking the center of the sheet, draw with compasses a circle marking the outer edge of the scanning disc, also the six holes for lightening the disc. Then, using a pattern if necessary, draw the 60 radii, running to the center of the disc and separated by angles of 6 degrees. This drawing must be done very exactly, using good dividers and a large needle for drawing the radii; which need be done only near the edge of the disc, in the ring which is to contain the holes for scanning the image.

Take any one of the radii and mark on it a point the proper distance from the edge of the disc, which is to be the position of the first outer hole.

Now cut the disc from the sheet and afterward cut out the six holes for lightening it; using for this purpose a keyhole saw, to avoid the possible deformation coming from the use of scissors or such things.



A practical design of television scanning disc and hub support members is here illustrated. Note the holes cut in the disc to lighten it, where a small motor is to be used.

The design also gives the dimensions of the hub for connecting the disc with the motor. This hub, of brass or aluminum, which can be constructed cheaply by any lathe-operator, is connected to the disk by eight rivets or eight small screws. The holes for fastening the hub are first made with a drill, taking good care that the center of the disc coincides perfectly with the central hole in the hub. If necessary, determine the diameter of the hole, which must be exactly equal to the diameter of the shaft of the motor at your disposal; and make the holes separately in the hub and the disc.

Making the holes is the most delicate operation and is rarely a perfect success, unless the holes are exactly as they have been laid out on the disc with compasses and an accurate scale. Whenever the holes are not placed along a perfect spiral, the image is streaked with light and dark lines whenever one of the holes either partly coincides with another in the revolution of the disc, or does not scan closely enough, in rotation, to the next hole. In drawing holes, say .012 inch in diameter, it is very easy to commit a slight error. Since the height of this spiral is only about ¾-inch, for 60 holes laid out on a spiral of 17 inches outer diameter, evidently passing from one hole to the next means shortening the radius just .012-inch. This is difficult, if not indeed impossible, to do exactly by hand, but it can be done with maximum precision by a mechanical screw or thread arrangement, similar to a micrometer. In particular, the radial difference of all the holes can be made uniform by using the movement of a screw of the proper pitch.

The arrangement and the application of the principle are shown in Fig. 1 and the detailed construction in Fig. 2, so simply as to be easily understood by everyone.

Fasten on a table or piece of very flat, hard wood, a peg or stud of diameter equal to the shaft of the motor on which the disc is to be mounted, and place the disk over this. Because

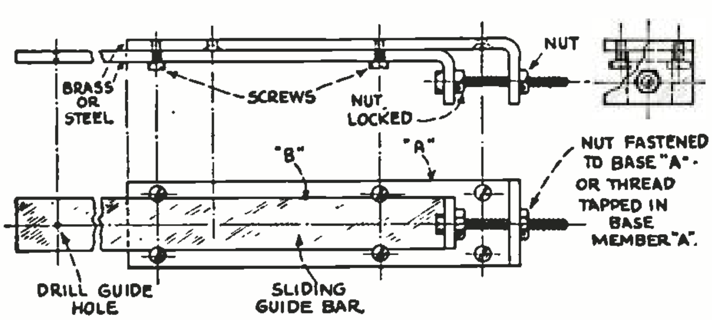
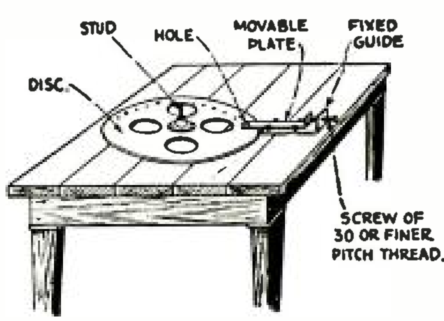


Fig. 2 (left)—Appearance of precision drilling jig, the guide of which can be moved with precision to any desired point, by means of a threaded screw.

Fig. 1 (right)—Arrangement of scanning disc on top of work bench, together with hole drilling jig.



of the presence of the counterflange which is to be put underneath it, the lower surface of the disc will be a slight distance away from the table. Fasten on the table a metal plate, which will serve as guide for another in the radial direction of the disc; and move the latter plate by means of a screw with, say, 30, 40 or 60 turns to the inch. The second plate has, at its end toward the disc, a hole to serve as a guide for boring the holes in the disc. The determination of the distance between the holes in the radial direction, .012-inch, is secured by giving the proper amount of turn to the screw which settles the relative motion between the two plates. With this arrangement, not only are the holes perfectly spaced, along the radii, at the necessary distances, but they are also perfectly centered; because the boring is done with the flange already fastened to the disc and with the latter revolving about the properly-fitting center stud.

TABLE OF THREADS FOR DRILLING JIG

If guide screw has 30 threads per inch, then

1 turn = 1/30th inch = .033 inch
½ turn = 1/60th inch = .0165 inch
⅓ turn = 1/90th inch = .011 inch*
¼ turn = 1/120th inch = .00825 inch

If guide screw has 40 threads per inch, corresponding to pitch used on micrometer spindles, then:

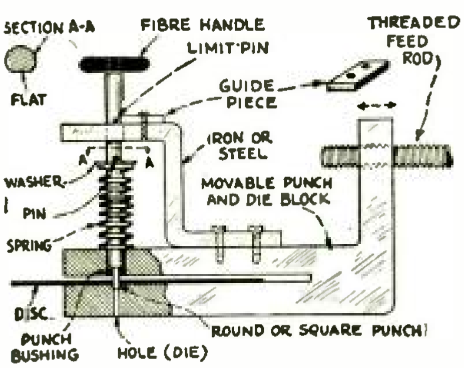
1 turn = 1/40th inch = .025 inch
½ turn = 1/80th inch = .0125 inch*
et cetera.

If 20 threads per inch are used on guide spindle, then:

1 turn = 1/20th inch = .05 inch
½ turn = 1/40th inch = .025 inch
¼ turn = 1/80th inch = .0125 inch*

*Right value for disc described in Mr. Wienecke's article on page 188.

Fig. 1 shows a very simple form of making the apparatus in question, with which good results can be obtained; but, if the constructor has at his disposal proper tools, it is better to stick to the layout indicated in Fig. 2, which is without doubt better from the point of view of precision attainable. In this type of construction, the four 12/24 or 8/32 screws serve to guide the moveable plate in both the horizontal and the vertical directions.



Detail of a suggested design for scanning disc punch. The punch and die are accurately moved simultaneously to any predetermined position, by means of a threaded screw. Suggested by H. W. Secor.

Scanning Disc Hints

¶ All holes must be smooth.

¶ Thin disc desirable or else counter-sink holes.

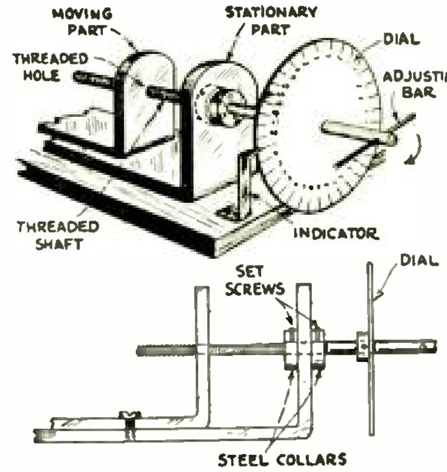
¶ Holes should over-lap 3 to 5 per cent; this helps to eliminate "lines" in image.

¶ Best to check up holes with lamp behind disc; magnifying lens helps.

¶ Misplaced holes may be shifted by patching disc or by peening and filing hole.

They need not be inserted all the way to the bottom, but only far enough to prevent excessive play of the movable plate in a vertical direction.

The best hole is obtained by using a punch; in which case it is not hard to make square holes. Without a punch, one must use a small drill, fitted in a very light hand drill or drill press and kept perfectly vertical. Use a push-pull ratchet stock; the speed of rotating the drill point must be very slow. To use a punch, the piece of hardwood put under the disc for drilling must be replaced by an equally thick sheet



Improved form of punch or drilling jig, with threaded screw to accurately move guide block to predetermined radius on the disc.

of bronze or steel, with a hole for receiving the punch. Obviously this plate must be moved radially at the same time as the movable plate of the boring apparatus.

One quarter-turn of the screw (having say 20 turns to 1 inch) will make the guide hole placed on the movable plate move .012-inch. One simply gives a quarter-turn to the screw when passing from one radius to the next, to make a new hole; in this way exactly arranging the spiral of 60 scanning holes.—*La Radio per Tutti (Italian).*

SHEET METAL TABLE
American "Wire Gauge" for Aluminum

Gauge No.	Thickness Mills	MM.	Lbs. Weight per Sq. Foot
2	257.6	6.544	3.632
4	204.3	5.189	2.880
6	162.0	4.115	2.284
8	128.5	3.264	1.812
10	101.9	2.588	1.437
12	80.8	2.053	1.139
14	64.1	1.628	.904
16	50.8	1.291	.716
18	40.3	1.024	.568
20	32.0	.812	.451
22	25.3	.644	.357
24	20.1	.510	.283
26	15.9	.405	.224
28	12.6	.321	.178
30	10.0	.255	.141
32	7.95	.202	.112
34	6.3	.160	.089
36	5.0	.127	.070
38	4.0	.101	.056
40	3.1	.080	.044

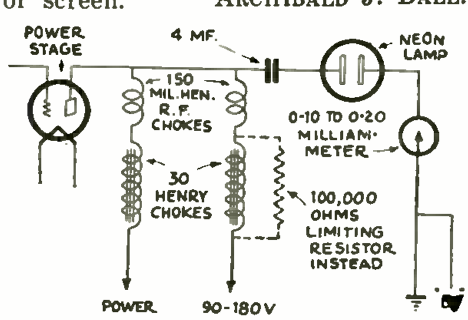
(The thickness of copper is the same, but the weight is 3.28 times as great.)

Television Volume Indicator

In the course of my experiments, I chanced on this unique volume indicator for television receivers.

The circuit for modulating the neon lamp was taken from Radio Pictures' *Data Sheets.*

My addition was the 0-20 or 0-10 milliameter. The louder the signal, the quicker the ionization breaks down in the tube; and more current is drawn from the "B" supply. Thus one may tune a television station to resonance without the infernal crescendo from the loudspeaker. The meter may be switched out of circuit, or left in. It will give the operator a chance to notice the change in signal when a person or object moves on film or screen. ARCHIBALD J. BALL.



Mr. Ball's idea for eliminating the loudspeaker as a monitor in a television receiver; he substitutes a milliammeter for the speaker.

A SHORT COURSE IN TELEVISION

The Elements of Synchronism—Including a New Method

By C. H. W. Nason,
Television Engineer

LESSON 3

FOR proper reception of television signals, where the scanning disc is employed, it is essential that the rotational speeds of the scanning mechanisms at the transmitting and receiving points be absolutely identical. When two units are rotating in *synchronism* their relative speeds are not only identical but are uniform. True synchronism also demands that the *relative positions* of the two devices be also exact. This means that the first scanning aperture of the receiving disc will have its radius in the vertical position, at the same instant the radius through the first aperture of the transmitting disc passes through the vertical. We will first concern ourselves with methods of maintaining the two discs at uniform speed.

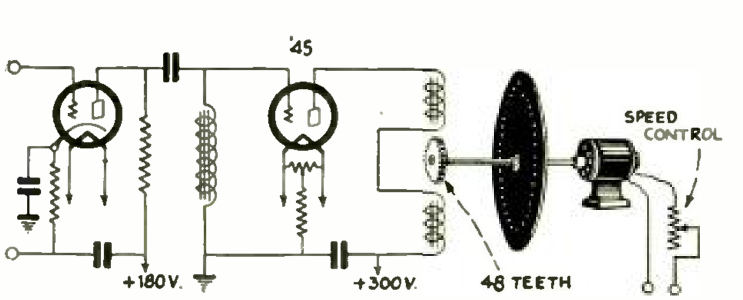


Fig. 1. at left, shows "phonic wheel" synchronizing motor and amplifier circuit, the main power for rotating the disc being supplied by the larger motor shown at the right of the shaft.

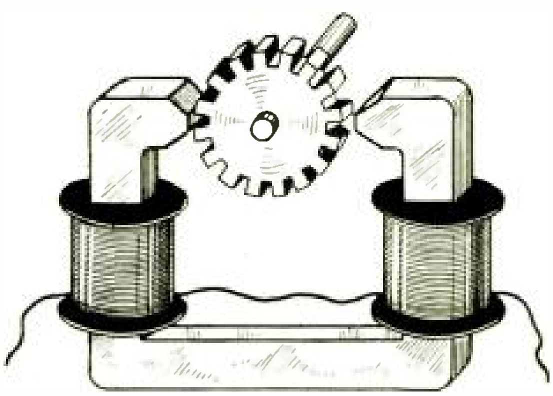


Illustration at the right shows construction of "phonic wheel" motor used to preserve synchronism of the scanning disc at the television receiver. It is best to use a laminated toothed rotor and a laminated field core.

A. C. Power Net Works

For the sake of economy, the public service corporations *tie in* their various power stations and, through the use of complicated electrical equipment, maintain the relative phases of the generators in step with one another. In New York City, for example, the alternating-current generating stations are *tied in* with those serving Long Island, some parts of up-state New York and portions of Connecticut. The public service supply lines in New Jersey are tied in throughout that state, parts of Pennsylvania, Maryland and Delaware. Information regarding your own locality can be obtained from your power company.

Where the transmitting station is on the same A.C. network as the receiver, full synchronization may be obtained through the use of simple synchronous motors at both points. The speed of a synchronous motor depends upon the frequency of the supply and the number of poles on the motor, being equal to the number of impulses per second (twice the frequency) divided by the number of poles. Thus a motor with two poles operating on a sixty-cycle supply would have a speed of sixty revolutions per second, or 3,600 r.p.m. (revolutions per minute). Conversely, a speed of 1,200 r.p.m. requires a motor with six poles.

In certain cases, a synchronous motor has *direct current* flowing through its windings, and the number of basic impulses is the same as the frequency of the supply. Here the number of poles is half that required when no D.C. is provided.

How Scanning Frequency Is Used

The television signal contains a strong component of the scanning frequency, which is derived from the number of scanned lines per picture multiplied by the picture frequency. In the 48-line picture, transmitted at 15 pictures per second, the scanning frequency is 720 cycles per second; and a strong component of this frequency is found in the signal. In the 60-line image, at 20 pictures per second, the scanning frequency is 1,200 cycles. The strength of this component can be increased by *blanking out* a portion of the scanned scene, in order to produce a well-defined "no signal" area.

In cases where we are unable to use the regular supply lines for purposes of synchronization, we may amplify the scanning component by means of a *tuned amplifier*, and employ this amplified signal for driving the disc; this is not as difficult a job as it may seem. If we employ a small variable-speed motor for the sole purpose of overcoming frictional losses and maintaining our disc in rotation, the load placed on a second *synchronous* motor, designed merely to maintain the speed of rotation constant, will be not greater than three or four watts; a single '50 or a pair of '45s will do this admirably. Remember that, in determining the number of poles the motor should have, we must decide whether the motor will operate directly in the plate circuit of the tube, with D.C. flowing through its windings; or whether we will use an output transformer, so that only alternating current, of the scanning frequency will reach the motor windings. In operation it makes little difference which method we employ; although the transformer will be a necessity if we are figuring on the use of a push-pull stage.

Tuned Circuits Essential

For the 48-line pictures, where the scanning frequency is 720 cycles, the number of poles will be (for a speed of 900 r.p.m.) 48 if D.C. flows in the windings, or 96 if pure A.C. is supplied. For the 60-line images at 1,200 r.p.m. the number of poles will be 60, where D.C. is flowing or 120 where pure A.C. is supplied. In order to achieve a current of the desired frequency in the amplifier output, it is essential that tuned circuits be employed.

In the amplifier circuit shown in Fig. 1 the motor is isolated from the direct current, and the amplifier is tuned to the required frequency as shown. The values of the capacity and inductance required will be as follows: at 720 cycles a Samson 3-henry choke was employed for the grid inductance, and the capacity is .016-mf. At 1,200 cycles the choke was a 1-henry Samson, and the condenser .0175-mf. These are not calculated but experimental values; since manufacturing variations make necessary adjustment of the capacity values by building up from small fixed units, until maximum amplification at the desired frequency is obtained.

Input for this amplifier is obtained from the output of the television receiver proper, by tapping off a small voltage across a resistor in series with the neon lamp. It is essential that the constructor make adjustments on the resonant circuits, to compensate for manufacturing variations, since the circuits are quite sharp.

The Phonic Wheel Motor

Motors of the type described are known as "phonic wheels". Their power is so limited as to make it almost impossible to drive a disc directly without some other motor to take up the frictional losses. The toothed wheels themselves may be simple gears cut from cold-rolled steel, or they may be built up from iron or transformer-steel laminations. The latter process is difficult, unless dies are available, and is not recommended for amateur purposes. The magnetizing coils are connected in series and consist of about 5,000 turns of No. 36 S.S.C. copper magnet wire on each winding. The magnet poles are, preferably, cut from transformer steel laminations in the form shown in the sketch; the stacks being built up to the thickness of the toothed rotor. These motors will run alone only when brought up to synchronous speed by some outside source of power. While the phonic motor exerts a considerable resistance to any change in speed, it cannot be expected to compensate for extreme variations in line voltage, under the influence of which synchronism will be lost.

The Thermionic Brake

In the course of experiment the writer has developed another synchronizing system which is not entirely different from that outlined above. It does, however, have considerable merit from many points of view. The driving, or variable-speed, motor is at all times set to have a speed slightly "leading" that of synchronism; and a vacuum-tube circuit has been devised to have a braking effect to limit the speed to that of synchronism.

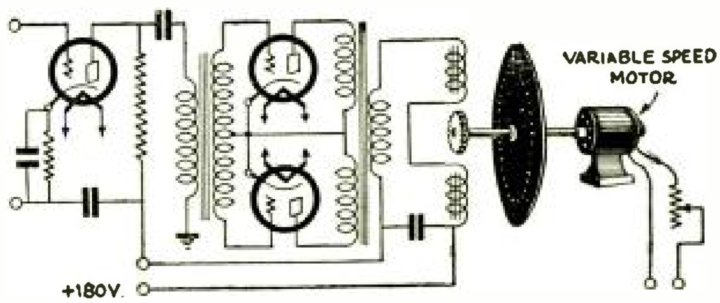
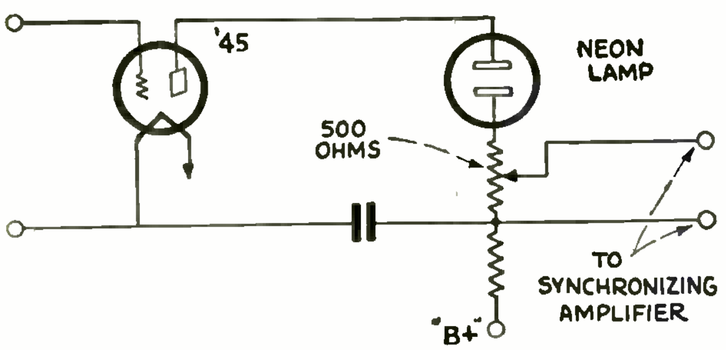


Fig. 2, at right, shows the author's new method of preserving synchronism at the television receiver, by causing the "phonic wheel" device to act as a generator. A variable speed motor carries the main load.

> *In the Next Issue*
> **Lesson 4**
> of the
> **Course in Television**
> will be on
> **BASIC PRINCIPLES OF TELEVISION OPTICS**



The diagram at the left shows the method of tapping off the synchronizing motor signal, from the output circuit of the television receiver.

In this device, the phonic wheel is used to generate an alternating current of the same frequency as the scanning frequency of the signal. The output stage of the amplifier, fed with filament voltage only, consists of two tubes in a push-pull connection. Under normal circumstances, the tubes draw no plate current but, at the instant when the current generated by the phonic wheel alternator is synchronous with the incoming signal, considerable power is taken from the generator circuit, and the tendency is to slow up the speed of rotation.

The cycle of operation is as follows: with the incoming signal so filtered by the tuned circuit that it allows only the scanning component to pass through, the variable-speed motor is turned on and gradually brought up to speed. At some instant the signal voltage on the grid of one tube will have its maximum positive value exactly when the plate voltage from the generator assumes its maximum positive value in that tube. At synchronous speed in the very next half-cycle, the same condition will obtain in the plate circuit of the other tube; and a continuous load will be placed on the generating system. Because of the fact that the grid swings positive at this instant, the current drawn will assume large proportions, and a load of no insignificant proportions will be placed on the generating system. If the speed is drawn below that of synchronism, the load will no longer exist; and the fact that the driving motor is adjusted, by means of its rheostat, to a speed slightly above the synchronous, will suffice to bring the speed of the disc up to synchronism once more. This cycle of events will cause a slight "hunting" of the motor when first brought to speed; but this will die out after a fraction of a second. Even large differences in voltage can be absorbed by this load.

One peculiar effect may be noticed in operating this type of synchronizing apparatus. If the scanned scene contains a large vertical band of light or extremely dark substance (such as a woman in white against a dark ground or *vice versa*) the synchronizing signal may be taken from this vertical strip. If, then, the *woman* should move from side to side in the scene the synchronizing wave will shift its relative phase accordingly; and the entire scene will appear to move, while the object in actual motion will appear to stand still.

Construction of the alternator is identical with that of the phonic motor carrying direct current. It is an essential this time that D.C. excitation be provided; this may be done from a separate source, or by bringing the plate current of the previous amplifier stages through the windings, as shown in Fig. 2.

Fig. 5A, above, shows proof of an original line cut illustration.

Fig. 5B, shows the same illustration formed with 120 dots per inch.

Fig. 5B, above, shows same image formed of 120 lines to the inch.

Fig. 5C—Here we see image formed of 60 lines per inch.

Fig. 5C shows image formed by using 60 dots per inch.

PRINCIPLES *of* SCANNING

The author explains in a very clear manner, just what happens when a subject is scanned at a television station, and just how the various degrees of light and shadow are transmitted and reproduced over the television circuit. The method of building up the image from a series of small picture elements is brought out in a very lucid manner.

By A. C. KALBFLEISCH*

THE development of television, up to the present time, is not far enough advanced to permit the transmission either by wire or by radio of a complete "still picture" at one time. We have to divide the picture up into many small areas and, by means of an equivalent electrical signal, transmit these small areas one after the other. This process of breaking up a picture or scene into elementary areas is known as *scanning*. We shall learn that the speed with which we reproduce these small areas determines whether we shall have a still or a moving picture.

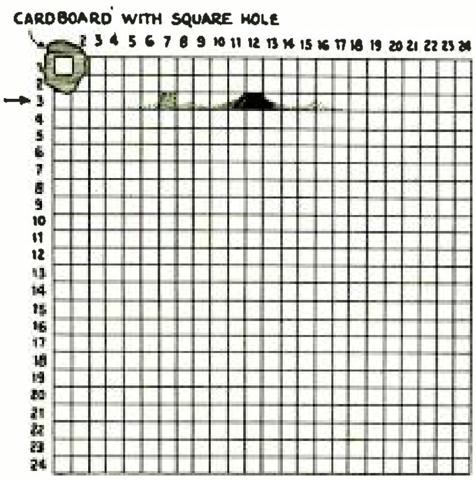


Fig. 1, above—Shows how light intensity of various picture elements across a scanning path, No. 3 in this case, varies in degree, No. 12 being full black.

Of vital importance in the process of scanning is the area or space to which the television pick-up system (the photo-cell) responds, and within which the subject or scene to be televised is confined. The area is defined as *the field of view*. In the present status of the art, the field of view is very limited.

We have said that it is necessary to transmit in rapid succession a series of elementary areas; which are then assembled at the receiving end, to form an image of the scene which is being televised. It is essential therefore that the light reflected from these elementary areas which are picked up by the photo-cell, deliver to the cell the maximum amount of light possible. We shall see that this is done by utilizing a series of *square* (or round) holes in the form of a spiral at the outer edge of a thin metal disc, known as a *scanning disc.*

Let us consider for a moment Fig. 1, which represents a picture area which has been broken up into many horizontal strips. Let us go one step further and choose a particular horizontal strip, such as No. 3 for discussion. You will notice that we have divided this particular strip into 24 squares.

If we were to take a piece of cardboard and cut into it a small square hole (slightly larger than the area of square No. 1, for example) and slide it over the picture horizontally along one particular strip, we would see through the hole a series of light and dark portions, such as squares Nos. 1, 7, 12 and 16. Square No. 1 is white, and its position is at the left-hand side of the picture. As we slide the strip along toward the right, we begin to notice various shades of black and white, corresponding to the shades of the photograph. No. 7 is partly shaded, No. 12 is the darkest part of our picture and is entirely black. Having passed over the picture with our scanning hole (if we may call it that), we find the remainder of the photograph is perfectly white.

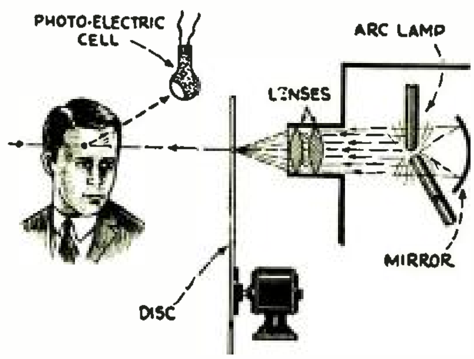


Fig. 2—This picture shows how a pencil of light projected from an arc, through the lens system and a hole in the rotating scanning disc, sweeps across the face of the subject; the reflected light ray falling on the photoelectric cell.

If we are able, therefore, to produce varying amounts of electric current, corresponding to the various shades which we observe as we slide along this horizontal strip, we will be able to transmit our picture by means of radio waves. The photoelectric cell is the device which changes varying light intensities into corresponding electrical impulses.

Importance of Varying Light Reflection

Different objects reflect different amounts of light; it is this fact which has enabled engineers to develop tele-

* Television Consultant, National Radio Institute.

vision successfully. Let us look for a moment at Fig. 2, which represents a light source behind a lens for focusing the rays of light from the lamp to a small point, as shown in the diagram. At this particular moment the little spot of light is focused on the man's forehead, which will reflect a considerable amount of light. If we were to focus a spot of light toward the top of the man's head, not so much light would be reflected, because of the color of the man's hair. In the same way, the white collar would reflect a large amount of light, while the coat would reflect hardly any. Our problem, then, is to use a device which will cause a spot of light to pass back and forth, from left to right and from top to bottom, in a series of strips across the man's face. The scanning disc projects the light from the arc lamp upon the subject being televised. It is interesting to note that, in order to have a clear image of the object which we are scanning, we must divide up the picture into from 2,500 to 3,500 spots to one square inch of picture.

Sequence of Scanning

Fig. 3 illustrates what we have been talking about. (Naturally, our spot of light is magnified for the sake of illustration; for in actual practice the scanning spot is only about 1/32 of an inch in diameter. You will see from Fig. 3 that the spot or square of light moves from left to right, drops down a line, and moves from left to right again; in much the same way that we "scan" or read pages of a book.

