TELEVISION News

HUGO GERNSBACK Editor

NOW 25¢

April

How To Build Your Own Lens Disc Television Receiver

J. E. Smith, President, National Radio Institute, the man who has directed the Home-Study training of more men for the Radio Industry than any other man in America.

YOU'RE WANTED for a Big Pay Radio Job

I'll Train You at Home in Your Spare Time for RADIO · TELEVISION · TALKING MOVIES

Set Servicing

Spare-time set servicing is paying N. R. I. men $200 to $1,000 a year. Full-time men are making as much as $65, $75 and $100 a week.

Broadcasting Stations

Need trained men continually for jobs paying $1,200 to $5,000 a year.

Ship Operating

Radio operators on ships see the world free and get good pay plus expenses.

Aircraft Radio

Aviation is needing more and more trained Radio men. Operators employed through Civil Service Commission earn $1,620 to $2,800 a year.

Talking Movies

An invention made possible by Radio. Offers many fine jobs to well-trained Radio men, paying $75 to $200 a week.

Television

The coming field of many great opportunities is covered by my course.

IF YOU are earning a penny less than $50 a week, send for my book of information on the opportunities in Radio. It is free. Clip the coupon NOW. Why be satisfied with $25, $30 or $40 a week for longer than the short time it takes to get ready for Radio?

Radio's Growth Opening Hundreds of $50, $75, $100 a Week Jobs Every Year

In about ten years Radio has grown from a $2,000,000 to a $1,000,000,000 industry. Over 8000,000 jobs have been created. Hundreds more are being opened every year by its continued growth. Men and young men with the right training—the kind of training I give you—are stepping into Radio at two and three times their former salaries. J. A. Vaughn, Grand Radio and Appliance Co., 3107 S. Grand Boulevard, St. Louis, Mo., writes: "Before I entered Radio I was making $35 a week. Last week I earned $110 selling and servicing sets. I owe my success to N. R. I."

You Have Many Jobs To Choose From

Broadcasting stations use engineers, operators, station managers and pay $1,200 to $5,000 a year. Manufacturers continually need testers, inspectors, foremen, engineers, servicemen, buyers, for jobs paying up to $7,500 a year. Radio operators on ships enjoy life, see the world, with board and lodging free, and get good pay besides. Dealers and jobbers employ service men, salesmen, buyers, managers, and pay $30 to $100 a week. There are many other opportunities too.

So Many Opportunities Many N. R. I. Men Make $200 to $1000 While Learning

The day you enroll with me I'll show you how to do 28 jobs, common in most every neighborhood, for spare-time money. Throughout your course I send you information on servicing popular makes of sets; I give you the plans and ideas that are making $200 to $1,000 for hundreds of N. R. I. students in their spare time while studying. My course is famous as the one that pays for itself. G. W. Page, 2210 Eighth Ave., S., Nashville, Tenn., writes: "I picked up $935 in my spare time while taking your course."

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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!

J. E. SMITH, President
National Radio Institute
Dept. 2CC4
Washington, D. C.

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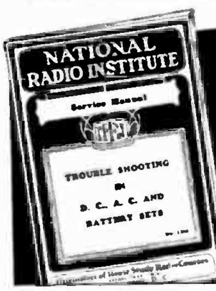

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Vol. II

TELEVISION News

No. 1

HUGO GERNSBACK, Editor

H. WINFIELD SECOR, Managing Editor

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And Television is already here! Soon there'll be a demand for THOUSANDS of TELEVISION EXPERTS! The man who learns Television **now** can have a great future in this great new field. Get in on the **ground-floor** of this amazing new Radio development! Come to COYNE and learn Television on the very latest, newest Television equipment. Talking Picture and Public Address Systems offer opportunities to the Trained Radio Man. Here is a great new Radio field just beginning to grow! Prepare NOW for these wonderful opportunities! Learn Radio Sound Work at COYNE on actual **Talking Picture and Sound Reproduction** equipment.

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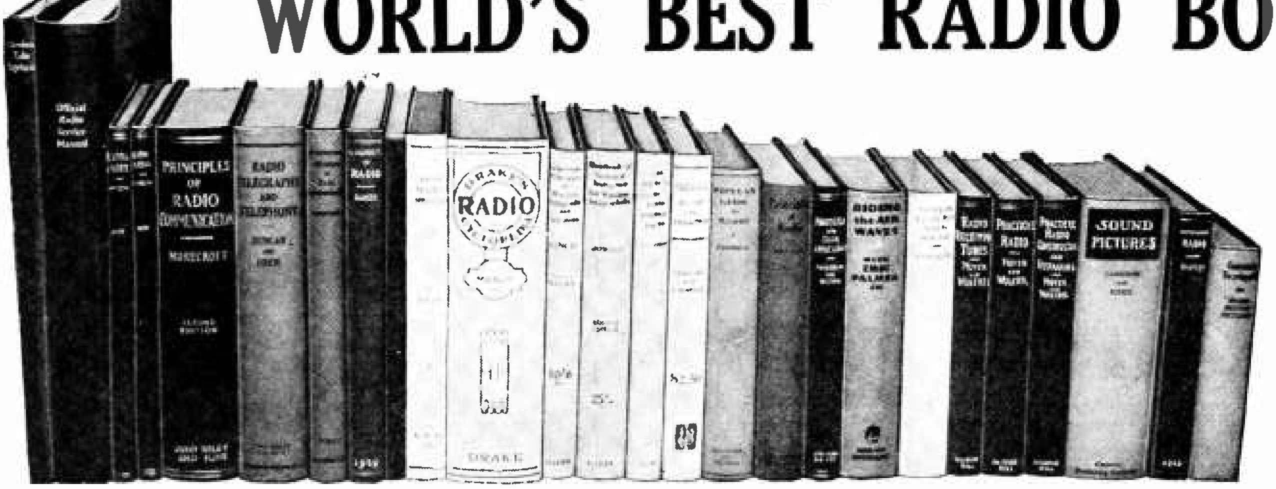

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WE herewith present to the readers of TELEVISION NEWS the most complete collection of recent important radio books. We have, after an exhaustive study, selected these volumes because they represent the foremost radio books of their kind in print today. There is such a great variety that we are sure it will satisfy any taste as well as any requirement that the student of radio might have.

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EXPERIMENTAL RADIO, by R. R. Ramsey, Professor of Physics, Indiana University. Cloth covers, size 7½x5½", 256 pages, 168 illustrations. Price, postpaid **$2.75**

This book by Professor Ramsey is written in the nature of an experimental radio course and contains 128 experiments, illustrated and described in a clear and interesting style. The experiments cover such valuable subjects as: A test on a loud speaker; the impedance of coils; construction of a filter, screen grid tube; beat note audio oscillator; etc.

PRINCIPLES OF RADIO COMMUNICATION, by J. H. Morecroft, Prof. of Electrical Engineering, Columbia University. Cloth covers, size 9¼x6", 988 pages. Profusely illustrated. Price **$7.50**

A radio classic, indeed, is Professor Morecroft's very complete text-book which covers such important radio phenomena as: the action in condensers; self and mutual induction in a circuit; phase and phase difference; effect of condensers and coils on wave shape; resonance frequency of coupled circuits; skin effect in coils; antenna resistance; transformers; vacuum tubes; radio frequency alternators; modulation and circuits; amplifiers and filters.

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

This valuable handbook starts off with instructions on how to learn the code in considerable detail, with a list of abbreviations. Then comes operating rules and regulations of the Radiomarine Corporation of America with operators' report forms; followed by the rules of the International Radiograph Convention; the United States Radio Act of 1927; the Ship Act of 1912; etc.

PHOTOCELLS AND THEIR APPLICATION, by V. K. Zworykin, E.E., Ph.D., and E. D. Wilson, Ph.D. Cloth covers, size 5¼x8", 210 pages, 97 illustrations. Price **$2.50**

Photocells today occupy a very important place in radio and talking pictures, as well as other branches of applied science, and these two experts have provided the very latest information as to the action taking place in various types of photocells. The theory on which these different cells operate, including color sensitivity, together with amplifier and scanning discs used in picture as well as television transmission, etc.

PRINCIPLES OF RADIO, by Keith Henney, M.A. Cloth covers, size 8x5½", 478 pages, 306 illustrations. Price **$3.50**

The author is well known in radio and he has here provided a very complete and clearly written discussion of radio circuits and apparatus, including such important topics as: condensers; transformers; determination of inductance; vacuum tube action, including Screen Grid and Pentode; wave meters, their calibration and use; modulation; amplifiers; long wave receivers; and different types of rectifiers.

HOW TO PASS U. S. GOVERNMENT RADIO LICENSE EXAMINATIONS, by R. L. Duncan and C. E. Drew. Flexible covers, size 9½x7", 170 pages, 92 illustrations, appendix. Price **$2.00**

The authors are thoroughly conversant with their subject and all of the most important information including hook-ups; types of antennae and receivers with wiring diagrams of both small and large receivers and transmitters of commercial type, including ship sets are given.

RADIO RECEIVING TUBES, by Moyer and Wostrel. Cloth covers, size 7½x5½", 298 pages, 181 illustrations. Price **$2.50**

No radio student or operator can do without this authoritative book on the radio vacuum tube. The various chapters include construction of vacuum tubes; electrical fundamentals; elementary action taking place in the vacuum tube, with graphs; reactivation of tubes; testing of tubes including determination of amplification factor; plate resistance; grid resistance, etc.

PRACTICAL RADIO—INCLUDING THE TESTING OF RADIO RECEIVING SETS, by James A. Moyer, S.B., A.M., and John F. Wostrel. Cloth covers, size 8x5", 378 pages, 223 illustrations. Price **$2.50**

Everyone will find this volume of the utmost practical value as the authors have explained in text and diagrams, for the practically-minded student, such interesting subjects as telephone receivers and crystal sets; various types of aerials; current sources for vacuum tubes; audio and radio frequency amplification with hookups; loud speakers and how they work; various radio receiving sets with diagrams and just how they work.

PRACTICAL RADIO CONSTRUCTION AND REPAIRING, by J. A. Moyer, S.B., A.M., and J. F. Wostrel. Cloth covers, size 8x5", 354 pages, 163 illustrations. Price... **$2.50**

This handbook is one that every radio set tester and general student will want to read carefully. These experts have given a very complete description of instruments used to test and repair modern radio sets, together with complete diagrams of many modern receiving sets, with explanations on how to test the radio and audio frequency stages for faults.

ELEMENTS OF RADIO COMMUNICATION, by Professor John H. Morecroft. Cloth covers, size 9x6", 270 pages, 170 illustrations. Price... **$3.00**

Professor Morecroft explains in an authoritative and clear manner such important radio phenomena as current flow in circuits containing capacity and inductance; propagation of radio waves; vacuum tubes as detectors and amplifiers; fading of radio waves and its causes; neutralization; superheterodynes for short waves, etc.; audio frequency amplifiers; how filters work, etc.

RADIO TELEGRAPHY AND TELEPHONY, by R. L. Duncan and C. E. Drew. Cloth covers, size 9½x8", 950 pages, 468 illustrations. Price **$7.50**

This 950 page book forms indeed a most complete treatise on radio facts. The authors treat thoroughly the magnetic circuit; Ohm's law; transformers and induction; motor generators and starters; storage batteries; alternating currents; capacity and inductance formulae. Vacuum tubes as detectors and amplifiers; oscillographs; radio compass; wavelength measurements and short wave receivers.

RADIO SERVICE MAN'S HANDYBOOK WITH ADDENDA DATA SHEETS. Flexible covers, size 9x12", 200 pages, 200 illustrations. Price, prepaid **$1.95**

This remarkable book contains several hundred illustrations with wiring diagrams and charts covering every conceivable subject, including radio sets, tubes, etc. The book is strictly up-to-date and contains the newest practical information which every radio man absolutely must have.

OFFICIAL RADIO SERVICE MANUAL, by Hugo Gernsback and Clyde Fitch. Flexible covers, size 9x12", over 1,000 illustrations, 352 pages. Price, prepaid **$2.98**

Commercial wiring diagrams for all the regularly manufactured receiving sets are included in this manual and no radio service man or student who builds and repairs radio sets can be without this tremendously useful compilation of circuits and their descriptions. This book is worth $100.00 to anyone who has a use for it. The Manual is indexed so that any commercial receiving circuit can be found instantly. One of the most valuable radio books ever published.

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Dr. Ramsey gives us a very refreshing treatment of the fundamentals of radio, including battery and dynamo action; alternating currents; inductance; vacuum tube constants; aerials of different kinds and how they operate; radio frequency instruments and apparatus; audio amplification and receivers in general.

RADIO TROUBLE SHOOTING, by Ennor R. Haan, E.E. Flexible covers, size 6x9", 323 pages, 257 illustrations. Price **$3.00**

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

DRAKE'S RADIO CYCLOPEDIA, by H. P. Manly. Cloth covers, size 6x9", 1035 pages, profusely illustrated. Price **$6.00**

This massive cyclopedia covers radio apparatus—its operation and maintenance, the various subjects being alphabetically arranged. There are 1735 subjects in alphabetical order ranging from A-battery to zero-beat. This volume contains 1110 illustrations, diagrams, etc. There are 414 illustrations and articles on the building and designing of radio sets, alone; 110 articles with 383 illustrations on the methods of repair, service and adjustment of radio sets.

S. GERNSBACK'S RADIO ENCYCLOPEDIA, by S. Gernsback. Stiff leatherette covers, size 9x12", 168 pages, profusely illustrated. Price **$1.65**

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

TELEVISION TO-DAY AND TO-MORROW, by S. A. Moseley and H. J. B. Chapple. Cloth covers, size 8x5¼", 130 pages, profusely illustrated. Price, prepaid **$2.50**

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

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

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

RIDING THE AIR WAVES, WITH ERIC PALMER, JR., by himself. Cloth covers, size 7½x5½", 328 pages. Price **$2.00**

Short wave fans cannot miss reading this highly entertaining and informative book which tells the story of youthful Mr. Palmer and his remarkable achievements in amateur radio. "Around the World with 5 Watts" and many other interesting subjects appear between the covers of this book.

A POPULAR GUIDE TO RADIO by B. Francis Dashiell. Cloth covers, size 5½x8½", 286 pages, profusely illustrated. Price, prepaid **$3.50**

The author starts off with an excellent section on electricity and magnetism; the use of radio aerials and grounds; the fundamental principles of radio; the electron tube and crystal rectifiers—how they work; the principle of radio amplification; radio inductance coils and condensers; fundamental radio receiving circuits; electrical reproduction of sound; the atmosphere and radio phenomena, etc.

RADIO VISION, by C. Francis Jenkins. Cloth covers, size 9¼x6", 144 pages, profusely illustrated. Price, prepaid **$1.25**

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

RADIO MOVIES AND TELEVISION, by C. Francis Jenkins. Cloth covers, size 9¼x6", 144 pages, profusely illustrated. Price, prepaid **$2.50**

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

RADIO PUBLICATIONS • • • **245-S GREENWICH STREET NEW YORK, N. Y.**

MAR. - APR., 1932

TELEVISION News

VOLUME II
NUMBER 1

HUGO GERNSBACK, Editor
H. WINFIELD SECOR, Managing Editor

MUST WE SCAN?

By HUGO GERNSBACK

EVER since the days of Nipkow, we have been taught that we cannot transmit images electrically at a distance unless we use some sort of a scanning device. We have been taught to believe that in television we must do the same thing that the printer does when he prints a half-tone, *i.e.*, to cut up the picture into small units,—half-tone dots—and then reassemble the image in the same manner at a distant point, also by a number of dots or more correctly, by a number of electrical impulses sent successively between the transmitting and receiving stations.

It may be said that this method so far has not been wholly successful. There are many technical reasons well known for this shortcoming, one being the great speed required to transmit the successive points; second, the wide frequency band required to accomplish this; third, the synchronism which must be maintained between the two stations, if we are to get any image at all.

I therefore ask the question, *Must we scan?* Can we not imagine a method, or methods, which eliminate the scanning, a rut into which we have gotten ourselves with the present method of television?

Telephone Receiver Does Without Scanning

Let us look around and cite some examples that show that it must be possible to transmit images in television without the present-day point or line scanning. Take, for instance, the telephone receiver, a marvelous piece of apparatus which even today is not sufficiently appreciated. We broadcast a symphony—the telephone receiver or loud speaker, using a diaphragm or moving coil, as in the dynamic speaker, reproduces SIMULTANEOUSLY the sounds of from fifty to one hundred musical instruments, from the lowest to the highest audible frequencies, all at the self-same instant! No scanning is needed!

Of course, a television engineer will at once say that we only get a composite of different musical instruments, but this in reality is not true. Not only do you hear the different frequencies, but you also get the color (timbre) and quality, as, for instance, when a soprano sings. You instantly note the difference between two sopranos singing the same selection, simply by the difference of the over-tones, all faithfully received by the one telephone or loud speaker diaphragm. You do not have to "scan" and use mechanical means to accomplish this result. It is all done *simultaneously*, in the same instant.

The Camera Does Not Scan

Consider a photographic camera. You take a picture through a single lens (a single instrumentality) and you faithfully reproduce on the photographic plate, INSTANTANEOUSLY, the true features of a face, building, etc. It is possible to take a complete and accurate photograph today in a thousandth of a second (and spark photographs of sound or air waves in one-hundred-thousandth of a second), a space of time *much* shorter than we even use in television scanning today. In photography, again we require no scanning. It is all done with a single instrumentality.

Behold the Mirror—It Scans Not!

The same is true of the ordinary mirror. When you look at yourself in a mirror, you can move as fast as you like, the image from the mirror will follow as fast as anything can move without point-wise transmission or scanning.

In a forthcoming issue of TELEVISION NEWS, we shall demonstrate that these principles just mentioned are not just plain theory or dreams, but that a sort of television—without scanning—actually occurs in nature, and electrically at a distance at that!

What Lightning Showed Us

It has been shown repeatedly that figures or other marks on a tree or pole, when struck by lightning, have been bodily transferred on to the arm or other part of a human body, and accurately reproduced by the burning mark *into an exact duplicate of the original!* Here is a transference of a complete image instantly, at a distance, and electrically, without scanning!

We have also another counterpart in nature, and if you may call it such, this is the *perfect* television transmitter; much more perfect than any designed by man to date. I refer, of course, to the *animal eye*. It is true, that physicists will point out to me that in the back of the retina we have the so-called rods and cones, each of which is connected separately with a nerve. But they will also tell you that there is no scanning. The image is transmitted from retina to our brain almost instantly *as a whole*—no scanning is required. Translated mechanically, into our present-day television, this would resolve itself into a great number of photo-electric cells, from which the transmission starts. Television engineers should not lose sight of the fact that with our eye, which is the finest television apparatus in existence now, we do not scan either at the transmitting end—that is, the back of the retina—or inside of the brain, which is the receiving end.

Here are convincing proofs, if they were needed, that scanning is a make-shift, and will not prevail in the future.

A Forecast

I firmly believe, that during the next few years, an entirely new method of television transmission will be realized, wherein the image will be transmitted *in toto;* that is, the complete image transmitted instantly, without having recourse to the present *scanning*, whether this scanning be mechanical as with our present scanning disc—or electrically, as in the cathode tube.

Just exactly how this will come about I do not profess to know, but I am quite certain that it will come about, and when it does, it will prove to be the solution of our television problem.

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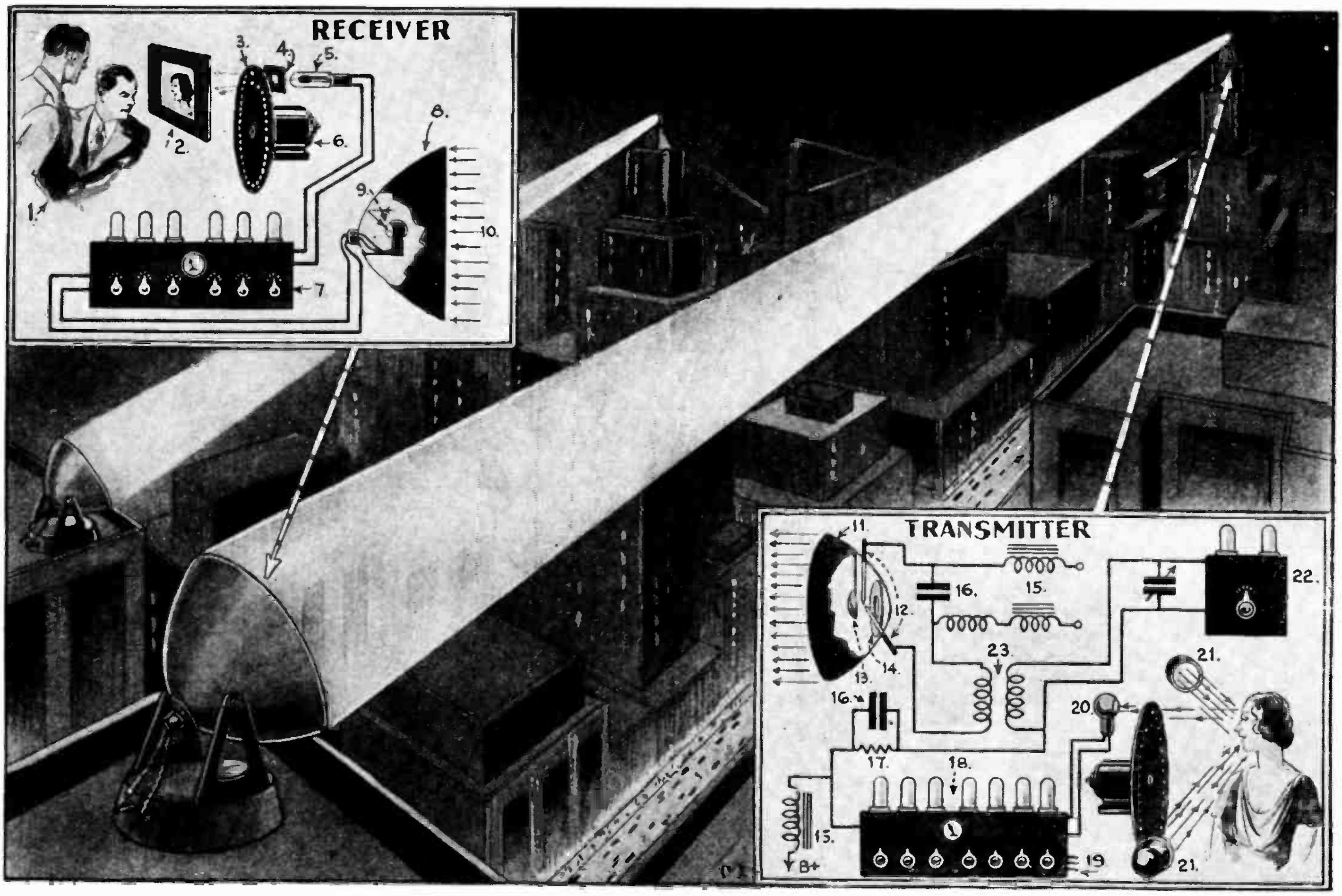
THE NEXT ISSUE COMES OUT APRIL 15TH



Television over a light beam—Transmitter: Subject scanned by lights 21, disc and photo-cell 20. Photo-cell current, amplified by 7 stage amplifier 18, modulates oscillator 22 (15 choke, 16 a condenser, 17 a resistance): which in turn modulates current to arc between carbons 12. 11 reflector, 13 small spherical reflector, 14 diaphragm, 23 transformer, 16 condenser, 15 iron core chokes. Receiver: 1 observers, 2 image, 3 scanning disc, 4 diaphragm, 5 neon tube, 6 motor, 7 detector and amplifier, 9 photo-cell, 8 reflector, 10 light beam.