Fig. 4 represents a peculiar curve, which we get by plotting the photo-cell current as the spot of light passes over the subject; it is meant to represent the variations in reflected light from the man's head in Fig. 2 as the light travels across one particular horizontal strip. It is interesting to note that the currents produced by the photo-cell, due to this reflected light striking it, would correspond very closely to the rather irregular curve of Fig. 4. That portion of the object which reflected the most light would produce the greatest photo-electric current, while the portion which reflected the least amount of light would produce hardly any current. In this way, then, we build up our picture by means of varying photo-electric currents.

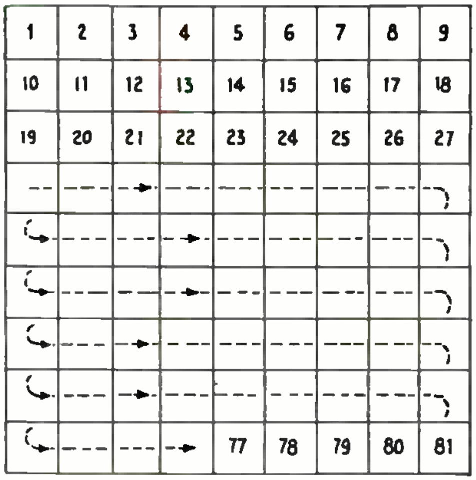


Fig. 3—This chart shows the progression of the scanning light pencil, eaih path being scanned one after another, very rapidly and continuously.

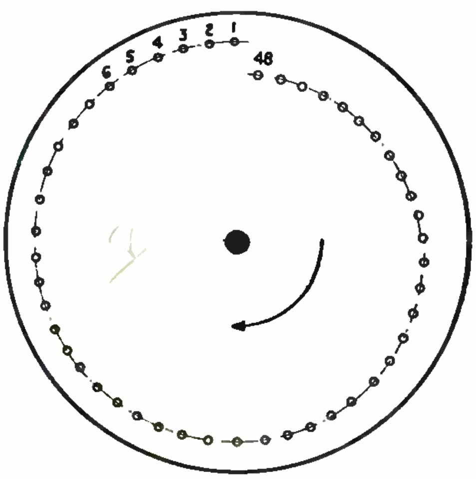


Fig. 6—Typical scanning disc layout. No. 1 hole scanning the subject first, then No. 2, etc.

Photo-Cell Is the "Eye"

The photo-cell is the eye of the television system, and scanning is the method by which this eye picks up and reproduces an image of the action taking place before it. The human eye observes a rather broad field of view. Unfortunately, the eye of television, the photo-cell, is limited to an extremely small field of view. However, a television pick-up device can render a distinctly useful service if a well-chosen field of view is selected. Furthermore, the eye will make up for the minute details which present-day systems lack.

If a comparison is made between a scene as depicted in a newspaper and an actual photograph of that scene, we can see that the latter has much greater detail. The newspaper picture is an attempt to show a photograph on the printed page. The clarity of the newspaper print is determined by the size of the screen used in making it. Figs. 5a, 5b and 5c represent, respectively, the original; a newspaper print in which a 120-mesh screen was used; and a print in which a 60-mesh screen was used. Just what is the connection between Figs. 5b and 5c, and scanning? Simply this: in Fig. 5b we have divided one picture into 14,400 elementary areas, while in Fig. 5c we have divided it into 3,600 elementary areas. It is customary to consider the detail of a picture such as Fig. 5a in terms of *elements per square inch.*

Therefore our detail would be 14,400 elements or dots per square inch. As an experiment, look at these pictures: first one foot away; then three feet away; and finally five feet away. The farther away the picture is, the less noticeable are the elementary areas. This is an important factor in television for, as we stated previously, present television systems are capable of reproducing a detail of 2,500 to 3,500 impressions per square inch. For a square picture, therefore, we should have our scene to be televised divided into 50 squares per row and 50 rows.

How Scanning Disc Works

Let us consider the action of a scanning disc when rotated slowly. Fig. 6 represents the disc and we shall rotate it in a clockwise direction. Since the disc consists of 48 holes, one revolution of the disc will divide our picture or scene into 48 strips. Hole No. 1 would produce a strip across the top of Fig. 2. Hole No. 2 would produce a picture strip one row lower. It is evident, therefore, that with one revolution of the disc we have completely covered the man's face with one little spot of light. As the disc rotates, this process is repeated over again.

It is interesting to note that, for television of moving objects, fifteen complete pictures are required per second. Our scanning disc must cover the man's face fifteen times per second, if we are to have what is called a continuous picture. With a 48-hole disc, therefore, we would have 48 x 48 x 15, or 34,560 impressions per second

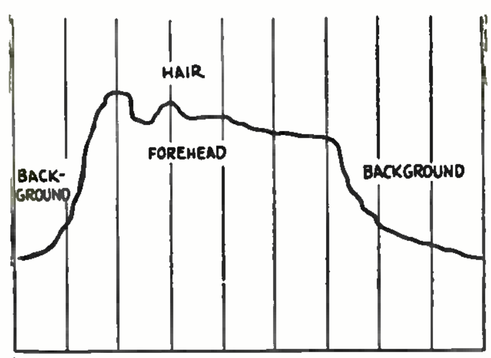


Fig. 4—Shows the curve we obtain by plotting the photo-cell current, as the scanning light spot passes over a subject's face, for example.

to be picked up by the photo-cell. Since the number of lines into which the scene is divided is determined by the number of holes in the disc, television systems are classified as 24-, 48-, 50-, 60- and 72-line systems. It is evident, that, the larger the number of lines, the clearer the picture will be. It is also true that the greater the detail, the higher the *picture frequency,* and the more difficult, therefore, it becomes to construct apparatus which will pass this wide band of frequencies.

In a 48-line system, the highest frequency which we must pass is

$$\frac{48 \times 48 \times 15}{2}$$ or 17,280 cycles per second;

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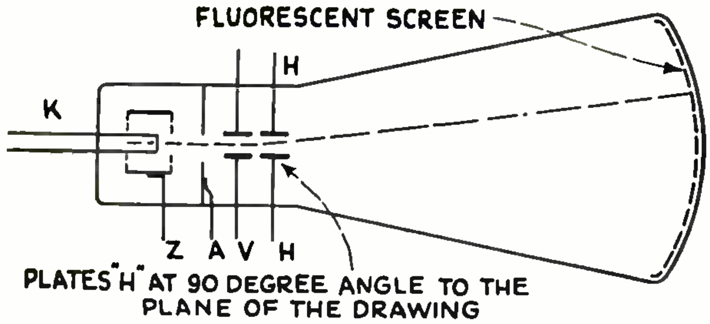

Fig. 1. Shows the general arrangement of Von Ardenne's Cathode Ray Oscillograph tube used for the reproduction of a television image.

THE ELEMENTS *of the* CATHODE-RAY TELEVISOR

By H. BRYKCZYNSKI

An extremely important point bearing on the practical application of any television system is the question of cost especially at the receiving end. Probably today sets can be made for receiving every kind of television broadcast, but they would be quite expensive.

After a superficial judgment, one might include the oscillograph televisor with this class; for it requires a large Braun tube, which is operated at very high voltages, and an extensive filter apparatus.

Two Types of Oscillograph Tube

There are two types of the oscillograph tube for television purposes, one the model of Manfred von Ardenne, and the other, that made by the Westinghouse Co., according to V. Zworykin's design. These two types differ; in that the first has all the electrodes controlling the electron flow, located inside the tube; while in the second these electrodes which control the horizontal and vertical deflections of the electron stream, are arranged outside the tube.

The two types of tube differ also in that only one anode potential is used with the first; while with the second two different potentials are used. The reason for this is found in the arrangement of the control electrodes, the schemes of which appear in Figs. 1 and 2.

The closer the control electrodes are to the electron stream, the easier this is to control with the given electrostatic or electromagnetic field strength, which is determined by the amplifying power of the receiving set.

Furthermore, the cathode-ray is more easily deflected as its velocity is less: *i.e.*, the lower the anode potential. If therefore (as in Fig. 1) the control electrodes lie very near the flow of electrons, successful operation can be obtained at a higher electron velocity than with the arrangement of Fig. 2, whereby we can attain the same control over the electron flow only by operation at a relatively low anode potential—always presupposing the same electrostatic or electromagnetic field strength. Since to obtain a useful image luminosity requires a fairly high anode potential, this is applied (Fig. 2) only after the deflection of the electrons.

Therefore the final effect is the same in Figs. 1 and 2; but there is a very great difference in the construction of the tubes and in their cost.

Oscillograph Tubes Must Be Exactly Built

In Fig. 1, the placing of the control electrodes and the anode relative to the electron flow must be very exact, in order to ensure a uniform deflection of the flow in all directions. This entails considerable labor; because the electrodes must be solidly fused in. However, the concentric position of the control electrode Z and the anode A1 (Fig. 2) can be fairly simply attained; the same holds true for the arrangement of the deflection electrodes.

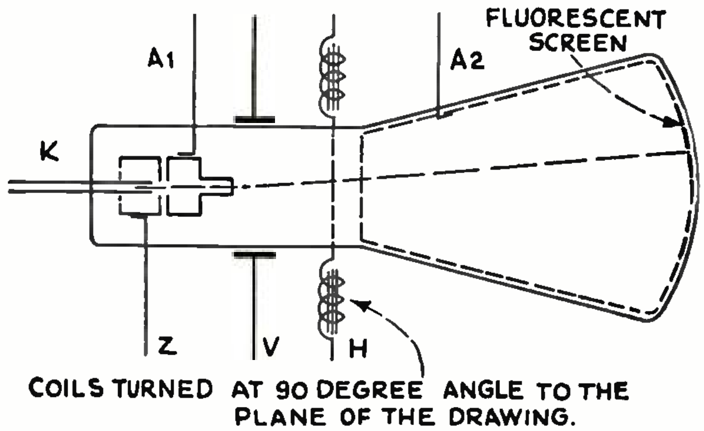

Fig. 2. The general arrangement of the electro-static plates and also electro-magnets (placed at right angles to the plates) in Zworykin's Oscillograph tube for television. The Cathode Ray swings back and forth, up and down, and reproduces the image or picture on the fluorescent screen at the end of the tube.

As is well known, the oscillograph tubes are operated at high voltages—up to 3,000. The fact that Fig. 1 requires only one and Fig. 2 two anode potentials, is relatively unimportant. It is, however, important that in such tubes the anode current be extremely small; so that the wattage output of the current source (always an A.C. filter connection) is very low.

This high-voltage connection cannot be used simultaneously, however, for feeding the amplifier tubes; for then the receiver would be far too costly. For this there must be used a second filter connection which, of course, is already built into most radio receiving sets.

To operate the oscillograph televisor, three distinct operating frequencies are needed: the pictorial-element frequency, the strength of which varies with the character of the picture transmitted; the vertical scanning frequency, and the horizontal scanning frequency.

Of these last two, the vertical frequency is produced at the receiving end, and is simply controlled by impulses from the transmitter. On the other hand, the horizontal frequency is radiated by the transmitter. Since it would be far too expensive to have a separate transmitter and a separate receiver for each of the three frequencies, all three are impressed upon one carrier wave, amplified by one receiver, and separated at the output by filters. This can be done very satisfactorily, within limits.

Fig. 3 shows a plan of the filter arrangements. At the output of the receiver there is, first, a band-pass circuit which separates and filters out the horizontal scanning frequency from the other two frequencies. Then this frequency is passed into an amplifier and from there brought to the magnet coils serving to cause a horizontal deflection of the electron flow.

Two Control Frequencies

From the two other frequencies there is then filtered out that which controls the vertical frequency, which is generated locally. This is a succession of A.C. impulses having, for instance, a frequency of 4,000 cycles. First, these scanning-frequency impulses are filtered, then passed through a low-power amplifier, rectified, and sent to the grid of the control tube. By this means there is produced an alternation in the charges on the condenser plates of he oscillograph tube; and by this action the periodic deflection of the electron flow in a vertical direction is accomplished.

Attention must be given to see that the electron flow in the oscillograph tube is moved in a vertical direction, *at the same speed as the scanning at the sending end.* This control is obtained by switching in different capacities across the generator tube TG.

The necessity of such a filter arrangement, of course, increases the cost of the set considerably; although such a filter system (since we are dealing with low-frequency alternating potentials) is much cheaper and easier to make than high-frequency filters.

The filter coils are built exactly like the little coils of the usual audio-frequency transformers in radio sets; though naturally without iron cores. They can be adjusted to different frequency values, like the tuning coils of radio-frequency circuits, by means of parallel or series capacities; which, however, cannot be here continuously variable, but are made variable in steps.

The filter circuits themselves, therefore, do not cost much. The only expensive parts are the tubes. If these are built in with the usual receiving set, they can be fed from the same source of current as the latter.

It is important that tube TG, which is coupled with T_2 as a D.C. amplifier, should have a considerable bias (as high as 110 volts negative). This disadvantage might be overcome by having the function of TG taken over by T_2. Then the power of tube T_2 must be increased; for instance, by using a pentode here.

Then T_2 (or, otherwise, TG) must receive a negative bias so high that, while no current is passing through the amplifier, the anode current is zero; the tube therefore must represent an infinitely high resistance.

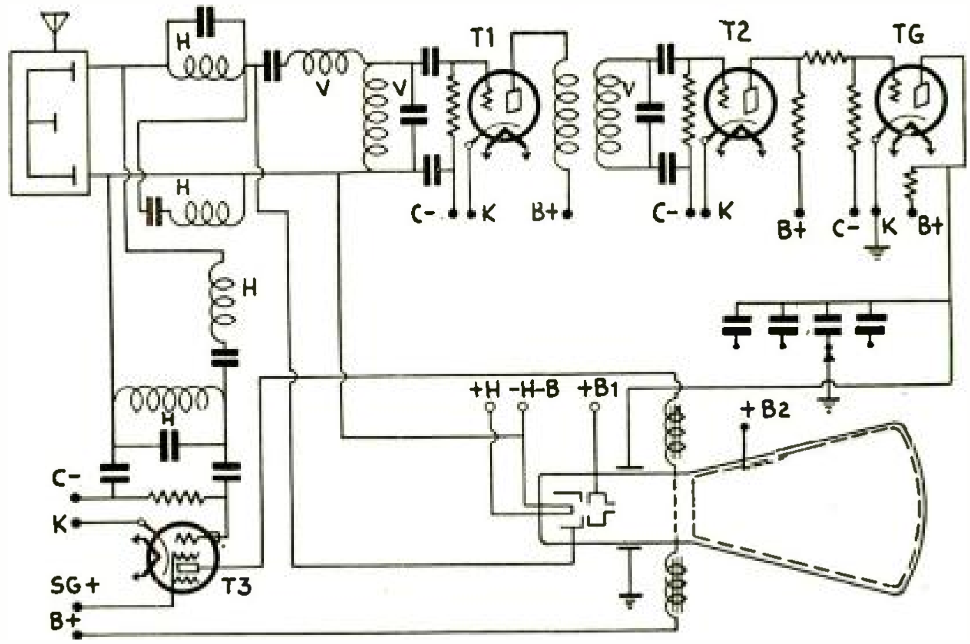

Fig. 3—Typical television receiver circuit employed in connection with the cathode ray oscillograph tube for reproducing television images.

The total cost of the complete television set with the oscillograph tube is today about $150.00. This cost may be considerably reduced by making for oneself many parts, such as those of the high-voltage connection and the filter system. An oscillograph tube alone costs about $35.00. This price is far too high in relation to the effort used in manufacture; for making such a tube is, after all, a very simple matter, compared with the production of many receiver tubes, such as the pentodes.—*Bastelbriefe.*

What's This Thing — Synchronization?

ALTHOUGH the word synchronism is probably current everywhere, its exact technical definition is certainly known to few. To establish this idea exactly, let us study a few examples. Think of two watches; one for example in Vienna and the other in New York. In both cases, the time of revolution of the hands will be the same; since, obviously, twelve hours last as long in one place as in the other. Therefore the hands of the two watches will turn on their shafts at exactly the same speed. But while the Vienna watch indicates 12, the one in New York will only read 6. One says that the two watches run *iso*chronously, not *syn*chronously. They would run synchronously, only if both should indicate exactly the same time. This difference is very important.

Another example: look at two wheels of a wagon. Of course they will make the same number of revolutions, *i.e.*, isochronously (Fig. 1A).

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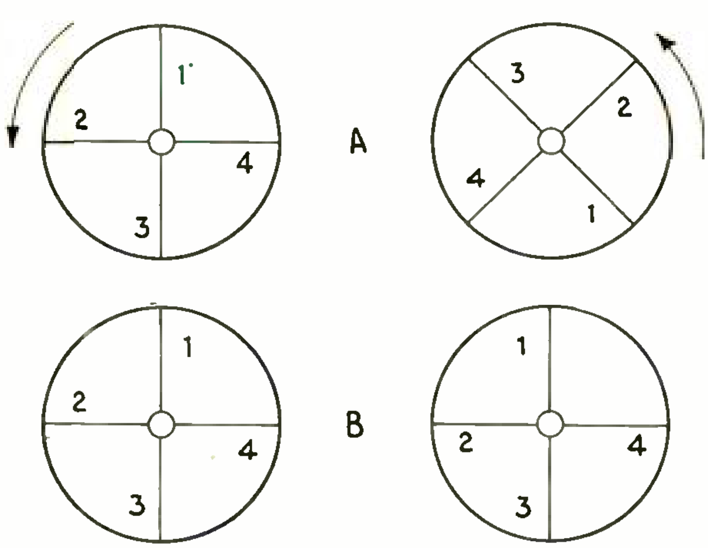
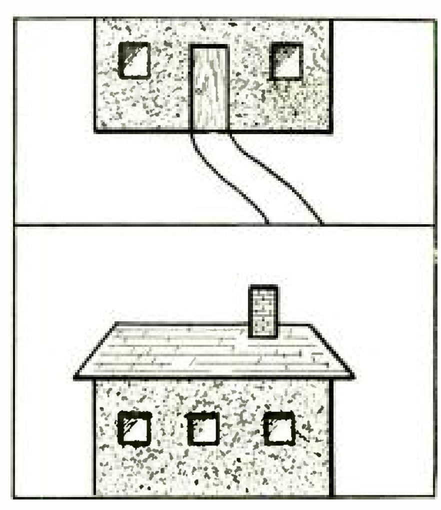


Diagram at left shows how two discs at "A" may be rotating at the same speed but the various points on the two discs, representing the transmitter and receiver, are not in perfect register as the numbers disclose. Two discs running in this fashion are said to be running in isochronism.

The two discs shown at "B" on the left are running in perfect synchronism the lines 1, 2, etc., lining up exactly at the transmitter and receiver. Another example of pictures not in register is shown at the right.



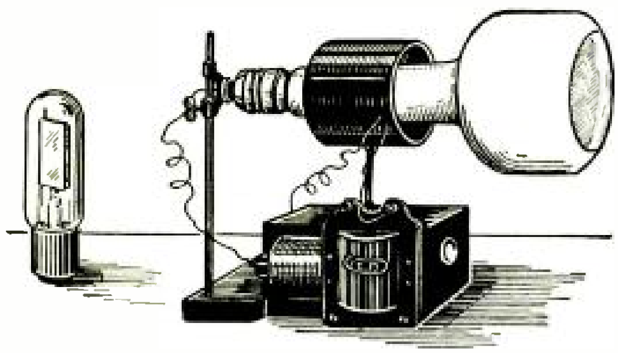


Fig. 1—Ordinary Neon glow tube at the left; at right the new super-frequency tube, a special new type of television lamp devised by Mihaly.

INERTIA-FREE *Light Sources* for TELEVISION SETS

By FREDERICK WINCKEL

THE problem of television was solved in principle fifty years ago; but the then-existing state of technology made it impossible to build a serviceable transmitting apparatus. Only the perfection of the selenium cell by Mihaly and the invention of the photo-cell (based on the investigations of Heinrich Hertz, Hallwachs and others) made it possible to send the pictorial elements of moving pictures fast enough over a single wire. The scanning of the pictorial elements, which can be accomplished in various ways in so far developed that the collective images already have the fineness of definition found in a coarse newspaper picture.

But the weak point, today, is still the insufficient illumination of the image, which appears in reddish-black or bluish-black contrasts. Imagine that in the use of a glow lamp, for example, only one point of its lighting surface is utilized at any one time; namely, that point whose light is allowed to pass through by the hole in the scanning disc! For explanation, imagine an image ten centimeters (four inches) square which may consist of 10,000 pictorial elements each 1 millimeter (1/25-inch) square. On each pictorial element falls only 1/10,000 of the available light, for only 1/100,000 of a second, if the scanning of the image takes place in 1/10 of a second.

At the same time the reproduction of images at 10 images to the second is the minimum rate; since, with motion pictures, the minimum is 16 pictures a second. Only a few years ago eminent scientists declared television in our present sense impossible; since the eye cannot form such short and feeble light impressions into a pictorial impression, they said. It was therefore a mighty achievement to provide a source of light for such rigorous demands; but still the improvement of the lighting of the image remains the central problem.

Basically, we know two possibilities of converting the image current coming from a transmitter into corresponding light-values: either to make an electric lamp light up more or less brightly through the current oscillations, or to use the picture current to modulate a constant source of light, *i.e.*, to strengthen and weaken it alternately. In both cases, it is necessary to amplify the pictorial current by means of electron tubes (a radio amplifier), so that the feeble current fluctuations are sufficiently differentiated in the image.

Among the interesting sources of light for Television sets, the author discusses the action of ordinary Neon tubes, as well as the newer Tungsten Arc, the Braun oscillograph and the Mihaly super-frequency lamp.

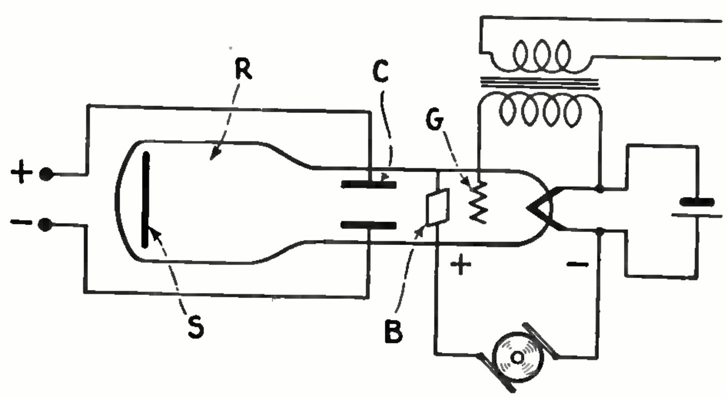
Unluckily, the electric incandescent lamp, with its high candle-power, cannot be used for the source of illumination; since, in consequence of its high heat capacity, it operates much too slowly.

Action of Glow Lamps

Accordingly, for the first method, there remain only the different types of glow-lamps. Their principle of operation is familiar: between two electrodes, across which is an electric potential, a luminous glow is formed in the gas, which is rarefied. Generally the electrodes consist of aluminum; since most other metals are gradually reduced to dust by the discharges. The cathode (*in the German lamps*) is in the form of a circular disc, while the anode consists of a wire. The glow, which forms as a ring at about 50 mm. pressure (about one pound to the square inch), gradually spreads, with decreasing pressure, to a reddish band of light which, starting from the anode, finally spreads through the whole tube at 3 or 4 mm. pressure—a phenomenon familiar in Geissler tubes. With further rarefaction, there forms on the cathode a blue spot of light, which finally completely covers the cathode. At a pressure of 0.5 mm., stratifications appear in the band of light, which has become brighter; while the blue light rises from the cathode and spreads toward the anode. At the same time there forms at the cathode a reddish layer, so that three strata are now present (the one just named, the blue cathode light, and a dark space lying between) which are collectively termed "negative glow." With still further rarefaction, the blue cathode light decreases and completely disappears. Thereafter, at .02-mm. pressure (about 1/1500 atmospheric) green and blue fluorescence appears at the glass wall opposite the cathode, which is due to the cathode rays now forming. To utilize this, one bends the glass tube at a right angle.

The cathode rays consist of an electron flow, whose velocity on leaving the cathode depends on the voltage across the tube. That the cathode rays are diverted by magnetic and electrostatic fields, and that they have the characteristic of charging negatively bodies which they strike, is well known.

Fig. 2—Arrangement of the Braun oscillograph tube as televisor. A dynamo is shown as the source of potential between the plate and the filament: the fluorescent screen at S.



New Television Lamps

The processes taking place in glow-lamps must be so extensively considered, because they are used for the different television systems in every stage of rarefaction. The cheaper receivers use the reddish light of the first type, requiring rarefaction only to 3 mm., and needing only low voltages. Then the gas content consists of neon, or of a mixture of mercury vapor and argon, with which less power is required than with the nitrogen formerly used. For this reason the mercury vapor and argon mixture is generally used today.

Lately, Mihaly has replaced the aluminum electrodes by electrodes made of an iron alloy; in this way he produces a glow-lamp called the "super-frequency" lamp (Fig. 1), which costs no more than an incandescent light, offers no difficulties in operation, and requires no special sources of current. The last is an important requisite in constructing a television receiver for popular use and much research has been devoted to this purpose.

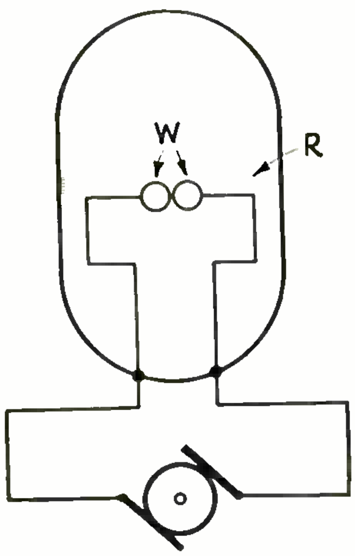


Fig. 3—The Tungsten arc experimented with by Mihaly. Inside the tube there are two tungsten balls (W) separated 1/25 inch. The tube is filled with an inert gas.

The Reichspostzentralamt (the German Postal Service's Central Office) exhibited at last year's radio show (in Berlin) glow-lamps with blue light at 10 mm. pressure, which the Post Office developed in its laboratory. The light is indeed bright enough, but it might tire the eyes after a while by its flickering. There is also danger, with these lamps, that under D.C. stimulation dark strata may form inside the *positive column of light*, and change the exact light value of the picture current. With a definite pressure of mercury vapor, however, stratification can be avoided, even in D.C. operation.

It is certainly better to use modulated radio-frequency current, which a transmitter of low power can furnish. By a little control sender the main transmitter affords the lamp the necessary constant voltage; so that the glow does not break down under modulation by the picture current. An especially good illumination surface is obtained by bending a glass tube 2 mm., in diameter back and forth in serpentine form.

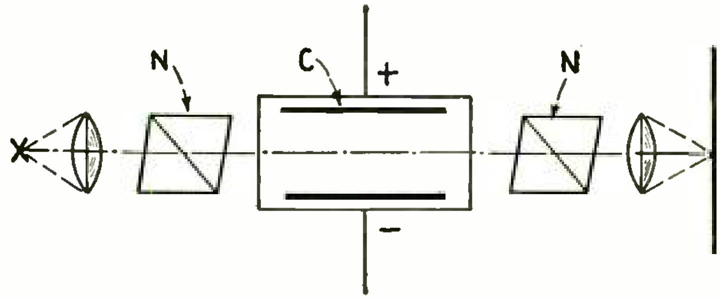


Fig. 4—Diagram showing the arrangement of the Kerr light valve; prisms are represented by (N), condenser plates by (C), which are placed in a vessel containing nitrobenzol.

Cathode-Ray Lamps

Glow lamps in the last stage of rarefaction (*i.e.*, with .02- to .001-mm., gas pressure, such as the Braun tubes) find use in the television system of Zworykin. Skaupy also has had very good results with them in corresponding experiments.

Skaupy uses the Braun oscillograph tube in the way shown in Fig. 2. The cathode rays produced in the tube R are diverted by electrostatic fields of changing strength, which are created across the condenser plates C; so that the spot of light moves back and forth on the fluorescent screen S, reproducing the image by scanning. The image current is controlled by the grid G. The cathode ray must pass in its path the screen B which, at the same time, serves as the anode, so that only a thin ray (producing a point of light) falls on the screen S. The disadvantages of this method are due to the fact that the cathode rays possess a magnetic spectrum; and because of their spreading, they appear, not as dots, but in the form of bands.

The directly-controlled lamps, described above, which respond to current fluctuations, are being supplemented by a great number of original and ingenious productions which, however, are not in practice equal to the exacting demands of television. This is true of many sources of steady light, of which we shall mention only those possessing practical importance.

Mihaly has long experimented with the tungsten arc light, which unites the advantages of the arc light and the incandescent light. As shown in Fig. 3, it contains, in a tube R, two tungsten spheres W, 2 mm. (.1-inch) in diameter, separated 1 mm. (1/25-inch) which are the electrodes; the tube is filled with an inert gas. Its great advantage lies in the formation of no visible arc of light; instead, the electrodes themselves are made white hot by the electric current and thereby form a dot-shaped source of constant light. The radiation of light is then modulated in accordance with the image-current fluctuations, by two screens; which move toward each other and thereby cut off more or less light.

Since, in this system, mechanically-movable parts are impracticable, resort is usually made to another method, which depends on the rotation of the plane of polarization of the light under the influence of a magnetic field. This phenomenon, discovered by Faraday, was used by Nipkow for the making of an inertia-free light-relay. The light rays of a constant source of light are made parallel by a lens, then pass a nicol prism (polarizer), go through a rod of Faraday glass, which is surrounded by a coil having a current passing through it; and, after passing a second nicol prism (analyser), they fall on the picture screen. If the two prisms are so placed that no light passes through, and the image current is then passed through the magnetic coil, there is formed on the picture screen, by the rotation of the plane of polarization, a dot of light.

The Nipkow light relay was considerably improved by the English physicist Kerr, through his discovery of the double refraction in liquids produced by electricity. If there is placed between the Nipkow prisms N (Fig. 4) a vessel of nitrobenzol, separating two charged condenser plates C, the optical properties of the nitrobenzol are altered under the influence of the electric field; *i.e.*, it becomes doubly refracting, and the light can now pass the analyser.

For reconstruction of the image, however, the Nipkow disc should not be used here; since the pencil of light leaving the Kerr cell is very concentrated. Therefore Karolus, who uses the Kerr cell in his televisor, employs in reconstructing the image a Weiller mirror-wheel, which projects the pictorial elements on a screen.

Attempts have been made to prepare the picture screen in such a way as to give an "afterglow" to the pictorial elements, which are of extremely short duration. It is difficult, however, to find a suitable substance, which has an afterglow neither too long nor too short.

(*Continued on page* 233)

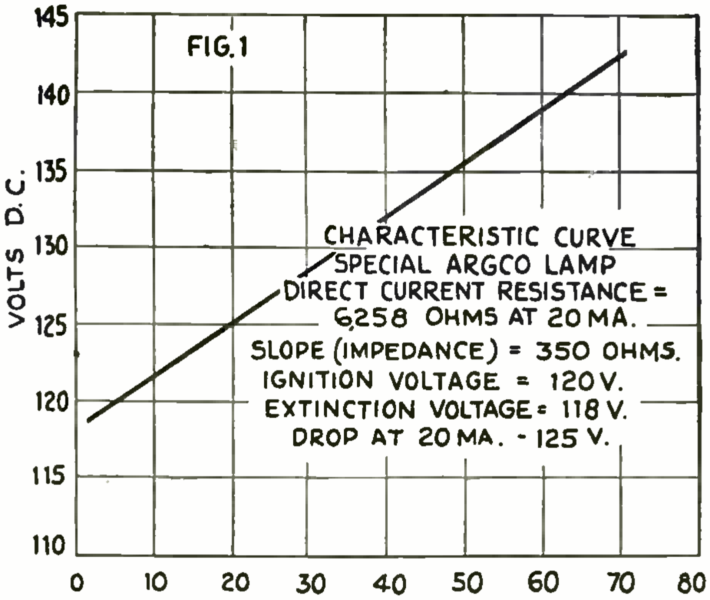


Fig. 1—Characteristic curve for a typical neon glow tube.

HOW TO COUPLE *the* NEON TUBE

Did you know that excess voltage may ruin your neon tube? The use of suitable current-limiting devices in the neon tube circuit, also the best methods of connecting the neon tube for maximum results are here discussed.

TRANSDUCERS are those pieces of physical apparatus which convert energy of one kind into energy of an entirely different nature. The photo-tube is a transducer, inasmuch as it converts a variation in light intensity into a variation of an electric current. The loud speaker is a transducer of a highly complex nature. The neon lamp employed in television is a transducer also. Because of the complexity of the problem we will consider the neon lamp only as a piece of electrical apparatus in the load circuit of a vacuum tube, leaving all consideration of its characteristics as a source of light to some later article. We might here mention two facts concerning its use as a source of light—namely, that the lamp is rated as to its sensitivity in candles per milliampere. This is the figure of merit for neon lamps of a particular class, much as mutual conductance is used in comparing vacuum tubes. We also note that the intrinsic brilliancy varies directly as the current passing through the tube.

How Impedance Is Found

The neon lamp for which the characteristic curve is given in Fig. 1, has a mean D.C. resistance of 6,250 ohms; and this drop must be considered in designing power-supply apparatus. Unfortunately, when considering the neon lamp as a load for a thermionic vacuum tube, we are concerned not with the D.C. resistance but with the impedance, or differential resistance, as determined from the slope of the characteristic curve. This value is obtained by dividing a given change in voltage by the corresponding change in current. In this case the slope of the curve shows an impedance of 350 ohms—much too low a value to work in the plate circuit of a vacuum tube, without undue distortion.

Fig. 2A shows the method employed in connecting the neon lamp directly into the plate circuit of a vacuum tube. In order to create a more favorable load, we have connected a 2,000-ohm resistance in series with the lamp. Under these conditions the impedance of the load has become 2,350 ohms; but it must be borne in mind that the D.C. resistance has become 8,250 ohms, which corresponds to a voltage drop of 165 at 20 milliamps. Any variation in the initial brilliancy of the lamp must be obtained by changing the plate current of the vacuum tube (and, naturally, the plate voltage) by varying the resistance shown in the figure. Such a change in plate voltage demands a corresponding change in the bias of the tube, if it is to operate on a favorable portion of its characteristic curve at all times. If it is desired to operate the output tube at a constant plate voltage some form of isolation for the neon lamp must be resorted to; such an arrangement is

(*Continued on page* 233)

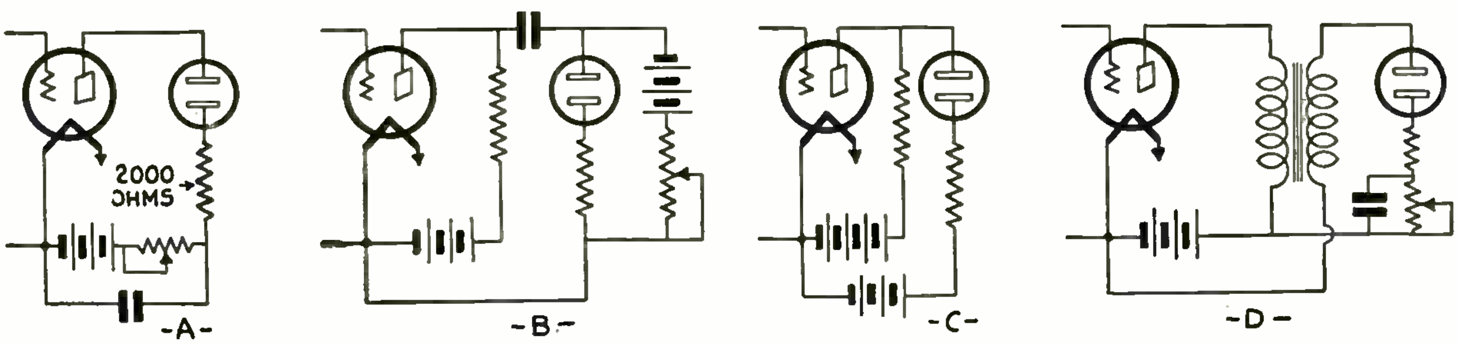


Fig. 2—Various methods of connecting a neon tube to the output amplifier stage of a television receiver.

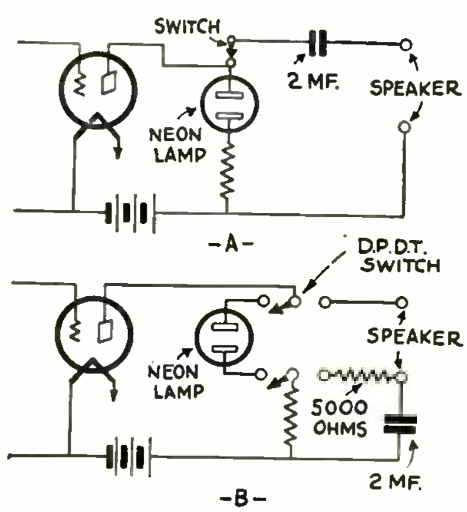


Fig. 3—Loud speaker should either be isolated from the circuit by the use of a coupling condenser, as shown at A above, or it should have a resistance in series to make the drop through the speaker circuit the same as that through the neon tube. In the first case a simple snap-switch will do, while a D. P. D. T. switch is required in the second instance.

RESULTS of $50.00 "New Word" Contest

The Prize-Winning Word "VISUALIST" to Replace "*Lookers-In*"

IN the first and second issues of TELEVISION NEWS, we printed the following announcement:

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

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

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

Here are the rules.

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

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

In response to this announcement there were received a total of several thousand entries to this contest and, from the quantity standpoint, the contest itself may be declared a huge success. Unfortunately the success was somewhat doubtful from the quality standpoint.

So many people participated in the contest, it would seem more or less necessary that a really adequate word should be found to replace the cumbersome one "lookers-in".

While under the rules of our contest we must award the prize to one individual, we do so with some misgiving, because it is somewhat doubtful whether the prize-winning word will find its way into general use. However, stranger things have happened and, perhaps, the word may be adopted.

The contest brought forth hundreds of suggestions, most of which, however, were duplicated; some words sent in received as many as thirty and forty duplications from various readers! Some of the more common words suggested were the following:

Televistor
Televisionist
Telespectator
Eyers
On-Lookers
Visibilist
Televist
Televiewer
Tel-o-Seers
Photo-Gazers
T. V. L. (Television Looker)
Peekers
Telespectors
Radio-Gazers
Radioviewers
Visionites
Site-Seers
Teleseer
Space-Gazers
Scanners
Sees-All
Visagers
Opto-Visors
C-ers
Etherscanist
Telespect
Vis-Scans
Radio-Seers
In-Lookers
Visionees
Telefans
Vis-Fans
Viewers
Photo-Seekers
Telezers
Tele-Optors
Televites
Vision-Ears
Televin
Mien-a-Scope
Tele-Optics
Phonoscope
Teleseers
Spectauds
Scan-Fans
Teleconist
Spectators
Gaze-Ins
Telespy
Seers
Viewee
Oberv-Airs
Airscanners

The humorous element, as in all contests, was well represented. We mention a few titles, which were submitted in all seriousness, no doubt, but they sound quite humorous when you first hear them.

Ravizzier
Air-Peepers
Picture-Hunters
Opticklers
Labarinthians
Penumbrains
Vis-Hams
Ether-Lookers
Gaze-Hounds
Cathodeons
Locusolians
Pantograph-ographers
Radiopeeks
In-Gazer
Cyclodramains
Kinetoscopsters
Nipkownairs
Televigilante

We also came into receipt of an entry from a very distinguished scientist, Dr. D. McFarlan Moore, the inventor of the television tube. Some years ago, Dr. Moore suggested the word *Telorama* instead of television (this word was approved by Dr. Vizatelly, for insertion in the *New Standard Dictionary*); the word Dr. Moore entered was *Teloramists*.

Another distinguished entry was from H. J. Barton Chapple, Wh. Sch., B. Sc. (Hons. Lond.), A.C.G.I., D.I.C., A.M.I.E.E., a famous television writer connected with the Baird (English) company and co-author of the book, *Television Today and Tomorrow*. He suggested the word *Televiewer;* however, this word had about one hundred and fifty duplications.

Dr. W. F. Belmont, of Woodstock College, Woodstock, Maryland, made out a very good case for the word, *Scopers*. He advised that the word *radioscope* is made up of *radio* plus *scope; radio*, of which we all know the meaning, and *scope*, meaning seeing or watching—hence "*scoper*". Dr. Belmont gives some examples of how to use the word:

"Many letters were received from *Scopers*."

"The last *Scope* was put on the air at 10:30 P. M."

"*Scoping* was very poor last night," etc.

In awarding the prize to Sidney Karl Steinfeld, of New Orleans, we feel that under the circumstances we have done as good as can be expected. The word VISUALIST is a fair one, and it may serve a good purpose in television. This word was selected because it was euphonious and expressed exactly what it is supposed to. Sitting in front of a television receiver you visualize the image before you; this, consequently, makes you a VISUALIST. But, as we have said at the beginning, it may be doubtful that the word finds its way into the common language. Only time can tell.

$50.00 Prize awarded to:

Sidney Karl Steinfeld
3706 Gen. Pershing Street,
New Orleans, La.

for the new word

VISUALIST

to supplant the cumbersome word "lookers-in" in television.

In connection with our "New Word" contest, special honorary mention is given to:

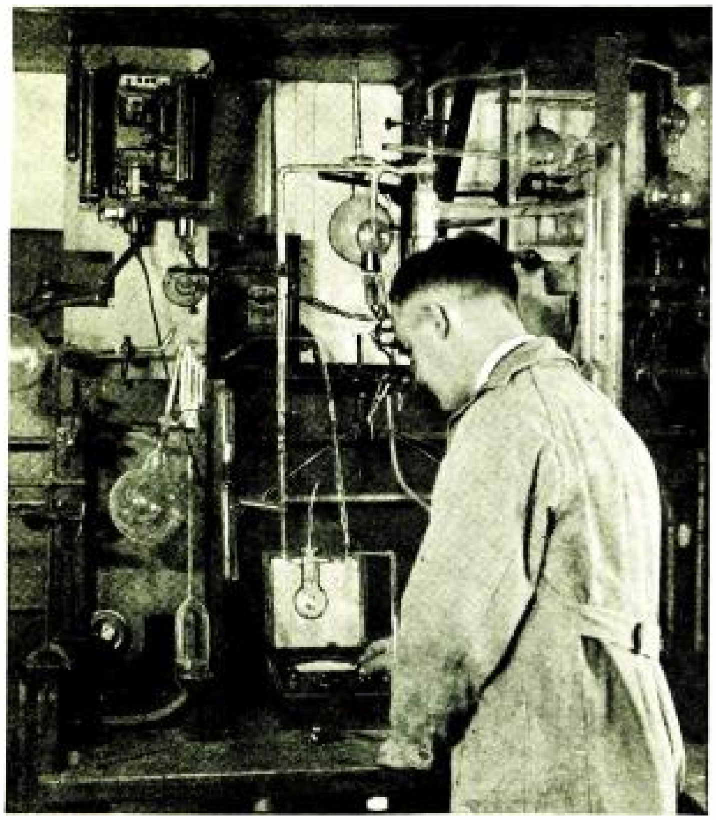
William J. Crocker
738 Snow Street,
Negaunee, Michigan

for the word

SCENIST

We suggest and recommend this word for the television technicians at the transmitter. The men who operate the television transmitter, and put the television scenes on the air, may be termed quite properly SCENISTS. We believe this to be an excellent word which should find its way into the common language.

We may say in the future, for instance, "The SCENISTS of television station XYZ gave an excellent rendition of *Faust*, which began at 8:30 P. M."



Mr. Olpin, author of this article, testing photo cell in laboratory.

NEW TYPES *of* PHOTOELECTRIC CELLS

By A. R. OLPIN

Member of the Technical Staff,
Bell Telephone Laboratories

The photo cell or light-sensitive device, so important to the television art, has been the subject of a vast amount of laboratory research. Some of the things science has found out about the behavior of different metals and gases when used in a photo cell are here explained by Mr. Olpin.

KNOWLEDGE of the photoelectric effect dates from 1887, when Hertz discovered that ultra-violet light, falling on a spark-gap, permitted an electric discharge to take place more readily than when the gap was in darkness. A second but allied effect was discovered the following year, when Hallwachs observed that a well-insulated and negatively charged body lost its charge when illuminated with ultra-violet light. Both of these effects, although of the highest theoretical importance, were too feeble to be of any practical significance at the time.

The evolution of the photoelectric cell as it is known today really began in 1889 when Elster and Geitel discovered that electro-positive metals, such as sodium, potassium, rubidium, and caesium, exhibited photoelectric activity when illuminated with ordinary visible light.

The history of the modern photoelectric cell has been essentially that of the development of a technique for the proper handling of these chemically active metals in a vacuum. Early advances were made by improving the degree of vacuum so that the metals could be used in a purer state. More recent developments have come from treating the surfaces of these pure metals with limited amounts of various gases or dielectrics.

In popular literature the photoelectric cell is frequently referred to as the "electric eye" because it is commonly employed to do the work previously done by human observers. The response of the electrical eye to light of various colors however has generally been quite unlike that of the human eye.

Of the photoelectric cells using pure metals as the light-sensitive element, only those employing caesium exhibit a response to colors that even roughly approximates that of the human eye. This may be seen from Fig. 1, which gives curves showing the photoelectric response of the pure metals and, in dotted lines, of the human eye to light of various colors. The ordinates of all curves have been multiplied by convenient factors to make their maximum values equal.

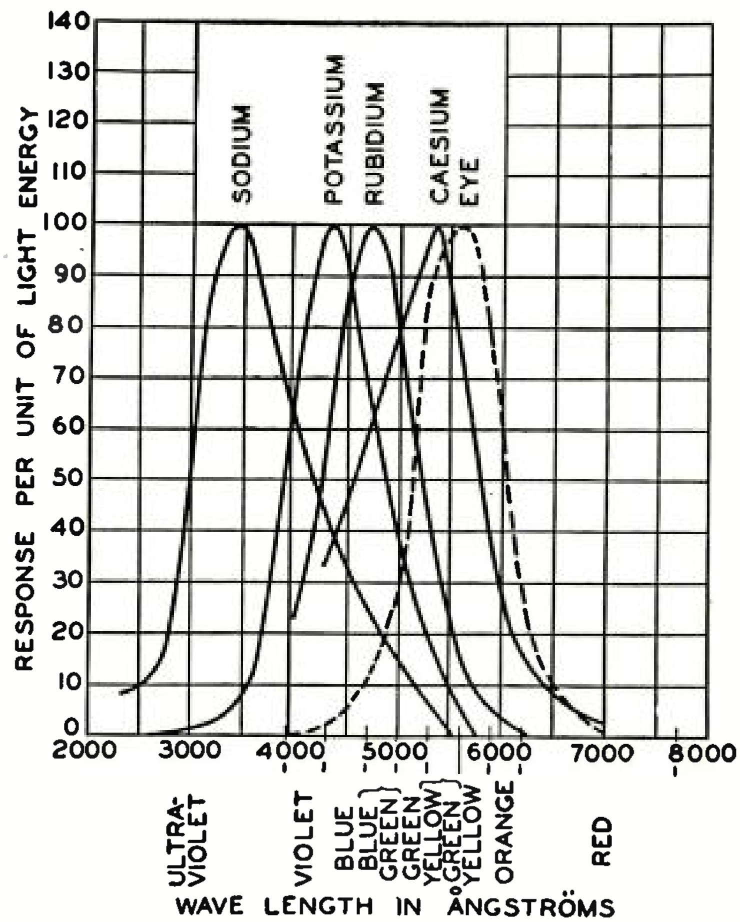


Fig. 1 — Photo-electric cells using the pure alkali metals respond differently to light of various colors.

The caesium type, which, of the pure-metal cells, most nearly approximates the response of the eye, is difficult to make; because caesium itself has such a strong affinity for oxygen and such a high vapor pressure that

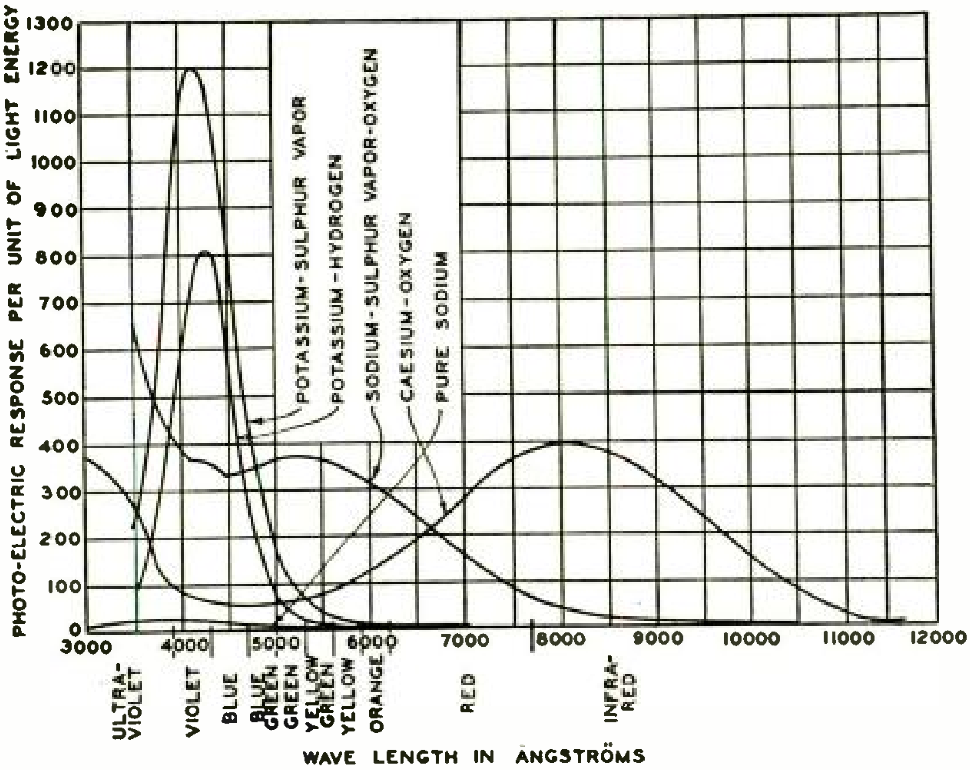


Fig. 2—By special treatment of the metal surfaces, the sensitivity is greatly increased and the points of maximum response are shifted in the spectrum. The curve for pure sodium is given for comparison.

it is difficult to obtain or prepare in its pure form, and it is only the pure metal in bulk form that yields the form of curve shown. The rareness and consequent cost of the metal also contribute to make it impractical for general use.

That an electrical eye should have a response similar to the human eye, however, is not necessarily essential. The shape of the response curve of the eye does not affect the appearance to us of an object in black and white—such as a photograph, an engraving, a printed page, or a pen and ink sketch. For correct reproduction of such objects all that is required is a response to difference in average intensities. The cell giving the greatest output per unit of incident energy would thus be the most desirable for such purposes. The No. 1-A photoelectric cell used up to the present time in picture reproduction and similar fields, has been one of the best cells available in spite of the fact that it responds selectively to blue light and is insensitive to red. The cell is made by ionizing hydrogen on a surface of potassium—a treatment which, as Elster and Geitel discovered about twenty years ago, considerably enhances the emission of electrons without greatly changing the color response from that of pure potassium.

Recent advances in photoelectric cells have been made by treating the surfaces of alkali metals with gases other than hydrogen, or with vapors of various dielectrics (such as sulphur or organic dyes). The results have been very satisfactory. The selective response has been found to depend not only on the materials used but on the ratio, in the surface compound, of the number of atoms of the sensitizing material to the number of atoms of the alkali metal. This ratio is usually very small and the technique for controlling it varies for the different metals because of the large differences in vapor pressures and chemical affinities. In many cases small amounts of a suitable dielectric are sublimed from a side tube, or small amounts of gas are introduced from a nearby bulb. In other cases, particularly where caesium is used, the procedure is decidedly more involved.

The actual response to equal amounts of energy of various wavelengths of four of such cells is shown in Fig. 2. The high sensitivity of the potassium-hydrogen cell to blue and violet light is here evident; but sensitivity at these wavelengths is even greater for the potassium-sulphur cell. Such curves, however, giving the response of cells to equal quantities of energy at different wavelengths, do not tell the entire

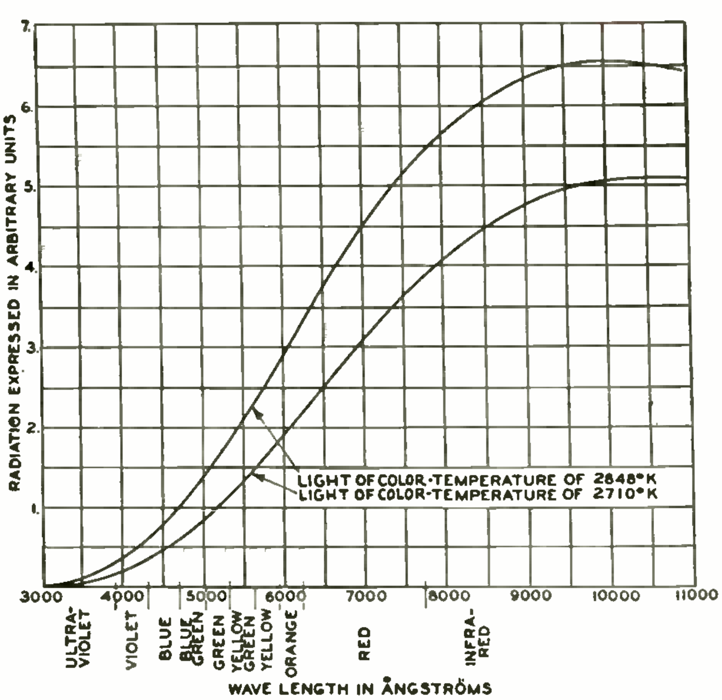


Fig. 3—Tungsten light sources radiate the greatest amount of energy at the longer wavelengths, but the actual distribution depends on filament temperature.