LIGHT BEAM TELEVISION

ONE can never tell today what is being transmitted over a search-light beam. Without any translating apparatus such as a television receiver, you would not know that a television image was possibly being transmitted by slight variations in the light. Just recently a very interesting and startling demonstration of television over a beam of light took place in the Radio Research Laboratory of the General Electric Co., at Schenectady, N. Y.

Dr. E. F. W. Alexanderson, well-known television expert and consulting engineer of the General Electric Co., directed the experiments and the accompanying drawing shows the arrangement of the apparatus. Many interesting variations of this latest television scheme may present themselves in the future. For one thing, the light-beam does not have to be radiant or visible, for we may make use of the invisible infra-red or ultra-violet rays. It is believed that this demonstration and the experiments lying behind it may indeed pave the way for a new day in television, and that we may expect as a consequence more distinct and better detailed images. The wave length used in the light beam television demonstration was of the order of a millionth of a meter.

How Dr. E. F. W. Alexanderson of the General Electric Co., successfully transmitted and received television images over a light beam.

As revealed in the diagram the image of the subject being televised, is picked up by photo-cells and then amplified by a seven-stage amplifier. The television signal is caused to modulate a carrier frequency, which, in turn, modulates the arc light source. The fluctuations in the light beam, even though slight at times, are faithfully picked up and translated into electrical currents by the photo-cell (light-sensitive relay), placed in the focus of the parabolic reflector at the receiving station, located 130 feet from the transmitter in the demonstration.

The minute fluctuating electric current coming from the photo-cell in the receiver reflector, is greatly amplified by a shielded, resistance-coupled amplifier of six to eight stages. The amplified television signal is then past into a neon tube, and by whirling a scanning disc in front of the pulsating neon light, an image of the person or object before the transmitter is reconstructed. A crater or spot source neon tube may be used, together with a lens disc and ground glass or other screen, to provide an enlarged image.

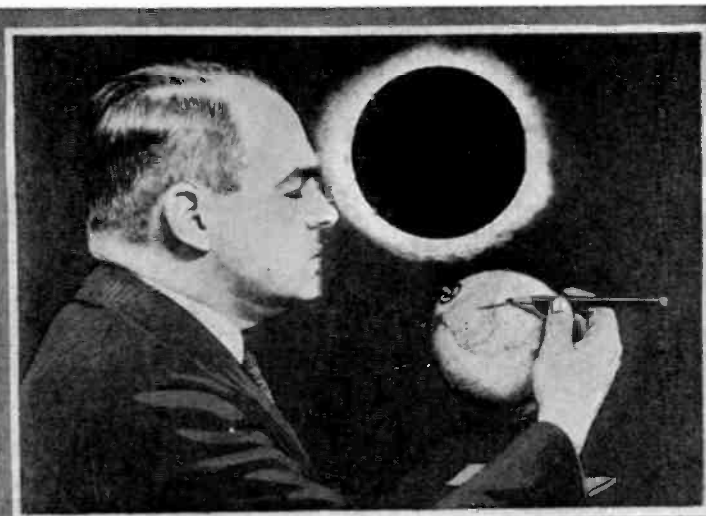
Telecasting With Powerful Light Beams

"The work thus far is highly experimental, yet some day we may see television broadcast from a powerful arc light, mounted atop a tower high above the city," Dr. Alexanderson said. "These modulated light waves will be picked up in the homes by individual photoelectric tubes, or electric eyes, instead of the present-type wire antennae.

"Light-broadcasting may have the same relation to radio broadcasting that the local newspaper has to the national newspapers. These light waves can be received only at relatively short distances, perhaps ten miles. Each community could then have its own light-broadcasting system."

The greatest difficulty in television today, Dr. Alexanderson believes, is in the method of transmission. Radio waves usually follow several paths in travelling from the transmitter to the receiving station. Each ray following a different path produces a different image, so that a composite image is apt to be blurred. For this reason, television has been tending toward shorter and shorter waves.

(*Continued on page* 57)

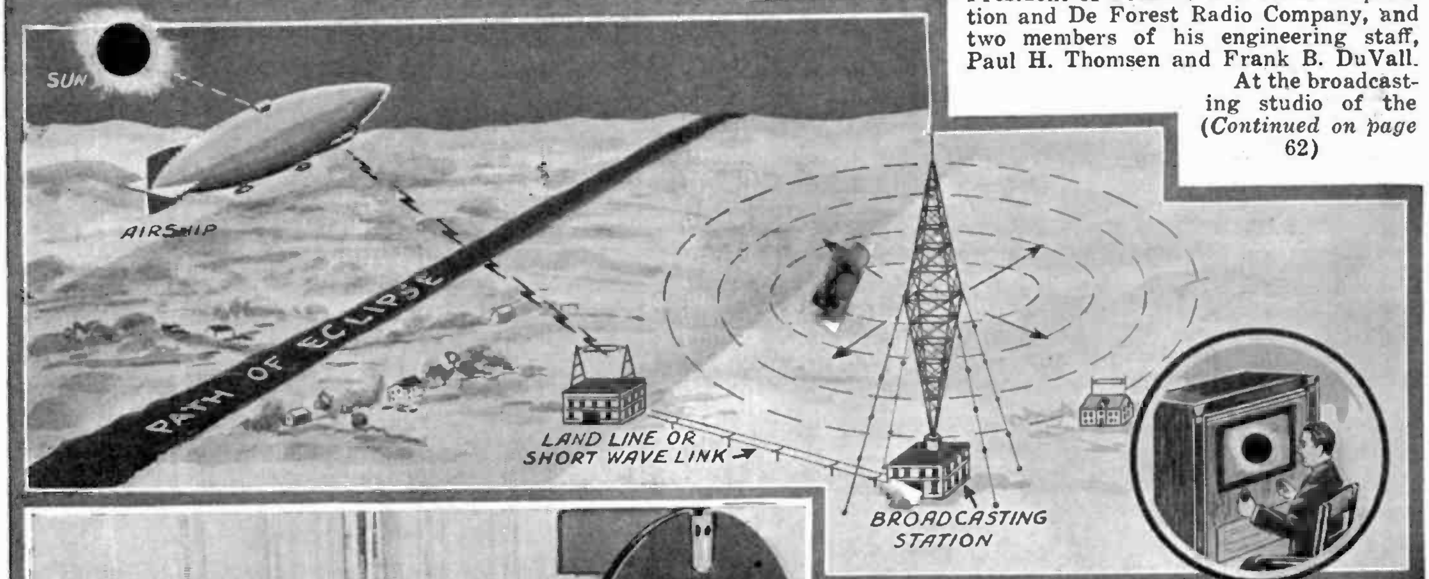


O. H. Caldwell, tracing the path of total eclipse: he hopes to broadcast image from airship.

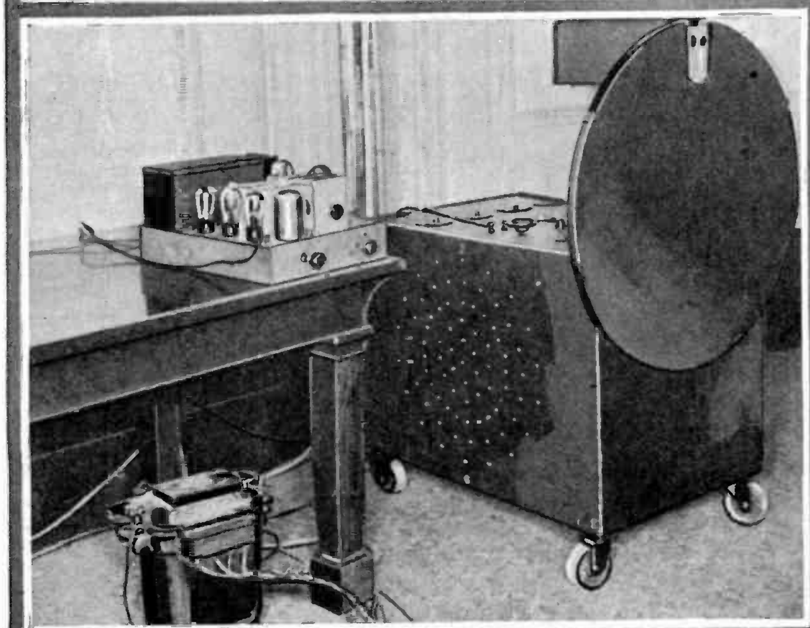
Televising Sun's Eclipse

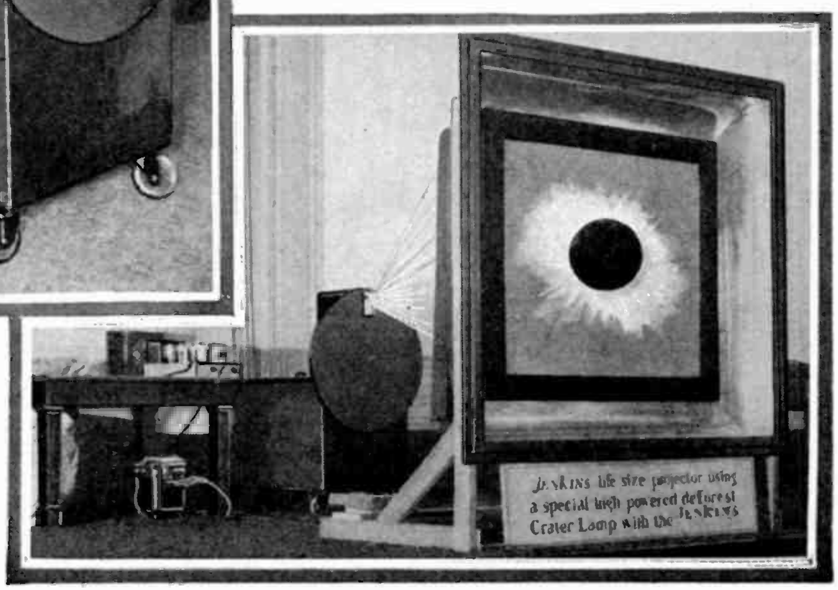
A bold plan to televise the "total eclipse" from an airship and broadcast the image to all "visualists".

By D. E. REPLOGLE*



The route along which the total eclipse of the sun next August will be visible, is a narrow path extending, in part, across New England. Along this path, about fifty miles in width, it is proposed to send an airship fitted with a television pick-up camera. The image of the "total eclipse" can thus be radioed to a land station and re-broadcast to thousands of "visualists". Below and at left—eclipse demonstration described by Mr. Replogle.



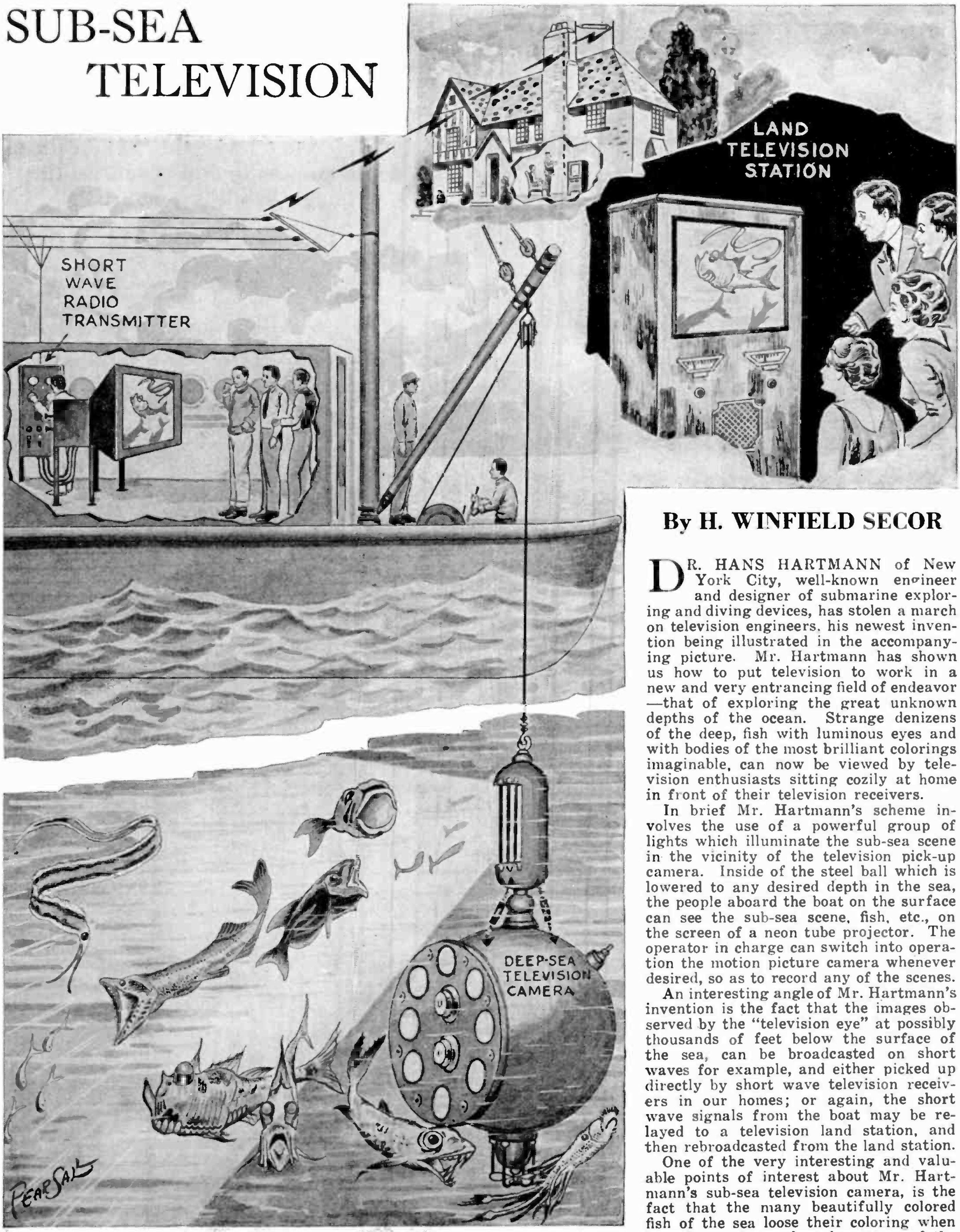


ANTICIPATING a solar eclipse by several months through the instrumentality of *radiovision* presents its whimsical side in conjunction with the importance of showing in advance just what the heavenly constellations will do this coming August. All of which occurred on December 2nd at 9:15 P. M. The scientists and engineers who carefully rehearsed and finally put on this unusual show were O. H. Caldwell, the eminent astronomer, formerly member of the Radio Commission, editor of *Electronics* and other publications; Doctor Fisher, president of the New York Astronomical Society; the author, D. E. Replogle, Chief Engineer and Vice-President of Jenkins Television Corporation and De Forest Radio Company, and two members of his engineering staff, Paul H. Thomsen and Frank B. DuVall.

At the broadcasting studio of the (*Continued on page 62*)

* Vice-President, Jenkins Television Corporation.

SUB-SEA TELEVISION



Dr. Hans Hartmann, well-known New York engineer, who has devised and utilized "deep sea" exploration cameras, has brought his ideas up-to-date, and here shows us how to utilize a "television camera", for the study of deep sea life as well as recording any desired scenes on a camera.

By H. WINFIELD SECOR

DR. HANS HARTMANN of New York City, well-known engineer and designer of submarine exploring and diving devices, has stolen a march on television engineers, his newest invention being illustrated in the accompanying picture. Mr. Hartmann has shown us how to put television to work in a new and very entrancing field of endeavor—that of exploring the great unknown depths of the ocean. Strange denizens of the deep, fish with luminous eyes and with bodies of the most brilliant colorings imaginable, can now be viewed by television enthusiasts sitting cozily at home in front of their television receivers.

In brief Mr. Hartmann's scheme involves the use of a powerful group of lights which illuminate the sub-sea scene in the vicinity of the television pick-up camera. Inside of the steel ball which is lowered to any desired depth in the sea, the people aboard the boat on the surface can see the sub-sea scene, fish, etc., on the screen of a neon tube projector. The operator in charge can switch into operation the motion picture camera whenever desired, so as to record any of the scenes.

An interesting angle of Mr. Hartmann's invention is the fact that the images observed by the "television eye" at possibly thousands of feet below the surface of the sea, can be broadcasted on short waves for example, and either picked up directly by short wave television receivers in our homes; or again, the short wave signals from the boat may be relayed to a television land station, and then rebroadcasted from the land station.

One of the very interesting and valuable points of interest about Mr. Hartmann's sub-sea television camera, is the fact that the many beautifully colored fish of the sea loose their coloring when brought to the surface, by means of the "deep sea traps" used heretofore by scientists. Also, the swimming action and general behavior of many deep sea

(*Continued on page* 53)

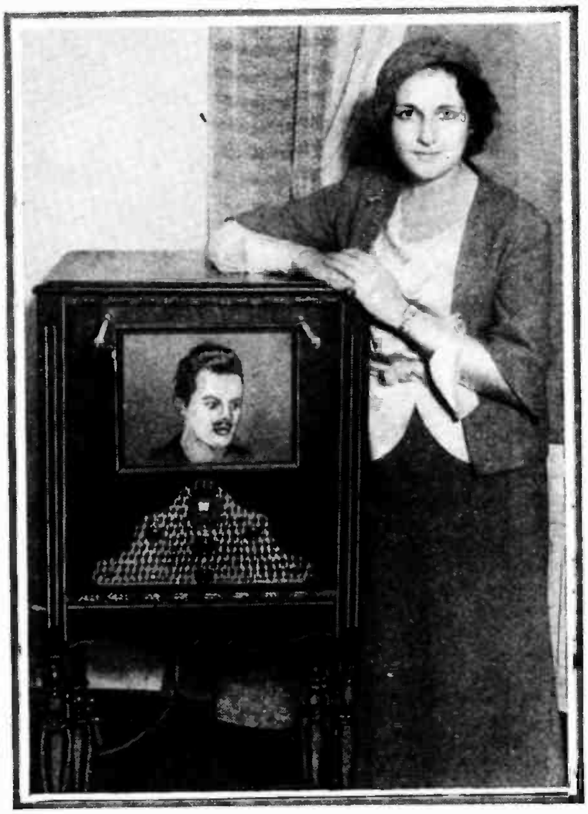
In the Television Eye

Dual Voice and Image Receiver

THE two young ladies pictured above with the Jenkins combination "image and voice" receiver are the Misses Fay Christian, and Kay Campion, of Washington, D. C. The tuning dial for the television receiver is the lowermost one, while the tuning dial in the upper cabinet, just above the image screen, tunes in the voice on the loud speaker of the short wave set. This image receiver is one of the new Jenkins lens disc and crater tube sets, which provides a large picture as shown, which can be enjoyed by the whole family.

Large Image Home Scanner

THE charming young lady observed in the picture at the right is resting her hands on a new television console which provides tuning and focusing controls as shown. The image of a man's head gives an idea of the large image produced with this receiver. A lens type scanning disc and crater tube is used to produce the large image. A number of new engineering features are incorporated in this set. All of the current required for operating this receiver is supplied from the power-pack built in the apparatus.—*Photo courtesy of Short Wave & Television Corp.*



Sanskrit Via Television

LANGUAGES never before spoken before a microphone in the United States were heard and seen on the twin stations W1XAV and W1XAU in Boston. Albert E. Andre, Orientalist, displayed characters representing Tibetan, Sumarian, Sanskrit, Hindustani and Chinese before the photoelectric cells—and at the same time spoke sentences in the various tongues. Mr. Andre is one of the three men in the United States who can speak Tibetan.

There is no word in the Tibetan language for technical terms such as electricity or television. Therefore, Mr. Andre coined a new expression with the literal meaning "long distant vision" which in Tibetan is "Tagring-zigpani".

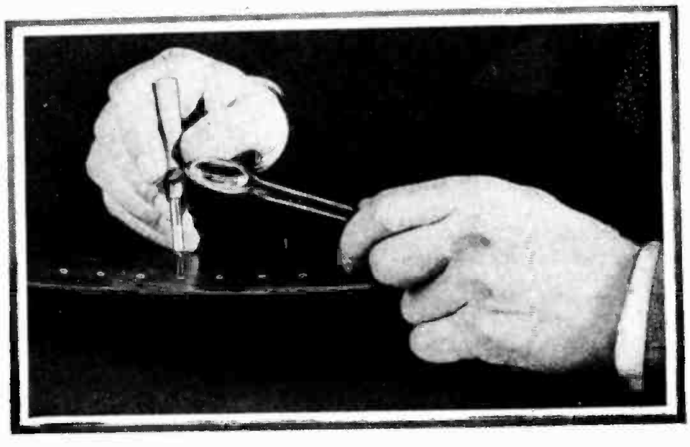
The fact that the intricate characters of Tibetan and Chinese could be recognized is another indication of the development of television transmission and reception.

Photograph shows Mr. Andre bearing Tibetan script written by himself, the translation of which is: "Television is destined to become of greatest benefit to mankind."