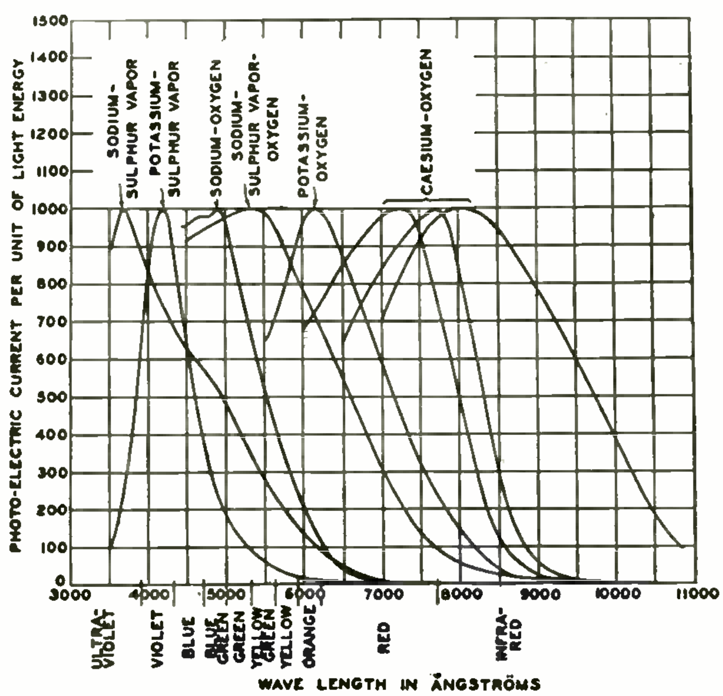


Fig. 5—Response curves having their maximum value at almost any wavelength may be obtained by proper treatment of the alkali metals.

story. The effectiveness of any particular cell depends not only on its response curve but on the energy distribution of the light source with which it is used. Typical energy distribution curves for two types of incandescent lamps are given in Fig. 3. From the curves it will be seen that by far the greater part of the energy is radiated at wavelengths longer than yellow.

The response of cells to light from such sources is proportional to the product of the ordinates of one of the curves of Fig. 3 by those of the curves of Fig. 2. The resulting response for the five cells plotted is given in Fig. 4. The total response per unit of illumination is equal to the areas under these various curves. The response of the caesium-oxygen cell, which from Fig. 2 might seem to be less than the others, is actually the greatest where the source of light is a tungsten lamp.

For such systems as sound-picture or picture-transmission, where incandescent lamps are used as light sources and where, because only differences of intensities need be reproduced, no attention need be paid to color distribution, a caesium-oxygen cell has great advantages. For television, on the other hand, particularly where full color is to be reproduced, the requirements are different. In the color-television system, demonstrated by the Laboratories in 1929, a satisfactory response was obtained by using both potassium-sulphur and sodium-sulphur-oxygen cells. The combined response of the two cells satisfactorily reproduces all colors.

Another interesting application of the use of cells of different responses was made in the recent demonstration of two-way television. Here a person at one end, at the same time that he is seeing the image of the person at the distant end, is being scanned by a beam of light so that his image may be transmitted. Early trials were made, using cells sensitive only to blue light and employing a blue beam for scanning to obtain a light that would not dazzle the eyes of the observers in the booth. The potassium-sulphur cells were used. The system was very satisfactory in so far as glare from the scanning beam was concerned; but, because only blue light was employed, the reds and yellows in a person's face did not appear quite natural in this reproduced form. To improve this feature, some caesium-oxygen cells were added. These cells reproduce the reds very well and to make them effective a red component was added to the scanning light which changed it from a blue to a purple. The purple light is just as satisfactory from the standpoint of glare, and the resulting image, because of the presence of reds, is much more natural. From Fig. 4 it will be noted that the combination of these two cells is practically insensitive to yellow light; so that the booth may be lighted with a low-intensity yellow light without affecting the television transmission.

Photoelectric-cell manufacture has now reached the point where selective response to light of almost any color may be obtained. Curves for some of these cells, which although made for experimental purposes are not commercially available, are shown in Fig. 5; but the curves are not complete, as most of them have other selective maxima in the ultra-violet region. The study of methods of sensitizing alkali metals is being continued. Among the profitable results already obtained are many valuable theoretical deductions which promise to aid greatly in the further development of the subject.—*Courtesy Bell Laboratories Record.*

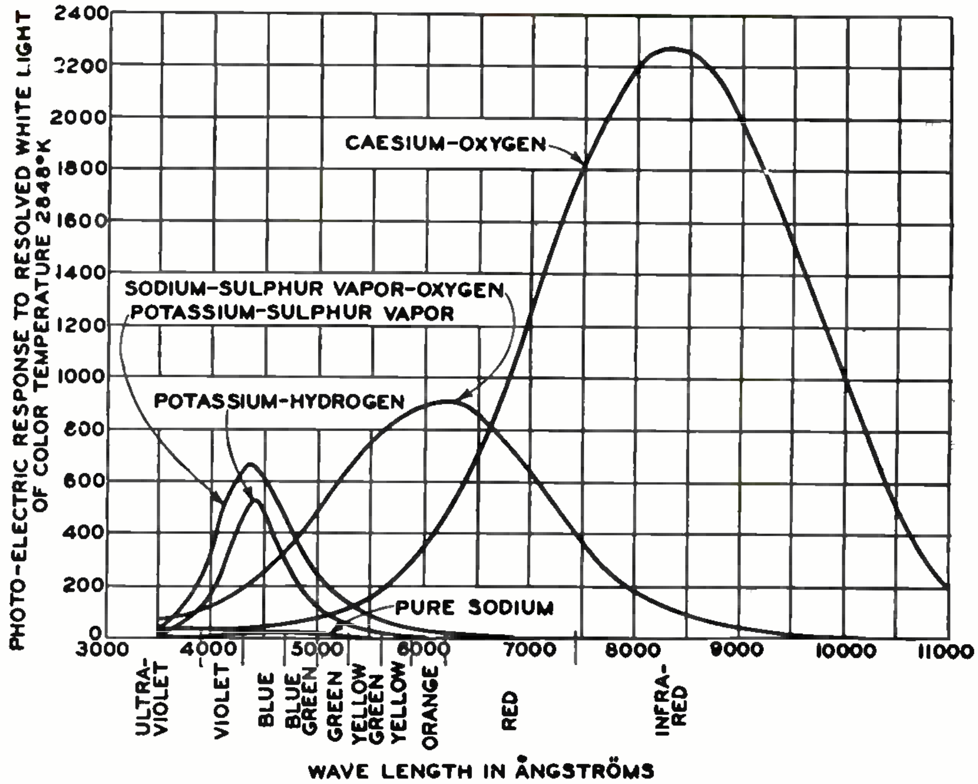


Fig. 4—The response of a cell to light from a tungsten filament depends on the characteristics of both cell and filament.

In Our Next Issue

A HELICAL MIRROR SOLVES THE SCANNING TRICK

LATEST TELEVISION NEWS FROM BOSTON, by Hollis S. Baird

SYNCHRONOUS IMAGES OBTAINED WITH "HOME-BUILT" MOTOR—SIMPLE DEVICE EASY TO MAKE AND CAN BE ADDED TO ANY TELEVISOR, by Clyde J. Fitch

THE ELEMENTS OF SYNCHRONISM, by H. Winfield Secor

DIGEST OF IMPORTANT TELEVISION PATENTS, by C. H. W. Nason

THE PRACTICAL OPERATION OF A COMPLETE TELEVISION SYSTEM, by Allen B. Du Mont, V.-P. and Chief Engineer, DeForest Radio Company

HOW SHALL I SYNCHRONIZE BETTER? by Rudolf Schadow (Berlin)

THE NEW BARTHELEMY TELEVISION RECEIVER

STAGING TELEVISION SHOWS

NEW TELEVISION AMPLIFIER WITHOUT RESISTANCE COUPLING

THE NEWEST TELEVISION SCANNERS AND RECEIVERS FOR HOME USE

LATEST PHOTOS AND DESCRIPTIONS OF TELEVISION STATIONS

QUESTIONS AND ANSWERS

SOME of the PROBLEMS of TELEVISION

The Television experimenter, if he ever expects to make any worth-while inventive contributions to the Television Art, must first of all know what some of the unsolved problems are. Mr. D. E. Replogle,* who has been very closely associated with the growth of Television in America, points out in this article what some of these outstanding problems are.

It would require 2,236 dot elements (per one-sixteenth of a second) to reproduce this photograph in the same size by television. Eye fatigue would cause the individual dots to blend harmoniously.

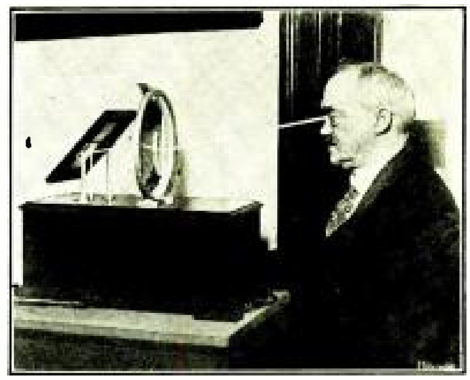
THE radio audience is radio blind. Irrespective of the marvels of radio broadcasting, and without detracting in the slightest degree from the praise due broadcasters for their magnificent service to society in bringing a world of music, entertainment and enlightenment into every home equipped with a radio receiver, the fact remains that the radio audience is blind and must continue to be blind until broadcasting technique includes television to complete the presentation. Today we have only listeners-in for our radio audience; tomorrow, we shall have lookers-in, as well. Television will supply the *visual*, as a supplement to the *aural*, effects in completing the service of broadcasting.

Television Technique

However, as engineers we cannot permit our enthusiasm to run away with our better judgment. Most of us know in a general way the many and the serious problems that stand in the way of television development. In fact, we have received the greatest challenge yet issued to our branch of engineering; for television, we note, calls for doing a lot of things in a fraction of a second; it calls for minute attention to detail; it requires the analysis of images in terms of dots and light values, and the transmission of such an analysis, followed by the reconstruction of the dot elements into a replica of the original image. Electricity, mechanics, gaseous conduction, distortionless amplification, new forms of modulation and demodulation, chemistry, optics and even a new stage technique are among the problems confronting us.

It has been held by some students of television that the greatest problems to be solved are in the direction of presentation. Such views, however, appear unfounded. The same was said of talking motion pictures, yet even at this early date many excellent talking picture plays have been produced. With the entire world to draw upon for visual as well as aural material, there should be no dearth of subjects, although, it is true, much ingenuity will be required to present the world through the tiny window of the television screen. As television develops, the presentation will become increasingly popular, but at first there will be serious but not insurmountable problems by way of staging playlets within the limitations of the close-up picture, which is as much as television can handle for some time to come.

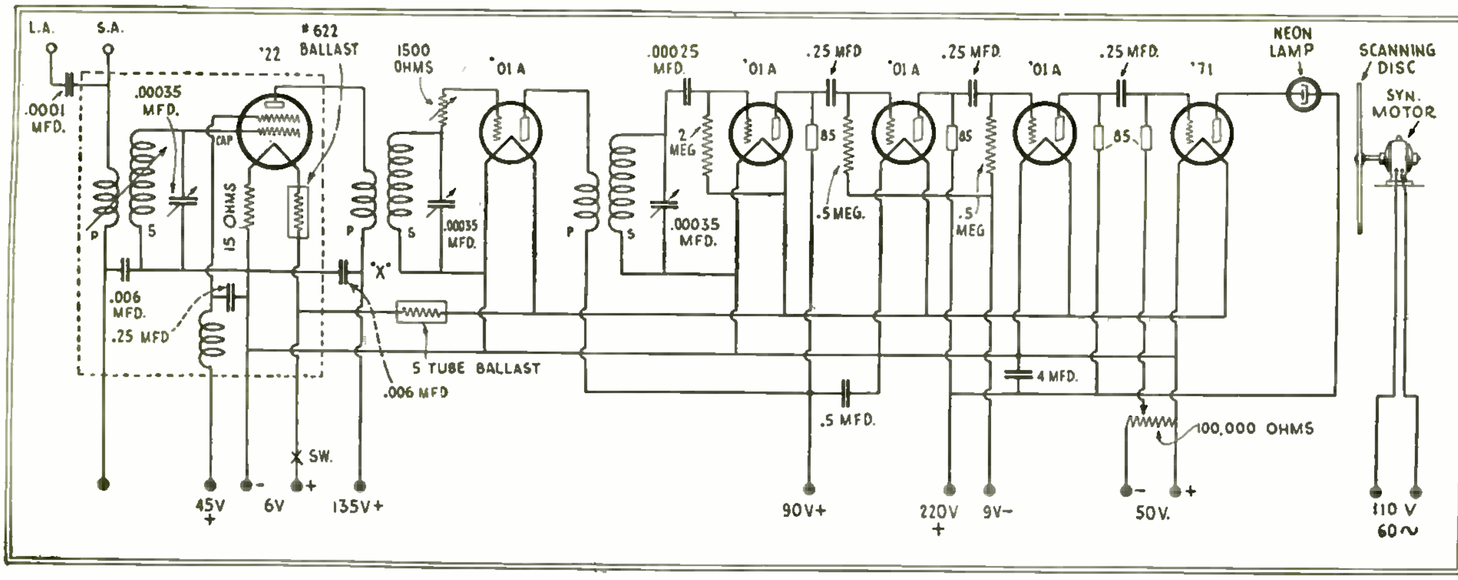
The "20-line screen" used to photographically produce the former effect, has here been replaced with an 80-line screen. This view of Jean Arthur, Paramount star, indicates the "detail" which a greater number of dots makes possible.



Mr. Jenkins and a modern version of a television receiver. "The Father of Television," we call him. In England, however, they prefer to think of Mr. Baird as such.

As I see the matter, television presentation may be based on the subject matter of the usual cinematograph screen, except that it has the added advantage of instantaneous reproduction. In other words, the television presentation shows the subject as it is at that particular moment. There is no elapsed time, as with the motion picture. And so the television screen will no doubt be largely devoted to portraits of speakers and artists before the broadcast microphone, with the aural accompaniment entirely optional. Later, there will be playlets, to take the place of the present shadowgraphs which show such simple things as playing ball, dancing, skipping rope, and so on. Today we are not so much concerned with the theme of our television pictures, as we are with the propagation and reception of

* *Vice-President, Jenkins Television Corporation.*



An amplifier designed particularly for television work. Such an amplifier should be capable of amplifying over an unusually wide frequency range extending beyond audio limits, per se. The chokes No. 85 have a D.C. resistance of about 100.000 ohms. (One type is the "resisto-choke.") A battery supply with low internal resistance is absolutely essential (to prevent "motor-boating").

the images, irrespective of their interest, *per se*.

I believe we should, as engineers, be vitally interested in television presentation. For instance, there are already certain television actors, whom, we are told, have the necessary "television faces" and television acting requisites. These consideration are highly important in the early stages of television. Just as early motion pictures, with their frugal amount of detail, called for persons with prominent features, plenty of make-up, and a high degree of expression in their hands and arms, so must we count on these requisites while television is scanty in detail. Later, with more refined image reproduction, we shall come down to the beautiful technique of screen acting with the slight arching of an eyebrow conveying the same thought which the waving of an arm would now convey.

So among our first problems are those of acting and stage setting for our television pictures. We must have the cooperation of those skilled in the histrionic art and stage setting art, if we are to have suitable material to handle with our television systems. Already the General Electric Company has done some excellent work by way of developing a suitable television stage technique, even with a multiplicity of television pick-ups for quick changes of scene, special settings, actors, made up for television requirements, and so on.

Channel Selection

The logical problem that follows the production of the television subject is that of detail. In fact, the problem of detail will be a difficult one to solve, since it involves questions of dot elements, time limitations, luminous intensity, accurate synchronizing, and wave band available.

Because of the wide frequency band required for satisfactory television modulation, we are compelled to employ high frequencies or short waves. The broadcast spectrum, which covers from 200 to 550 meters in the United States, and up to several thousand meters in other countries, cannot provide a place for a television channel at least 100 kilocycles in width, which is necessary for satisfactory detail. In the United States the broadcast channels are placed every ten kilocycles apart, which is deemed the narrowest possible channel consistent with good broadcasting results.

One make of light-sensitive cell. It is used at the transmitting end of the circuit.

With the necessity of employing short waves or high frequencies, then, a number of considerations are immediately introduced into the problem. Short waves, unlike the higher wave lengths, are by no means universal in application. Thus, a single wave length cannot be employed in the short-wave spectrum for a universal television service. An analysis of satisfactory television service discloses the necessity of utilizing three simultaneous short-wave channels, as follows:

1. A channel for urban or city service, under conditions of marked absorption of radio waves. A satisfactory frequency will have to be found by actual experiment, so as to provide television service to those residing in congested metropolitan areas.

2. A channel for suburban or rural audiences, located outside and at varying distances from the metropolitan areas. Since the particular wave length employed for urban or city service may not have the desired carrying power, both this frequency and that for the metropolitan service will have to be determined through long and careful experimentation.

3. A channel for distant service and rebroadcasting purposes, with the skip-distance phenomenon of certain short-wave frequencies utilized to the best possible advantage. It will be this channel which will provide an exchange of television services between nations, and will span the oceans with pictorial and living presentations of important events.

Those who legislate the division of the crowded radio sky or ether may well question the necessity for wide television bands, especially since our present-day broadcasting is handled on relatively narrow channels. Yet the width of the channel determines the dimension of the television image and the amount of pictorial detail. With a radio channel 10 kilocycles wide, such as we employ in American broadcasting practice, the television image will be limited to one capable only of handling close-ups of heads or other comparable figures, with crude detail. Such, obviously, is not the ultimate ideal in television.

The Fundamentals

Let us stop for the moment to analyze just what the basic television technique comprises, as we know it today:

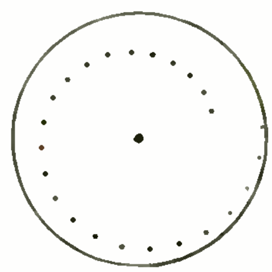
At the transmitting end, we really analyze or scan our image by lines. The greater the number of lines into which we break up our image, the greater the detail, as is the case with the dots of the half-tone screen used in making photo-engravings. We obtain our line analysis by utilizing what is known as the scanning disk, comprising a revolving disk with a suitable arrangement of holes. The holes are so spaced from the center of the disk and from each other on the spiral curve as to provide practically straight lines for just that portion of their swing through the field of vision.

The scanning disk can either throw a beam line by line on the subject, with photo-electric cells picking up the reflected light and translating the varying light intensities into electrical variations; or again, the scanning disk can analyze the focused image line by line and pass the varying light intensities back to a photo-electric cell contained in a camera or light-proof box. The first system is the most commonly employed. The subject, in this case, must be in a studio or indoors, where the light can be controlled. However, it is surprising how powerful the lighting may be, without interfering with the scanning beam action. The second system permits of scanning subjects outdoors, in bright sunlight, since the photo-electric cell, and not the subject, is being subjected to the scanning beam.

At the receiving end, we have just the reverse operation. The signals are amplified and fed to a kino-lamp or neon glow tube, which varies in luminosity according to the modulation of incoming waves. The varying luminosity must now be translated into lines corresponding to those used in analyzing the subject at the transmitting end. A scanning disk, revolving in step with the scanning disk at the transmitting end, is employed. The holes serve to break up the glowing kino-lamp plate into a series of lines of varying intensity; there is only a single point of light on the television receiving screen, and this dot may be bright, medium or dull depending on the radio modulation at that given instant. However, in the short space of less than a fifteenth of a second, the lines for the entire image have been formed by the sweeping dots. The persistence of vision, which causes the eye to retain an image for approximately one-fifteenth of a second, causes all the dots projected for that interval to appear as a complete pattern. By overlapping the lines slightly, the pattern appears fairly solid. In this way, therefore, we convert the moving dot into an apparent line, and the many lines into an apparent solid pattern. Thus we have a continuous illusion, with fresh dots and lines constantly forming to replace those fading out of sight, giving us the living image effect.

A form of conductive-gas lamp. It is similar to the neon-filled lamps, in operation. The square surface becomes intermittently luminous so rapidly the eye cannot possibly follow the fluctuations. It is this "optic fatigue" which makes television possible.

Our television image is therefore a pattern of successive lines, so closely packed together that the usual screen fails to suggest successive lines. In some respects it is much the same as the usual half-tone engraving used in printing, made up of dots of varying size. We obtain black when the dots are so large that they meet; gray when the dots are medium sized with a little space between; and white when the dots are very small and surrounded with a preponderance of space. Actually, the varying shades of gray are simply an optical illusion, since we are working only with black ink and white paper. Television, likewise, is an illusion. We have dots woven into lines, and lines into a complete image. It is simply a question of how many lines we are using, how much contrast we have between full intensity and minimum intensity, how accurately the lines meet or overlap, and how well we can maintain the synchronism of transmitter and receiver scanning disk.



The "scanning disk". It is to television what the "half-tone screen" is to the printer. The distance between two dots (holes) is the width, while the span between the start and finish of the spiral is the height of the picture.

Now a newspaper half-tone is usually a 65-line engraving, which means 65 horizontal rows and 65 vertical rows to the square inch, or a total of 4,225 dots. Everyone is familiar with the modest amount of detail permissible with such engravings; it leaves much to be desired.

An early American television unit incorporating scanning disk, neon lamp, television frequency amplifier and power supply.

In television practice, however, in order to present an even more crude image, say of 50-line texture, or the equivalent of 2,500 dot elements to the square inch, we must transmit these lines in one-sixteenth of a second, or at the rate of 40,000 dot elements per second!

Size Limitations

Our experiments so far lead us to believe that with single side-band transmission, it is necessary that the frequency in kilocycles be one-half times the number of dot elements. For a 50-line image, a 20-kilocycle band is required for satisfactory results, and for a 100-line image, an 80-kilocycle band is necessary.

If we refer back to our newspaper half-tone, we will note that an image 3 by 5 is about the minimum for viewing persons and events and entertainment. It would be, in fact, a very small window through which to look out upon the world. Yet such dimensions, with, say, a 50-line texture, would call for an image 150 lines high, and 250 lines wide, or the equivalent of 37,500 dot elements to be transmitted in one-sixteenth of a second!

We have accepted the 100-line image as about the maximum for present-day technique. It permits of presenting two or three persons, full length, with some background, and again with two or three lines of type for caption, if desired, together with sufficient detail considering the nature of the picture.

Even with a 100-kilocycle band, we cannot expect to enjoy anything like the crisp, crystal detail of the motion picture screen. We cannot hope to see the individual bricks in a brick wall. We cannot expect to see individual soldiers in a parade. To provide such detail, an exceptional requisite becomes apparent; a frequency-band thousands of kilocycles wide would be needed.

Unfortunately, there are various systems now being exploited, with 24-

(*Continued on page* 235)

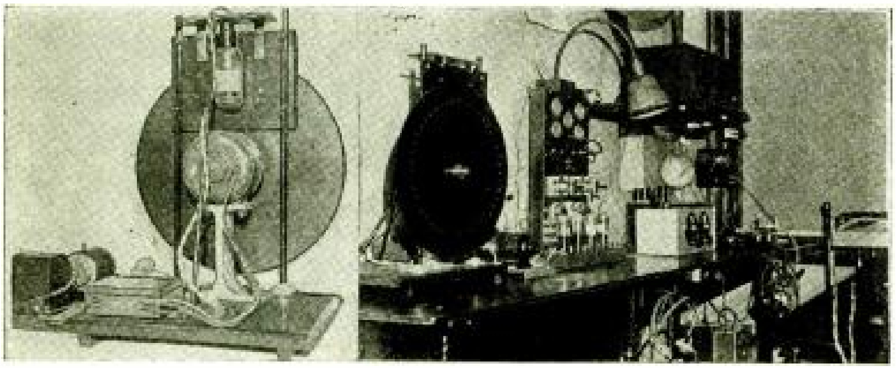
SEEING IS BELIEVING

Receives Television Clearly

Editor TELEVISION NEWS:

Herewith two photographs and a description of my television apparatus, which may interest you.

I am using a Silver-Marshall short-wave set, which I assembled several years ago. I connected a jack between the detector and transformer coupled audio amplifier in the receiver, so that I can plug in a resistance coupled amplifier when I use the television outfit. This resistance coupled amplifier has three stages, with two tubes connected in parallel in the last stage. This outfit is operated by one storage "A" battery and nine 45 volt "B" batteries. All connections are made from a switchboard, which also includes A.C. and D.C. meters, jacks for plugging in meters to read "B" voltages, switches, pilot lights, etc.



Mr. Mundt's amateur "television" receiving station, from which he has obtained very good results.

The scanning mechanism was constructed of scraps found about the house. The 1/20th H.P. motor turns a 16 inch, 48 hole disc. The motor is supported on a babbitt pedestal, which in turn is bolted to a wooden baseboard. The neon lamp is hung in back of a sheet of bakelite, which has a 1¼ inch square opening for viewing the pictures. Two iron pipes and a ¼ inch iron rod hold this lamp assembly rigid. A Clarostat motor control resistance is used for regulating the motor.

I have received radio movies from the Jenkins Stations, W3XK, Washington, D. C., and W2XCR, Jersey City, N. J. Strange to say the clearest pictures came from the furthest station, namely, W3XK at Washington, D. C. When conditions are favorable, I can distinguish the finest detail in the silhouette movies.

WILLIAM MUNDT,
828 Broadway,
Bethlehem, Penna.

He Found Kit Parts in Kresge's

Editor TELEVISION NEWS:

I wish to express by appreciation and thanks. TELEVISION NEWS is a welcome addition in the magazine world. May you and the public derive mutual benefit and pleasure from this new and needed publication.

Those of us who have tinkered with radio, built sets, and had the satisfaction of listening in on programs near and far through the sets built with our own hands, look forward with keen pleasure to spending more pleasant hours building *television receivers*. There must be many like myself who cannot afford to purchase a complete set or kit at one time. There also are many who enjoy shopping about for their parts. I was browsing about in one of S. S. Kresge's .25 to $1.00 stores, where I discovered, much to my pleasure, that *Television parts* could be procured there. They also had a booklet entitled the "Romance and Reality of Television." This booklet gave a very comprehensive account of how television works and also instructions for building a short wave receiver as well as a television receiver.

I feel that you would be doing a great service to your readers by making known this source of short wave and television equipment. It was by chance that I discovered it, and I believe that there are many who are not aware of this fact. Though not a believer in rushing this new science too much, the more lookers-in, or as I would term it "hearseers", there are, the more attention will be given to the production of television broadcasts.

Again wishing you success with TELEVISION NEWS, I remain,

PHILIPP L. KOCH,
2115 N. Spaulding Ave.,
Chicago, Illinois.

He "Sees" Washington and Boston Images

Editor TELEVISION NEWS:

W2XCF is the best television station I receive (at Jamaica, L. I.) so far as direct pick up at the transmitter is concerned. A few weeks ago W2XCR televised four girl singers and the tallest girl was the best looking one, as far as the television image disclosed. (Here's your chance, girlie!) One interesting fact, well worth mentioning, is that in each case the teeth could be readily seen. I pick up the accompanying sound such as music and voice from WGBS on my regular broadcast receiver. (*WGBS transmits the voice and music accompanying the television program of W2XCR—Editor.*) I pick up television images from W3XK in Washington, D. C., and also from the television station W1XAV up in Boston. I built my own single control television receiver and it has three stages of tuned screen grid amplification. The audio amplifier is resistance-coupled and the output tube is a '50 type. I can shift scanning discs so as to scan with 48 or 60 holes. The aerial I use with my television receiver is of the "T" form, one side of the "T" measuring 50 feet and the other side 75 feet.

B. HEINAMEN,
Jamaica, L. I. C.,
New York.

Picks Up Four Television Stations

Editor TELEVISION NEWS:

Looking over my list of radio parts, I suddenly had a bright idea; with all these television programs appearing in the newspapers every day, says I, why should I waste this opportunity to "see" what is going through the ether as well as "hear" what the stations are broadcasting. The first discovery I made was that I had one of the old Daven "bass note" receivers and I immediately proceeded to convert this for operation on the television band; that is, from 100 to 150 meters. I rebuilt the receiver, put in new coils and condensers and arranged for the use of two screen grid '24 tubes, a detector, followed by a three-stage resistance-coupled audio amplifier. I use a '45 tube in the last audio stage which feeds into the neon tube. I picked up the following television broadcast stations: W2XR, W1XAV, W2XBS and W2XCR.

H. LIEBERMAN,
Brooklyn, N. Y.

"Sees" 4 Stations With Home-Made Televisor

Editor TELEVISION NEWS:

Using a 60 hole scanning disc and a "non-synchronous" motor I have succeeded in obtaining very good results in picking up television images, (including excellent half-tones) from the following stations: W2XCD, W2XBS, W2XCR and W3XK. The latter station's television signals fade at times. However, the best images I have received from this station is when they use film transmission. I receive the image on my home-made receiver. "The little girl with the golden locks" came in fine, as well as the film showing Dr. de Forest. Even though my motor is of the non-synchronous A.C. type, with a normal speed of 1,800 r.p.m., I have been able to quite accurately regulate the speed to 1,200 r.p.m., by means of a variable resistance, and "believe it or not" I can hold the image from W2XCD (Passaic) in a practically perfect manner. I have also been able to keep the image framed in surprisingly fine order from stations W2XBS and W2XCR.

L. BELLINGER,
Newark, N. J.

A Bouquet and An Idea

Editor TELEVISION NEWS:

In the March-April issue of TELEVISION NEWS an article appeared asking the reader to express his thoughts on television and of the magazine itself.

Well, I think that your magazine is very good. It is full of very interesting articles on the subjects of which I am very much interested in.

I suppose that Mr. Farnsworth has about the most advanced television apparatus to date. Leaving out the details of the machine, let's see here a minute.

I have in mind an apparatus that can register a picture in all its true and original color, distinction of all details and yet undisturbed by any atmospheric conditions that may take place between the transmitting and receiving end. This apparatus is small in make-up and the picture can be magnified to any dimensions.

The camera was invented in 1558 but moving pictures didn't come in until over two centuries later. Why is it they try now to transmit a moving picture when they can't perfect a still picture by radio?

Would a still picture of such qualities as I have mentioned be of value in any way? It would take some three to five minutes for the transmission of such a picture. I hope someone will answer my letter.

JAMES A. GLASS,
146 West Spring Street,
New Albany, Indiana.

Television Demonstrated at the University of Kansas

Editor TELEVISION NEWS:

I am glad to see the publication of a magazine which will supply information on television equipment started. I have been experimenting for some time myself and have been receiving the Jenkins signals quite regularly.

I am sending you a description of a television demonstration at the 1931 engineering exposition at the University of Kansas. I thought it might be interesting to you to know what the universities are doing to interest the general public in television.

C. BRADNER BROWN,
1138 Kentucky Ave.,
Lawrence, Kansas.

DURING the recent engineering exposition, the author set up and demonstrated a television set. The exhibit was located in the electrical laboratory in one of the rooms used for "thesis" research. Owing to the distance from any radio station sending television signals and also to the fact that it was necessary to operate at hours which were unfavorable to short-wave reception, it was decided to set up a local sending station and connect the receiver with line wires.

The Transmitter

The sending set is shown in Fig. 1. At the extreme left can be seen the lamp house containing the 1,000 watt projection lamp used as a light source. A standard set of condenser lenses was used to concentrate the light on a lantern slide immediately in front of the lamp house. Further to the right is the projection lens which forms the image of the lantern slide on the disc. The discs used were 32 hole, 14 inch sheet iron affairs, which were constructed on a large lathe. The discs were turned down and the hole spacing located by using the micrometer carriage feed. The angular spacing was determined before centering the disc, so the hole spacing was found by turning the disc one angular position at a time and feeding the micrometer adjustment a predetermined amount. The tool rest carried a sharp scriber, which was used to mark the center of the hole. In this manner, a very even distribution of light was obtained. The picture was a little over 1.25 inches long and scanning was done from bottom to top and from left to right. The angle between holes was 360/32 or about 11.2 degrees. The choice of 32 holes was made because this was a power of 2 and simplified the division of the disc.

The driving motor was a rebuilt direct current machine of about a ¼ h.p. rating. A slip ring was added and two opposite commutator segments tapped, one going to the slip ring and the other being grounded. The result was a rotary converter operating on D.C. supplying A.C. from the slip ring and the grounded frame. This A.C. was used in synchronizing the discs as will be explained.

Photo Cell

A lens system concentrated the light coming through the disc on to a photo-electric cell, contained in the shielded cabinet at the extreme right. The cell is shown standing in front of the disc and is a gas-filled Western Electric Co. cell, of the type used in talking picture equipment. From the photo-cell, a shielded wire leads to the "low level" amplifiers which consists of a two stage, impedance-coupled system, using W. E. 239-A's.

Figure 2 shows the receiving set. The amplifier at the extreme right is a "re-vamped" Westinghouse, having three stages of impedance coupled amplification which can be used at will by plugging in the jack at the bottom. The center panel contains the power amplifier which consists of a '45, feeding into a '10 or a '50, all impedance-coupled. The impedances used were telephone "retard" coils. The impedance-coupled amplifiers used in this set-up were a compromise between transformer coupling and resistance coupling. The range of the amplifier system was well up to the limit necessary in this demonstration, as the discs were only 32 hole discs and were operated at 15 frames per second.

To the right of the power amplifier can be seen the rheostat controlling the speed of the driving motor of the receiver disc. This disc was equipped with two tandem motors. The first was a series motor driven from the D.C. supply and operated solely to synchronize the receiver disc. The second motor which was a double shafted machine was a two pole synchronous alternating current motor. The latter was supplied with current from the connections to the sending motor already described.

The operation was quite simple. The sending motor was started and a slide placed in the slide rack. The image was focused on the disc and the amplifier turned on. A small speaker was used to monitor the output before switching onto the line. At the receiving set, the volume was set at a low level with the volume-fader control, which can be seen in the center of the power amplifier panel, below the '45. The rheostat controlling the series motor was advanced a few steps and when the disc came up to speed the A.C. was connected to the synchronous motor, which fell into step readily. The series motor rheostat was then lowered two or three steps and the output from the amplifiers switched over to the neon lamp.

Due to the fact that the synchronizing motors were two-pole machines, a slight amount of hunting was noticed. The weight of the discs was sufficient to prevent this from becoming serious, however, and the operation was surprisingly good. No attempt was made to send half-tone pictures as the amplifier limited this type of reproduction. During the exhibit, such things as a continuous string of letters spelling some messages such as television were moved across the screen slowly. Also, silhouettes of crosses and triangles were used.

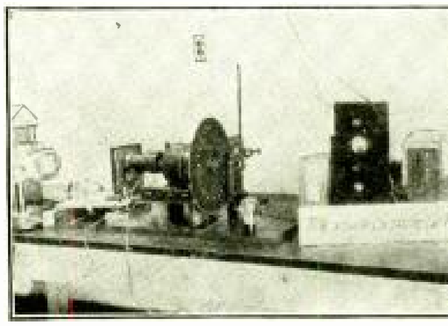


FIG. 1.

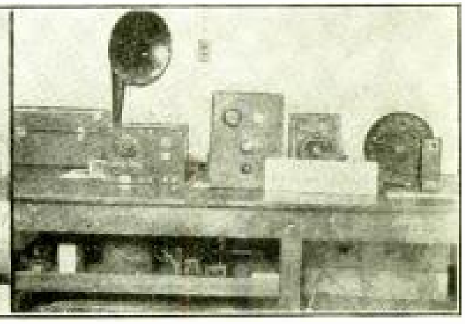


FIG. 2.

This television demonstration set was recently used at the University of Kansas.

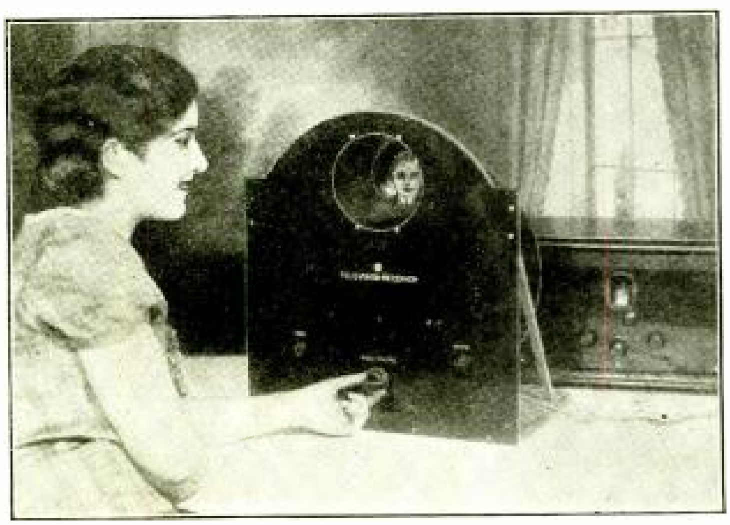
Hoo-Ray for W2XCR!

Editor TELEVISION NEWS:

I have been very busy the last few weeks enjoying the excellent "sound" and "image" presentations broadcasted over the air by W2XCR, the new Jenkins television transmitting station located in New York City, and the accompanying voice which I pick up on my separate broadcast receiver from WGBS. There has been an excellent improvement in the images broadcast by W2XCR in the past few weeks and I can easily see at any time now the teeth of the performer and also the beads of a necklace, if the lady appearing before the direct pick-up scanner at the studio happens to be wearing one. I am having a lot of fun and so are my friends: at times I have had as many as twenty people "looking in" as well as "listening in" on these excellent programs. I "see" W2XBS images great.

M. JOHNSON,
New York City.

The I. C. A. Scanner



THE accompanying photograph shows the I. C. A. television scanner which comprises a driving motor, and the usual scanning disc which is placed behind a magnifying lens. This lens is mounted on the end of a conical tube so that a visor is thus formed in front of the lens, which minimizes the effect of other light in the room. This television scanner unit is supplied with controls for synchronization and framing of the image. All of the controls are mounted on a front insulating panel, which renders them readily accessible for operation. This scanner will work with practically any short wave receiver capable of tuning in satisfactorily the television signals. The outfit is supplied with a 5" lens and visor, which is sufficiently large to permit several people viewing the image simultaneously.

Scanning discs, of special hard aluminum, containing 48 or 60 holes (round) are supplied. This scanner outfit is furnished in knock-down form ready for assembly, which requires but a few minutes time. Any neon tube can be used with this scanner. This outfit sells at a nominal price and is furnished with either a synchronous A.C. motor for use in A.C. districts, or with a universal D.C. and A. C. motor for use in D.C. districts, or for those that may want to change the speed of the motor such as from 1,200 to 900, etc.

The TELEVISION QUESTION BOX

Edited by
C. H. W. NASON

Nicol Prism Troubles

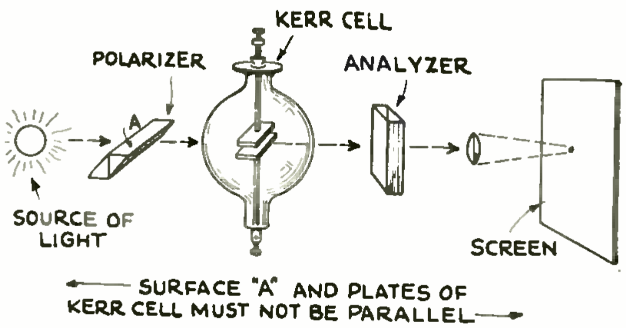
Clifton Marsh, Lancaster, N. H.

Q. 1. I have imported from Europe a pair of Nicol prisms and a Kerr cell. The latter consists of a pair of metal plates about 1 cm. (.4 inch) square in a glass bulb; the distance between these electrodes is variable over a wide range. I have set up this apparatus with a small arc lamp which gives me a good point-source of light, and have arranged the two prisms so that the light is entirely cut off. After placing as high a voltage across the Kerr cell as I could get from the "B" batteries available (about 400 volts) without passing any light through the system, I tried an old transformer with a secondary giving several thousand volts across it. I then succeeded in arcing over the electrodes and dirtying up the nitro-benzene; but no light has yet passed through the system. The nitrobenzene came from England with the cell, and is canary-yellow. Where can I obtain more, if this is where my trouble lies?

A. 1. STOP—LOOK—LISTEN! Unless my old friend "Final Authority" fails me, you are treading on dangerous ground. I cannot find any reference at hand regarding the toxicology of nitrobenzene; but it used to be called "artificial oil of bitter almonds" and was considered deadly. Also, I cannot find much regarding the substance beyond my own experience; but I handle mine with kid gloves—being under the impression that it is first cousin to dynamite. If you arced over your electrodes and are still here to tell about it, I may be mistaken; but just the same I'd not try the same thing again until I knew.

Eimer and Amend, chemists of New York City, can supply you with the same canary-yellow product; but I understand that they can also redistill it for you at a slight additional cost. This might improve the light transmission of the system as a whole. My own supply was yellow and gave excellent results until I started off on another track.

As for your present discouraging results—I think I can set you right in jig time. Run up to your laboratory and twist the polarizer prism through a small angle; then start over again where you left off. You can put all the voltage in the world across your cell, *with no results*, if the plane of the electrodes is parallel with that of the axis of the analyzer. The diagram shows what I mean, more graphically than I can describe it.



Arrangement of light source, polarizer, Kerr cell, analyzer, lens and screen on which television image is projected. This is the basis of the large image reproduction by Alexanderson.

I have indicated an Isenthal cell, as I note that yours came from England. If I remember correctly, a voltage of about 200 will give an excellent rotation.

Amateur Transmitting Station

R. W. Carr, Station W5UX, San Antonio, Texas.

Q. 1. I notice that certain of the amateur bands are open for experimental work in the field of television. Can you give me any information which will be of assistance to me in this work? I am an amateur of long standing, and you may remember me from the days when you were ML at old 3YK. I was formerly 5ABZ, and used to take your traffic for southern Texas, if you are the same one I think you are.

A. 1. Well, well, and a couple more wells! Now what do you know about that? I thought that my infamy in the days of Spark and the E. I. Company had been forgotten.

Yes. I am the same old bird, and mighty pleased to hear from you. I cannot give you a great deal of information outside your own experience, other than to tell you that you are going to take a lot of grief unto yourself. But it is the kind of grief that pays long dividends in enjoyment to the dyed-in-the-wool variety of Ham, and I think that you are starting up in a field of endeavor which will amount to something in the days to come. The writer has applied for an amateur license (I have been out of the field for years) and have already started construction of a station for the same purpose.

The only advice I can give at present is to the effect that you must have at least fifty watts of power output and must modulate to a full 100 per cent if you expect to "get out". The modulation must be out to a full 30 to 40 k.c. if your images are to be any good—that means that "band selectors" or similar arrangements must be used in the transmitter in all circuits subsequent to the modulator tube.

Crystal control is practically essential if your pictures are not to be "messed up" with noise. In other words, your first job is to build a 'phone transmitter of superlative performance—at the same time I would get started in the receiving end of television, in order to have a general idea of what it was all about, before it comes time to "go on the air". From time to time articles will appear in this journal and in SHORT WAVE CRAFT, which will assist you in your development. In the mean time—*Hasta Luego!*

Construction of a Nicol Prism

Carl Worch, Washington, D. C.

Q. 1. Would you please tell me of what kind of glass a *Nicol prism* is made, and will other glass do the same thing if substituted? In connection with the Kerr cell, does it perform any other function other than polarizing the light? Who could tell me all about it or the Kerr cell?

A. 1. Nicol prisms are made from Iceland spar crystals, cut at a precise angle, and cemented together again with Canada balsam. A pile of microscope slides, placed at an angle to the light source, will reflect polarized light but with a lesser degree of efficiency. Two such piles of glass plates will replace the two Nicols for use in conjunction with a Kerr cell. The scheme used by Alexanderson and described in TELEVISION NEWS has the utmost care paid to general efficiency of operation—yet the best light efficiency obtainable is in the neighborhood of 2 per cent. This means that the largest standard motion-picture arc obtainable will transmit only a minute quantity of light through the polarizing system.

The Kerr cell is placed between two Nicol prisms, so arranged that the light is entirely cut off. Application of a voltage to the plates of the Kerr cell rotates the plane of the polarized light reaching the second prism, and permits light to pass. The prisms serve merely to polarize the light.

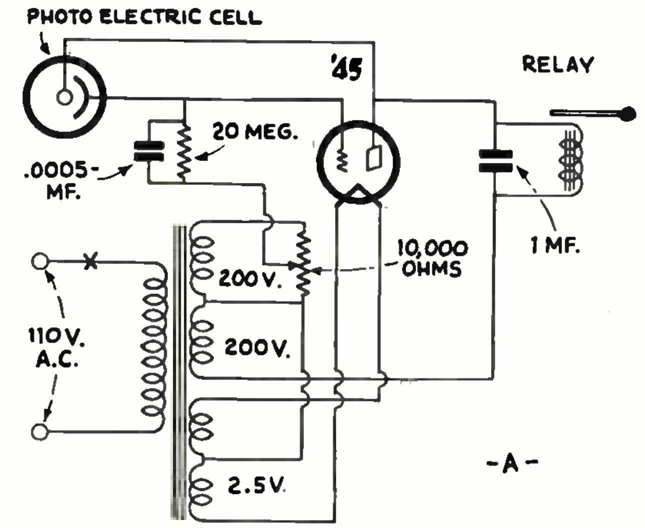
You ask, "Who can tell me all about the Nicol prism or the Kerr cell? I doubt whether anyone in this country can tell you *all* about them; but TELEVISION NEWS is bent upon becoming *the* source of reliable information on all subjects pertaining to television, and an article is in preparation for a future issue which will cover the field quite thoroughly.

Photo-Cell and Relay Hook-up

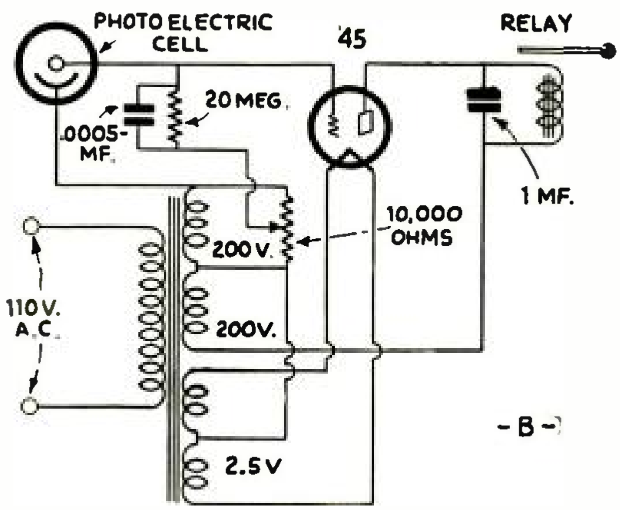
Gordon Keefe, Alexandria, Virginia.

Q. 1. Can you give me a circuit diagram for a photo-cell circuit to operate a relay from alternating current supply? I have already made a device which opens my garage door when the headlights of my car fall on the photo-cell and it operates very well. The circuit was taken from one of the articles by yourself in RADIO CRAFT (August, 1930), and uses a '12A tube.

A. 1. The circuit you request is reproduced here. You do not mention whether you desire to *open* or to *close* the relay when the light falls on the cell, so I am giving circuits for both methods. The design is self-explanatory. If any further information is necessary a second letter will reach me promptly.



Left: Hook-up of photo-cell to '45 amplifier tube and relay—here light on cell "closes" relay. Right: This hook-up causes relay to "open" when light is thrown on relay.



Scanning Drum Versus Disc

Myron T. Nathan, New York City.

Q. 1. Some commercial television scanning arrangements employ a drum instead of a disc. Is there any advantage in doing this, beyond the fact that the "lines" in the image are not curved, as in the case of the disc?

A. 1. In some of the arrangements of drum-and-shutter scanners, such as that used in the large Jenkins scanner, the equivalent of a four-foot disc is brought down to proportions enabling one to use it in the home; this is, of course, a distinct advantage. The simple drum scanner, in which the edge is turned up and operation is with the motor shaft in the vertical position, is of doubtful advantage over the disc. The lines are not curved, it is true; but if the image is transmitted by the disc method and received on a drum, there will be distortion of the image. So also will a distortional effect be in evidence, if a disc is used to scan a drum transmission. To the writer's mind, there seems little difference between the two. The small curvature of the lines is not bothersome in the case of the disc, nor is the distortion incurred by the mixing of the two methods too obvious in the image. One point is important—that the average motor will not operate for long periods in the vertical position without showing wear.

Special Neon Tube

Martin Eggleston, Bay St. Louis, Miss.

Q. 1. Can you tell me where I can obtain a special neon tube, having a plate three or four inches square? If this is possible, I think I have a method for obtaining a large picture with a scanning disc.

A. 1. The Argco Laboratories, of 150 West 22nd St., New York City, can manufacture a tube to your specifications; I can give you no idea of the cost of such a tube. I believe, from my own experience, that it would be best for you to concentrate your efforts on the problem of making the apparatus, necessary for a picture of about 1.5 inches square, more compact than is the present case. If your idea will enable you to get a picture of this size, without the use of a scanning disc of large dimensions, your apparatus should be quite suitable for home use. Do not let me dissuade you; but realize before you start that the motive power required to drive several moving parts through gear trains is perhaps greater than you imagine.

Television Images in Maine

Wm. J. Brooks, Jr., Cape Nedick, Maine.

Q. 1. Can I use my regular short-wave receiver for the reception of television images, if I rearrange the audio amplifier to use resistance coupling? The signals from the Boston transmitter come in here with tremendous kick, and I often receive signals with a good volume, from three stations operating in New York City.

A. 1. If you change your audio system to conform with one of the circuits published in this journal, you should be able to get fair results. I assume that you find it necessary to bring up your regeneration control in order to receive the New York City stations with any appreciable volume. If this is so, you will probably not get exceptional results on other than silhouette subjects; since regeneration is destructive of high-frequency image response. If you are willing to go as far as this, why not take the small step further and rebuild your entire receiver to conform with the requirements of television?

Adding Television to B.C. Set

George Varney, South Byfield, Mass.

Q. 1. I have a broadcast receiver which was purchased from a local dealer two years ago; this receiver has a pair of binding posts marked "Television". I was assured, at the time I purchased this receiver that within a short time television would become a reality and that my receiver could be used. I have asked this dealer if he could obtain the necessary equipment so that I could receive television programs now; but he says that, while television is not here yet, and will not be for a few more months, I will be able to use my receiver for it when the time does come. Can you tell me where I can get the necessary equipment to receive television from the stations listed in the last number of your paper?

A. 1. (With soft music.) You are not the only one who has asked us the same question. These receivers are quite widely distributed, and are an excellent example of what a radio receiver should be. Unfortunately, the sales department of this company thought they had a bright idea that would overcome all "sales resistance" based on the idea that it was best to wait for television before buying a new receiver. That idea is likely to cost that particular company a lot of good will, and through no real fault of their own, other than the wild imagination of some "high-pressure" sales executive. The binding posts were placed there so that you could connect in a separate amplifier for television reception—but it is unfortunate that the television signals are all in the *short-wave range* and are not receivable on your set.

I still feel that you have no "big kick" coming; for your receiver is an excellent one and no other on the market has provision for television reception. You need two receivers anyway, if you are to receive both the picture and the sound that goes with it, so I suggest that you ask your dealer to be more frank with you in the future and tell him to get in touch with one of the manufacturers who advertise in this journal. You seem to be a likely sale for a good television set and a good dealer never passes up a prospect.