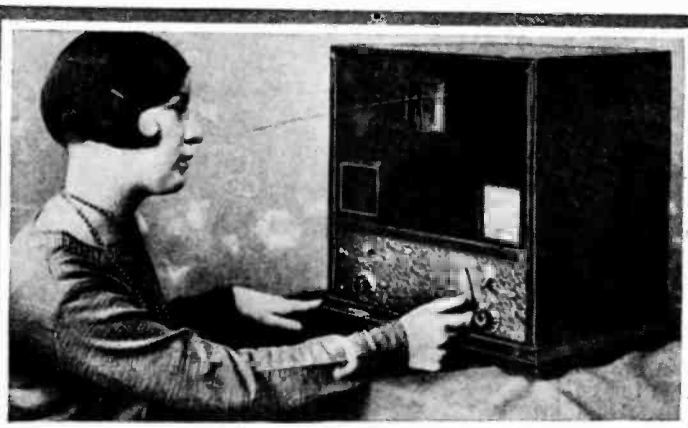
Scanning Disc Hole Cleaner

PHOTO at right shows simple, yet effective hole cleaning device for scanning discs. A small magnifying glass held as shown helps to make certain that the hole cleaning job is carried out thoroughly.

The holes in the scanning disc must always be kept clean if a good clear image is to be seen. The cleaner is a small holder fitted with a loop of horse-hair. *Bell Technical Journal.*

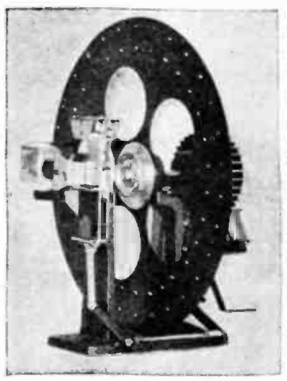


New European Television Kits



Television image (right) as received on one of the television scanner kits here illustrated; it looks odd to American fans because much of the European television scanning is done "vertically" instead of "horizontally," as is the case in this country. Several advantages are claimed for the vertical scanning method.

The television kits here shown are of the Telehor (German) design and manufacture, and illustrate the kind of apparatus European television fans are "looking in" with. Girl above is tuning one of the kits assembled into a cabinet.



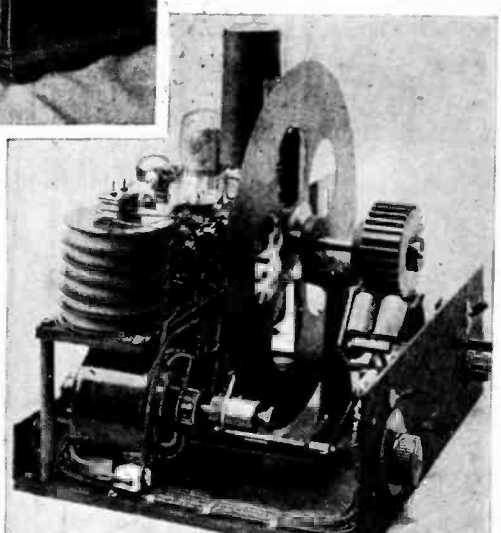
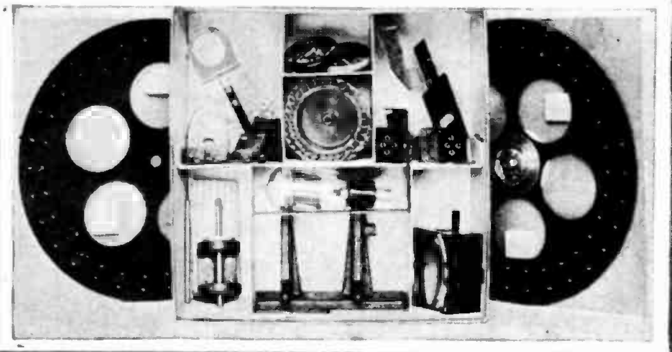
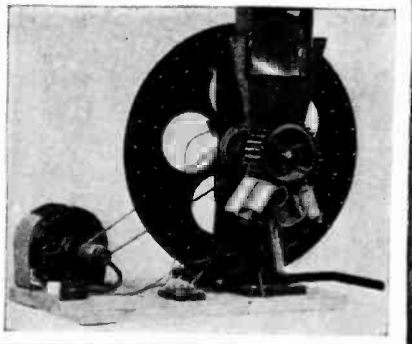


Photo at left shows high quality of workmanship on the European television scanner kits and receivers. Note that the scanning disc is belt-driven from the universal motor, while a phonic wheel motor at the right of the shaft is employed, to keep the scanning disc rotating in synchronism with the disc at the transmitting station. Note the powerful design of the phonic wheel motor, which has two magnets comprising each field pole. The lens mount can be swung from the vertical to a horizontal position so as to scan horizontally or vertically, as may be required.



At the left we see the neat appearance and fine workmanship employed in making one of the European television scanner kits. These kits can be fitted with scanning discs containing different number of holes. Note the neon tube which is supplied as a part of the kit, also the lens mounting. Some kits contain the parts for the receiving set as well. The phonic wheel parts are also included.



Possibilities of Ultra-Short Waves for Television

By D. E. REPLOGLE

Vice-President,
Jenkins Television Corporation

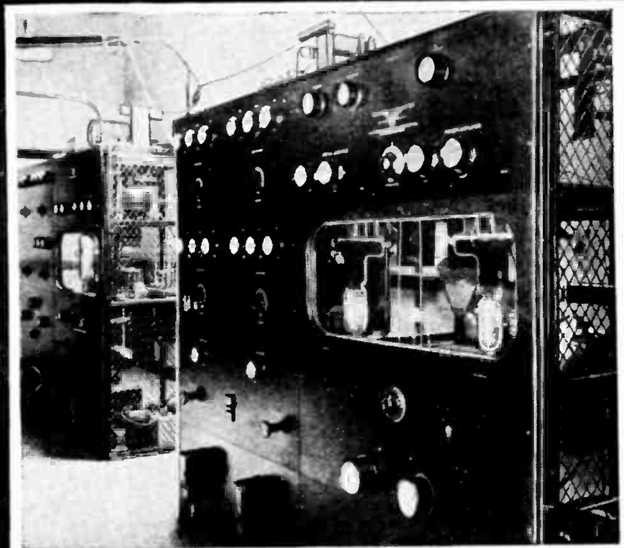
THE spectrum *below* 90 *meters* offers wonderful possibilities for development in the radio field. The great width of frequencies is particularly adapted to television, and because of the fact that the area covered may be limited they will allow for the coverage of many times the present area without interference.

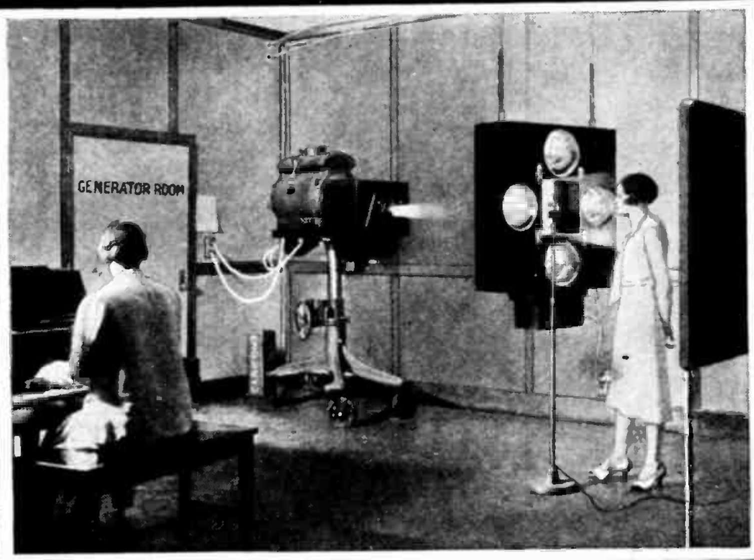
In television the *ultra-short wave band* holds the secret of detailed television transmission. When we have to transmit frequencies up to 40,000 cycles we are faced by the paucity of bands available for the purpose, but we find below 90 meters the necessary width. Another factor in television transmission that make these frequencies desirable is their controllability. With the ultra-short waves, we are able to place a great many more stations on the air within fairly close limits without interference.

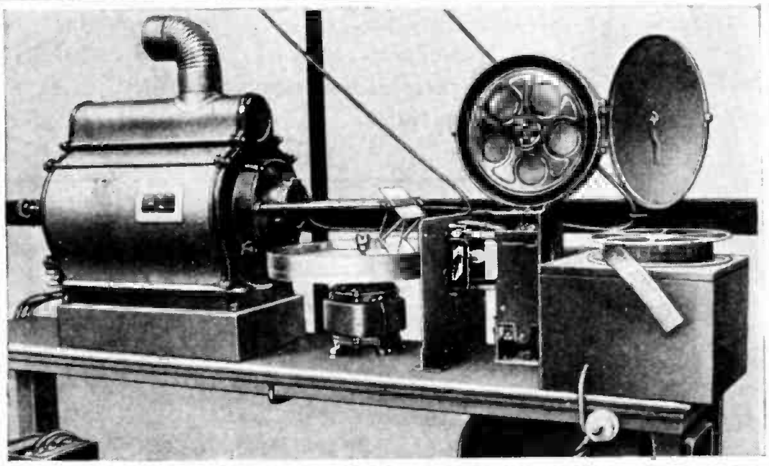
In the field of communication tests at Washington have shown fine reception from plane to plane and from tractor to tractor without interference. The field for short wave communication between mobile vehicles will be a large one in itself.

In short, our experiments have convinced us that we are on the frontier of a great open territory, that is to be exploited in the radio field, and which will give far greater service than ever before. The recent technical advances in the short wave field, will open up new channels of service of all sorts.

The Jenkins Television Company will open *two short wave television stations*, upon which work will start immediately, since experimental work already done indicates that *we have developed methods of using* 5 *K.W. of modulated power on the ultra-short waves.*







Above—The two transmitters at Boston; the further one, W1XAU, transmits voice with 500 watts on 1,550 k.c. The one in the foreground, W1XAV, rated at 3,000 watts, is licensed for only 1,000 watts, on a frequency of 1,600-1,700 k.c. There is also an ultra-short wave transmitter.

Top right—studio scene. Lower photo—Special film scanner used at Boston telecasting station W1XAV. —Photos courtesy Short Wave and Television Corp.

Drum scanning — 120 line images — ultra short wave transmission —white light crater tubes—new cathode ray tubes; are some of the new features here described by Mr. Baird.

The BOSTON *TELEVISION* STATION

By HOLLIS S. BAIRD*

EXPERIMENTAL television station W1XAV, operated by the Shortwave and Television Corporation, went on the air during January, 1930. For nearly a year prior to that, the television experiments had been carried on over amateur station W1WX; this was during the period necessary to get a construction permit, build, and get a license for an experimental station. At first W1XAV broadcast a 48-line picture, at 20 pictures per second, on 2,150 kilocycles, with a power of 500 watts. This was soon changed to 15 pictures per second, to comply with the accepted standard of that time. During December, 1930, the frequency was changed to the 2,850-2,950 kilocycle channel and during March, 1931, 60-line pictures at 20 pictures per second were adopted, to conform to present-day transmission standards. The power was increased to 1,000 watts in July, 1931.

From all records, W1XAV was the first television station to begin a regular schedule in synchronization with a broadcast station (in connection with WEEI) in February, 1930. This was continued for some months and then changed to WNAC, with seven other stations of the Yankee Network. This tie-up was discontinued when the license of W1XAU was granted on 1,604 kilocycles for a synchronized sound station.

During July, 1931, the first successful broadcast of vision and voice to a ship at sea was conducted from W1XAV to the steamship Leviathan, which was at the time over 300 miles away. This event was described in a past issue of TELEVISION NEWS; and it is sufficient to say here that the reception was so successful that several members of the audience on the boat were able to recognize both the picture and the voice of Mayor Curley of Boston, who participated in the broadcast.

W1XAV is the only television station which has had the facilities, or the inclination, to ask the general public to visit its studios for the past two years. Let us assume that we are about to begin a visit to this station and see how television is broadcast and to what point it is being developed.

First we are ushered into a spacious reception room. Here two television receivers are set up. One, the "peep-hole" type, shows a picture about three inches square. The other is a screen type, which projects an 8-by-10-inch image. These are not connected by wire to the transmitter, but contain *short-wave receivers*; so that pictures from New York and Washington may be tuned in also. Of course stations on the adjacent channel to W1XAV can be received only with the latter station off of the air. If there happens to be both a voice and vision program on when we arrive, our trip will have to stop here in the reception room temporarily, while we watch the images being broadcast, or view the action in the studio through the glass doors.

Let us assume that the voice part of the program is over and we have been invited into the studio to see the pick-up equipment. The arc and scanning drum seen in the corner are now located in a separate room, and the light comes into the studio through a window in front of the person or object to be televised. The four large photo-cells are of the potassium type, and are supplemented by four small caesium ones, which bring up the

(*Continued on page* 58)

* Chief Engineer, Shortwave and Television Corp.

The ROMANCE of THEATRICAL TELEVISION

By HERBERT S. FUTRAN
Asst. to the President,
Sanabria Television Corporation

A special Sunday ordinance prohibited trucking through city streets, so the engineers did a little "trucking" of their own.

Many unusual and exciting events occurred during the theatrical exhibition of the giant Sanabria television images in New York, Baltimore, and Newark. Mr. Futran has narrated some of these outstanding events which almost thwarted the efforts of Sanabria and his technicians, as they endeavored constantly to obey the unwritten law of the theatre—"The show must go on"!—and it did!

DURING the past few months Sanabria television equipment has been used in more than one hundred consecutive theatrical performances with only two interruptions (totalling a little more than a minute) because of mechanical difficulties!

This fact amply attests the high development of the Sanabria equipment; but it also bears witness to the ingenuity and ability of Ulysses A. Sanabria, the youthful inventor, and his staff of engineers. They have given television demonstrations, day after day, in the spirit of the theatre where the "show must always go on!" Their experiences make a noteworthy chapter in the countless romances of life behind the footlights.

It pleases Sanabria to consider his present experiences in terms of his earlier days in television, when he was laying the foundations of his present system. He recalls one incident, back in 1925, when the whole technique of television was in its comparative infancy. He had arranged to give a demonstration before a noted group of internationally-famous engineers, who were to see his system for the first time.

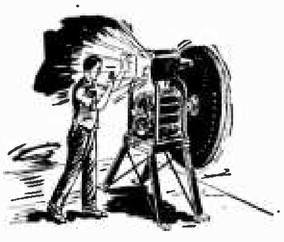
A Bunch of Keys

For six months he had labored unceasingly to perfect his apparatus but, due to the retarded development of a suitable glow-lamp, he had been unable to project a picture on a large screen; and the eve of the demonstration found him hard at work, still endeavoring to project a picture, all to no avail. "One of my assistants," reminisces Mr. Sanabria, "tried to cheer me up by bringing a young lady to the laboratory, and the two attempted to take me out for the evening.

"I refused, however, and the girl, annoyed at my stubbornness, moved the screen from its position in front of the receiver. I went over to reset it and was stooping over the aperture in front of the receiving apparatus when, to my amazement, I noticed the image of some keys dangling from a ring. I looked up to see the young woman nonchalantly tossing her key-ring in front of the transmitter. I knew then that I had at last been able to achieve at least a 'peep-hole' picture."

It is a far cry in the history of television from that night in 1925 to the present Sanabria equipment; but these last few months have been no less replete with thrilling experiences. The thousands who attended the demonstrations at Madison Square Garden (N. Y. City) late in September (1931) and those who have seen Sanabria television in theatres cannot know the romance with which these performances have been endowed.

Back in September, 1931, the newspapers carried large stories about the forthcoming radio show at Madison Square Garden, at which the public was



With the audience all seated and waiting, too strong a current was once fed into the neon tube at the giant projector and the tube blew up.

to see for the first time the largest television picture ever broadcast. A new glow-lamp had been invented, by Warren G. Taylor, which would make that broadcast by Sanabria equipment possible. This lamp, however, demanded greatly increased power which could be furnished only by a special power pack. That pack was manufactured by an outside concern and, finally, all the apparatus was shipped from Chicago by train on September 18.

The Mystery of the Missing Blue-Prints!

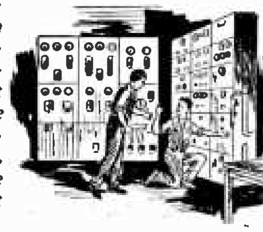
During the transportation of the apparatus from Chicago, however, the equipment was damaged and on its arrival in New York was found unsuitable for immediate use. Among other things, the bolts holding the transformers in the power pack had become loosened and the transformers had crashed down on one another. A frantic call for the wiring diagrams was telephoned to Chicago and they were, supposedly, mailed by the next air mail. What ever happened to those diagrams, however, no one will ever know. Suffice it to say, they never reached the Sanabria engineers in New York, who were anxiously awaiting their arrival.

Fortunately, another unit of the transmitting apparatus had been installed in experimental laboratories in New York, where development work in the studio and presentation technique for television had been carried on by Sanabria experimenters. When it became apparent, late on the night of September 19, that it would be impossible to repair the equipment brought from Chicago, it was planned to move the experimental unit to the Garden and to install it in the stead of the damaged equipment.

There is a city ordinance in New York, however, which forbids moving truckloads of apparatus through the streets on a Sunday, unless a special permit has been granted. Undaunted by this last-minute development, Sanabria officials roused the proper officials from their beds, and a special dispensation was secured. So, shortly after dawn Sunday morning, some of the equipment was loaded on a small truck, the only one available at that unearthly hour; while the rest was "pushed" through the deserted streets by heavy-eyed engineers.

We Have to Give a Demonstration!

Thus, on Sunday afternoon, amid the hundreds of carpenters and electricians



The giant television "act" in one of the theatre presentations almost became a "line on the program" only, when some "villain" cut wires!

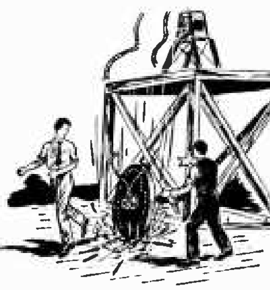
laboring to transform the huge Garden into an exposition palace, the engineers commenced to work on the installation of the apparatus while the wires between New York and Chicago "buzzed" in an effort to locate the missing diagrams. It was then four o'clock Monday morning. The new apparatus, despite the efforts of the engineers, was still in a useless state.

The crucial diagrams were still missing. Yet, at eleven o'clock, the doors would be opened to thousands who were erpecting to see a television demonstration. So Sanabria called his men together and said, "We have to give a demonstration," and each of those engineers—none of whom had been to bed for almost sixty hours—rolled up his sleeves and went to work.

There were two demonstrations scheduled at the Garden. The transmitting apparatus was installed in the basement of the building adjoining the "Television Theatre" where continuous performances of television on a four-foot screen were given. The other demonstration was of the ten-foot square picture! The ground-glass screen, weighing three hundred and fifty pounds and encased in a huge chromium-plated frame, was located high above the floor of the arena at the other end of the building, a distance of about nine hundred feet.

Without his new power unit, which was still damaged beyond the possibility of immediate use, Sanabria knew it to be impossible to furnish enough power to project his large picture; so he concentrated his efforts on the equipment for the smaller image and, when the doors opened on the first day of the show, was ready to demonstrate his four-foot picture.

What happened that first day at the Garden is history. Thousands stood in line awaiting the opening of the "Television Theatre" and, when the gates were opened, four policemen were unable to check the onrush. The walls of the theatre were crushed in and order was not restored until the afternoon showing was over, some four hours later. Workmen hastened to repair and strengthen the walls, and additional police were stationed to control the crowds.


. . . and then the rope broke! Just as the heavy lens disc was about to be lowered, a rope parted and the disc crashed to the floor, almost wrecking the show again.

The forty thousand people who attended the "Television Theatre" that first day have never known until now the labor that was expended in preparing for that showing. They had come to see a demonstration and, because of the untiring efforts of Sanabria and his men, they saw that demonstration. But Sanabria had made still a greater promise, that of showing his ten-foot picture; so, after three hours' sleep (the first in four days!) the engineers assembled for work again.

The wiring diagram was, seemingly, irretrievably lost; so there was nothing to do but to dissect the power pack and then to reassemble it. By late Tuesday afternoon, Sanabria had actually succeeded in solving the complex circuits of the unit, and reported that he was ready to show the large picture on Tuesday night. At a quarter past ten that night, almost twenty thousand persons were massed in the huge arena to witness the first public showing of the largest television picture ever seen.

For the purposes of communication between the widely-separated engineers, an intercommunicating-telephone system had been installed, with a station for Sanabria himself at a point of vantage in the crowd, where he could monitor the picture and relay his instructions. G. Clayton Irwin, managing director of the show, was at another station located high in the tiers of seats behind the large screen; while others on the telephone system were the electricians stationed in their pits out of sight of the audience; Copple, the engineer, at the lens-disc; Carter, at the amplifier; Walters, at the projector; Rein at the power pack; and the public-address announcer.


Once when the clutch between the motor and the scanning disc broke, Sanabria saved the day by quickly substituting a piece of rubber hose.

Bang! Goes the Neon Tube!

The time was 10:15; the time set for the demonstration, when Sanabria addressed the electrician to turn off the lights. The electrician confirmed the instruction by turning out the ceiling lights but left the exposition lights on, leaving far too much light for an effective showing of the picture. From this point on, it might be well to listen in on the conversations which followed over the telephone system:

Sanabria: You have to turn out all the lights.

Electrician: Can't; fire ordinance won't permit it.

Sanabria: Then we can't show the picture. There are lights all over the place. You won't be able to see a thing.

Electrician: Can't help it; ordinance.

Irwin: Try it anyway, Sanab. You've got twenty thousand people out here on the floor.

Sanabria: But it's ridiculous. You couldn't show a "'movie" with all this light on. How do you expect me to show a television picture?

Irwin: Try it anyway, Sanab. We can't keep these people waiting.

Sanabria: O. K. I'll try it. Copple, got the lamp ready? Carter, run up the "gain".

The engineers followed their instructions and the faint outlines of a picture appeared on the screen. Finally, Sanabria, desperately, called Carter. "Give her everything," he called.

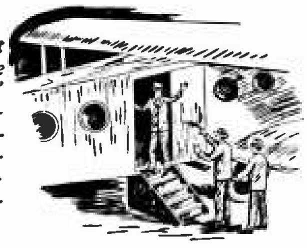
Carter: But I'm sending twice as much as ever, right now.