TELEVISION TIME-TABLE

Visual Broadcasting Stations, Alphabetically by Names of Stations

Station	Lines per Frame	Call Signal	Frequency in Kilocycles, Meters in Parentheses	Power (watts)	Owner
Illinois: Chicago	48	W9XAA	2,000 (150) to 2,100 (142.9), 2.750 (109.1) to 2,850 (105.3)	1,000	Chicago Federation of Labor.
" "	45	W9XAO	2,000 (150) to 2,100 (142.9)	500	Western Television Corp., 6312 Bway.
" "	45	W9XAP	2,750 (109.1) to 2.850 (105.3), 2,100 (142.9) to 2.200 (136.4)	1,000	Chicago Daily News.
Downers Grove	24	W9XR	2,850 (105.3) to 2,950 (101.7)	5,000	Great Lakes Broadcasting Co., 72 W. Adams St., Chicago.
Indiana: West Lafayette	—	W9XG	2,750 (109.1) to 2,850 (105.3)	1,500	Purdue University, 400-500 Northwestern Ave., West Lafayette, Ind.
Iowa: Iowa City	—	W9XAZ	2,000 (150) to 2,100 (142.9)	500	State University of Iowa
Maryland: Silver Springs	48	W3XK	2.000 (150) to 2,100 (142.9), 2,850 (105.3) to 2,950 (101.7)	5.000	Jenkins Laboratories, 1519 Connecticut Ave., Washington, D. C.
Massachusetts: Boston	48	W1XAV	2,850 (105.3) to 2,950 (101.7)	500	Shortwave and Television Laboratory (Inc.)
New Jersey: Allwood	—	W2XCP	2.000 (150) to 2.100 (142.9). 2.850 (105.3) to 2,950 (101.7)	2.000	Freed-Eisemann Radio Corp., Junius St. & Liberty Ave., New York, N. Y.
Camden	60	W3XAD	2,100 (142.9) to 2,200 (136.4), 43,000 (6.97) to 46,000 (6.52), 48,500 (6.18) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	500	R. C. A. Victor Company (Inc.)
Passaic	60	W2XAP	2,750 (109.1) to 2,850 (105.3), 2.000 (150) to 2,100 (142.9)	250	Jenkins Television Corp. (Portable.)
"	60	W2XCD	2,000 (150) to 2,100 (142.9)	5,000	De Forest Radio Co.
New York: Beacon	48	W2XBU	2.000 (150) to 2,100 (142.9)	100	Harold E. Smith.
Long Island City	—	W2XBO	2.750 (109.1) to 2.850 (105.3)	500	United Research Corp., 39-41 Van Pelt Ave.
" " "	48	W2XR	2,100 (142.9) to 2,200 (136.4), 2.850 (105.3) to 2.950 (101.69)	500	Radio Pictures, Inc., 3104 Northern Blvd.
New York	60	W2XAB	2.750 (109.1) to 2.850 (105.3)	500	Atlantic Broadcasting Corp., 485 Madison Ave.
" "	60	W2XCR	2.000 (150) to 2.100 (142.9), 2,750 (109.1) to 2,850 (105.3)	5,000	Jenkins Television Corp., 655 5th Ave., New York City.
Ossining	—	W2XX	2,000 (150) to 2,100 (142.9)	100	Robert F. Gowen.
Schenectady	—	W2XCW	2,100 (142.9) to 2,200 (136.4)	20,000	General Electric Co.
Pennsylvania: East Pittsburgh	60	W8XAV	2,100 (142.9) to 2.200 (136.4)	20,000	Westinghouse Electric & Mfg. Co.
" "	60	W8XT	660 (455)	25,000	Westinghouse Electric & Mfg. Co.
Wisconsin: Milwaukee	—	W9XD	43.000 (6.97) to 44,000 (6.81)	500	The Journal Co. (Milwaukee Journal).
PORTABLE					
New Jersey: Bound Brook	60	W3XAK	2,100 (142.9) to 2,200 (136.4)	5,000	National Broadcasting Co., Inc.
New York: New York	60	W2XBS	2.000 (150) to 2,100 (142.9), 2,100 (142.9) to 2,200 (136.4)	5.000	National Broadcasting Co., Inc.

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

Experimental television stations, such as those operated by the N. B. C., Westinghouse, General Electric Co., etc., are on the air practically every day, testing, and can be picked up.

The Jenkins stations' time schedules are as follows:

W2XCR—N. Y. City. 3 to 5 and 6 to 8 P.M. daily; 6 to 8 P.M. Sunday. Voice transmitted over WGBS, on 384.4 meters or 780 k.c. (Time is Daylight Saving.)

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

W2XAP—Passaic (Portable transmitter). 60 line, 20 frames per second "standard"—Time irregular—Experimental.

W2XCD—Passaic (De Forest Radio Corp.). 9 to 10 P.M. daily. Sound accompaniment transmitted on 1.604 k.c.

It is understood, of course, that two receiving tuners or sets are required to pick up voice and image, such as from W2XCR and WGBS, one set tuned to 147.5 meters for reception of the image and one set tuned to WGBS or 384.4 meters to pick up the voice.

Daily image programs are broadcast by the Boston station W1XAV, and also by the Chicago stations W9XAA, W9XAO and W9XAP.

Baird Tells Why We Need More Power

TELEVISION has been compared to early broadcasting of the vintage of 1922-25 when crystal sets, one tube regenerative squealers and the beginnings of tuned R.F. were recorded. This similarity is not only fitting in regard to the results obtained compared with present day broadcasting but even in the question of station power the analogy succeeds, according to Hollis S. Baird, chief engineer of Shortwave and Television Corporation.

Today broadcasters use 1,000 watts for the ordinary run of regional stations while 5,000 to 10,000 watts power is fairly common. Then there are the 30,000 to 50,000 watt broadcasters who dominate the cleared channels. Now 500 watts is considered a mere neighborhood station. Yet 500 watts is about the most that television has offered the public in power so far. This limited power gives television just one more obstacle, states Mr. Baird, since static, particularly of the man-made type, is "doing its darndest" at 100 to 150 meters, the television band. A little noise in radio reception is bad enough, but static in television causes literally a snowstorm of black flakes, reminding one of the streaks in the early motion picture films.

In television, however, the early experiences of broadcasters have been duly noted and immediate increase of power is on its way. Thus Station WIXAV of the Shortwave and Television Corporation has just had permission from the Federal Radio Commission to increase its power from its present strength of 500 to 1,000 watts.

While 20,000 watts has been authorized in two cases and several 5,000 watt licenses granted, about the most power used to date has been 1,250 watts. The NBC New York station, licensed for 5,000 is only using 850 watts at present. The Jenkins New York City station, also licensed for 5,000, has been using its full strength of 5,000 watts since about May 10th.

Station WIXAV will go up to its 1,000 watts some time in June. This increase in power comes most opportunely at the beginning of the summer season when increased power is most needed due to summer radio conditions. Broadcasters have learned that high power is particularly needed in the summer to over-ride static and compensate generally for summer radio reception.

At the Washington Television conference in December there was some talk of limiting television power but this was vigorously opposed, states Mr. Baird. Two noted engineers who were present spoke in behalf of more power, Dr. Frank Conrad of Westinghouse, who said it would be unwise to limit power, and Dr. E. F. W. Alexanderson of the General Electric Company, who pointed out that television needs more power than voice, that there is no earphone level in television as there is in ordinary broadcasting. Increased power will be television's program from now on, states Mr. Baird, insuring better and better reception.

A Correction

In the article entitled "Columbia Ready to Televise" by Mr. A. B. Chamberlain, the caption relating to the television receiver said that this equipment was designed by Columbia engineers, whereas it should have stated that the equipment shown in connection with this article was designed and built by the Television Development Section of the RCA Victor Company, Inc.

A New Modulated Arc Television Receiver

By HENRI F. DALPAYRAT

(*Continued from page* 199)

ate directly an arc of sufficient intensity. The use of much larger power tubes for receivers output being very doubtful, the writer decided to overcome this difficulty by utilizing indirectly the output of this well known tube. Fig. 1 shows an evacuated tube, No. 1, whose surface is opaque except for a small square opening. (No. 3) in a part of the tube; No. 2, facing that opening, is plated on the outside with a bright reflecting material (a reflecting mirror could also be used). Two long electrode plates, No. 4, having their widest surfaces facing each other, nearly parallel, are connected to a source of high D.C. potential. The upper edges of those plates are near together and reach the center of the tube just below the opening No. 3. Two other electrodes, No. 5, may be rods near together and evenly placed in spaced relations between the lower ends of No. 4 electrodes. The distance between the No. 5 electrodes, and the distance between No. 5 and the ends of plates No. 4, must be carefully adjusted at the manufacturing plant. A filament 6—heats a drop of mercury 7. The tube becomes filled with mercury vapor. When a signal is applied between electrodes 5, a small arc is formed; the intensity of which varies with the signal strength. The space between electrodes 5 changes its conductivity with the variations of the arc; this varies in turn the resistance between the lower ends of plates 4. Now, if an arc is steadily formed at the upper ends of the plates and the resistance between the lower ends decreases, more of the current which was used to produce this arc at point 8 will now flow from 4 to 4, going through electrodes 5. A portion of electrodes 4, between A and B, is made of high resistance metal, in order to dissipate the increase of current under the form of heat. This will prevent the space between electrodes 5 from becoming short circuited by too large a current which also could not be easily modulated.

As the resistance between electrodes 5 is decreased the upper arc decreases in intensity, and sinks between the upper ends of the plates. The opening 3 now receives less light.

When the power tube of the receiver does not draw any current, the arc 8 projects a maximum light intensity through the opening. In other terms, the lower or primary arc acts as a variable resistance across the upper or secondary arc.

Opaque Tube Has Clear Slot

Figure 2 shows a tube with its opaque surface and a small clear glass slot 10 from which a beam of light is projected and spreads slightly as at point 11. Fig. 3 shows the electrical connections to the last audio stage of a receiver. The electromagnetic relay 13 opens the circuit of the heating filament 6 as soon as the secondary arc at 8 is formed: 7 represents mercury. This relay, after that, keeps the filament open as long as the tube is in operation.

Fig. 4 shows how the scanning action takes place in the televisor. A mercury arc modulator 23, as described above, is placed in the center of a cylinder 25. A beam of light 3/8-inch high and 1½ inches wide strikes the inside surface of the cylinder, as shown in Figs. 4 and 5. The distance between each hole is exactly 3/8-inch. Each hole is 1/32-inch square. The approximate diameter of the cylinder is only about 6¼ inches. The cylinder is nearly 2 inches wide. As it rotates, a pencil of parallel rays shoots out of the holes, passing through the plano-concave bar lens 27, and diverges vertically to explore a square surface on the spherical double concave lens 20. The other side of the lens, 21, has a wider angle of curvature, so that the rays will diverge greatly in all directions in order to obtain a magnifying effect. The image is reproduced on a spherical, concave, translucent ground-glass screen 22.

In Fig. 5, the black lines around lens 19 represent the portions of that lens which may be rendered opaque by coating them with black paint or similar substance. Knob 28 serves the purpose of adjusting lens 19 until its surface is evenly scanned by the beams of light coming from the cylinder, and in such a way that the beams do not overlap. The transition from point to point, due to the linear speed of the light spot applied on the lens, must not produce a jumping-dot effect or other forms of distortion. The exact and correct position of lens 19 can easily be found by adjusting knob 28.

Fig. 4 also shows that, were it not for lens 19, the image would be smaller and projected at point *X*, which might be too far from the source of light. This would result in a weak faint picture. By employing lens 19 those disadvantages are entirely eliminated.

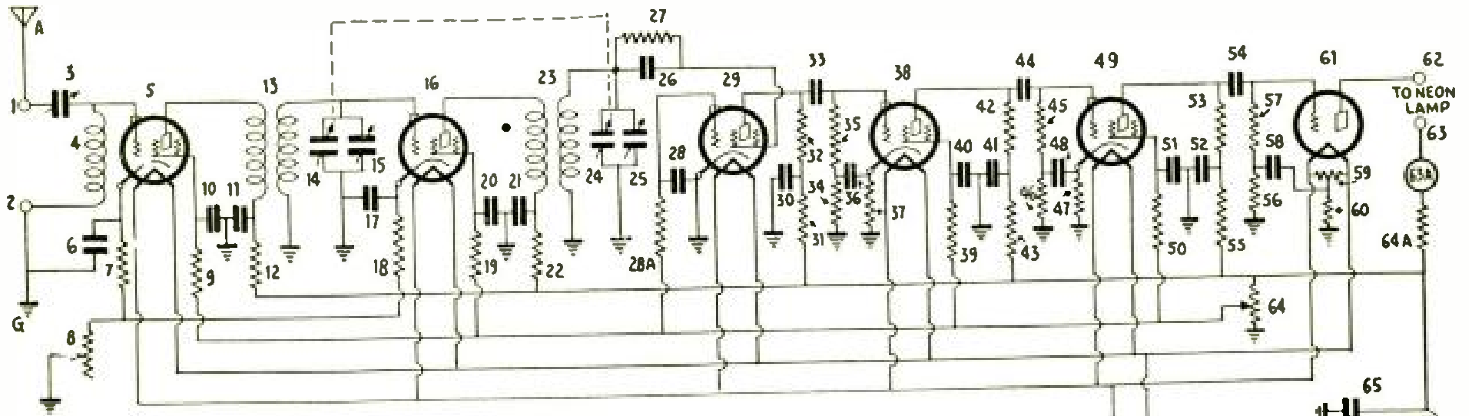
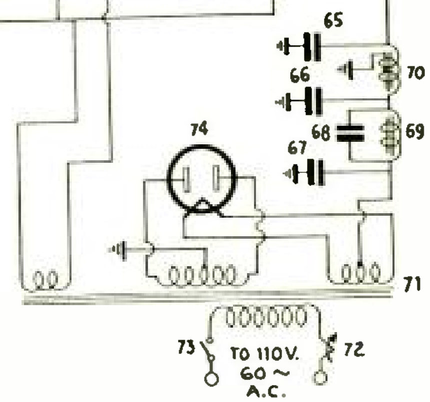


Diagram of "Find-All" Television Receiver, including power supply. It employs two dial control, one for tuning the antenna circuit.



The "Find-All" Television Receiver

A Super-DeLuxe Standard Parts Six Tube Set

By H. G. CISIN, M.E.

FANS and custom set builders who desire to construct a television receiver out of standard, nationally-available parts, will be much interested in the super-deluxe Find-All Television Receiver.

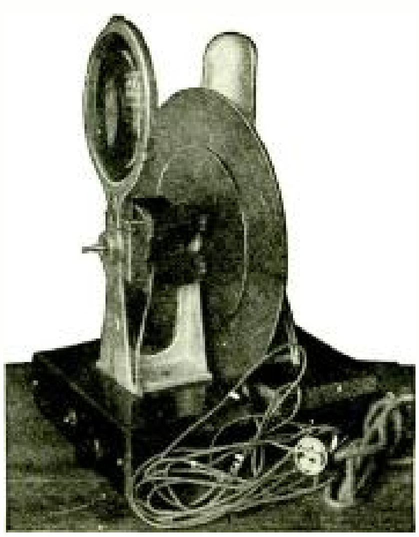
This employs a six-tube circuit, with two screen grid radio frequency stages, a space-charge, screen grid detector and three resistance-coupled audio stages. The output stage uses a '45-type power tube.

The circuit of the Find-All Television Receiver has been most carefully designed and engineered and only parts of the very highest quality have been specified. Two dial control has been selected, in order to get more accurate results and hence better pictures. It will be noted that the various screen grid circuits are carefully isolated by means of resistances and suitable by-pass condensers. The r.f. coils are shielded, as well as the screen grid tubes, and the receiver is built up on a metal chassis. A cathode series resistor is used for volume control; the use of a self-adjusting line-voltage control amperite adds another important feature to the design.

The Find-All Television receiver works especially well with the Jenkins Radiovisor. This radiovisor is available in kit form, together with a self-synchronizing motor for controlling disc speed by signal.

At first glance, the circuit illustrated may seem a bit intricate. Further study and comparison with the list of parts, however, will reveal the fact that this receiver is composed almost entirely of resistances and fixed condensers. For example, twenty metallized resistors are used and about nineteen fixed condensers. These parts are easy to mount and wire into the circuit, especially the resistors, so that there is nothing complicated about the circuit after all.

The completed receiver gave wonderful results when tested with the Jenkins Radiovisor. In the next issue of TELEVISION NEWS, complete constructional directions will be given, together with actual photographs of the receiver, showing top and bottom views, etc. Those who desire advance information on the Find-All Television Receiver can obtain a set of diagrams —including schematic top and bottom views, and chassis details—free of charge, by writing to the *Diagram Editor*, TELEVISION NEWS, 98 Park Place and enclosing 20c to cover mailing and office costs.



The assembled Jenkins scanner as used with the "Find-All" Receiver.

Complete List of Parts

1—.00026 mf. Cardwell "Midway" Variable Condenser, type 406-C (3)
1—.0002 mf. (each section) Dual Cardwell "Midway" Variable Condenser, type C (14, 24)
2—Small De-Jur Amsco Adjusting Condensers, 140 mf. max. (15, 25)
1—Electrad Volume Control, type RI-202 (8)
1—Electrad Truvolt Fixed Resistor, type B-15 (60)
4—1,000-ohm Electrad Truvolt Flexible Wire Grid Resistors, type 2G-1000 (7, 18, 37, 47)
1—Electrad Truvolt Fixed Resistor Voltage Divider, type C-200 with extra tap (64)
1—Electrad Truvolt Fixed Resistor, type B-30 (64A)
1—Electrad Truvolt, type V-20 center-tap Resistor (59)
1—Power Switch (73)
1—.0001 mf. Aerovox Fixed Mica Condenser, type 1460 (26)
1—.1 mf. Aerovox Fixed Condenser, type 207 (68)
3—.25 mf. Aerovox Fixed Condensers, type 207 (33, 44, 54)
1—1 mf. Aerovox Fixed Condenser, type 261 (28)
7—2 mf. Aerovox Fixed Condensers, type 207 (36, 40, 41, 48, 51, 52, 58)
2—.1 mf. (each section) Triple Section Metal Case Aerovox Condensers, type 461-31 (6, 10, 11) and (17, 20, 21)
3—8 mf. Aerovox Hi-Farad Dry Electrolytic Condensers, type G5-8 (65, 66, 67)
1—4 mf. Aerovox Fixed By-Pass Condenser, type 207 (30)
5—124 Arcturus Screen Grid Tubes (5, 16, 29, 38, 49)

The Jenkins scanner motor, with disc, lens, etc., in "Kit" box.

Kit of parts for building Jenkins "synchronizing" motor.

1—145 Arcturus Power Output Tube (61)
1—180 Arcturus Full Wave Rectifier Tube (74)
1—Weston Milliammeter, 0 to 50 ma. type 301 (63A)
1—Aluminum Chassis, 24 gauge, 12" x 15" x 3½" high
5—Aluminum Tube Shields
3—25,000 ohm Durham Metallized Resistor Powerohms with pigtail connectors, type MF-4 (31, 43, 55)
11—50,000 ohm Durham Metallized Resistor Powerohms with pigtail connectors, type MF-4 (9, 19, 28A, 32, 34, 39, 42, 46, 50, 53, 56)
1—50,000 ohm Durham Metallized Resistor Grid Leak with pigtail connectors (27)
2—75,000 ohm Durham Metallized Resistor Powerohms with pigtail connectors, type MF-4 (12, 22)
3—250,000 ohm Durham Metallized Resistor Powerohms with pigtail connectors, type MF-4 (35, 45, 57)
1—Find-All Shielded Television Antenna R.F. Inductance Coil (4)
2—Find-All Shielded Television R.F. Transformers (13, 23)
1—"Acratest" Power Supply Transformer (71)
2—"Acratest" 30 Henry Chokes (69, 70)
1—Roll Corwico Braidite Hook-up Wire, Solid Core
5—5-prong Wafer-type Sockets (5, 16, 29, 38, 49)
3—4-prong Wafer-type Sockets (61, 72, 74)
1—Amperite Self-Adjusting Line Voltage Regulator, type 8A-5 (72)
4—Binding Posts (12, 62, 63)
1—Jenkins Radiovisor Kit Assembly, type RK-2
1—Lens Assembly, type RK-11
1—Low Internal Capacity Neon Lamp, type 601
1—Self-Synchronizing Motor, type 502, with necessary amplifier kit, type SK-30

Quality of Television Images

By D. K. GANNETT

(Continued from page 187)

jointly by the Bell Lab.'s, and the A. T. & T. Co. Coarseness of detail is less noticeable in moving pictures. The apparatus demonstrated in May of 1927 used a scanning disc of 50 holes and transmitted about 2,000 elements. In fineness, therefore, the image would be slightly better than that of Fig. 3. With similar transmitting apparatus, the image of Fig. 2 would require a disc of only 28 holes and that of Fig. 3, one of 39. With the more recent two-way television apparatus, the disc has 72 holes. Some 4,400 elements are transmitted, which give a picture of slightly less detail than that of Fig. 4. The disc required to transmit the image of Fig. 4 would have needed 88 holes, and that for the image of Fig. 5, with about 12,500 elements, would have had 125 holes.

The illustrations were actually made by transmission as telephotographs, using apparatus in an American Telephone and Telegraph Company telephotograph station. A picture element in a telephotograph is 1/100 of an inch square; so it was only necessary to reduce the size of the pictures until they would contain the right number of elements of this size. The pictures in Fig. 2, for example, were each reduced to a length of 9/32 inch.

It is interesting that, in comparing the three pictures in any one of the illustrations with each other, the picture of the group in the prize-fight ring is about as satisfactory as the portrait or the football runner; even though the same number of picture elements is called upon to depict a larger number of objects.—*Courtesy Bell Laboratories Record.*

How You Can Experiment With the Cathode Ray Scanner

By C. H. W. NASON

(*Continued from page* 182)

—from side to side or from top to bottom. The disc scanner, however, does not assume this mode of motion for the beam; and we must employ a system which traverses the field in one direction only—from left to right for the horizontal component, and from top to bottom for the vertical. For the 60-line image, repeated 20 times per second, we must have our beam traverse the field in the horizontal "sense" from left to right 1,200 times per second; while the vertical traverse must take place 20 times per second. In order to do this, we must apply to one set of plates a potential which has a wave-form like that shown in Fig. 2, with a period of 1/1,200-second; and to the other set of plates another potential having a period of 1/20-second.

Oscillating Neon Tube Used

Vacuum-tube oscillators have been devised which give a wave form similar to that shown in the figure; but they are exceedingly complex in both construction and operation. Here a familiar device comes to our aid—the oscillating neon tube. If a neon lamp of the usual type is shunted by a condenser, and connected to a source of constant direct current through a resistance, it will oscillate; the period of oscillation being determined by the equation $P = KRC$; where K is a constant (determined by the characteristics of the tube being used in the circuit, and which varies from tube to tube) and where R and C are the resistance and capacity employed in the circuit.

The mechanics of the oscillation are simple; when first connected in the circuit the neon tube is drawing no current and the drop through the resistance is zero. The neon lamp therefore receives the full voltage across its terminals but, as the current builds up through the neon tube, this short-circuits and discharges the condenser. At the same time the drop through the resistance is increased until the voltage across the neon tube is insufficient to maintain the glow, and the discharge path is broken. The voltage across the resistance immediately drops to zero and the cycle described is repeated.

The circuit arrangement for such an oscillator is shown in Fig. 3. Although the neon tube may be made to oscillate at nearly all frequencies, its wave-form is not such as to recommend it for other than such specialized uses as make no demands on the purity of the wave obtained. In this case it is exactly as desired.

How Electron Beam Is Modulated

Although it is not the best-known way, we will have to vary the intensity of our electron beam by modulating the accelerating potential. The writer hopes that the tube described may shortly be obtained with an additional electrode for this purpose; by means of which complete modulation of the intensity of the beam may be had with very small power output. For the present, a signal of an amplitude in the neighborhood of 150 volts peak (such as can be obtained with any of the present-day power tubes) will serve admirably to modulate the intensity of the beam.

The arrangement of the circuit is as shown in Fig. 4. Values should be obtained from the manufacturers of the neon tubes employed in the oscillators, who will be able to give definite information as to the resistance and capacity values for the frequencies desired.

The picture's size is determined by the voltage obtained across the neon tubes—the deflection of the beam being approximately one millimeter (1/25-inch) per volt across the deflecting plates.

It should be definitely understood that this arrangement does not represent the last word in cathode-ray television reception; but it affords an opportunity for the amateur to start in.

In place of the neon-tube oscillators specified, a pair of motor-driven potentiometers could be employed—the arms being rotated at the required speeds.

Principles of Scanning

By A. C. KALBFLEISCH

(*Continued from page* 205)

this is for a square picture of 2,304 picture elements. It might be well to consider the picture frequency of the 72-line system, since the picture detail in a 72-line system shows considerable improvement over the other three mentioned systems. As before, the maximum frequency would be

$$\frac{72 \times 72 \times 15}{2} \text{ or 38,880 cycles per second.}$$

Let us study for a moment persistence of vision. Imagine that the eye is substituted for the photo-cell, and that we observe a scene through the aperture, or hole in the scanning disc. If the disc is slowly revolved and we confine our observation entirely to what we perceive through the small aperture, it will be difficult to piece together the scene before us. As the speed of rotation of the disc is increased, the number of our elementary impressions is increased; and it becomes easier to see the scene before us. Apparently the eye has the power to store up these elementary scenes, or areas, and build up the composite scene. This property of the eye is known as *persistence of vision.*

Back Issues of Television News

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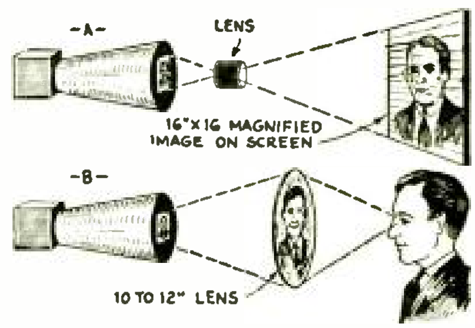
Television With the Braun Tube

By DR. FRITZ NOACK

(*Continued from page* 176)

ing living objects and of films. In this case it is advisable to operate with a picture frequency of about 20 to 25 (frames a second). Then, of course, a fluorescent screen with a shorter period of afterglow would have to be chosen. It is advisable so to choose the line frequency that the definition becomes equally good for both the line and picture potentials.

Thus the frequency of an electric-lighting system can, under certain circumstances, disturb a television picture; that is, if the light system frequency is an integral multiple of the picture frequency. One will therefore do well to choose a picture-frequency incommensurable with that of the power supply; the same rule is true for the line frequency. In this case



Two ways of obtaining enlarged image from Braun tube.

there will be no wandering of the lines across the picture; it will be possible to exclude the influence of drifting picture lines, if the size of the fluorescent screen is adjusted so that each picture line is adjacent to the next.

High Luminosity Attained

M. Von Ardenne has lately succeeded in producing luminous screens showing a spot luminosity of 2 to 3 candle power! To be sure, this requires an anode potential of 4,000 volts, which one must impress between the cathode and the screen. This anode potential is, however, easily produced with proper transformers; because high-current loads hardly enter into the question. As rectifiers, one can even select small and rather old amplifier tubes.

A very important subject, as we well know, is that of *synchronization,* which has always meant considerable difficulty in the case of television. Recently Von Ardenne proposed to combine the picture and line potentials and to transmit them on a single carrier wave. How far this is possible, though Von Ardenne sees no difficulties in this respect, has not yet been made sufficiently clear by experiments. Another proposal of Von Ardenne is to modulate the audio transmitter with a sine potential of super-audible frequency, and to split this in the frequency ratio 1 : 2 or 1 : 3. Getting the picture-frequency out of the line-frequency, say by means of a saw-tooth apparatus, entails great difficulties, in the case of high numbers of lines. In this case it will be necessary to connect several saw-tooth apparatus in series. Von Ardenne is at present occupied very seriously with this problem and will report on it at a later date.

Braun Tube As a Transmitter

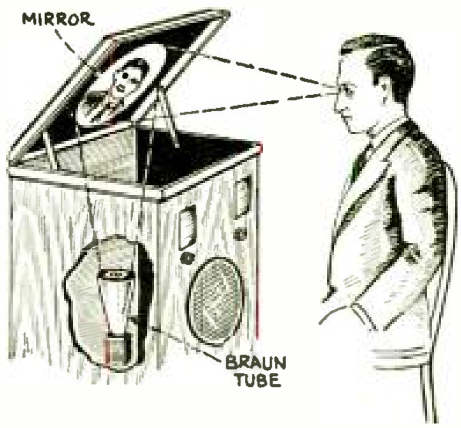
A recent very interesting point is the use of the Braun tube as a television transmitter. The principle of this system is extremely simple. Von Ardenne produces on the fluorescent screen of his tube the pictorial lines without modulation. These lines or the luminous rectangle are sharply outlined on the negative or film, which one would like to transmit by television. The photo-cell is set up either directly behind the negative or film, or with a converging lens between.

However, when transmitting a negative, it is even more simple to bring the negative directly to the fluorescent screen of the tube, and then conduct to the photo-cell, by means of a suitable system of lenses, the rays coming from the negative. The lack of sharpness resulting from the distance of the screen from the negative remains sufficiently unimportant, if a photo-cell of 0.77-sq. inch surface is arranged, at a distance of about 8 inches, and at the same time the radiation of fluctuating light in any other path than through the negative is avoided. To get good pictures free from distortion, it is, of course, necessary that the lens system itself be free from distortion. To overcome a lack of uniformity in the coating of the photo-cell, with regard to sensitivity, Von Ardenne has recently put a small ground-glass plate before the photo-cell; and he has found that, to avoid needless loss of light, it is best to use a glass plate which is smaller than the coating of the photo-cell and is at most 5/8-inch away from it. The ground-glass plate itself is to be put as close as possible behind the negative.

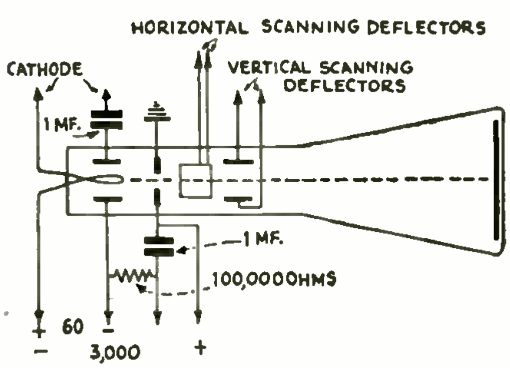
Transmission of Films

While in the transmission of negatives it is not essential at what point of time the saw-tooth discharge occurs, in the transmission of films which are moved by jerks, the discharge must take place just when the film is moved along. Only thus can one avoid a troublesome interference streak across the surface of the picture.

The picture frequency can be controlled by mounting a rotating contact on the film projection, directly on the axle which ordinarily carries the shutter. At the transmitter this contact then effects the timely discharge of the saw-tooth condenser. With this saw-tooth arrangement, by which the saw-tooth frequency is therefore given, one can easily change the potential and the picture size, by regulating the heater current of the tube, which is at maximum emission.



How large image can be obtained from a small cathode ray tube.



Schematic diagram of Braun tube as used by Von Ardenne.

How Braun Tube Scans Living Image

The scanning of living subjects by means of the Braun tube at the transmitter is effected in similar fashion to the scanning of films, *i.e., by concentrating the luminous rectangle of the Braun tube on the person to be scanned, by means of a system of lenses.* At present, however, because of the still insufficient surface brightness of the luminous rectangle, we shall have to content ourselves with the scanning of smaller objects.

Image Can Be Projected on a Screen!

Because of the brightness of the luminous rectangle, which is relatively great for receiving purposes, *it is possible to project it on a screen*, and thus effect *projection television.* So far it has been found possible to illuminate surfaces of 16 x 16 inches in a dark room, *the pictures still being well recognizable!* Yet it seems more advantageous, according to a proposal of Von Ardenne, *rather to use tubes with larger fluorescent screens; because in this way the picture's brightness is, after all, considerably greater than with projection.*

Novel Ray Intensity Control

Something more might be said about the novel intensity control of the cathode ray, which works so perfectly that the pictorial line-frequency is in no way prejudiced. As is well known, one can lessen the intensity of a cathode ray and, thereby, the light intensity of the fluorescent spot, by reducing the anode potential. But this also simultaneously changes the speed of the electrons and, if it is attempted to control the cathode ray capacitatively, to produce the pictorial lines, a wider pictorial line will result than at greater electron speed.

Von Ardenne therefore uses the following mode of controlling the ray intensity. The filament is surrounded by a cylinder; to which is conducted the intensity-control potential; that is, the voltage controlling the pictorial element. By this means, the cylinder controls the form of the space-charge cloud surrounding the cathode, and thus the total emission; without materially affecting, however, the speed of the electrons themselves! The change between light and dark amounts to 5 to 10 per cent at most. Now, by connecting in an ohmic resistance (say 100,000 ohms), this difference also is considerably reduced. Yet it is impossible to transmit well with this arrangement, which proves sufficient only in the transmitting of black-and-white pictures. Von Ardenne has very recently so improved the controlling feature that he also obtains fine half-tone reproduction. Since patents are being applied for, he cannot at present give fuller details.

How good the pictures, recently obtained by Von Ardenne with the Braun tube, really are, is shown by a picture test, in which about 5,000 pictorial elements were used. The pictures appear a trifle distorted optically. This is due to the fact that they were photographed from the inside of the tube. At any rate the pictorial quality is indeed very good!

All in all, it appears that Von Ardenne has already made wonderful progress with his new television system. If one considers that a Von Ardenne televisor requires only a Braun tube and a power supply, together with a saw-tooth oscillator apparatus built in at the same time; that furthermore radio receivers, even with poor amplifier tubes, suffice fully for the operation, because the Braun tube requires practically no power, but only control voltages; and, finally, that the whole management of a televisor with a Braun tube, once the saw-tooth potential is properly regulated, consists only in the correct adjustment of the phase—the prospects of the Braun tube for television purposes might be described as perfect! There is in addition the distinct asset of high pictorial brightness (brilliancy of the reproduced image), which, without doubt, many times surpasses that of an ordinary glow-lamp televisor.

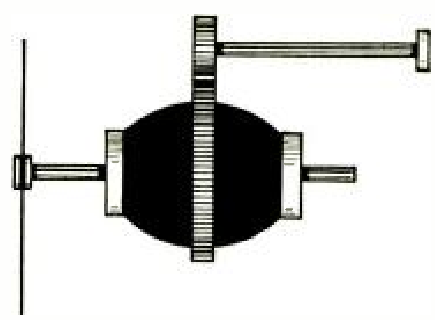
What's This Thing—Synchronization?

(*Continued from page* 207)

Only when the two wheels have, for example, a spoke at the highest point at the same time, can one call the motion synchronous (1B).

In television transmission the analyzing discs of transmitter and receiver must run synchronously, as is well known. It is not sufficient for them to make the same number of revolutions; there must also be *agreement in phase*. That is, when the uppermost opening of the sending disc begins to scan the picture, the same thing must happen at the receiving disc, to get the picture properly *in frame*. Otherwise the picture would appear to be cut apart; exactly as when the film of a motion picture jumps and the dividing line runs (Fig. 2).

Now, in television reception, the motor of the televisor is first brought through the middle of the picture to the same number of revolutions as that of the sender, when the picture will appear, though cut up. To correct this error there is built in a device which permits of turning the whole motor any part of one revolution on its axis. Thus it is easy to obtain the necessary synchronization. Fig. 3 shows in diagram one of the many possible models.—(*Das Funk Magazin.*)



Gear and rack arrangement to permit rotating motor frame for "framing" picture.

How the Cathode Tube Scans in Television

By HANS BOURQUIN

(*Continued from page* 183)

Therefore attempts have been made to replace the grid arrangement by other means. Of these the system of time modulation is the most promising. If one continually irradiates a point with light of a certain intensity, it will show a definite brightness. But, if one cuts off the radiation in this way, by letting the light strike full force for 1/1000th of a second and then causing it to disappear for exactly the same time, what is visible is not a flickering point but one less bright.—(*Das Funk Magazin.*)

Sanabria Produces 10 By 10 Ft. Images

(*Continued from page* 169)

system devised by Mr. Sanabria and his co-workers for the purpose of intensifying the slight electric currents developed by the photoelectric cells at the television transmitter. One of the photos herewith shows the bank of giant photoelectric cells which pick up the reflected light rays from the face of the subject being televised. A powerful arc lamp (or a high power incandescent lamp may be used, such as that now employed in the Bell Laboratories transmitters) projects a carefully focused ray of light through a revolving scanning disc, on to the face of the subject in the usual manner. As this rapidly moving light ray scans the face, for example, from top to bottom, each scanning path overlapping slightly the next one, the reflected light rays fall upon the large spherical glass photocells, which cause slight electric currents to be generated. These photoelectric currents, which correspond in magnitude or strength to the various light and dark tones of the face or other object being scanned, are then passed through as many as ten stages of vacuum tube amplification, each stage being an especially designed, resistance-coupled one. At least the first three stages of the amplifier are best placed in close proximity to the photocells, to avoid picking up stray electrical waves or currents, which might interfere with the pure pick-up and transmission of the television image.

So far as the immediate future of television in the home is concerned, and aside from the utilization of the Braun or cathode ray tube, such as is now being developed by more than one television concern, the hope of all television enthusiasts would seem to be very strongly focused on the *neon crater tube*, or else the newest development of Messrs. Taylor and Sanabria, the *neon arc tube*. Utilizing either one of these tubes, an image several feet square can be produced, and this is what the public will undoubtedly demand ere long, so that the whole family can enjoy the television picture simultaneously.

Harold Hayes, Federal supervisor for the Ninth district, described the Sanabria images as "marvelous and the best he had seen in three years of watching the growth of television." At this demonstration the young inventor—he is 24 years old—opened a bag of tricks. He gave one of his assistants a figurative shave, changing the light rays thrown on his face until evidence of a heavy beard had been almost eliminated. He threw such a tiny light on the subject that persons near by could not discern his features, yet the keen-eyed receiving set picked up the reflected rays and produced a clear view of the face. Then Sanabria tinted faces and objects placed before the closeup lens. Green on the label of a water jar was clearly apparent. Other colors also were faintly tinted into the television image. The color work was done with neon-mercury gas and the black and white pictures with helium gas turned into the special television lamp designed by Warren G. Taylor, collaborator with Sanabria. Neither claimed credit for developing color work in television, but only the ability to achieve minor effects. The work was done, however, with only one light channel for the three primary colors—red, blue and green.

"Colors in television are still in an embryonic stage," he said. "So is much of our work in sound effects. Many owners of radios fear their sets will be rendered obsolete by the immediate introduction of television. That is not true. Television will supplement the radio. Anyway it has not yet reached a commercial stage of development."

How I Get Television on a B.C. Receiver

By EDWARD L. COWAN

(*Continued from page* 178)

The first thing I did was to change the Atwater Kent receiver by the addition of a short-wave adapter, which converts the regular tuned radio frequency stages in the A. K. broadcast receiver, into the intermediate stages of a super-heterodyne. I have used some of the short-wave adapters to be found on the market and found them to work very well. The particular short-wave adapter shown in the accompanying diagram, I built up from parts found about my shop.

I can obtain either regular broadcast music and voice, or else television, by merely throwing two switches.

I would like to mention that the best television transmitting station I receive is W3XK. I receive both half-tone and silhouette pictures.

With regard to the switches, one may combine the switches shown in the diagram so as to be operated by a single knob, the *Best* or similar rotary switches being ideal for the purpose. The motor control switch may also be combined on the same operating shaft as the other switches. It will be noted that the audio frequency circuit of the A. K. receiver has been modified so that the grid of the '45 tubes are resistance-coupled to the plate circuit of the first ('27) audio stage. Also the two plate circuits of the '45 tubes are joined together in parallel to the neon lamp and the neon lamp or the loudspeaker is connected at will by throwing the switch indicated to the points marked "broadcast" or "television".

THE OPERATION OF THE NEON TUBE

By PAUL R. NACHEMSON*

THE re-conversion of the electrical impulse, which comprises the television signal, into a replica of the original light impulse, requires an illuminating device which is subject to modulation by frequencies ranging at least as high as 50,000 cycles.

This condition is amply met by the neon lamp now commonly used for television purposes.

Constructionally, the television lamp is an exceedingly simple device, although a high degree of precision is necessary for the production of a satisfactory unit.

In its most usual form the lamp consists of a glass envelope, tubular in shape and mounted on a conventional four-prong base. Contained within the vessel is a metallic plate, varying in size from an inch to an inch and a half square. This plate is used as the cathode, and connection to it is established through one of the base prongs. In close proximity to the rear of the cathode is a loop of wire, or another plate, which when connected to another of the base prongs serves as anode. The use of a double plate element permits either electrode to perform the function of cathode or anode, merely by the reversal of the terminal connections; resulting in a double life. The "Kino Lamp" manufactured by the National Carbon Co., is an excellent example of this form of construction. The tube is evacuated, except for a small quantity of neon gas, to which a trace of hydrogen is sometimes added.

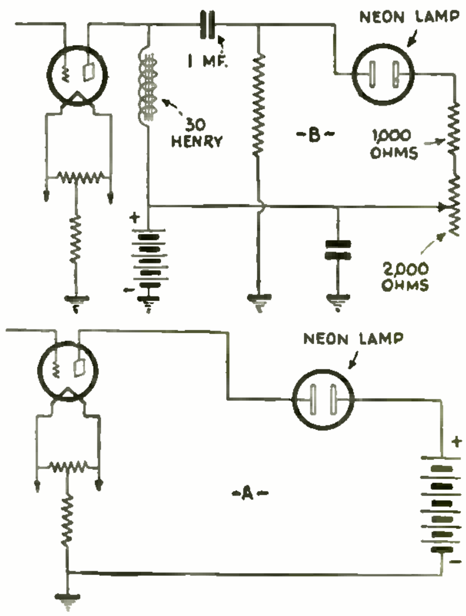
The operation of this lamp makes use of one of the most interesting phases of electronic phenomena.

At normal temperatures and at atmospheric pressure, gases possess a high dielectric coefficient; under these conditions a high potential difference is necessary to produce an electric discharge. On diminishing the gaseous pressure the requisite potential for discharge is proportionally reduced, until a critical degree of exhaustion is obtained; this usually occurs at a pressure of about two millimeters of mercury, or about 1/375 of normal atmospheric pressure. At this pressure, when an electric potential is applied to the electrodes, a soft velvety glow is seen to coat the cathode or negative terminal. The color of this glow will vary with the nature of the gas, the pressure of the gas and the value of the applied voltage; in the case of neon the color may range from a salmon pink to an almost violet hue.

Analysis and observation indicate that the glow is the result of gaseous ionization, one of the major causes of which is the collision of electrons and atoms.

When an electric potential is applied to the electrodes of a television lamp, the free electrons which are present in the rarefied gas are attracted to the anode or positive terminal; they thereby acquire sufficient velocity to knock loose electrons from any atom with which they may collide. These newly-freed electrons in turn strike other atoms and free still more electrons. Thus we have a cumulative effect. The atoms of the gas, having lost a portion of their negative charge, assume a positively-charged nature and, in consequence, are attracted to the negative electrode; where their equilibrium is restored through the replacement of the missing electrons. In striking the cathode, the positively-charged atoms knock off electrons from the electrode itself, thus contributing a "secondary-emission" effect.

The intensity of illumination is governed by the amplitude of the current flowing through the tube. Since neon tubes have a negative coefficient of resistance (or, in other words, the resistance decreases with an increase in current) it is imperative that a current-limiting resistor be employed. This may be nothing more than the internal resistance of the output tube of the amplifier or it may take the form of an external resistor. If this precaution is not observed the current will continue to increase, until an arc is created and the tube is destroyed. Normally the current flow in the average lamp should not exceed twenty milliamperes.



Hook-up for neon tubes.

It must be remembered that the neon tube requires approximately 300 milliwatts for full luminous output; this is about one-tenth the power used by a great many loud speakers employed in radio receivers at the present time. The undistorted power output of the '45 tube (which has been most commonly used) is 1,600 milliwatts. It therefore becomes evident that we have considerably more power available for the neon lamp than is needed. Consequently the neon lamp and the output tube can be matched to give minimum distortion in the neon lamp, rather than to secure maximum output from the audio tube.

The lamp may be coupled to the output tube by either of the circuits shown in the diagram. At (A) it is shown connected directly in the plate circuit of the output tube; a variable bias resistor may be employed on this tube, so that the current through the lamp can be accurately controlled. At (B) the lamp is operated through an impedance-coupling circuit, similar to that utilized in interstage amplification.

*Radiotechnic Laboratories.

How to Couple the Neon Tube

(*Continued from page* 210)

shown in Fig. 2B. Note that two sets of batteries or power supply apparatus are required. We may also achieve a measure of this advantage from a circuit like that shown in Fig. 2C, although careful adjustment of voltages is necessary.

Were it possible to obtain a transformer of the required characteristics we might solve all our problems by the use of the circuit arrangement shown in Fig. 2D. The same plate supply serves for both neon lamp and vacuum tube. Because of the natural variations in impedance of the neon lamp, it is advisable that a resistance be included in the load and the transformer ratio chosen accordingly. The bypassed potentiometer serves to vary the initial brilliancy of the neon lamp.

Under high currents, the neon lamp is likely to exhibit strong negative resistance characteristics. For this reason, a current-limiting resistance must always be included in the circuit.

Because of the larger voltage drop through the neon lamp, it is not directly interchangeable with a loudspeaker. If a speaker were thrown directly into the circuit, so high a plate voltage would be placed on the output tube, as to bring about the complete destruction of tube, speaker, or both. The speaker must either be isolated from the circuit by the use of a coupling condenser (as shown in Fig. 3A) or must have a resistance in series to make the drop through the speaker circuit the same as that through the neon lamp. In the first case, a simple snap switch will do; while in the second instance a double-pole, double-throw switch is shown.

The power output necessary to completely modulate the light values of a neon lamp of the type shown, together with a 2,000-ohm series resistance, is about 400 or 500 milliwatts. The maximum undistorted power output of a '71A with 180 volts on the plate is 700 milliwatts; so there seems to be little reason for employing a larger tube in the output. To obtain 180 volts for the '71A plate circuit, at least 345 volts is required at the power supply output.

Inertia-Free Light Sources

By FREDERICK WINCKEL

(Continued from page 209)

Thus the glow-lamp seems to have the most prospects, since special sources of current are unnecessary, and it is dependable in operation. Even Karolus, who at first worked exclusively with the Kerr cell, has built also a glow-lamp receiver, which was exhibited at the radio exposition previous to the last.—*RAFA* 1930-*H*-11.

Color Television

By DR. FRITZ NOACK

(*Continued from page* 179)

that at the transmitter, the observer (7) will see in the window (6) an image corresponding not only in its form but in its color values to that which is scanned at the transmitter, as in Fig. 1.

Because the photo-cell receives only the same number of impressions (one for each pietorial element) as in monochromatic (single-color) television, the same modulating frequency will serve for the transmission of these pictures.

However, the system actually to be used will employ, not the rotating color disc of glass filters, but the method of decomposing white light into its constituent colors which is afforded by a prism. Fig. 3.) Thus, if red light is sent into the prism (8), only a red ray will pass; if violet light is transmitted, the violet ray will be refracted to a different point, in accordance with a well-known optical effect. We may therefore arrange twelve photo-electric cells side by side, as shown at (10); and each will receive a different color of light from the prism. Should a ray of pure white light be projected through the disc, each cell will receive one of its constituents. By means of a commutator (12) the impulses are selected for amplification and modulation. However, it is the purpose of the inventor to proceed further, and to accomplish the desired result by the use of a single photo-electric cell; probably with a scanning device of the type of the Braun cathode-ray tube.

It has been shown that it is practicable to transmit the sounds recorded on a "talking film," together with the television images, on the same carrier wave, without widening the band. The interruption of the sound transmission by the picture transmission, during the scanning, has been overcome.

Two New Tubes for the Television Receiver

(*Continued from page* 184)

means of the shunt resistance), is taken care of in the original design. Adjustment of this current during operation would call for the addition of two additional controls—one to vary the plate voltage, and the other to adjust the bias to the proper value to maintain operation on a favorable portion of the tube's characteristic curve. The advantage is insufficient to warrant the additional complexity.

100 to 150 Meters Range

The receiver is designed to cover the band from 100 to 150 meters, with .0001-mf. condensers. In order to avoid the reduction of the gain, caused by using R.F. chokes in a parallel-feed system on these short waves, the coils are inserted directly in the plate circuits. Care should be taken in this respect, both in constructing and in operating the receiver; as the stator plates of the condensers are "hot". Single control is effected by removing the condenser shafts and replacing them with a single long brass shaft. The resistances furnishing the grid return for the R.F. tubes serve to slightly broaden the tuning of the circuits, in such a manner as to aid in covering the wide transmission-band necessary.

Care should be taken in shielding the R.F. coils; so that no regenerative effects will sharpen the tuning of the circuits.

Parts List

C 1—Hammarlund MC 23 midget condenser;
C 2—Hammarlund MLW 100 condensers, ganged;
C 3—Aerovox 461-21 double 0.1-mf. units;
C 4—Aerovox .00005-mf. mica condensers No. 1450;
C 5—Aerovox .01-mf. mica condensers No. 1450;
C 6—Aerovox 1-mfd. double unit. Type B1;
C 7—Aerovox 1-mf. unit. type 302;
C 8—Aerovox 1-mf. unit. type 302;
C 9—Aerovox B2 block—triple 1-mf.;
C10—Aerovox Type 300, 4-mf. unit;
C11—Three Aerovox 4-mf. type 402 units;
T1, L1, L2—Amertran 245 power block;
L 3—Primary of an old A.F. transformer;
L 4—Hammarlund LWI 120 inductors;
R 1—Electrad 350-ohm flexible resistor;
R 2—Aerovox 200,000-ohm leak;
R 3—Aerovox 100,000-ohm leak;
R 4—Aerovox 1-meg. leak;
R 5—Electrad type G 10,000-ohm potentiometer;
R 6—Electrad C- 75 resistor, 7,500 ohms;
R 7—Electrad C-150 resistor, 15,000 ohms;
R 8—Electrad C- 20 resistor, 2,000 ohms;
R 9—Electrad C-400 resistor, 40,000 ohms, with extra clips to tap voltages, as specified;
R10—Electrad C-4 resistor, 400 ohms.

Some of the Problems of Television

(*Continued from page* 217)

line images. While these may be capable of presenting close-ups of faces, with a crudeness of detail and pronounced shades suggestive of an animated poster rather than a living image, they are quite unsuited for the more serious purposes of ultimate television service. Such systems may even be crowded into a wave band 4 or 5 kilocycles wide, so as to be handled in the usual broadcast spectrum, yet the results are only in the nature of a crude experiment. Surely the radio audience will not be satisfied for long to gaze upon decapitated persons, with no promise of something different and better.

Aside from the matter of screen dimensions, a wide radio channel is essential for proper detail. High and low frequencies are imperative. Thus if we cut off the low frequencies, we introduce spurious shadows and also change the tone of the picture. If we cut off the high frequencies, we delete the sharp lines and lose details such as eyebrows in the case of a close-up portrait. Cutting off the high frequencies also limits us to slow motion, since fast motion is badly blurred. For a comparable picture quality, it requires a band at least twenty times the width of that for the finest broadcasting of good music.

The Scanning Beam

Another problem is that of greater luminosity. It is surprising what we are able to accomplish with the present neon tubes, which have such a low candle-power. Here there appears a genuine opportunity by way of developing new forms of lamps which will be as responsive as neon, yet will give greater light. Again, there is an opportunity by way of developing more efficient methods of utilizing the light that is available. In this connection the four-target or four-plate neon lamp of C. Francis Jenkins, pioneer television experimenter of Washington, D. C., is a step in the right direction, particularly in conjunction with his light-conducting rods. Jenkins has also developed a lens scanning disk, which permits of utilizing the light source to better advantage, particularly in projecting pictures on a screen for a small audience. Alexanderson has also made use of a scanning disk with lenses, instead of the usual plain scanning disk.

For the lens scanning disk, it has become necessary to develop a spot neon light of high luminous intensity and along these lines very considerable progress has been made.

It is now possible to obtain a spot lamp which with a current of about 55 m.a. is so brilliant one suffers pain

(*Continued on page* 236)

How to Build a Television Scanner

By BRUNO WIENECKE

(*Continued from page* 193)

so far toward the middle that they lie lightly against the drum. Spring H. which draws the two brake levers together, is somewhat tightened by turning out the threaded pin F by means of nut G. On lessening the exciting current, the brake shoes are pressed firmly against the drum and brake it. We make the connections to the resistance such that a movement of the crank to the right switches in more resistance and therefore decreases the excitation current.

Now set the contact arm of the resistor so that the armature takes a middle position; switch on the motor, and regulate it so that the perforated disc makes 1,200 revolutions a minute. This is best done by fastening to the front side of the brake drum a sheet of cardboard on which a six-pointed star is drawn. This is illuminated by an ordinary glow lamp fed by the 60-cycle current. On reaching the right number of revolutions, the star seems to stand still.—*Funk Bastler.*

when looking directly at the light. Other developments are under way in several other experimental laboratories and the greatest progress is being made in those laboratories in which the problems of gaseous conduction have been dealt with most.

The writer has recently had an opportunity to see an extremely brilliant spot source. Even more brilliant than anything hitherto developed. Experimentation is being made on this spot source now to determine its response to high frequencies and the most even way of obtaining the brilliancy.

Another method of obtaining brilliant illumination that can be controlled on television signals, is by means of the Kerr Cell which has been used by Professor Karolus in Germany. The Kerr Cell is merely a means of rotating the axis of polarized light by means of impressing an electrostatic or electro-magnetic field. It then acts as a shutter between a very strong arc lamp and the scanning mechanism.

Another development about which very little is known, is the work of Mr. Farnsworth on the Pacific Coast, in which he has made use of the electron stream in a cathode ray tube, to give quite brilliant illumination.

In view of the above experimental work it is believed that the problem of illumination, while yet very difficult, is well on its way to solution and its solution will greatly simplify the matter of reproducing the television image.

The Synchronism Problem

Synchronization is a problem which calls for the efforts of inventive minds. In metropolitan areas where the same alternating current system is available, it becomes a relatively simple matter to keep transmitting and receiving disks in step by means of synchronous motors. That system is the simplest and safest, of course.

However, television service is bound to extend over a considerable territory, where the same current is not universally available. Hence an independent means of obtaining and maintaining synchronous operation must be employed. Ingenious automatic speed controls have been developed, with centrifugal governors making and breaking contacts across speed-control resistances, for maintaining steady speed of the scanning disk irrespective of the fluctuations in line voltage or other causes.

To my mind, the problem will probably be solved more in the direction of ingenious braking devices, which will regulate the scanning disk by means of a definite frequency impressed on the television carrier wave along with the television signals. Again, there may be a synchronizing signal sent out for each revolution of the scanning disk, tending to start the scanning disk out in step with the transmitting disk, at each revolution. There are many ways in which synchronous operation may be obtained.

One very ingenious system of synchronization makes use of the group frequency which accompanies television signals. This frequency can be separated from the television signals and utilized in a synchronized braking arrangement to maintain the same speed at the receiving mechanism as at the transmitter.

One of the simplest devices that has yet come out of a laboratory, is a gear arrangement which permits adjustment of the phase relation between a synchronous motor and the position of the disk when the disk is in motion.