Sanabria: Then give it three times as much.

Carter: But it'll blow the lamp.

Sanabria: Try it anyway.

Carter: O. K. Here goes!


Airplanes, just one of the "high speed" carriers employed in obtaining replacement parts during theatre engagements.

At that moment the electrician announced that he would turn off all the lights, and immediately darkened the house; but the engineers at the transmitter had released three times the normal power used for the lamp and the strain proved too great on the lamp, which blew out!

Copple notified Sanabria, who told him to change lamps and then instructed the announcer at the public-address mike to report there would be a delay of a few seconds. The announcer, however, was too excited to make the announcement and, for a few seconds, the house was in utter darkness. At this moment the electrician too became panicky and threw in his switch, filling the arena with light, just as Copple announced that the apparatus was in readiness for the demonstration. The crowd, however, had begun to scatter and it was impossible to stage the demonstration that night.

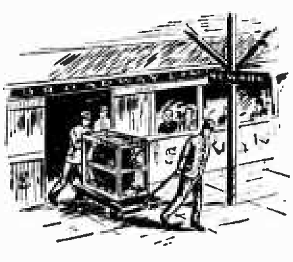
A conference with newspaper men and show officials was held following the demonstration, and Sanabria was asked whether he might be able to give a demonstration the next day. He promised to have a large picture within four hours and the reporters agreed to hold up their stories until that hour.

Sanabria returned to his apparatus and attempted to solve the situation. He tested ten lights but none of them responded. Seemingly met with defeat on all sides, he paced the floor of the Garden restlessly, his watch in hand. Suddenly he decided that, by heating a lamp greatly, he would be able to re-gas it sufficiently to give a short demonstration.

Eagerly he set to this new test; though realizing that he was risking all of his lamps to achieve this one demonstration. Nevertheless, he tried one light and the lamp blew out. Desperately, he took up a second lamp and repeated the experiment. This time he was successful and he hurriedly gathered the reporters to witness the demonstration. The lens-disc had been set at too great a distance from the screen—one sufficient for a picture fourteen feet square—so that only ten feet of the fourteen-foot picture showed on the screen. But Sanabria had shown his picture at three o'clock Wednesday morning, just four hours after he had made his promise to the reporters!

The next morning, the lens-disc was moved closer to the screen—to the position for a ten-foot picture—and a special scaffolding, which would alleviate the

(*Continued on page* 45)


Even the "Broadway Limited," carried a new lens disc from Chicago to Newark; a special long stop was made to unload the disc.

A SIMPLE LENS DISC PROJECTOR—HOW TO BUILD IT—

"Crater tube-lens disc" projectors are the last word in mechanical television scanners today. We have great pleasure in presenting a "how-to-make-it" article, written by one of the foremost experts in American television—Mr. Ivan Bloch. Mr. Bloch designed, built and successfully operated this 10 by 12 inch image projector: You can do the same.

By IVAN BLOCH, E.E.

IVAN BLOCH, E.E. Born in Geneva, Switzerland. Educated there and in United States: Case School of Applied Science; Polytechnic Institute of Brooklyn. Formerly associate member of A.I.E.E. and speaker on Farnsworth System of Electro-Scanning at A.I.E.E., April, 1931. Research in Television since 1929. Formerly Chief Television Engineer with Freed Television and Radio Co. He staged a recent demonstration of first "televised" physics' lecture for one hundred physics professors at Polytechnic Institute; the lecturer appeared at the Columbia Broadcasting System's television station in New York City. The voice and image were picked up on 105 and 49 meters respectively at the Polytechnic Institute.

A 10 by 12 inch image is possible with the Bloch lens disc scanner here illustrated and described in detail. Most any good receiver, such as the N. Y. Sun prize winner described on page 24, will operate the crater tube for this scanner.

THE Televisionist who wishes to graduate from his "peep-hole" televisor and has been wondering how to go about it, will find the answer in this comprehensive design, based on a machine built by the author. Although the total expense of this apparatus is greater than for the plain, unprojected-image type televisor, the results will certainly warrant the extra labor and cost.

What is needed for the projector? First, let us assume that the televisionist already has a receiver especially designed for the recention of television signals. Thus, he may wish to mount the receiver and the projector together in a small cabinet. In any event, this design will allow him to adopt either of the two alternatives, as indicated further on. In order to have sufficient illumination with the present neon-crater lamps, and to fit all parts in a moderate-size cabinet, we shall design our projector for a 10" by 12" image, with fixed or adjustable screen, as may be desired.

In order to systematize the work, we shall list the important items in the construction of the projector:

(1) The lens disc with its sixty matched lenses.
(2) The driving motor, with a spring-hub, condenser, mounting brackets, vibration-absorbing rubber mat, horizontal framing device and synchronizing wheel if necessary.
(3) The screen, frame and support.
(4) The cabinet.
(5) The lamp support and focusing device.

The Lens Disc and Lenses

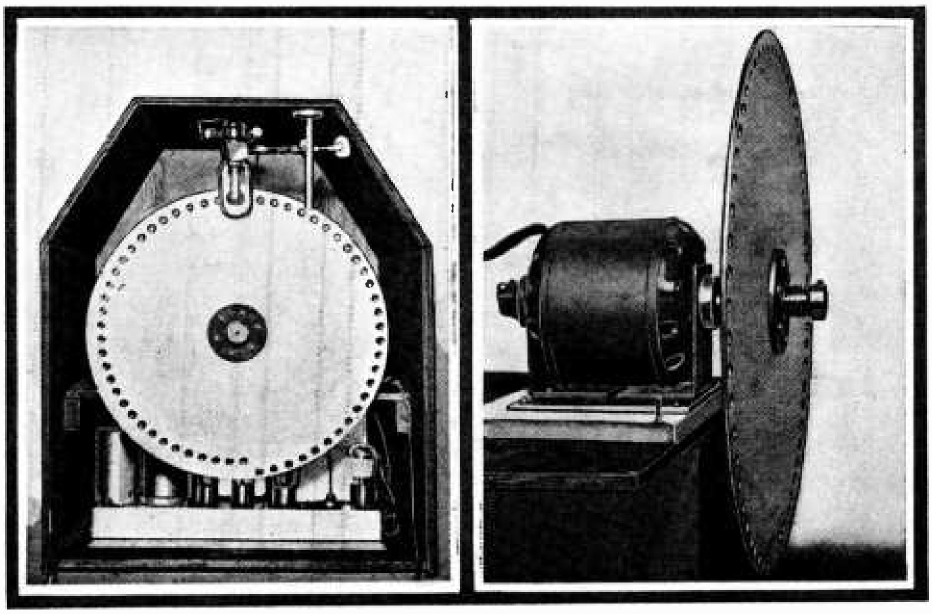
As this design is intended to give the proper screen element overlap, to minimize angular lens distortion, occupy the least space and require the least power to drive the disc, we shall use sixty double-convex matched lenses, 1.75 inches focal length, 0.5 inches diameter, which may be obtained from a good optical concern for about fifteen cents apiece.

It is advisable to pay as much for these lenses; for the variations which occur in cheaper lenses will, as a rule, spoil the perfection of our image.

From the focal length, image dimensions, overlap specifications and crater-lamp anode aperture of 0.020 inch, the disc will have the following dimensions (as indicated in Fig.1) and will be made from a flat duraluminium blank, three thirty-seconds of an inch thick. It is necessary to follow all dimensions rigorously.

(a) Overall diameter .... 15.85"
(b) Hub hole (see "Motor") .. 5/8"
(c) Circumferential separation of lens hole centers .. 6°
(d) Radial intervals of lens-hole centers .... 0.0112"
(e) Distance from center of disc to center of furthest hole .... 7.565"

(Continued on page 16)



Rear view of lens disc and crater tube at left; and at right, close-up of Baldor synchronous motor and lens disc, with Baldor spring coupling.

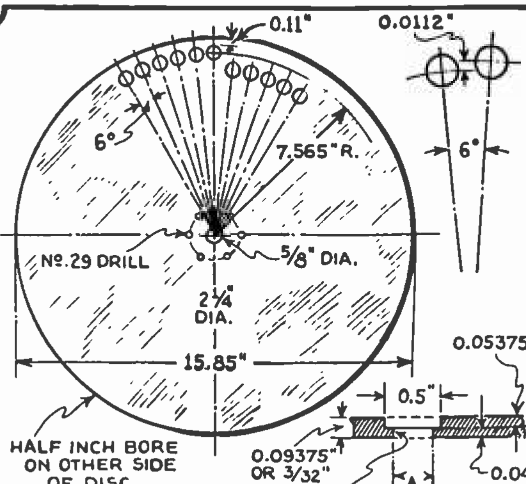


FIG. 1

Layout data for building the lens disc.

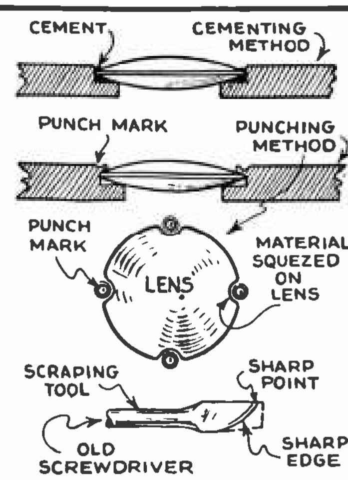


FIG. 2

Different methods and tool used for fastening lenses.

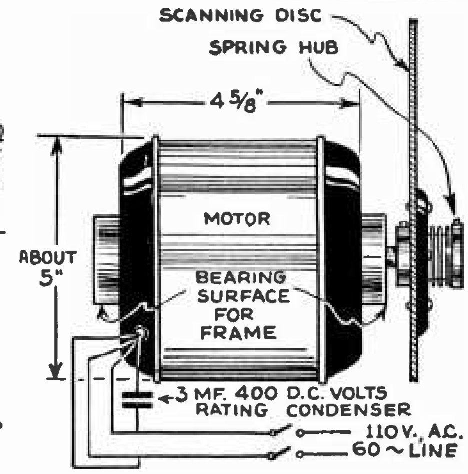
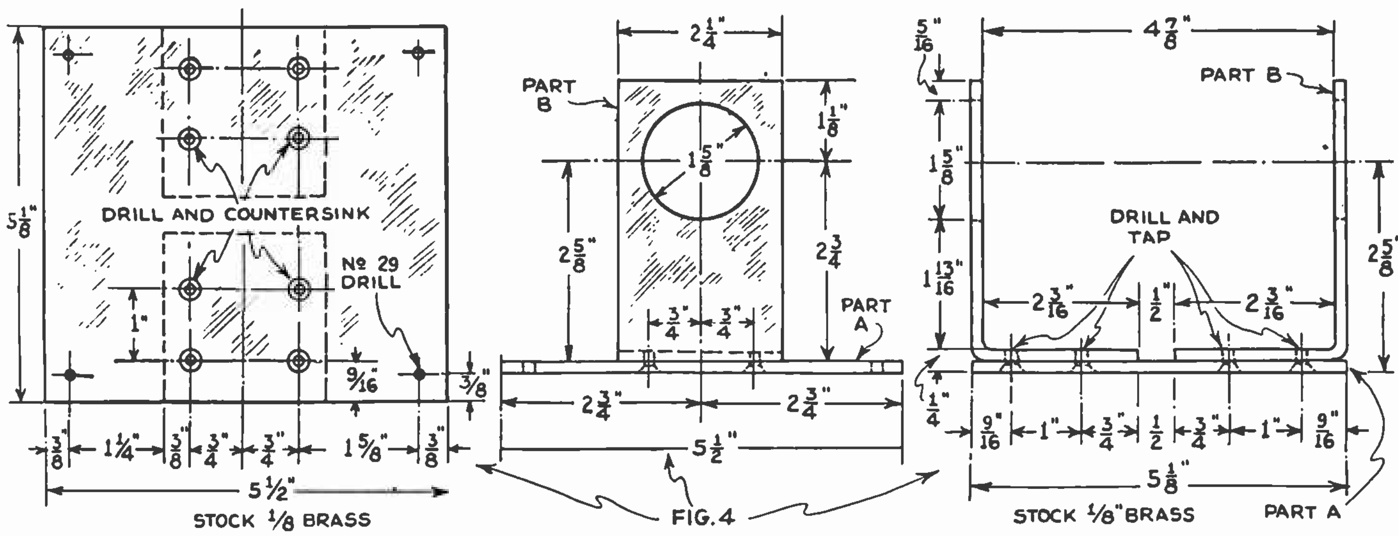


FIG. 3

Arrangement of scanning disc, motor and current supply circuits.



Details for drilling bottom plate of motor cradle support.

End view of motor cradle support screwed onto base plate.

Side view of motor cradle supports screwed to base plate.

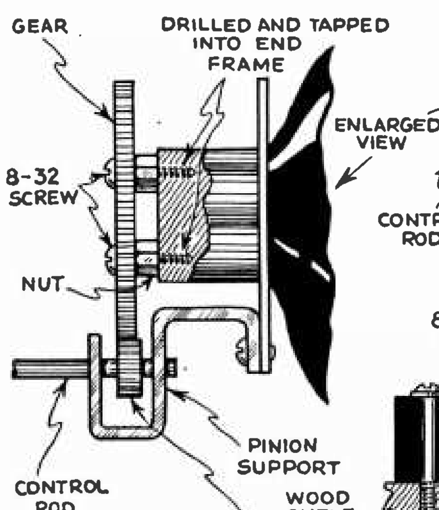


FIG. 5

How control rod and pinion turn motor through gear shown.

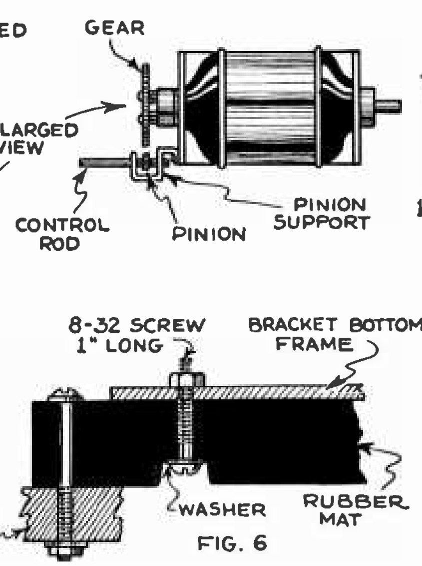


FIG. 6

Vibration is absorbed by rubber mat.

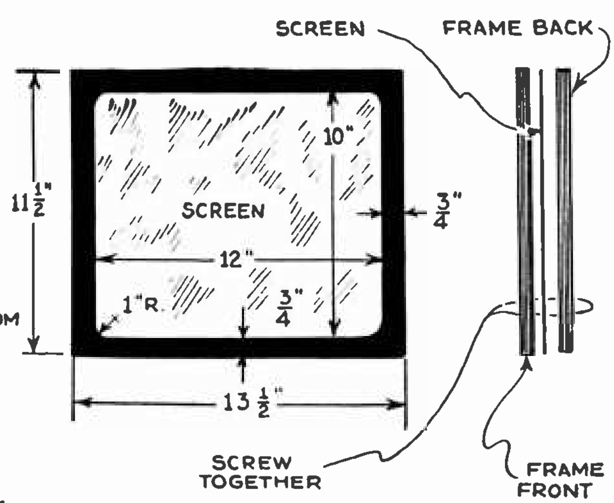
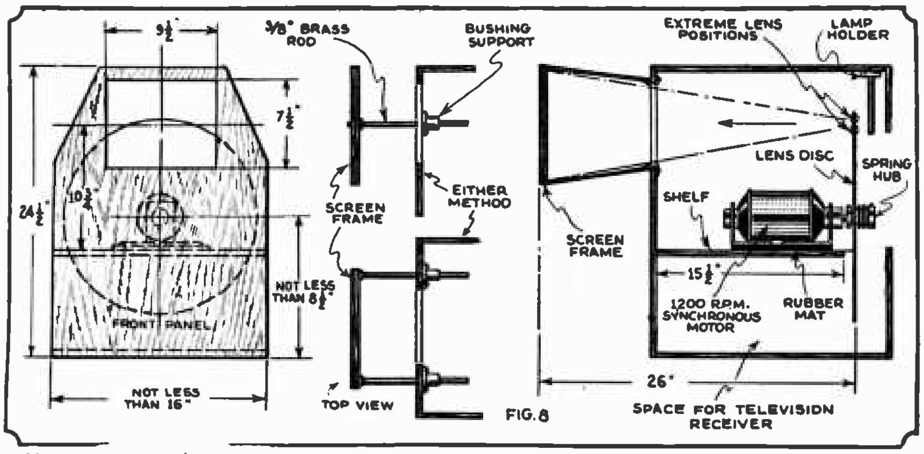


FIG. 7

Details of projection screen and frame.



Side and front views of lens disc projector mounted in cabinet. This machine produces a brilliant image 10 by 12 inches. Special "framing" means are provided.

Unless the televisionist is an exacting mechanic and can use a dividing head with ease, it will be quite worth while to leave the making of the disc to some good machine shop. (See note at end of article.)

Each hole is first drilled all the way through with a 0.4375" drill, then each hole is counter-bored to a diameter of 0.5" and down to a depth of 0.05375" leaving a shoulder 0.04" thick. These dimensions are such as to fit the lenses perfectly; and it is extremely important to have the shoulders of the same thickness, to obtain perfect focusing at the screen. The tool for the counter-bore may be of the shape shown in Fig. 1.

The spiral shown in the sketch represents the 0.4375" holes facing the reader, the 0.5" holes being away in the plane of the paper. The hub holes and holes for the fastening screws will depend on the type of hub used; the dimensions here indicated being for the make of motor mentioned under that heading.

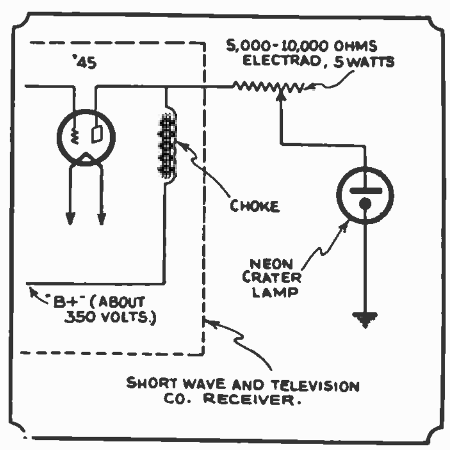
After the disc has been drilled, it should then be thoroughly cleaned with some alcohol to remove grease and oil; then both sides of the disc should be sprayed or dipped in a dull, dark lacquer or "optical-black" paint. (Since the object of the paint is to remove cause for reflection, it should be dull.) When the paint is completely dry, with a sharp tool, such as the filed-down screwdriver shown in Fig. 2, each hole is thoroughly cleaned; that is, the paint layer in the hole is scraped off, care being taken not to scratch off any metal.

Securing Lenses in Disc

The disc is now ready for the lenses. Two courses of action are open to the constructor: One is to cement the lenses in; the other to force the surrounding material against the lens surface at several points by punching. See Fig. 2.

The first method is the simplest; but the choice of cement is important. As a rule, cellulose-base cements do not prove satisfactory; the author found a "Capitol" cement which did the job splendidly. The first step is to take a pin, or small piece of wire, and with it gently coat thoroughly the lens hole and shoulder; then, at once, press a lens into place firmly and yet carefully. This process is repeated until the disc is filled. After a few hours the excess cement is carefully scraped off with the sharp tool by which the paint was removed; care being taken not to scratch the glass at the edges. If a small amount of cement overlaps the lens edges by about 0.01", the job will be most satisfactory; as this thin film helps to firmly hold the lens in place.

The punching method is a good one, but the danger of breakage is great. All that is necessary in this case is a small nail punch and a light hammer. The disc is laid flat on the work bench, in which a ½" hole has been drilled. The procedure is to roughly center one disc hole over this opening; place a lens in



Suggested "output" circuit for connecting last amplifier tube with "crater" type neon tube.

the disc; then gently punch the material near the edge of the hole four or more times, until enough material has thus been squeezed over the lens surface (Fig. 2). Before continuing with the next lens, it is best to make sure that the previous lens is well secured and cannot move. On holding the disc by the hub hole and tapping the edge, a loose lens will be revealed by its rattle.

The author recommends the cementing method; although it takes more time, the breakage and chipping is nil and, consequently, the cost is a minimum.

The Driving Motor

The disc will require a 1/20-horsepower motor to drive it synchronously and to allow vertical framing, through stopping and starting by means of a switch. However, the motor itself is not quite powerful enough to start the disc and bring it up to synchronism immediately; and therefore we make use of the transfer of the potential energy of the disc to a spring which will then release this energy and give the disc a surging twist, thus bringing it to synchronism. No further explanation of this well-known expedient is required, as foregoing issues of TELEVISION NEWS have covered the subject thoroughly. Furthermore, we shall have to rotate the whole motor frame for horizontal framing; so that accordingly some provisions must be made on the motor frame itself.

Without hesitation, the author recommends the well-known BALDOR motor, type M3CN, which is equipped with a spring-hub and bearing surface for frame rotation. Although the cost of this motor is around $17.00, it will be most satisfactory and will "stand the gaff" admirably. This motor runs synchronously at 1200 R.P.M. and requires no auxiliary starting equipment, save a 3-microfarad condenser, 400 D.C. voltage rating. Fig. 3 shows the motor in outline, indicating its dimensions and the wiring diagram.

Horizontal Framing Device

In order to rotate the frame and support it, brackets must be made. Full and complete dimensions of these are shown in Fig. 4 for the above mentioned Baldor motor. Obviously, to mount the motor, one leg of the bracket must first be removed, and replaced after the motor is slipped into place. The motor frame should rotate fairly freely.

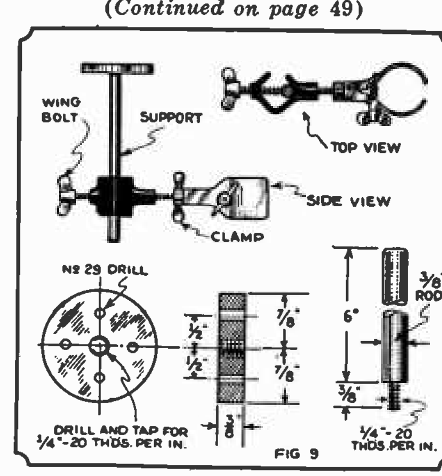
The next step is the horizontal framing device. Each picture frame is bounded by radial lines six degrees apart; that is, our extreme frame width is 6°. A direct connection to the motor frame is too rough an adjustment, but a simple gearing arrangement is quite satisfactory. If the junior male member of the family has an "Erector" set, surreptitiously "borrow" two gears, one of 72 teeth and listed as P50, the other a 12-tooth pinion P13. If unable to borrow, these may be ordered from the company for the total sum of $.60. The gears may be mounted in several ways, the easiest is shown in Fig. 5.

Should the televisionist possess a geared reduction dial, he may use it also to advantage instead of the gears mentioned above.

Turning the framing rod should turn the motor frame. This may require some adjustment of the bracket legs, if they are too tight on the frame-bearing surface.

To reduce the inevitable motor and disc vibrations, the whole motor and bracket is mounted on a sheet of rubber (preferably sponge or "live" rubber) one-half-inch thick, seven by seven

(Continued on page 49)



Support and "physics clamp" used to hold "crater" tube in any desired position.

How Shall we TEACH *Television?*

Student Training at First National Television, Inc.

By SID NOEL

President, First National Television

An outline of the television course given at one school is given by the author—one of the strong features being the training of the students with actual television transmitters and receivers in front of them.

EVER since *television* broke into the front pages of our daily newspapers a few years ago, the numberless throngs have continued in their endeavors to "crash the gates" of the several television laboratories throughout the nation. Persuasion, bribery and all sorts of ways and means have been brought into action; for old man John K. Public is writhing with "curiosity" to know what has been and is going on behind those closed portals.

Television appeals to the human imagination. When one hears the description of "Battler Jones" struggling to his feet at the count of nine, a vivid and exciting picture is built up in the mind of the listener. When the ball is on the one-yard line in the last minute of play, the interested observer has only to watch the audience gathered around the home radio, clenching their fists and gazing into space —*seeing*, not with their eyes, but with their minds—and imagination. Our eyes —the most valued of our senses, are useless—the radio audience of today might just as well be a nation of blind individuals. Television, whether he knows it or not, is what the radio listener utmostly desires.

Left: Rear of image monitor panel—students learn by actually experimenting with commercial television apparatus.

Above: Students busy with photo-cell bank. Right—Checking current and "image" on monitor.

Last summer it was decided to compile and offer courses in television training. Having provided completely-equipped laboratories, television pick-up apparatus on the transmitting end, as well as a 500-watt radio transmitter designed expressly for television broadcasting, we knew that we were in a position to offer a fine, well rounded-out training in this new art, for a surprisingly moderate tuition.

The main course of training is for the man without any past experience in radio or television. The student starts off with elementary electricity and learns the primary fundamentals of radio; continuing on through the complexities of television, receiving, sales, servicing and broadcasting; all of which, of course, represents advanced radio science which everyone interested in television should absorb.

The secondary course is for the experienced radio technician, and is more or less a special curriculum of study outlined to fit the applicant's past experience. This course takes up the same work that is covered in the main course, except that the students start at an advanced stage.

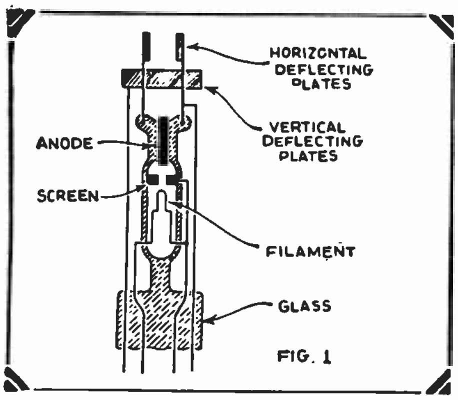
The main course consists of sixty lessons or subjects; some containing as many as five parts. Lecture-room work takes up about one-third of the time; while the other two-thirds comprise actual laboratory work and practice. The training in the earlier portion of the course is directed toward qualifying the student for a *limited broadcast license;* and the period of time taken is a minimum of ninety days or three months.

The staff of engineer instructors at First National Television are all university graduates with lengthy experience in radio and television. "Jerry" Taylor, chief of staff, is well known in broadcast technical circles, having been a former engineer of the Federal Radio Commission. C. Bradner Brown, another member of our staff, was elected to Sigma Xi at the University of Kansas, for his valuable research work in television. He is continuing his development work in the school laboratories, perfecting a black-and-white glow lamp for receivers. Meyer Eisenberg is a graduate of a prominent technical school and is the chief broadcast operator of a Kansas City radio station. H. C. Austin, a member of the advisory board, is the author of a number of published technical treatises on radio and television.

Each month a limited number of student applicants are accepted for resident training. The photographs here reproduced are views of the school's apparatus used in educational work as well as in the field of new development and research. A "home study" course is not given; as the field of study is too broad for a correspondence course to be considered. We feel that TELEVISION NEWS is amply filling the bill through their present publication.

PRACTICAL HINTS

The "hottest" thing in television today is the cathode ray scanner. Those who read Mr. Rappaport's valuable article in the last issue on the construction of the scanner will find many practical operating hints given here. N. B. C. is transmitting test signals on about 6 meters; 120 lines and 24 frames per second. W6XAO, Don Lee, Los Angeles, transmits cathode images on 6.75 meters; 80 lines, 15 frames per second.



Arrangement of the electrodes in the Western Electric Co. cathode ray oscillograph tube.

AT PRESENT, there are on the market a few different makes of cathode-ray oscillograph tubes which are very adaptable for television purposes. Certain inherent characteristics which have made these tubes indispensible in the electrical research laboratory have enabled engineers to utilize them successfully for television reception and transmission. The distinguishing feature of the cathode-ray oscillograph tube is a rapidly moving beam of electrons (or cathode rays) which have negligible inertia; as a result, extremely high frequencies may be dealt with. When this feature is considered in regard to television, it means that the cathode-ray television system is not limited to sixty-line scanning. but may extend to an unlimited number of lines. This extremely important fact is the main reason why the foremost authorities on television believe that the future television system will be entirely of the cathode-ray type.

In this article, the fundamental operating characteristics of the cathode-ray oscillograph tube developed by Mr. Johnson of the Western Electric Company, will be discussed first. When the principles of operation of the Western Electric tube are once understood, the operation of any other tube on the market may be readily analyzed; for the theories of operation are not radically different.

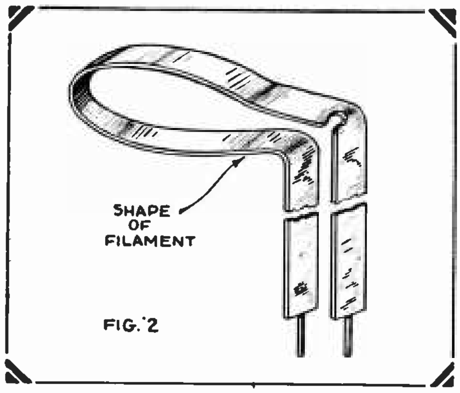
The distinguishing features of the Western Electric Company's tube are:

(A) The low potential of about 350 volts, employed for the purpose of propelling the electrons from the cathode to the anode;
(B) The rather minute dimensions of the electrodes;
(C) The short spacing between the electrodes; and
(D) The small quantity of residual gas present between the electrodes.

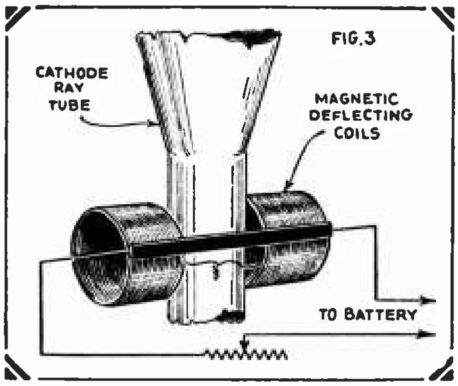
To accomplish the last, the electrodes are mounted within a small glass tube, which in turn is placed inside the main pear-shaped glass container. The volume of the remaining argon gas between the electrodes is not allowed to exceed one cubic centimeter. By making the electrodes extremely short, and the gas pressure rather low, there will be left an insufficient number of ions to permit arcing.

How Electrodes Are Mounted

In Fig. 1, the electrode unit may be seen mounted on a glass tube. The horizontal and vertical deflecting plates are made of German silver, in order to minimize eddy currents when magnetic deflecting coils are employed to produce deflection of the beam. The anode is a tube one centimeter (0.39 inch) long, having a diameter of one millimeter (.04 inch). This platinum tube almost touches



Special shape of the filament in a Western Electric Co. tube in order to protect it from positive ion bombardment.



Method employed for producing electromagnetic deflections of the electron stream.

the screen which is placed between the cathode and the anode; the screen, which is connected to the cathode, has a very small hole in the center. The cathode is an oxide-coated platinum ribbon having the shape shown in Fig. 2. The reason for such an odd shape of the cathode is to protect it from the positive-ion bombardment, which comes through the hole in the screen.

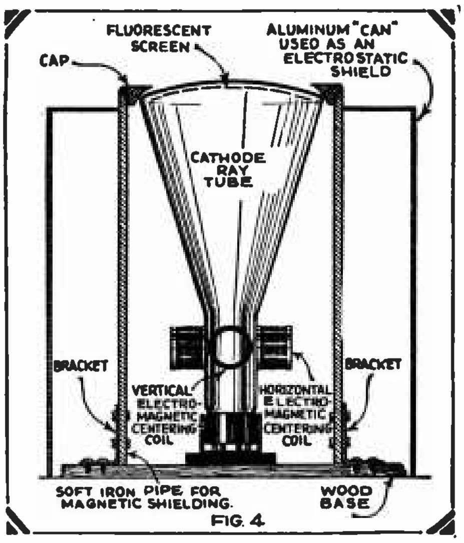
The Cathode—Its Purpose

The cathode serves the purpose of supplying the free electrons when current is passing through it. The electrons which emanate from the cathode are now drawn through the aperture of the screen by the strong electrostatic field (produced by the potential difference existing between the cathode and the anode) and are discharged down the anode tube. These electrons, which pass along the axis of the tube, emerge as a beam and pass between the two pairs of deflecting plates.

The propelling or anode voltage of the Western Electric tube is quite low and, as a result, the velocity of the electrons is comparatively low. (The electron velocity is a function which varies with the anode potential.) There is allowed, therefore, considerable time for the electrostatic repulsion between the electrons to cause dispersal. This phenomenon would cause considerable trouble were it not for the presence of residual gas in the tube. The greater the velocity of the electrons, the less the gas pressure required. In the Western Electric tube, 0.001-millimeter of mercury pressure is employed.

100,000,000,000,000 Electrons per Second!

The focusing action of the residual gas in the tube is an extremely clever adaptation and may be explained quite simply. The number of electrons passing in beam form along the tube's axis is of the order of 100,000,000,000,000 electrons per second; this quantity depends directly upon the voltage applied between the anode and the cathode, as well as the filament temperature. The velocity of the electrons is about 1,000,000,000 centimeters (six thousand miles!) per second, and as a result every centimeter along the beam contains approximately 100,000 electrons in motion.



How cathode ray tube is shielded with iron and aluminum cans.

on CATHODE RAY SCANNERS

By M. RAPPAPORT, E.E.

Research Engineer
Television Mfg. Company of America

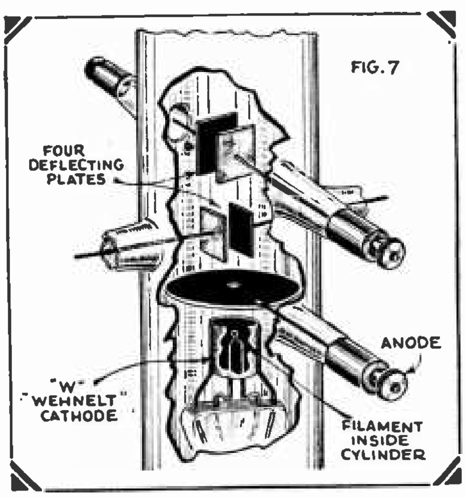
Some of the electrons during the flight will impinge on molecules of the residual gas and produce *ionization;* this means that the molecule is broken up and an electron released. The released electron is charged negatively and, having come from a neutral molecule, leaves an ion carrying a positive charge. The velocities of the original and displaced electrons are high, and as a result they leave the beam-path at a great speed, while the relatively heavy ion leaves the beam-path slowly. There is, therefore, along the beam an excess of positive ions over negative ions; resulting in a "drawing in" or compression of the beam towards the axis.

If the numbers of ions and electrons are about equal, there will be no compressing force on the electrons, and the beam will naturally spread, because of its initial divergence. By increasing or decreasing the filament current, the number of electrons will increase or decrease respectively; thereby giving us a focusing control.

Dynamics of the Cathode Tube

Let us now consider the dynamics of the cathode-ray oscillograph tube. There are two common methods employed for deflecting the beam of electrons: namely, the electromagnetic and electrostatic methods. Electromagnetic deflection is accomplished by placing a coil (whose axis is perpendicular to the axis of the cathode-ray tube) as shown in Fig. 3, and allowing a current to pass through its winding. The beam of electrons, as a result, will be deflected in a direction perpendicular to the axis of the coil. If the electronic beam passes through a distance "S" in the electromagnetic field, whose strength is represented by H, then the amount of deflection in centimeters is represented by the equation:

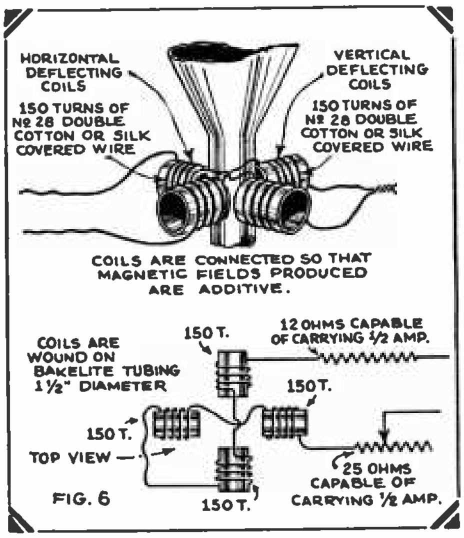
$$Z = \frac{0.3\ H\ S\ L_2}{\sqrt{V}}$$



How the deflecting plates, anode and the "Wehnelt" cathode are arranged in the Von Ardenne (General Radio Co.) cathode ray tube.

where
Z = deflection of the beam in centimeters;
L_2 = distance from the center of the coil to the fluorescent screen; and
V = voltage between the cathode and anode.

If a pair of coils were placed on the sides of the tube, approximately where the deflecting plates are located, the deflection would be about one millimeter per ampere-turn. The magnetic deflecting coils are utilized in a cathode-ray television receiver for the purpose of centering the picture on the fluorescent screen.



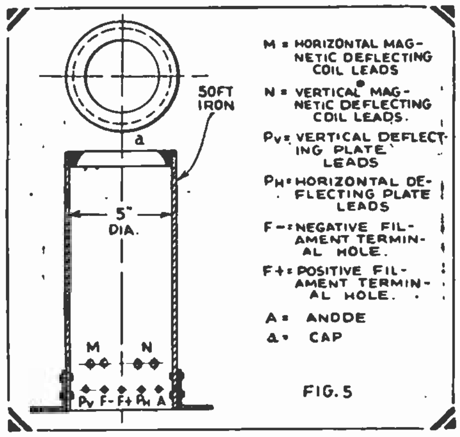
Size and position of magnetic deflecting coils used for centering the image on cathode tube screen.

Once the adjustment of the current flowing through the coils is made, it may remain fixed during the life of the tube.

The "electrostatic" or "deflecting-plate" method is used for scanning the image. The formula representing the amount of deflection with the standard constants of the Western Electric tube is:

$$Y = \frac{P\ L_1\ L_2}{2\ V\ D}$$

where
Y = deflection of the beam in centimeters;
P = voltage across the "electrostatic" deflecting plates;
V = voltage between the cathode and anode;
D = distance between a pair of deflecting plates;
L_1 = length of a plate (in the direction of the electron flow in the beam);
L_2 = distance from the center of a pair of plates to the fluorescent screen.



Details of soft iron electro-magnetic shield for cathode ray tube.

Voltage Required for Deflecting Ray

In the Western Electric tube, L_1 is 1.27 centimeters and L_2 about 20 centimeters (1 cm. = 0.39 inch). The plate separation is 0.475 centimeters. When an anode potential of 300 volts is used, the potential difference between the plates required to produce a deflection of one centimeter is:

$$P = \frac{2\ V\ D\ Y}{L_1\ L_2} = \frac{2 \times 300 \times 0.475 \times 1}{1.27 \times 20} = 11.2 \text{ volts}$$

The capacity between a pair of deflector plates is approximately 10 mmf. (micro-micro-farads) which is so small that it may be considered as negligible. There is also a conduction between the plates which varies with the plate voltage as follows: at 10 volts the conduction is about 19 micro-amperes; at 20 volts, 24 micro-amperes; at 30 volts, 26 micro-amperes and at 40 volts, 28 micro-amperes (1 micro-ampere is one one-millionth of an ampere). The source of this current is the return of the electrons from the fluorescent screen and, to a lesser extent, the ionization in the cathode-ray tube.

As far as I know, the uppermost frequency recorded by tube cathode-ray oscillograph is 220 million cycles per second!

Chemicals for Tube Screen

As the energy stored in each moving electron is proportional to the square of the velocity, the energy given up when it strikes the fluorescent screen rises very rapidly with an increase in anode voltage. The fluorescent screen is composed of fine willemite crystals, or calcium tungstate in addition to zinc silicate, which fluoresce under the tremendous bombardment of the cathode rays, and thereby indicate the position of the rays or spot. The calcium tungstate gives a deep blue light, which is about thirty times as active on a photographic plate as the greenish-yellow light of the zinc silicate; while the silicate produces a fluorescent light which is much brighter visually than that from the tungstate. By

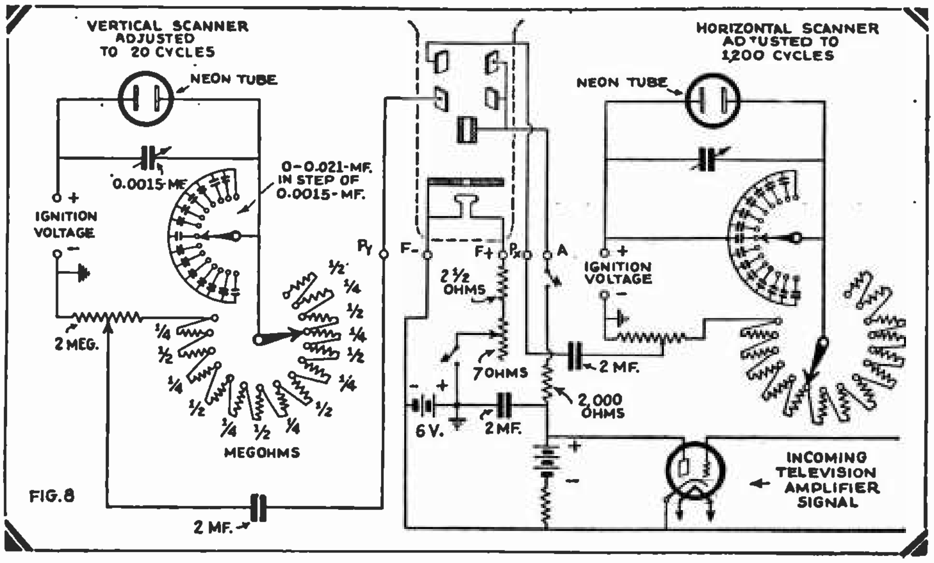


Fig. 8—Method of connecting "saw-tooth" oscillators and signal amplifier to a Western Electric Co. cathode ray oscillograph tube.

combining the two compounds, a screen is produced which is excellent for both "photographic" as well as "visual" purposes.

The cathode or filament of the Western Electric tube draws 0.85 to 1.15 amperes initially, at about two volts, direct current. Since a rheostat is employed in adjusting the filament current for focusing, a six-volt storage battery or eliminator should be used. As the tube ages, the filament current will require adjustment to properly focus the spot of light on the fluorescent screen. By lowering the initial filament current (which, however, should be consistent with a sharp focus) we may increase the life of the cathode-ray tube considerably.

The filament rheostat, which is of the slide-wire type, should be of such construction as to permit rather close adjustment of a linear type, and have a resistance of seven ohms. In the filament circuit there is inserted, in addition to the rheostat, a 2½-ohm protective resistor capable of carrying about two amperes; a toggle switch is used in the circuit.

There is connected in series with the anode-cathode circuit, through another toggle switch, a 2,000-ohm resistor capable of carrying about five milliamperes, in order to prevent destructive arcs forming within the cathode-ray tube. The toggle switch, which should be capable of carrying 400 volts, is employed for the purpose of applying the anode potential only during periods of observation; *since the life of the tube depends very largely upon the period of time the anode potential is applied.*

Of course, the anode potential is supplied from the amplifier circuit in addition to another potential. This other anode potential should be of such value that the spot of light it produces on the fluorescent screen is barely visible, or practically invisible. When this propelling voltage is used, in addition to the rapidly changing potential at the output of the amplifier delivering the television signal, the two voltages will add up to give a series of bright, dark, and "in-between" spots of light on the fluorescent screen, which is naturally the modulated television signal. Now, if this irregular flicker is scanned properly, by means of two "saw-tooth" or "right-triangular" wave oscillators, we will have reproduced the "televised image." The amplifier should be so designed, that the potential applied between the anode and cathode of the cathode-ray tube should not exceed about 400 volts; as the Western Electric tube is not designed to operate at more than 400 volts, without seriously decreasing its life.

Shielding the Cathode Tube

The cathode-ray tube is very sensitive to stray electromagnetic and electrostatic fields. For proper operation, it therefore is essential to shield the tube well. Fig. 4 shows a method for shielding which is ideal, yet not expensive. The electrostatic shielding is accomplished by making the cabinet out of aluminum. I have found a can about 12 x 12 x 12 inches very applicable for this purpose. The main reason for such dimensions is that the resulting apparatus should not be top-heavy, and thus likely to upset. In addition, this aluminum cabinet may have its appearance greatly improved by simply applying a black crackle, lacquer finish upon its surface.