With this arrangement a synchronous motor can be used to drive the transmitting scanning mechanism and the receiving scanning mechanism can be controlled by this very ingenious device so that it will make up for differences in phase between the transmitter and receiver as both are on the same power supply and can be used quite satisfactorily to make up for variation in frequencies between separate power systems.

In this connection it might be interesting to note that transmission in Washington from a synchronous motor run on the Washington power system was followed very easily in

(*Continued on page* 238)

"RADIO" is our "MIDDLE NAME"

BALTIMORE RADIO CORPORATION

SEND FOR OUR NEWEST FREE CATALOG
AND INSURE GREATER PROFITS

Quality — Value — Service

"Wise Dealers" the "World Over" are dealing themselves a "No Trump Hand" by investigating our items and prices. Everyone of the many thousand items that means "Greater Profits". We guarantee "Satisfaction", our aim being, to please you and keep you pleased. Look at these values and order from this page.

STRATFORD 1,000 Volt Condensers

Highest grado voltage condenser made. 100% replacement. Individual cartons. Each has flexible leads.
Small. Compact.
1 mfd. 50c
2 mfd. 75c
4 mfd. 1.00

SANGAMO FILTER CONDENSER

2 Mfd. 1000 volts D.C. In Metal Case Part No. P568
Our Price .. 95c

Greatest Amplifier Value Ever Offered
LOFTIN-WHITE DIRECT COUPLED 245 AMPLIFIER
For Home or Auditorium

Quality amplification from a unit of rugged and of sturdy construction, the finest developments that electrical and mechanical engineering could have possibly put into it. Ideal for phonograph or receiver. Reproduces with enormous volume, maintaining an ultra superior quality. Tubes employed are 224 screen grid first audio, 245 output tube, and a 280 full wave rectifier.

Completely wired—ready for use—simplicity of connections—beautifully finished in brown lacquer—power supplied for any tuner—sturdy oversize parts—no possibility of breakdown, and volume plus, having an undistorted power output of 1,600 milliwatts.

Regular $60.00 list, our special price of 110 volts, 50-60 cycle.......................... $9.95

NEW! PENTODE LOFTIN-WHITE DIRECT-COUPLED AMPLIFIER

The Pentode amplifier tube is the newest development in radio design, having an undistorted power output of 2,500 milliwatts and a power sensitivity four times as great as that of type 45 tube.

When the Pentode tube is combined with the above illustrated direct coupled amplifier, we have the last word in modern distortionless power amplifiers. Tubes employed are the 224 screen grid first audio, 247 power output tube and a 280 full wave rectifier. Ideal for home, dance halls, auditorium and other large public assemblies.

Pentode Model "P7", 110 volts, 50-60 cycle. List price $70.00, our special price...... $12.95

R. C. A. PUSHPULL Input and Output

A. F. Transformer Assembly for Radiola 80, 82 and 86; Part 8554. Price .. $1.50

BALDWIN "RIVAL" UNIT

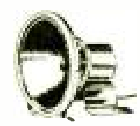
Can be used for Phonograph, automobile or portable radios.
Lowest price ever quoted.
Our Price—less Shell 40c
Our Price—complete with Shell 50c

ACME B and C ELIMINATOR Model E-36

An attractive B and C Eliminator utilizing the 280 full wave rectifier, delivering "C" voltage and plus 45, 90, and 180 volts of "B" power.

Equipped with 5 terminals, and beautifully finished in Bronze Green Metal Case, compact in size. Plenty of voltage to operate a power tube in the last audio stage. Our price.......... $6.95

FARRAND DYNAMIC D.C. SPEAKER CHASSIS



12-inch Cone; 600 ohm D.C. Resistance.
Ideal for home or auditorium use.
Our Price $4.95

"VALUE PLUS" STRATFORD SIX TUBE "TRIPLE" SCREEN GRID MIDGET

Midget in Size, Gigantic in Performance

Advanced in design, beautiful in appearance and sure to win the favor of your most exacting customers.

More profit in your cash drawer with this Summer Sales Booster.

The finest low priced quality Midget Radio on the market—dynamic speaker and phonograph jack. Compact trouble proof circuit utilizing three 224 screen grid tubes. 227 audio stage. 245 power output tube and a 280 full wave rectifier.

A magnificent two-tone cabinet, handsomely finished in Walnut with Birds Eye Maple overlay, encasing the all metal chassis—14½ inches wide, height 17 inches overall.

This beautiful and efficient midget sells on sight! Dealers should feature it immediately. Build up a tremendous repeat business with substantial profits. Order a sample today!

Regular $69.50 list.

Reg. $69.50 List, 110 volts 50-60 cycle Less Tubes $23.95

"Boost Your Summer Sale—Show More Profit"
This set is also available in 220 volts A.C. or 110 volts D.C.

OUR PRICE $24.95, LESS TUBES.

GENUINE! PEAK! R. C. A.! LICENSED! 100% GUARANTEED!

SUPREME QUALITY! LONG LIFE! SERVICE! PERFORMANCE!

To fully assure you that these are high quality tubes, we will replace any that are found defective within ninety (90) days of date of sale. Each and every tube is checked on a Weston tube checker before being shipped, assuring delivery in perfect condition.

"PUT THEM TO A SERVICE TEST"

Look our list over. They include all the new tubes, including the new

PENTODE AND MULTI-MU TUBES

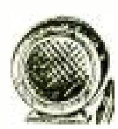
Tubes	List	Tubes	List	
CX 330	$1.60	CX 380	$1.40	OUR PRICE
PX 531	1.60	CX 112-A	2.25	
CX 332	2 30	CX 300-A	4.00	48c
C 347	2.40	PX 301-A	1.25	
C 335	2.20	PX 326	1.75	EACH
C 551	2.70	CX 371-A	2.25	
C 324	2.00	CX 371-AC	2.25	
C 327	1.25	CX 199	2.50	
CX 345	1.40	CV 199	2.75	
CX 350	$5.00	OUR PRICE		$1.25 EACH
CX 381	5.00			

These tubes are of the highest standard and are sold on a money back approval basis if not satisfactory.

VICTOR A.B.C. Power Transformer

As used in Victor sets. For use with six 26's, two 45's and one 80; can also be used for any power amplifier using 245. Price $2.75
25 Cycles $3.25

QUAM MAGNETIC SPEAKER



Improved in every respect. Housed in beautiful gold stipple finished metal cabinet, 14x12x5. Reproduction is excellent.
Price $2.25

Super-Powered Combination Amplifier and Power Supply

R. C. A. component parts compose the major portion of this superior constructed combination amplifier and power supply.

Transformer coupled first audio stage employing a 227 tube. Second audio stage utilizes a 245 power output tube, and a 280 full wave rectifier is used to supply all power including "A and B" power for any tuner. Terminals are provided for all "A and B" supply, as well as both input and output to amplifier.

Beautifully housed in a black Japanned metal cabinet presenting a unique and attractive appearing unit, being 5 x 7⅝ x 13 inches.

Model BRC 1, 110 volts, 50-60 cycle, A.C., list $70.00, our price.................. $13.50

PENTODE POWER AMPLIFIER

Model BRC 2. This model differs from Model BRC 1 only in the use of a Pentode power amplifier tube in place of the 245 tube.

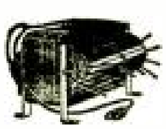
List $80.00 for 110 volts, 50-60 cycle, A.C., our price.......................... $14.50

PENTODE SCREEN GRID POWER AMPLIFIER

Model BRC 3. This model differs from Model BRC 1 in the tubes used and the method of coupling employed. The 224 screen grid tube is used in the first stage and is resistance capacity coupled to the 227 Pentode power output tube. This makes an ideal television amplifier.

List $90 00, 110 volts, 50-60 cycle, A.C., Our price $16.90

LOW POWER CURRENT-SUPPLY TRANSFORMER



Three secondaries, will deliver filament current for two '71A, or '12 A tubes in push-pull and sufficient "B" and "C" potential for these tubes.

Ideal for a push-pull stage for any receiver 95c

R.C.A. VICTOR UNCASED CONDENSERS

1,000 Volts D.C. Working Voltage

Genuine R.C.A. Victor uncased condensers composed of highest grade materials. Compact and moisture proof. Impregnated in heat resisting compound. Packed in individual cartons.

100% Replacement Guaranteed

	Ea.	Doz.		Ea.	Doz.
½ mfd....	$.25	$2.50	2 mfd....	$.50	$5.50
1 mfd....	.35	3.60	4 mfd....	.85	9.00

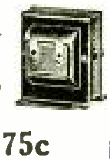
R.C.A. BRUNSWICK CATACOMBS

Six tube panel for amplifying units.
Price $5.40

A.K. REPLACEMENT TRANSFORMER

For all battery sets and early electric sets.
Price $1.45

ZENITH OUTPUT TRANSFORMER PUSH-PULL



Ideal for use between power tube and speaker.
Take no chance on burning out your speaker.
Our Price 75c

CARBON 1 Watt Resistors

Our Price 75c doz.
All Resistance values.

TERMS
20% with order, balance C. O. D., 2% discount allowed for full remittance with order only.

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AGENTS!
SET BUILDERS!
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Send for Our Newest Catalog

Some of the Problems of Television

(Continued from page 236)

Boston on a receiver run on a synchronous motor on the Boston Edison system. It was only necessary to make an adjustment every ten or fifteen minutes.

For the immediate future this holds out the most satisfactory method of solving the synchronizing problem.

The problem of obtaining a nation-wide television broadcasting service is a serious one. In fact, the production of television receivers is largely handicapped until television service is available in various parts of the country. Here it is my belief that the film or radio movies method of broadcasting is going to meet with the greatest favor at first, until such time as broadcasters are prepared to give the necessary time, space, care and money involved in broadcasting television subjects themselves.

Jenkins of Washington, D. C., Frank Conrad of Westinghouse and others, have worked out systems whereby the television pictures are first recorded on film, the positive of which is placed in a machine which scans each frame line by line. The advantage of the film is that the subjects may be posed under ideal conditions in the motion picture studio, with all the talent desired; secondly, that the films can be widely distributed and broadcast by small or large stations without special skill or equipment; thirdly, that a nation-wide hook-up can be effected by the radio movies method, even though no wire lines are required; fourthly, that the uniform service over a large part of the country will permit of selling television service to large advertisers, who can sponsor television in much the same manner that broadcast programs are now patronized. Of course, broadcast radio movies, will lack the news value which is available when the subject is picked up direct and televised. However, in time the direct pick-up will come into more extensive use, and network operation will be necessary.

There has been considerable technical difficulty in picking up an outdoor or indoor scene of large dimensions and transmitting it to the scanning mechanism with sufficient elemental light to readily actuate the photo-electric mechanism of the transmitter.

A new method has been proposed and is now in the process of test, that will provide for the photographing of a scene directly on a film. This film will then be developed in a matter of three seconds and the developed film run through the transmitter scanning mechanism thus causing a lag of only three seconds before the transmitting of the picture.

CROSLEY Electro Dynamic Speakers

FIRST TIME SOLD AT THIS PRICE

YOUR CHOICE $6.50 Net

Model "A"—7" Chassis housed in beautiful metal cabinet Equipped with output transformer.
Model "B"—Same as Model "A" Chassis only.
Model "C"—9" Chassis with 900 ohm field and output transformer. Can be used with any set employing 1-171A or 1-245 power tube. Also can be used in Majestic Model 71.
Model "C"—9" Chassis with 725 ohm field and push-pull output transformer.
Model "E"—6 Volt Chassis for operation on storage battery or "A" eliminator. 85 ohm field and push-pull output transformer. Can be used with sets using the new 232 tubes. Can be converted for A.C. by use of a step-up transformer and 280 tube.

CROSLEY Type F Dynacone Speaker

This Crosley Speaker is meeting the increasing demand for an automobile radio reproducer which can be expected to give a full measure of satisfaction. Dynamic Tone!

OUR PRICE $2.95 Net

MUSIC MASTER Model "PETITE"

110 Volt A.C. 50-60 Cycle
THE SMALLEST
17" x 13" x 7½"
THE LIGHTEST
Net 18½ lbs. Ship'g. Weight 23 lbs.
THE MIGHTIEST in performance.

That, briefly describes this NATIONALLY and INTERNATIONALLY FAMOUS Midget Receiver. Made by a well known manufacturer. FULLY GUARANTEED to us and by us.
The chassis is a masterpiece of compact radio engineering, sturdy, clean construction. Uses three 224 screen grid, one 245 Power and one Rectifier tubes, Loftin-White amplification, Electrolytic Condensers, Magnavox or Jensen Dynamic Speaker, and all housed in a beautiful Walnut Veneer Cabinet of graceful lines.
The manufacturers' price is $49.50 less usual trade discount.

OUR NET PRICE $25.45

Optional: A set of good tubes supplied with each Receiver at $1.25 additional.
Convince yourself of the tremendous value of this offer. Order samples at once, examine and test them, your order for as many as you can handle will follow quickly.

GENERAL ELECTRIC HIGH VOLTAGE FILTER CONDENSER

3 MFD. — 800 VOLTS
Size: 5x2¾x1 Inch.

Encased in a sturdy metal container with 8 inch flexible insulated wire leads. Equipped with handy mounting brackets.

OUR PRICE 95c Net
$10.00 per dozen

MAXIM "Silent" Power Supplies Reduced

DRY "B" POWER

Contains no liquids. A distinct radio bargain that will be of interest to the experienced radio buyer. (Complete with tube.) For A.C. Current.

OUR PRICE $6.50 Net

DRY "A" POWER

Regardless of price no finer "A" Power Eliminator can be procured. No need of bothering with expensive "A" batteries. Complete—for A.C. current.

OUR PRICE $9.00 Net

DRY "A-B" POWER

Ultra modern design. Compact. Simple to install. Only one switch. Comes complete with a 280 tube ready to operate.

OUR PRICE $16.50 Net

SONORA ELECTRIC MOTORS WITH 12" TURNTABLES

FULLY ASSEMBLED and MOUNTED

on ½ inch thick, warp-proof, five-ply boards, size 15 x 15, ready to install into cabinet.
These motors are absolutely NOISELESS, of very rugged construction, operate on 110 volt A.C. current, and are equipped with Speed Regulator and 6 foot cord and plug. The 12" turntable will take any standard size record.
By a special adjustment (at no extra cost) these motors will operate on D.C. current. Please specify when D.C. current is wanted, otherwise A.C. motors will be supplied.

An exceptional Value.

OUR SPECIAL PRICE $9.75

RADIART STEP-DOWN TRANSFORMERS

INPUT 220-250 Volt 50-60 cycle A.C.
OUTPUT 110-120 Volt, Rated at 150-160 Watt

For use in localities where 220 volt, 60 cycle A.C. current is supplied. These Transformers adapt current of that voltage to any A.C. Radio or other Electrical Appliance which consumes up to 160 watts. Encased and easily mounted.
Size: 4x3¼x5⅜"
Ship'g w't: 6¼ lbs.

VERY SPECIAL $3.75

List $5.00
NATHANIEL BALDWIN RIVAL UNIT

This Nathaniel Baldwin unit is one of the finest made by that company. Can be used for Phonograph, Automobile and Portable Radio Outfits.
Order your supply today before it is too late.

OUR PRICE 65c Net

JENSEN "CONCERT" D. C. ELECTRO DYNAMIC SPEAKERS

Model D7DC 10" Diameter
2500 ohm field 8 ohm voice coil

These units contain suitable push-pull transformers and are absolutely hum-free. Connect directly to the set, no outside wires.
As most standard manufactured A.C. sets are engineered for D.C. speakers of this ohmage, the possibilities for replacement with this really good speaker are practically unlimited.
The wise merchant or repair-man will take advantage of this real "buy". Never before offered at a cut price. The quantity available at this price is limited. Act quickly.

List $27.50
OUR NET PRICE $7.90
Original factory packing of 2 in a carton.

All offers are F.O.B. New York, and subject to prior sale. Terms: A deposit of 20% is required with every order. Balance may be paid on delivery. Or, deduct 2% if full amount is sent with order.

DO NOT WRITE FOR CATALOG!

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STOP SHOPPING!!

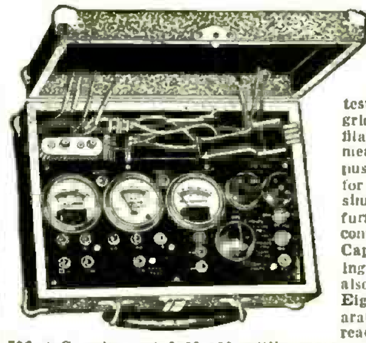
HERE'S a NEW plan, which saves you money. *Stop shopping—the lowest prices are right on this page.* Yes, lower than in our own catalog. Why? Because no house can get out a new catalog every month, but by advertising in this magazine we can bring you the latest and lowest prices *up to the time this ad is printed.* We watch our competitors and *do not allow anyone to undersell us.* We meet ANY price on NEW merchandise. *Order direct from this page and save money. 100% satisfaction on every transaction.*

Dry Electrolytic Condensers

Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

No.	Mfd.	Diameter	Length	YOUR PRICE
1801	1	¾ in.	2⅛ in.	$0.27
1802	2	1 in.	2½ in.	.44
1804	4	1½ in.	2⅛ in.	.83
1808	8	1⅜ in.	4⅛ in.	1.20
1816	16	3 in.	4⅛ in.	2.10
1824	21	3 in.	4⅛ in.	2.70
1832	32	3 in.	4⅛ in.	3.30
1854	54	3 in.	4⅛ in.	4.73

NEW READRITE Analyzer



This three-meter analyzer has selector switch for checking all parts of tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid done quickly and accurately. Plate current, filament volts, line and power supply volts are measured. Grid swing test for tubes used. Just push one button for screen-grid and other button for other tubes. Makes testing of all type tubes simple and thorough. 4½-volt grid battery is furnished. Battery is used for grid test and continuity testing of transformers, chokes, etc. Capacity and resistance charts furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. Eight scale readings of meters may be used separately with the jack terminals provided. Scale readings are 0-60-300-600 D.C. volts, 0-10-140, 700 A.C. volts and 0-20-120 milliamperes. A.C. and D.C. filament voltages are accurately measured on the one meter. Strong case with leatherette covering. Attractive. Compact. Size 10¾x3½x8 inches. Shipping weight 15 lbs. List Price $25.00.

No. 700—READRITE ANALYZER. YOUR PRICE........ $14.70

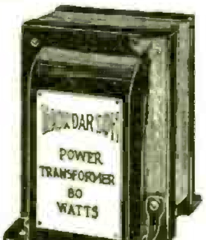
Utah Dynamic A.C. Power Speaker—Model 33A

110-volt, 60 cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone. List Price $50.00.

No. 1506—YOUR SPECIAL PRICE $7.45

THORDARSON "245" Power Transformer

A Miniature Power Plant — Supplies All ABC Voltages — 80 Watts



In addition to supplying a full 250 volts to the plates and 50 volts to the grids of two type '45 tubes in push-pull, this transformer may be used to light the filaments of seven or eight 2.5-volt filament tubes; and by connecting in series two of the three 2.5-volt filament secondaries it is possible to light 5-volt filaments too. Five secondaries: S1—5 V., 2 Amp.; S2—340 V. Cent. T.; S3—2½ V., 3 Amp. Cent. T.; S4—2½ V., 10½ Amp.; S5—2½ V., 3 Amp. Cent. T. **Just the power transformer for building up a high-grade public address amplifier to use a screen-grid A.F. amplifier to boost the output of a microphone or phonograph pick-up;** following this with two stages of push-pull amplification consisting of two '27's in the first stage and two '45's in the second. Bottom of transformer has bakelite panel on which are mounted all taps. **It outperforms ANY similar transformer.** Many Service Men keep this model transformer on hand for emergency replacements in hundreds of makes of radio sets. For 110-120 volts, 50-60 cycles. Size: 5 in. high x 4 x 3½ in. Shipping weight, 8 lbs. **List Price, $15.00.**

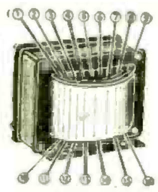
No. 1450—Thordarson Power Transformer. YOUR PRICE.......... $3.85

Flewelling-Dayton SW Adapter

This wonderful instrument connects to any A.C. radio set by putting into tube socket in place of the tube (which must be a type '27, or "heater" tube) the plug which is on the end of its 2-ft. cable; then put tube into tube-socket of adapter. Remove aerial from broadcast set and connect to antenna post on adapter. Special plug-in coil No. 1 covers a wavelength band of 17 to 29 meters; coil No. 2, 27-28 meters; coil No. 3, 47-81 meters. Plug-in coil inductances come with the adapter. 5½x7¼x4" high, overall. Ship. weight 4 lbs.

No. 1613 — Dayton Flewelling Short-Wave Adapter. List Price. $15.00. YOUR PRICE (without tube).... $4.93

Earl Power Transformers

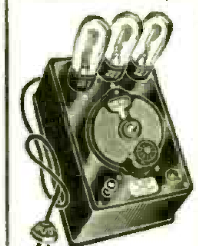


Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen-grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's and for '71A's are center-tapped. Size, 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. **List Price, $7.50.**

No. 1410—Earl Transformer (without brackets). YOUR PRICE.... $1.73

No. 1411—Earl Transformer, the same but with mounting brackets.. $1.98

NEW! NEW!! Superheterodyne S-W Converter



At last a short-wave converter that converts any broadcast set into a superheterodyne short-wave receiver. Employs three 227 tubes and covers from 20 to 115 meters. No plug-in coils! Coil switch is used to cover all wavelengths. Single dial control, no body capacity, no squeals. This converter has built-in filament transformer to heat the three 227's. All you need to obtain from your receiver is a positive B voltage anywhere from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. So simple a child can operate it. Size 7 x 10 x 5 inches. Shipping weight, 8 lbs. **List Price $25.00.**

No. 1614—Super Converter (less tubes). YOUR PRICE........ $15.93

Baldwin D.C. Dynamic Speaker

A brand new addition to the famous Baldwin line of speakers. Never before has a speaker of such small size offered such fidelity of response. 9 in. diaphragm. 2500-ohm field winding with 15-ohm voice coil. For use across D.C. line or with field coil acting as filter choke in power supply circuit. Furnished without coupling transformer. Shipping weight, 10 lbs. **List Price, $12.00.**

No. 1513—Baldwin D.C. Dynamic Speaker. YOUR PRICE.......... $4.73

Columbia Phonograph Pick-Up

An exceptionally fine phonograph pick-up unit complete with tone arm. Made for Kolster by the famous COLUMBIA organization. Pick-up swings back over arm while changing record. Cushion stop prevents jarring of pick-up head. Handsome bronze finish. An ideal pick-up for home, theatre or auditorium. Brand new merchandise. Shipping weight, 5 lbs. **List Price, $19.75.**

No. 2304—Columbia Phonograph Pick-Up. YOUR PRICE......... $4.58

High-Voltage Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS Cat. No.	Mfd. Capac.	Your Price	800 VOLTS Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.40
1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

Television Receiving Lamps

These Television Receiving Tubes have been designed to avoid high space charges, and at the same time confine the light to the most useful portion of the cathode. Brilliant light spots usually found on the cathode and caused by high frequency current vibrations have been entirely eliminated by a special process which minimizes "sputtering" under the influence of the discharge. Rigid support of the elements is obtained by the use of sturdy glass rods. 1⅛ in. x 3½ in. with cathode 1 in. square. Shipping weight, ½ lb.

No. 775—Television Lamp. List Price, $4.00. YOUR PRICE..... $1.98

FREE! New Summer Edition

The new Summer Edition of our greatly enlarged RADIO SERVICE TREATISE has just come off the press. If you liked the Winter Issue, you will like this one a hundred-fold. It contains some 75 new hook-ups, circuit diagrams; and some 350 illustrations. **POSITIVELY THE GREATEST BOOK EVER PUT OUT BY ANYONE.** Among the new matters listed are:

VACUUM TUBE TREATISE, with many illustrations; full page Vacuum Tube Average Characteristic Chart; How to Take Care of Your Tubes; How to Connect Phonograph Pick-ups; Improving the Tone Quality of Old Sets; Connecting Additional Loud Speakers; all fully illustrated with diagrams.

Other articles: Modernizing Old Radio Sets; How to Convert Battery to Power Sets; Selection of Tubes; Push-Pull-Amplifiers; Replacing Audio Transformers; Phono Attachments; How to Choose Power Transformers; Voltage Dividers; Wattage of Power Transformers; Selecting and Installing Replacement Parts in Radio Sets; Filter Condensers; Repairing Eliminators.

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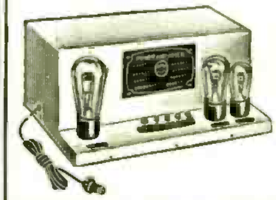
Pacent "250" Power Auditorium Amplifier



One of the Most Powerful Super Power Amplifiers ever made.

CONTAINS 2 STAGES SUPER POWER A.F. AMPLIFICATION

This famous amplifier is provided with input and output transformers for working from a phonograph pick-up into a 2000-ohm transmission line or into the coupling transformer furnished with most dynamic reproducers. The tubes required are one '26, one '50 and one '81 rectifier. Where maximum output is not required a '10 may be substituted for the '50 in the output. Automatic adjustment takes care of the discrepancy in voltages. The undistorted power output is 2.5 watts—enough for four small dynamic reproducers. This degree of power output provides satisfactory coverage for auditoriums having a volume of 25,000 cubic feet. The input voltage necessary to provide maximum output is but .025 volts.

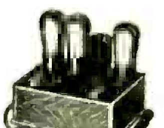
Ideal for theatres seating approximately 3,000 people, dance halls, schools, lectures, hospitals, auditoriums, outdoor gatherings, etc., etc. The gigantic power is at all times within control—for that matter, it can be used in any home, as the volume can be regulated down to a whisper!

A PHONOGRAPH AMPLIFIER—PUBLIC ADDRESS AMPLIFIER SYSTEM, ETC.

Use of the '26 tube in the input stage makes the long "warming up" period unnecessary. Shipping weight, 30 lbs. Overall size, 16 x 9¼ x 6¾" high. **List Price, $90.00.**

No. 1925—Pacent Model 250 Power Amplifier (less tubes). Your Price $14.20

A.C. Short Wave Converter



The thrill of tuning in short waves is yours, because you can connect this short-wave converter to your broadcast receiver, no matter what type receiver you have. Tunes from 10 to 200 meters, using only two plug-in coils. Coils, already wound, are supplied with outfit. Converter has built-in filament transformer to heat three 227's. All you need obtain from your receiver is a positive "B" voltage, anything from 45 to 180 volts. Voltage not critical. No molestation of the receiver. No tricky regeneration control, only a single, smooth-operating dial to manipulate. No squeals, no grunting, no body capacity. All parts for 3-tube short-wave converter, including cabinet, with filament transformer, complete instructions and pictorial diagram. Shipping weight 8 lbs.

List Price $20.00.

No. 1617—YOUR PRICE, less tubes $9.45

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