The electromagnetic shielding is accomplished by constructing a tube out of soft iron pipe with an internal diameter of five inches, as shown in Fig. 5. The height of the pipe is made to conform with the height of the cathode-ray tube, plus its socket, totaling thirteen inches. Holes are drilled and insulating washers inserted in the lower portion of the tube, to pass wires to the control panel. In order to improve the appearance, a cap may be constructed as represented by (a) in Fig. 5; it is threaded in order to remove the cathode-ray tube when necessary. A fine cut may be taken with a lathe on the outer surface of this iron pipe, and the same black crackle, lacquer finish applied.

The Von Ardenne Cathode Tube

Another cathode-ray oscillograph tube, excellent for television reception, is known as the Manfred Von Ardenne tube and distributed in the United States by the General Radio Company. The arrangement of the electrodes in the Von Ardenne tube may be seen in Fig. 7.

The glass bulb of this tube is shaped approximately like that of the Western Electric cathode-ray tube, except that the electrodes are taken out through the sides of the tube instead of through the base. The reason for this difference will be explained later.

The fluorescent screen is made up of the same combination of fluorescent salts as in the Western Electric tube, consisting of a mixture of calcium tungstate and zinc silicate, with pure water-glass (sodium silicate) as binder.

The method employed by Von Ardenne for concentrating the beam of electrons is unlike that used in the Western Electric tube. The cathode-rays emanating from the filament are concentrated electrostatically by means of a Wehnelt cylinder, as represented by (W) in Fig. 7. This cylindrical electrode surrounds the cathode and has its axis along the axis of the tube. The anode, which is placed at a distance from the Wehnelt cylinder, is in the form of a plate. If sufficient negative potential, with respect to the

(Continued on page 53)

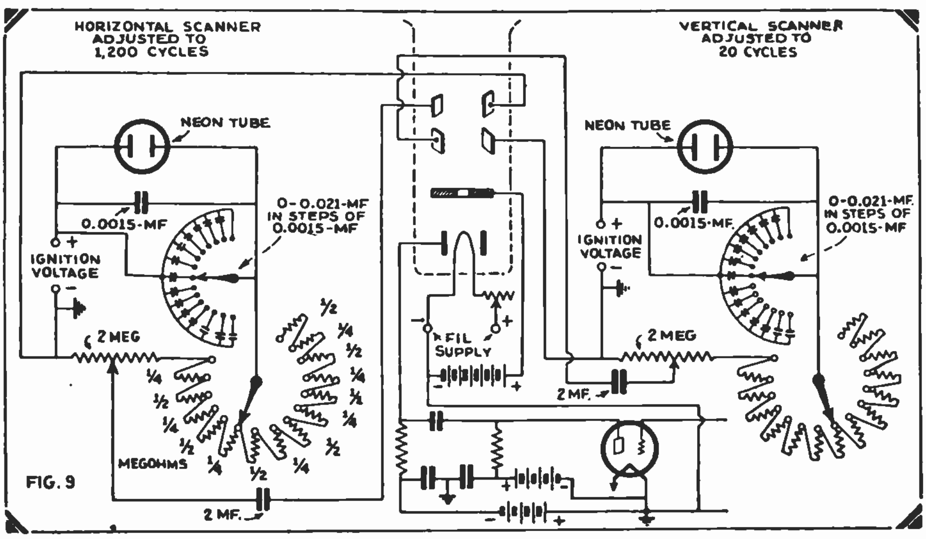


Fig. 9—How the 1,200- and the 20-cycle "saw-tooth" oscillators, also the signal amplifier are connected to a Von Ardenne (General Radio Co.) cathode ray oscillograph tube.

A DRUM SCANNER

How To Make It

By MILTON TREUHAFT

Simple directions are here given for laying out and constructing a drum type scanner.

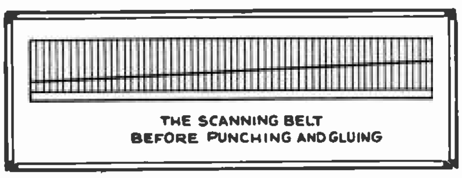
THIS drum is for the amateur visualist who has thrown down and jumped on at least one scanning device. Simplicity is its main feature.

While the only tools needed are a 45" ruler, a 6" ruler, a square, a needle, a pencil with a sharp point, and a pair of scissors, accuracy is not sacrificed. The material for the drum is of the tin-can and hair-pin variety. It consists of a strip of long flexible cardboard and a large, round cracker-tin cover, such as may be had for the asking at any grocery store.

The first thing to do, is to center the cover in order to mount it on a shaft. To do this, trace around the cover on a large sheet of paper. Then, take the 6" ruler, and rule several 2" lines, so that both ends of the lines touch the circumference of the circle. Next, take the square, and draw perpendiculars from the midpoint of the lines (simply measure an inch on each line) across about three-quarters of the circle. The center is located at the point where the lines intersect.

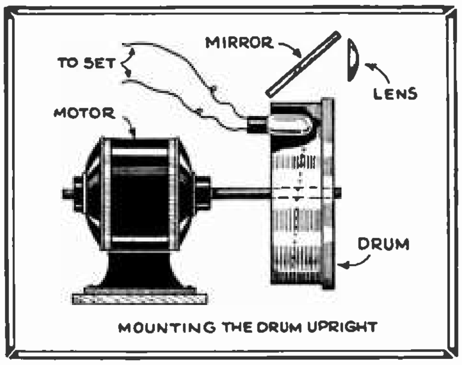
Now, for the scanning belt. First, measure around the inside of the cover. It will be found that the large-sized National Biscuit Company covers have an inside circumference of 38⅜". By lining the inside of the cover with a narrow strip of heavy paper, the circumference will be reduced to 38". For those who cannot obtain an N. B. C. cover, the best thing to do is to try to reach the nearest even number, such as the nearest ⅛", etc.

With the 45" ruler, measure the circumference on a strip of cardboard. Use the square to get perfect right-angle



Layout of scanning belt before it is punched and glued.

ends; the belt should be about 3" in width. Draw a line about ½" from the edge right across the strip. This line has two purposes; first, it serves as a guide toward getting the belt into the cover straight, and, secondly, it serves as a base on which our measurements can be taken.



Mounting of drum scanner on motor shaft: the light rays from the neon tube are reflected by the mirror to the lens.

Our job now is to divide the belt into 60 parts. If the inside circumference of your cover is an even number, such as 38", then divide the belt into quarters immediately. That means that the quarters still have to be divided into 15 parts each. Here's how it can be done without the use of delicate instruments.

Take a large sheet of paper and draw a diagonal line across it equal to one of the quarters. At one end of the line, draw a long perpendicular and stick a pin into the other end. Now, take the long ruler and put the 15" mark at the pin and revolve the ruler until the end touches the perpendicular. Draw the line. We now have a right triangle with a 15" hypothenuse. Now, put a mark at every inch on the hypothenuse and draw perpendiculars from the bottom leg (the quarter of the belt) so that they pass through the marks on the hypothenuse. The perpendicular divides the quarter into 15 parts. Merely transfer them on to the belt and draw perpendiculars across it.

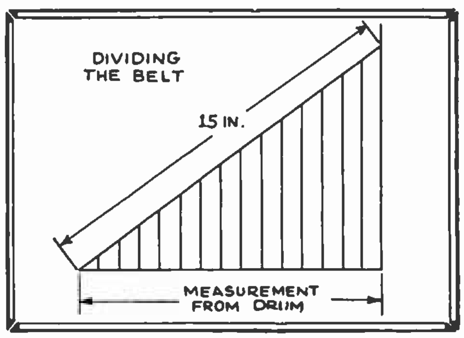
For those who are not fortunate enough to have an even measurement, for their inside circumference, the above method will serve with a few changes. Draw the whole length of the belt on the paper and make the hypothenuse 60" instead of 15".

In transfering the dividing mark to the belt, the first mark should be about half the distance of one division from the end. This is to avoid having a hole at the end of the belt.

Now to locate the holes. It is necessary to have a ratio of 5 to 6 between the width and the height. The simplest way to do this is to use the same method as was used in the division of the belt. Just divide, into 5 parts, one of the 60 sections of the belt; and use any one of these sections as a unit of measure. On the first cross line, measure up from the main line 6 units. At the last cross line, measure up 12 units. Connect these two points carefully with a line drawn with the long ruler. The holes are to be located at the intersections. In order to receive stations whose scanning lines are in the height instead of the width, the ratio is reversed. Divide one of the 60 divisions of the belt into 6 parts and then measure up on the first cross line five units and on the last, ten.

A simple drill may be made in this way: take the measurement on the first cross line of the belt and divide it into 60 parts by the same method as used in the previous operations. This is easily done by using 1/16" as a unit of measure

(*Continued on page 57*)



Scheme used by the author for laying out one-quarter of belt into 15 equal divisions.

In Our Next Issue

AN IMPROVED TELEVISION RECEIVING SET, by Clifford E. Denton

CRYSTAL DETECTORS FOR TELEVISION RECEIVERS — THEIR VARIOUS ADVANTAGES, by R. William Tanner, W8AD

A NEW 3 TO 6 METER TELEVISION RECEIVER, by C. H. W. Nason

A NOVEL SCANNING DISC "LAY-OUT" SCHEME

HOLDING THE SCANNER AT CONSTANT SPEED

PHASING THE TELEVISION IMAGE

LATEST NEWS ON CATHODE RAY TRANSMITTERS

BETTER OPTICS FOR LENS DISCS, by C. Bradner Brown

CATHODE RAY TELEVISION, by Hans Günther (Germany), Illustrated

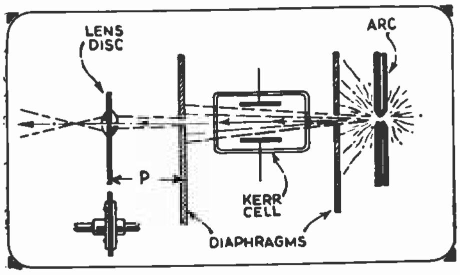
HOW I RECEIVED THE U. S. TELEVISION SIGNALS IN GERMANY, by Horst Hewel

OPTICAL SYSTEM *for* CONTROLLING SIZE OF CRATER

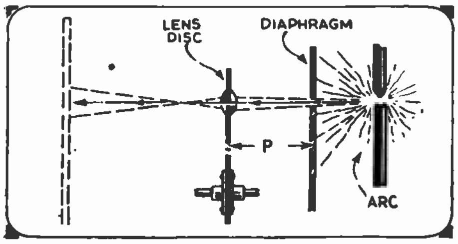
By IVAN BLOCH, E.E.

The optics of crater tube-lens disc scanners is but little understood by the beginner. This article by Mr. Bloch, an expert on television optics, gives sound practical advice which you will find valuable.

IN THE use of Kerr or Karolus cells, modulated arcs, crater- or neon-arc lamps as the illuminants in a lens-scanning system, the televisionist may have been confronted with the problem of properly concentrating the light source so that the lenses in the scanning disc may pick up the brilliant point source and project it on to the screen for image formation.



Use of diaphragms with an arc, Karolus cell and lens disc.

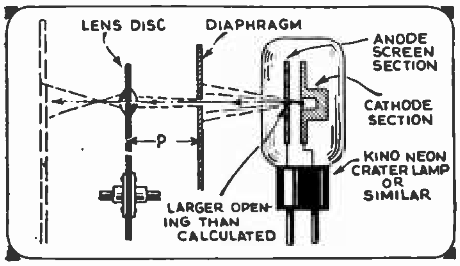


Use of restricting diaphragm between spot source of light and lens disc; the distance "P" is important, as explained in the text.

In most cases, a brilliant cone of light emanates from the source, especially in cases where the aperture of the source of light is either unlimited in size (as in arc lamps) or larger than calculated for the correct screen picture element size, as shown in the diagrams:

It is thus necessary to use some sort of restricting diaphragm (as shown in the figures) just before the lenses on the disc, at a location "*p*" determined from the well known formula of elementary optics, "$1/p + 1/q = 1/f$" (where "*p*" is the distance from the point source to the lenses on the disc; "*q*" is the distance from the lenses to the screen; and "*f*" is the focal length of the lenses used in the scanning disc).

A plain diaphragm located at "p" is obviously inefficient; for the amount of light transmitted is just that fraction corresponding to the portion of the total cone represented by the area of the diaphragm aperture.

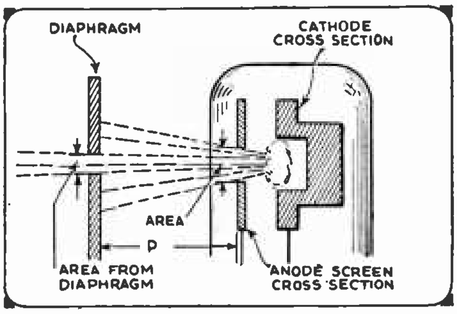


Restricting size of light beam from a crater tube by means of a diaphragm.

Here a condensing lens will greatly increase the transmitted light, by picking up the total emission of the light source and converging it on the diaphragm aperture.

The author has actually constructed such schemes and (keeping in mind the fact that the televisionist tries to do the most with the least expenditure), has devised an inexpensive and efficient scheme the design of which follows.

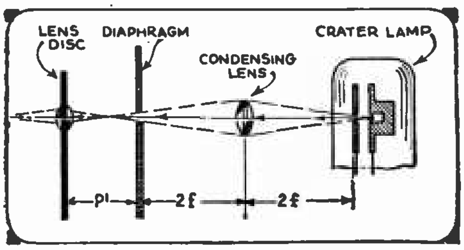
The only optical formula required is that a beam of light emerging from a source located at a distance $2f$ from a lens of focal length f will be converged at a like distance $2f$ from that lens.



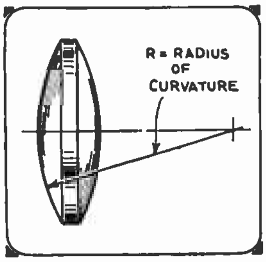
Close-up of crater tube showing relations between external diaphragm and anode screen.

In order to reduce the loss of light (since the intensity decreases with the square of the distance), it behooves one to choose a lens of short focal length, yet remember that a lens of given diameter can only be made down to a certain focal length: for, according to our fundamental optics, the radius of curvature of a lens is equal to "(n-1) f;" where "n" is the index of refraction, and can be taken as 1.6 without introducing serious error. The radius of curvature, as the name implies, is that radius which will describe the boundary of a lens surface. For instance a 2" focal length lens has a radius of curvature of about 1.2"; a 1" lens has its radius of curvature equal to 0.6"; and so on for any values of focal length.

Naturally, the higher the "speed" of our lens, the better the efficiency. A 1" focal length lens, ½" in diameter has a speed F2. Using this lens, our distance thus (from the light source to the condensing lens) will be 2"; from the condensing lens to the diaphragm, another 2", and from the diaphragm to the lens disc, a distance "p" inches, depending on the focal length of the latter's lenses. Condensing lenses of the above focal lengths and diameters may be obtained for about 15¢ to 25¢ apiece.



Above—How condensing lens improves efficiency by focussing light upon the diaphragm opening.



Right — The radius of curvature of a lens is important in television optics.

If the source of light is an arc or a Kerr cell, the loss of luminous intensity is not so serious and, to overcome that slight handicap, we can then use a lens of greater focal length with correspondingly larger diameter. A 3" focal length lens with a diameter of about 2" will answer the purpose and cost about 50¢.

If the televisionist wishes to spend more to improve his system's efficiency, he may be able to use a combination condensing lens of very low focal length and fairly large diameter. However, combination lenses are not generally within the modest range of the experimenter's purse.

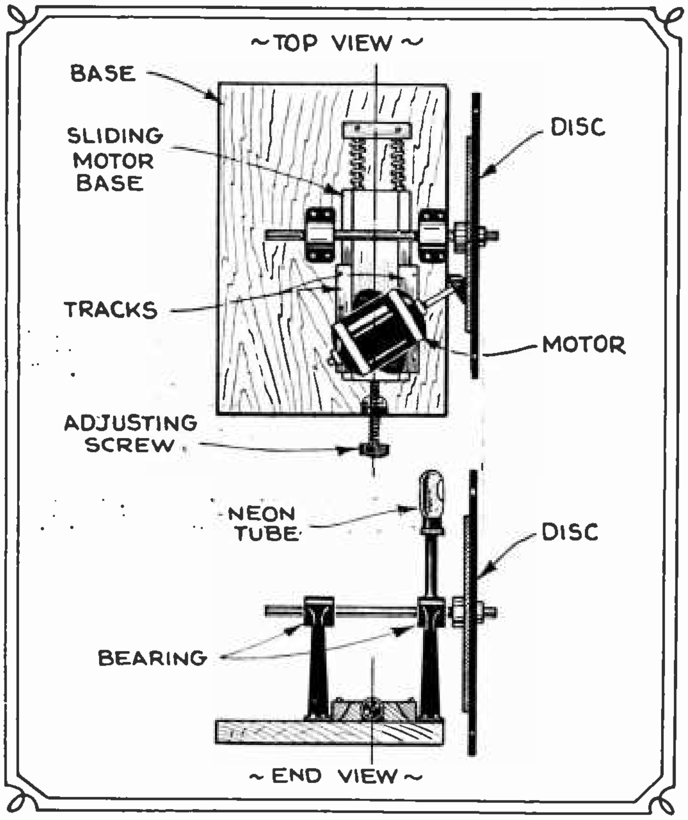
The main facts to keep in mind are: the shorter the focal length, the less the loss of light due to distance; the larger the lens diameter, the greater the light gathered together. In other words, greater speeds and smaller focal lengths spell better results and greater efficiency. Keep in mind, however, that for single lenses, the focal length and diameters are kept within bounds determined in manufacturing by the radius of curvature, as indicated heretofore.

Television in Politics!

A television broadcast of speakers at next Summer's National Democratic Convention has been offered by *The Chicago Daily News*, operator of television station W9XAP, as an inducement to bring the convention here.

Edward N. Hurley, chairman of the Chicago Citizens' Committee, who will present the city's invitation to party

(*Continued on page* 58)



A Simple Motor *Synchronizing* SYSTEM

One of the simplest yet best scanning motor drives of the friction type, which has been used very successfully by many television experimenters. It was first suggested by Mr. C. F. Jenkins.

NEARLY two years ago the writer was called upon to make some tests with a view toward the ultimate design in a simple radiovisor to be issued in kit form. While the report covering this series of experiments was later discarded in favor of a design of a more novel and startling character (which is now available on the open market), the tests are not to be belied and the writer feels that a description of the apparatus which best fulfilled the requirements would be of interest to those who "roll their own".

Here, in New York, reception of those stations in the metropolitan area is best accomplished with a disc rotated by means of a simple 1,200 R.P.M. synchronous motor, with the disc affixed directly to the shaft. Of course this is worse than a variable speed motor, when one desires to receive transmissions from out of town—or when an experimenter outside New York desires to receive the transmissions from W2XCR, W2XBS, W2XAB, etc. The ideal is then a motor of variable speed—but of constant speed. Variable-speed motors of the usual type cannot be expected to fulfill these conditions, but a synchronous motor or an induction motor of good design can be set up to fill the bill admirably.

Friction Driven Disc Used

The motor shaft is first supplied with a leather wheel, which should be made quite pliable with some good grade of belt dressing; although it should not be made so flexible as to be limber. The scanning disc is then mounted on a shaft, and the shaft so mounted by means of bearings that it will retain its position fixedly. The motor bed is not fixed in position, but mounted to slide in a pair of tracks as shown in the figure. A screw is passed through a tapped hole in a block fixed firmly to the baseboard; and a knob is attached to the screw, to make it easy to move the screw in and out through the block. At the opposite side two rods, firmly attached to the motor bed, are passed through holes in a second block, and have placed over them small springs of sufficient resilience to keep the motor bed forced firmly back against the adjusting screw. The motor is mounted with its shaft at an acute angle to the plane of the disc, and firmly fastened to the motor bed.

Motor Mounted on Sliding Base

The disc itself must be re-enforced over that portion against which the driving force will be brought to bear. Sliding the motor in and out by means of the adjusting knob will vary the speed of the disc over a wide range, so that a motor of almost any speed may be employed; one of about 1,200 to 3,600 R.P.M. will do nicely. If the bearings are of good quality a device of this type driven by a synchronous motor may be adjusted to the proper speed and left there day after day, with no more adjustment than a slight touch of the adjusting knob. The same is true when a good induction motor is used. Where small universal or D.C. motors are employed, rapid fluctuations in the supply voltage may make some adjustment necessary, but by no means as much as is required when a resistance form of speed control is used.

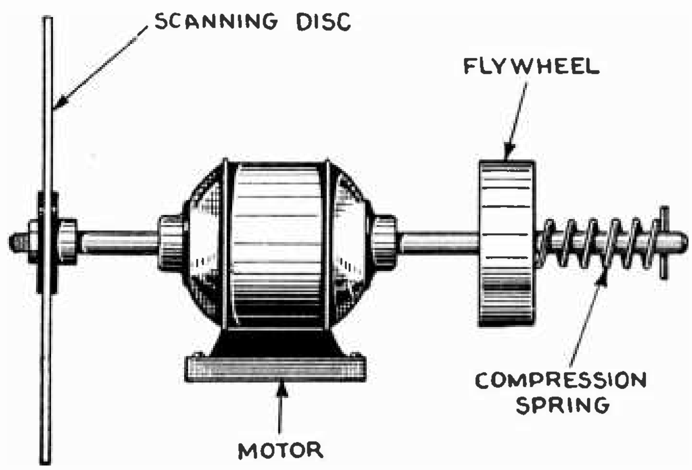
(*Continued on page* 48)

Flywheel Steadies Image at Receiver

IN the accompanying drawing is shown a simple method for improving the accurate speed maintenance in any television system. The idea here shown involves the use of a fairly heavy flywheel, which is secured to a stiff spiral spring; the stiff end of the spring being in turn secured to the motor shaft. This idea was recently suggested by Mr. C. Bradner Brown in *Radio Engineering*. The driving motor used in these experiments is a small 1/50 H.P. series-wound universal type. It is driven from the alternating-current mains, using a 100-watt lamp in series with the motor. A 200-ohm rheostat across the armature gives good control of the speed.

This system works very well except (*Cont'd on page* 48)

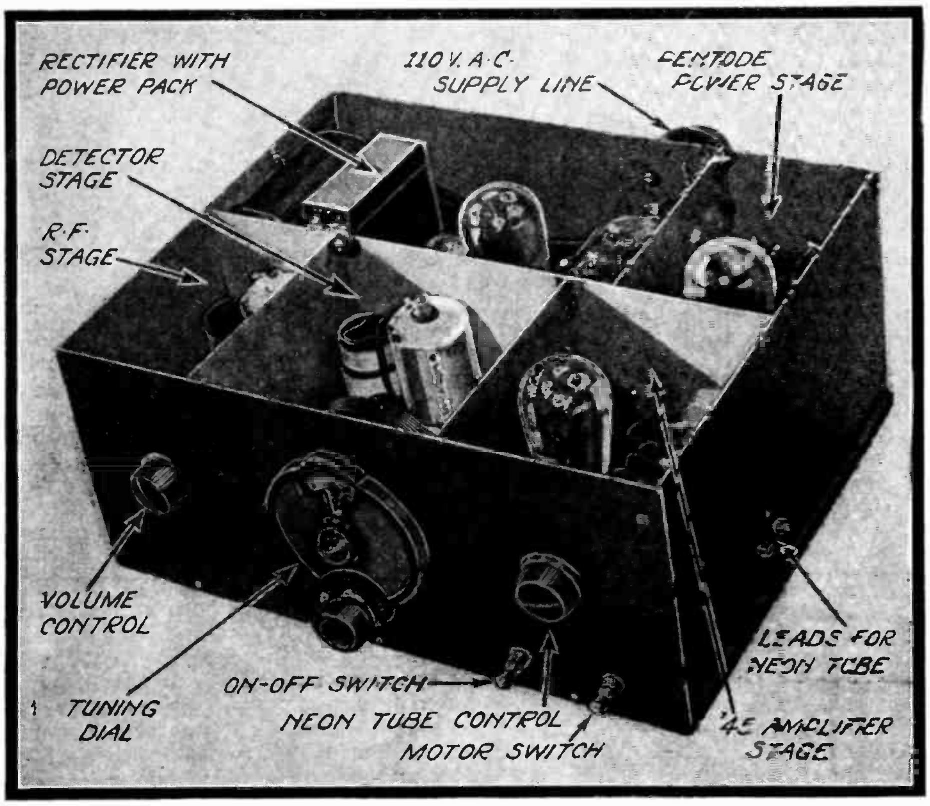
A simple yet valuable means of stabilizing the image by means of a fairly heavy flywheel, secured to one end of a stiff spring, the free end of which is fastened to the scanning motor shaft.



N. Y. SUN 2nd PRIZE WINNER

In TELEVISION SET BUILDING CONTEST

At Last! The Loftin-White amplifier adapted to television reception in this unusual receiver, which uses pentode output tube. Coil winding and other data included. Set works a Crater tube.



Perspective view of second prize winner in N. Y. Sun's television "set building" contest. The first prize winner was described in last issue. This set, all constructional data on which is given in the article, is shown as it appears from the top, in photo at right. This set works a "crater" tube.

TO L. K. DEGAN of 220 Jackson Avenue, Long Island City, N. Y., goes the unusual distinction of winning two awards in the recent television set-building contest conducted by the New York *Sun*. His very interesting receiver, described below, impressed the judges by its all round excellence and its performance with a minimum number of tubes. The second and fifth prizes were accordingly awarded to Mr. Degan.

In many ways the television receiver which won second prize in *The Sun's* contest embodies features with far more appeal to home builders than the more elaborate and expensive first prize set. Not only does it accomplish results with a minimum number of tubes, but the circuit involved shows a high degree of engineering ability and utilizes several of the latest developments in tubes and tube circuits. If after reading these details experimenters do not experience an immediate urge to upturn the box of odds and ends and commence to build a duplicate receiver for themselves, then the old build-for-yourself era is past and the pride of accomplishment is dead.

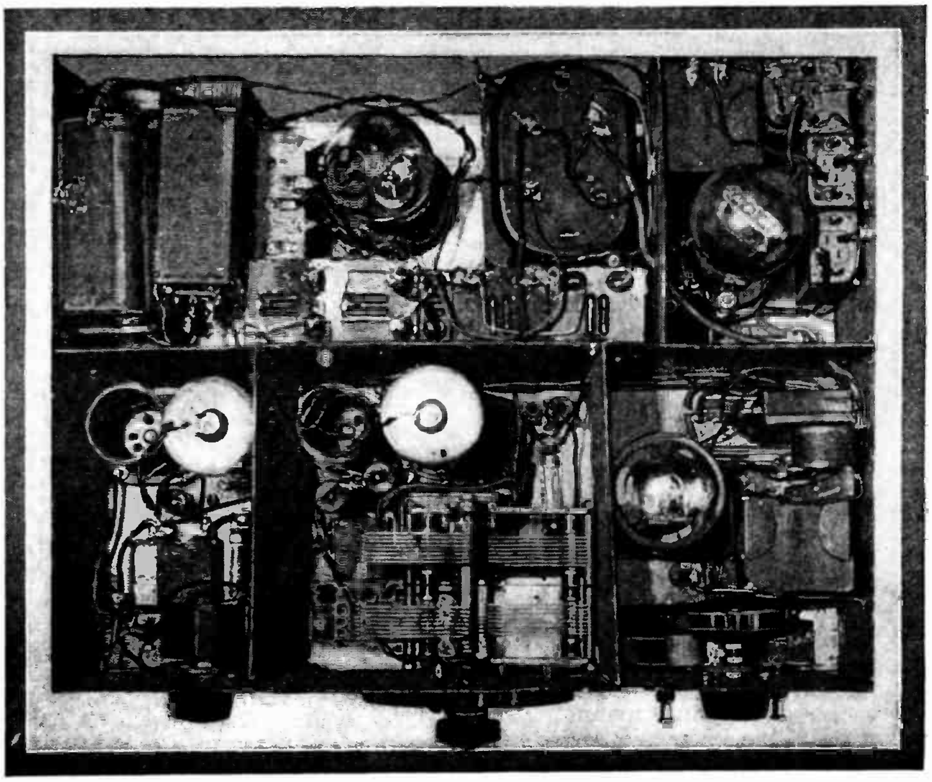
Loftin-White Amplifier Used

The mere fact that the designer adopted the modern Loftin-White principle of high-gain audio amplifier, instead of the more usual resistance-capacity form of coupling, sets his apparatus apart from others.

As every radio man knows, the advantages of this system of direct coupling is the high gain possible with a minimum number of tubes and the fidelity with which all frequencies are transmitted without distortion. Its ultimate possibilities are limited only by the ability of the last tube to handle the signal created. That is why Mr. Degan has utilized the tube combination of a type '45 emptying into a pentode type '47. Add to this the gain obtained through the use of a screen-grid detector, and the story is half told.

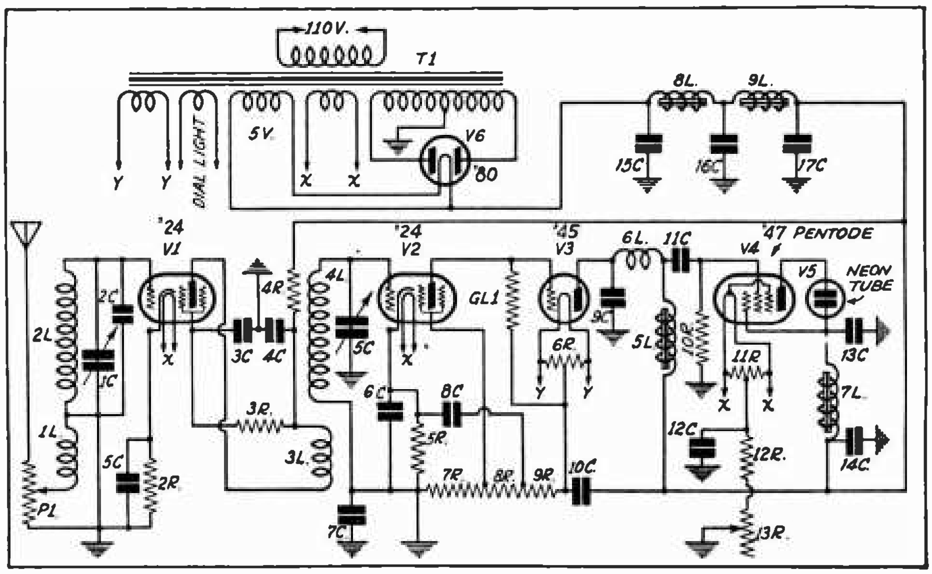
The Power Pack

The first unit to consider is the power pack. This includes a transformer supplying two 2.5-volt windings, a 5-volt



LIST OF PARTS

1L and 2L—Antenna coil.
3L and 4L—Detector coil.
5L, 6L, 7 L, 8L and 9L—Each 30-henry chokes.
1C and 5C—.00035-mf. variable condensers.
2C—Trimmer condenser.
3C and 4C—.1 mf. (fixed).
6C—1 mf. (fixed).
9C—.004 mf. (fixed).
7C and 8C—0.1 mf. (fixed).
10C and 11C—1 mf (fixed).
12C—2 mf. (fixed).
13C and 14C—4 mf. (filter).
16C—8 mf. (filter).
15C and 17C—4 mf. (filter).
P1—100,000-ohm (potentiometer).
GL1—1 megohm grid leak.
2R—1,000 ohms (fixed).
3R—½-megohm.
4R—50,000 ohms (fixed).
5R—200,000 ohms (fixed).
6R—Two 20-ohm center-tapped resistors.
7R—600 ohms (fixed).
8R—400 ohms (fixed).
9R—2,500 ohms (fixed).
10R—1 megohm.
11R—Two 20-ohm center-tapped resistors.
12R—500 ohms (fixed).
13R—2,000 ohms (variable).
V1 and V2—'24 type screen grid tube.
V3—'45 type power tube.
V4—Pentode output tube.
V5—Neon lamp.
V6—'80 type rectifier.
T1—Power transformer.



Wiring diagram for Mr. Degan's prize-winning television receiver—it possesses many desirable features—simplicity; power; wide frequency response, and small number of tubes and parts.

winding and the plate winding for the rectifying tube, which should be about 350 volts on each plate of the tube. The rectified high voltage is then filtered by means of two chokes of 30 henries each, or one 60-henry choke, designated in the diagram as 8L and 9L, and the needed filter condenser blocks 15C, 16C and 17C. This unit furnishes all the "B" supply required to operate the set, and is turned on and off by a 110-volt switch on the front of the panel.

R.F. Amplifier and Station Selector

The next unit is the radio-frequency amplifier and station selector, located on the left front portion of the base, immediately behind the front panel. This unit consists of the antenna coil and the screen-grid tube with the 100,000-ohm potentiometer located directly in front on the panel. Directly alongside, but in the next shielded compartment, is the detector stage with the coil, the tuning condensers and the screen-grid detector tube. Both of these circuits *have been designed to pass the wide frequency band,* which is essential in the reception of good television images.

The third unit, directly alongside, separated by a metal wall, is the '45 type power tube, which is directly coupled with the preceding '24 screen-grid detector tube and the impedance coupler needed to pass the signal output from this tube to the pentode. Directly in front of the first power stage, but on the panel, is the brilliancy control for the neon tube and two switches.

Pentode Output Tube

In the right rear compartment is the pentode output tube and a 30-henry choke, with proper filter condensers needed to provide the necessary power to operate the spot-source (crater type) neon lamp.

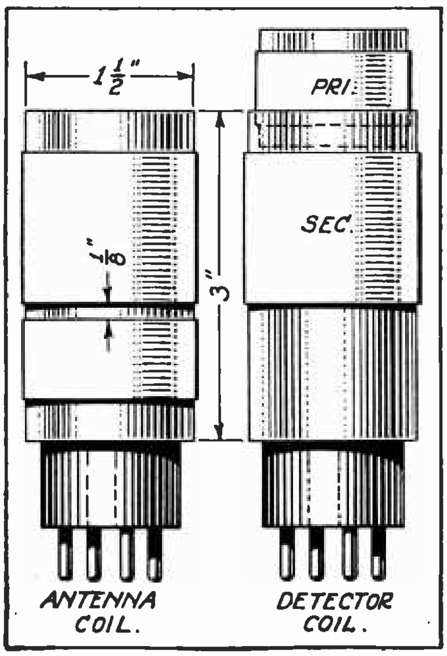
Coil Winding Data

Two types of coils are employed, both wound on fiber forms 1½ inches O. D. (outside diameter), which are then fitted over UX bases. The wire used on all coils is No. 28 single-silk-covered copper.

The antenna coil consists of a primary of fourteen turns and a secondary of twenty-eight turns. Spacing between these windings should be about one-eighth of an inch; which, however, can be varied to give broader or sharper tuning.

The detector coil is made somewhat differently. The secondary consists of the same number of turns on the same size tubing as the antenna coil and also mounted over a UX base. But the primary coil, which consists of forty turns, should be wound on a tube which can be made to slide snugly inside the secondary as shown in the diagram. It is necessary at times to adjust this coil with reference to the secondary for increased sharpness of signal, and this is best accomplished by sliding it out or in of the secondary coil.

Coil winding data for the broadcast



Details of R.F. coils, for Mr. Degan's television receiver.

band is given in the illustrations, and consists of the same size wire and forms. The primary winding for the antenna coil consists of twenty turns and the secondary of 105 turns.

Wiring the Set—Grid Bias

The grid voltage on all the tubes is supplied through fixed resistors in the cathode leads. That of the output tube is supplied through a variable resistor. The plate current of the pentode is sufficient to light brilliantly the spot-source neon light. This last stage is necessary to produce a positive picture and the adding or subtracting of a tube in the amplifier section should not be attempted; otherwise a negative picture will be the result.

After the parts have been fixed in place the wiring is commenced. By following out the general placement of units shown in the illustration the all too common examples of "hay-wire" assembly will be obviated and the best principles of wiring adhered to. The usual warnings should be given here lest carelessness ruin an otherwise excellent receiver. Remember these points:

Don't solder connections without first scraping the parts to be soldered.

Don't make wires or leads longer than necessary.

Don't leave excess solder on leads.

Don't splice a broken lead; use a new one.

When connecting leads to binding posts don't leave the ends dangling over.

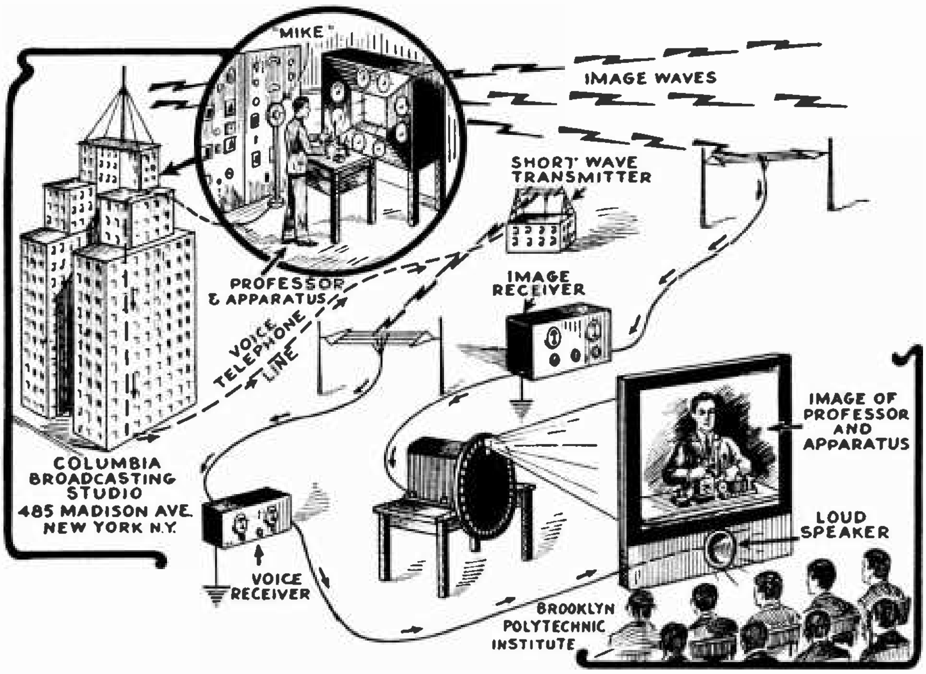
For the convenience of the builder the cathode wires should be all yellow, grid wires all green, plate wires all red and all other wires black.

First the complete filament circuit should be wired according to the diagram. When this is completed the tubes should be inserted in their respective sockets and tested. This is done by connecting the plug of the set to the supply line and the switch turned on. If the tubes show that the filament circuit has been wired correctly the switch should be turned off, shutting off the A. C. supply.

Next in order is the wiring of the grid and plate circuits. After this has been

(*Continued on page* 57)

First Physics Lecture by Television



The voice and image of a lecturer on physics was recently successfully broadcast and received as shown.

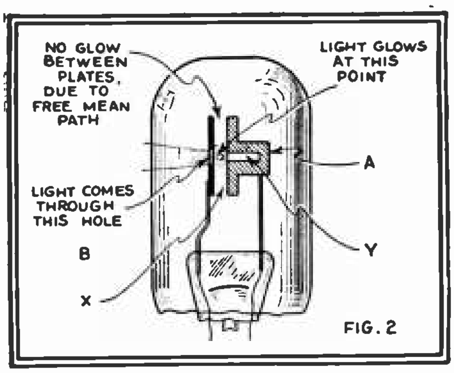
IN ORDER to demonstrate the boundless possibilities of Television as an educational agent, the Polytechnic Institute of Brooklyn, New York, in conjunction with the Columbia Broadcasting system, arranged for a *televised* "physics lecture" to be shown to a group of physics professors and teachers of the Metropolitan area in the main lecture room of the Institute.

About one hundred men and women watched with keen interest Professor E. P. Slack unfolding certain experiments in acoustics at the Columbia Broadcasting System's television studio in New York City, over television station W2XAB, while his voice was carried over short-wave station W2XE. The whole demonstration was carried by radio and the reception was exceptionally clear, considering the great amount of electrical noises emanating from the Polytechnic Institute's many laboratories.

Previous to the lecture, Mr. Ivan Bloch, E.E., consulting television engineer and a graduate of the Polytechnic, explained the operation of the receiving apparatus designed by him, which projects an unusually brilliant image about a foot square.

The audience was very enthusiastic and agreed with Dr. Erich Hausmann, well known physicist and Dean of Graduate Study at the Institute, that it is now feasible to have a great physicist reach, not only the few elect in his immediate vicinity, but those spread for miles about him, by means of education's latest and most powerful adjunct—Television.

A New Crater Tube Development



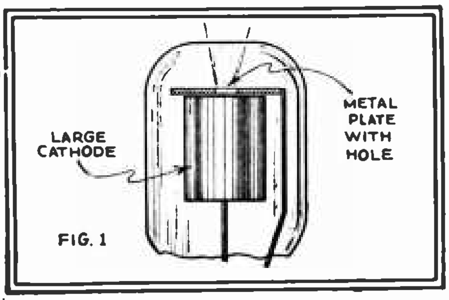
Sectional view of ordinary crater tube.

By HARRY ROSENTHAL

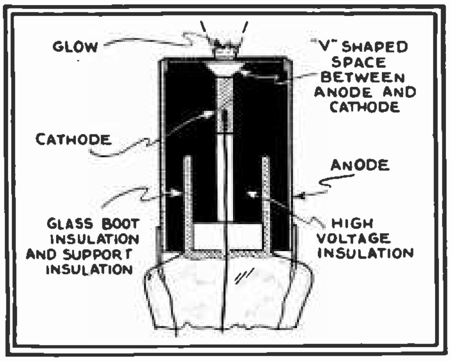
Consulting Engineer,
The Television Apparatus Co.

IN the present state of the television art, one of the major necessities is a point source of light of good modulation capability. Such a tube is required in all so-called "projection type" apparatus. Various methods have been employed in achieving the desired "point source". In some lamps the light available is limited by a shield placed within the tube, which is pierced by a minute hole of the desired dimensions—the size being governed by the characteristics of the optical system to be employed. Fig. 1 shows a lamp of this type in cross-section.

In Fig. 2 there appears a method evolved in the attempt to achieve a lamp of improved modulation characteristics. The "crater" takes the form of a hole in a metallic plate "A". The plate "B" contains a hole or aperture of a size determined by the optical system to be used. By a correct relationship between the distance separating "A" and "B" and the pressure of the gas with which the tube is filled, it is possible to achieve a condition wherein the space between the two plates is within the Crookes' "dark space", so that no discharge will form in that area. The portion of the crater outside the "dark space" will determine the position of the discharge formed. That is to say that the discharge will not occur at "X", as might be supposed, but at "Y".



In ordinary crater tubes the light emitted is limited by a shield as shown.



Cross-section of improved crater tube perfected by the author, in which the glow is brought out in front of the anode cylinder. Fig. 3.

An exceedingly efficient source of light could be attained, if the discharge could be brought out to the front of the aperture plate or "Anode" ("B") in the form of a ball, and maintained at that point when the total amount of light available to the optical system would be tremendously increased. Not only this but the modulation capability of the tube, particularly at the higher frequencies, would be improved.

To accomplish this result the writer set about the design of a tube of the general structure indicated in Fig. 3, and of the form shown complete in Fig. 4. Such a tube has a true "crater" source of

(Continued on page 61)

FIDELITY TESTS *for* TELEVISION SYSTEMS

By A. F. MURRAY,
Research Division, R. C. A. Victor Co., Inc.

Up until the present time there has been no very definite system for checking up accurately, in a standardized way, the fidelity of the television image as reproduced at the receiver. Mr. Murray here describes the latest charts used for this purpose.

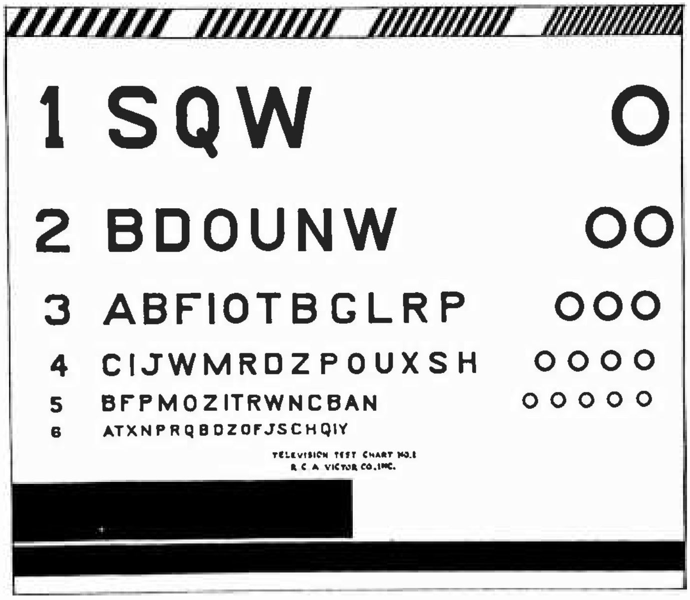


Fig. 1—Black and white chart, which has been found very useful in checking up fidelity in transmission.

WE are told that our imaginations, like a number of our other attributes, may be developed by exercise. If this is true, then television broadcasting, during these days of its infancy, certainly contributes greatly to the stimulation of the observer's imagination through exercise. We unconsciously imagine we see more in a television reproduction than actually is there. This fact makes it difficult for even the engineer to form a definite opinion of the fidelity with which the picture he may be observing is reproduced; and, if he does form an opinion, he has no means of conveying to others the degree of merit of the picture.

What we need is a measure of perception afforded by various television systems. For such a measurement we turn to charts as those shown in Figs. 1 and 3. The purpose of this brief article is to describe the use of these previously mentioned charts as they are employed at the television transmitter, W3XAD, of the Research Division, R. C. A. Victor Company, at Camden, N. J.

The chart of Fig. 1 is enlarged, photographically or otherwise, to the size of 15" x 18" (5-to-6 ratio). The surface must be dull, so that bright reflections of the scanning beam are avoided. The chart may be attached to any convenient support at the proper height in front of the transmitting scanner, as shown in Fig. 2. The proper distance and the proper lens are selected, so that the scanned area just covers the chart and no more. Careful focusing at both the transmitting and receiving scanners (if such adjustment is provided at the latter) is, of course, necessary. If the size of the picture is adjustable at the receiver, the size ordinarily used should be employed in this test.

When the average television engineer first looks at this fidelity chart over his system he usually gets a surprise—and it is seldom a pleasant one! Let us analyze what he can see at the receiver.

Letters must be at least three scanning elements high to be recognizable. Those using 60-line scanning report Line 3 readable, and the diagonal bars in the second group from the left-hand border clear-cut. Those using systems capable of greater detail find they can read the lines of smaller type.

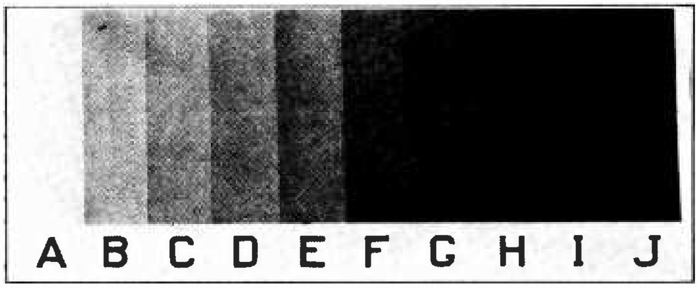


Fig. 3—This chart permits checking up the fidelity of "half-tone" transmission.

Across the top of the chart in Fig. 1 are groups of alternate white and black slanting bars; each group, left to right, is progressively narrower. In this way the horizontal definition of the system is measured. The heavy black bar, across one-half the lower portion of the chart, is for use in indicating phase-shift in the transmitting and receiving equipment. If the phase-shift is of sufficient magnitude to affect the fidelity of the picture, the observer will notice that there is no clean-cut edge at the end of the black bar. The narrow, black bar, extending across the entire width of the chart, tests the low-frequency response of the system. Along the right-hand border of the chart are circles to test for distortion which, if present and of a certain type, would make these circles appear elliptical.

Checking Half-Tone Fidelity

It is possible, of course, to have good definition in a television system which is capable of reproducing only black and white; therefore, in order to measure the degree of merit of a televison system, it is necessary to use, in conjunction with the definition chart of Fig. 1, the second chart shown in Fig. 3. It is somewhat difficult to expose one sheet of photographic paper successively to secure ten shades which vary from white to black in equal steps. With proper photographic equipment this can be accomplished; but, to make the half-tone chart shown in Fig. 3, we cut the photographic paper, exposed during various experiments, into strips of the desired width, and then selected from about 100 strips of various shades, those which the eye indicated were needed to give the desired number of equal steps. For uniformity, this chart can also be constructed 15" x 18"; so that it can be conveniently mounted on a suitable support in front of the scanner.

While the chart is being televised, its reproduction at the receiver should be inspected by several independent observers. The results as to the number of distinct shades noted should be averaged; because there may be slight differences in the reports of the various observers.

The record of a typical television fidelity test would read something like this:

DEFINITION: Line 3, readable, every letter perfect.
HORIZONTAL DETAIL: Group 2, clear-cut.
PHASE-SHIFT: None observable.
LOW-FREQUENCY RESPONSE: O.K.
DISTORTION OF CIRCLES: None.
HALF-TONES: Four out of ten shades distinguishable.

By the use of charts we see that television fidelity can be measured and recorded in a really scientific way.

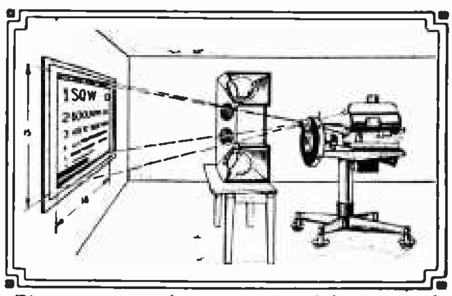


Fig. 2—How charts are placed in front of television transmitter.

The LORA CATHODE RAY Television Tube

By LUIS A. LORA
Its Inventor

THE electrical scanning system of the cathode-ray tube appears to be almost ideal, and synchronism can easily be obtained by using specially designed "sawtooth" oscillators. It is quite difficult to find a chemical compound for the fluorescent screen, which will be able to glow very brightly and instantaneously when acted upon by a beam of electrons, yet have that glow rapidly extinguished without any objectionable *afterglow*. The picture reproduced on the ground-glass end of the ordinary cathode-ray tube, although sometimes bright enough to be comfortably viewed from a distance, often lacks a certain clearness of definition or sharpness of details, and therefore is rather tiresome to watch. The light produced is usually insufficient to be magnified optically in order to project a large image upon a screen. It is also very improbable that very large cathode-ray tubes will ever be built, on account of their prohibitive price and greater technical difficulties. One thing certain is that the cathode-ray tube offers great possibilities, on account of its electrical scanning and compactness. It is possible that an improved, modified type of this tube might become popular in the future, and supplant the ordinary mechanical scanning systems used at present.

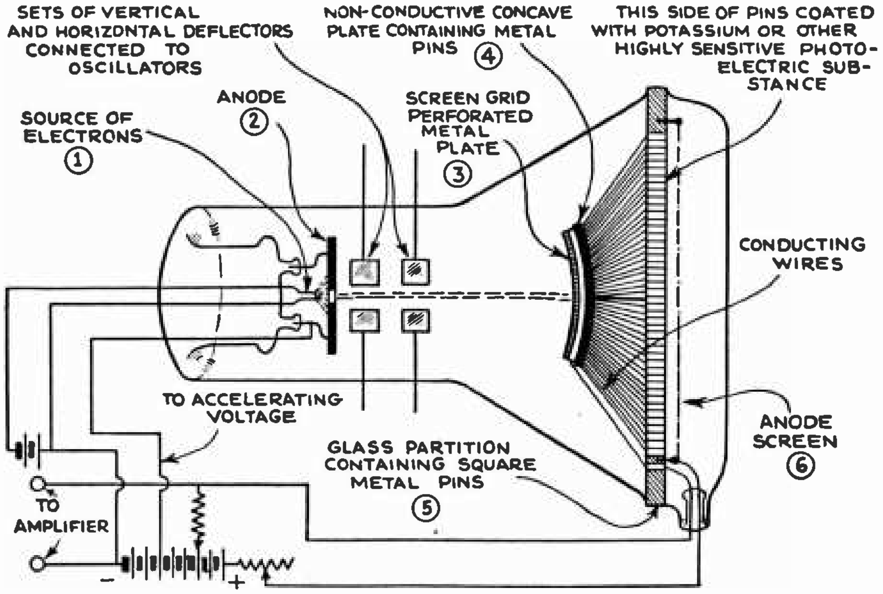


Fig. 4—The Lora "transmitting" cathode ray tube scanner. A photo-electric layer of pins are affected by the image, which is focused on to the anode screen by a camera.

A New Cathode-Tube Scanner

Keeping those facts in mind, the writer has designed a special cathode-ray tube, working on an entirely new principle, and which has none of the above-mentioned limitations, though it possesses the same advantageous possibilities, with several added improvements.

Description

The new tube has the general appearance of an ordinary cathode-ray tube, except that the end of the tube is not frosted, but made of clear glass through which an intense light is projected. The image is to be viewed upon a large screen; but could also be seen at the end of the tube, provided that its end is posted or a frosted plate be placed directly in front of it.

Fig. 1 shows a conical-shaped glass bulb, divided into two chambers by a glass partition (4). Small metal pins (7) are imbedded within this glass partition; so that each pin has one end in

The advantages claimed for the new cathode tube by its inventor, Mr. Lora, are: A much brighter image than that heretofore obtained; the image can be focused on a large external screen; white light can be used; freedom from distortion of image; practically unlimited scanning speed.

contact with the neon gas contained in chamber (8), while the other end is exposed to a beam of electrons in chamber (9). The element (1) may be either a D.C. filament or an A.C.-heated cathode, emitting electrons which are attracted by a positively-charged anode (2). Electrons shoot through an opening in the center of this anode and form a narrow beam or pencil of electrons (10). They are further attracted and accelerated by a perforated metal plate (3). There are as many perforations in this plate as there are pins in the glass partition (4). In a 60-line picture, 3,600 perforations as well as 3,600 pins are necessary. Of course, instead of one pin several very thin pins may be made to face a perforation. The end of each pin faces a hole in the perforated metal plate as may be seen in Fig. 2, which shows portions of those elements greatly exaggerated for clarity.

Theory of Operation

As in ordinary cathode-ray tubes, the scanning is accomplished by two sets of deflecting plates placed at right-angles to each other. For a 60-line picture, one set of plates is to be connected to a 20-cycle oscillator and the other set of plates to another oscillator working at a frequency of 1,200 cycles. When the electrons shoot through a perforation in plate (3) and strike the end of a pin, they give it a negative charge. The flow of electrons bridges the space between the perforated plate (3) and the pin end facing it, and a concentrated glow-discharge takes place in the gas chamber between the other end of the pin and the wire-screen anode (6). The high D.C. voltage operating power tube (11) will now flow to the anode (6); then through the pins (7); and then through the beam of electrons reach plate (3) and thus complete the power tube circuit. Plate (3) acts as a control-grid; as its voltage varies with the signal, it attracts more or less electrons through the perforations, thus varying the resistance between plate (3) and pins (7). The pins receive from the wire screen in the gas chamber a positive charge, due to the conductivity of the gases or vapors which can be used. They become less positive or more negative when the electrons strike their surface. The negative voltage on the pins being variable, the glow between the wire-screen, anode (6) and the pins also varies in the same proportions.

A maximum glow is produced at the end of a pin when a maximum voltage flows through it. This glow-discharge spreads slightly around each pin, so that there are no blank spaces left between them. Fig. 3 is a partial end view of the tube, showing the location of the pins with respect to the anode screen (6).

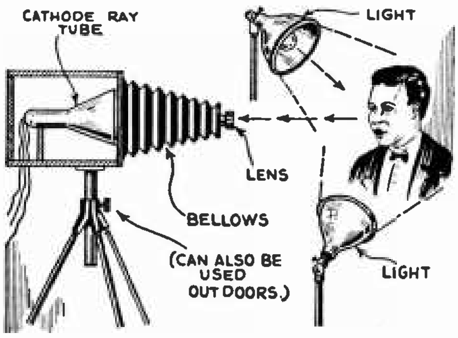
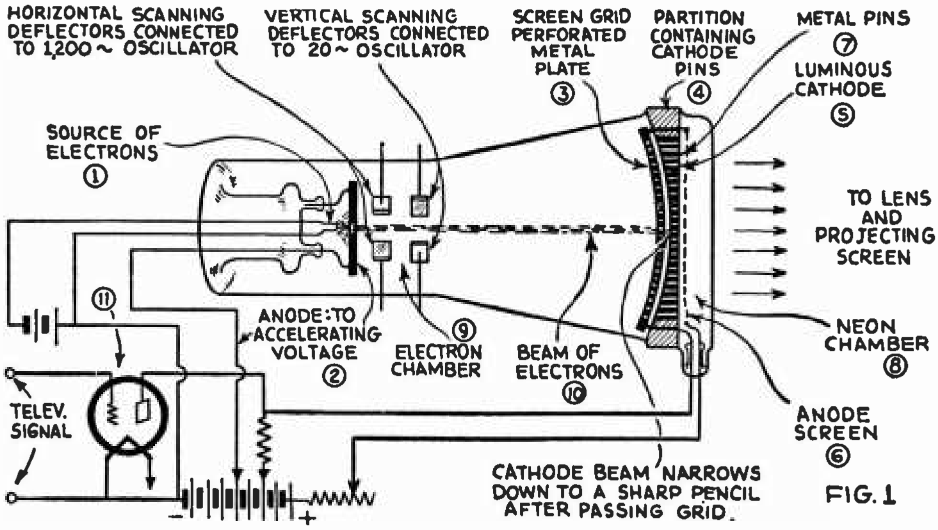


Image of subject, illuminated by lights as shown, is picked up by lens of camera and focused onto photo-sensitive end of the special cathode ray tube.

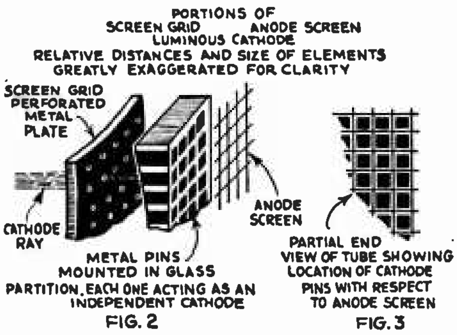


The Lora cathode ray tube is designed to project brilliant image through a lens onto a large screen, as shown below. The flow of electrons bridges the space between the perforated plate, 3, and the pin end facing it, causing a glow discharge to occur in the neon chamber, between the other end of the pin and the wire screen anode 6.

Advantages of New Tube

It has been calculated that a very powerful light could be obtained from this tube. This light is to be focused upon an optical lens arrangement, to project a large image upon a screen. Neon, helium or mercury vapors, or a mixture of different gases, may be used to obtain a brilliant white light, which would be best suited for the reproduction of clear distinct pictures.

In this tube the distortion of pictorial elements is entirely prevented; because the modulation takes place after the deflection, at the very instant that the steady beam of exploring electrons sweeps over the surface of the control-element (3). The pins being of uniform shape and symmetrically aligned, spreading or overlapping effects are also prevented. Since all the voltage is applied to each pin consecutively, the illuminating power of this tube ought to be quite powerful. Each pin constituting a picture element may be considered as a minute individual "crater" tube. It might be possible to use less audio amplification, or perhaps do away with large power tubes, with this system; since all the voltage is applied on each pin at any given instant.



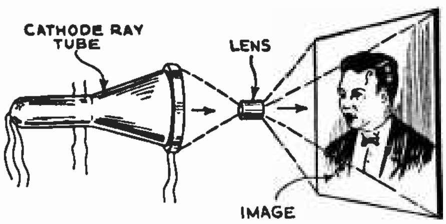
Close-up views of screen grid and anode screen used in Lora television cathode ray tube.

The amount of light obtainable from the fluorescent screen has been, and still is, the most difficult problem to solve. The writer's new tube design is not limited in this respect, and it has several unique features which distinguish it as an important improvement over similar devices.

Using Tube for Transmission

The principle of this new tube can also be applied to the *transmission* of television images. In that case, the ends of the pins, protruding into the gas chamber, are to be coated with potassium or some other sensitive photo-electric substance. A suitable gas, instead of neon, can also be pumped into the gas chamber to increase the conductivity between the elements.

Looking at the camera transmitter illustrated in the diagram, one may see a cathode-ray tube nearly similar to the one previously described for reception. In order to make this new tube practical for outdoor camera transmitters, it was found necessary to make the tube as small and light as possible, as well as reduce its current consumption. It was also calculated that the amount of electrons given off by each photoelectric pin surface is very small. For that reason, the pins are made larger and the total size of the photoelectric surface is thus considerably increased. This, of course,



Projecting the image from neon chamber on end of new Lora cathode ray tube onto screen.

under ordinary conditions, would necessitate a much longer and much wider tube; requiring a stronger source of electrons and much higher voltages. To do away with those inconveniences, a perforated concave metal plate (3) is placed in front of a concave insulating plate containing small pins. Each collector pin is connected by a wire to a large photoelectric pin facing the anode screen (6).

Operation

The image to be televised is reduced optically by a camera. The image reproduced upon the end of the cathode tube, covers all the photoelectric pins. Each pin emits electrons in proportion to the amount of light it receives. Only one pin is connected at a time by the sweeping beam of electrons. The amount of current flowing through each pin is in proportion to the amount of electrons it emits. Those different values of potential, being successively transferred to the amplifier, similar impulses are transmitted; at the receiving end these are re-amplified and cause a certain pin to glow in the receiving tube at exactly the same time that the corresponding photopin is connected at the transmitter.

For indoor studio television, the camera transmitter could employ a much larger tube, built exactly like the receiving tube, except that the pin-ends in the gas chamber will be coated with a photoelectric substance, and the neon gas will be replaced by a non-luminous gas.

Several types of these tubes are being made, with important modifications, to obtain different effects. Lack of space prevents us from giving more details now; but the results obtained, if worth while, will be described later.

Letters from our Readers

"Sees 'Em All" Way Out In Kansas

Editor Television News:

I have built a television receiver which incorporates several unusual design features, being a super-heterodyne instead of the conventional tuned radio frequency receiver.

The following list of television stations have been picked up with this receiver; and I believe this to be the largest number of stations received in this part of the country:

W9XAO and W9XAP, Chicago. Ill.

W2XAB, W2XBS, and W2XRC, New York City.

W1XAB, Boston, Mass.

W3XK, Wheaton, Md.

W2XR, Long Island City, New York.

All the above stations have been received with *unusual clarity.*

Sincerely yours.

W. R. Mitchell, Manhattan, Kansas.

Editor Television News:

It gives me great pleasure to sit down and write to you. It is a great responsibility that you have tackled to get every single bit of news to print in the Television News.

It is one of the most outstanding magazines today; it contains more logical information about *television* than any other magazine. I enjoy every article; especially the "Television Course" lessons in which Mr. Nason gives so many details concerning television.

More power to you, Mr. Nason! I can hardly wait for the next issue.

Yours for Success.

Shavarsh Papazian,
823 Courtlandt Ave., Bronx, N. Y.

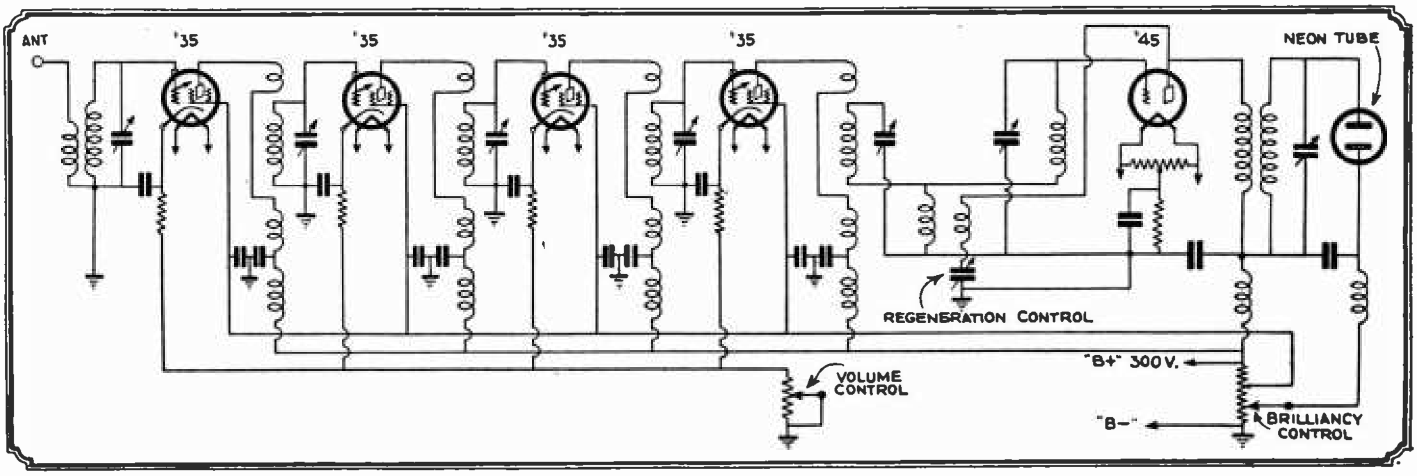
Radio Frequency Operation of NEON TUBES

By HARRY WALDRON

A NEW development in the art of television is always of interest to the experimental investigator—but especially so when that development hits close to home, so that it is directly applicable to his own work. Such an advance has recently been accomplished in the writer's laboratory, after a year or more of delay due to the pressure of commercial work. The receiver developed along this new principle is one destined for commercial production; and therefore cannot be at once described in its complete form. We believe, however, that the data contained herein will be sufficient to provide enough food for thought to last until a more stabilized arrangement can be crystalized out of the mass of technical data resulting from the experimental program.

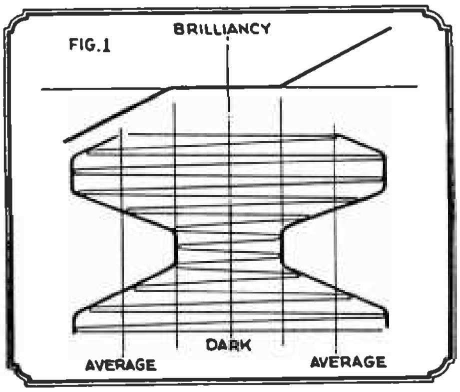
Detector-less reception of television signals is made possible by the fact that neon tubes can be built to operate at carrier frequencies. Improvement over ordinary receiver is elimination of distortion caused by detector.

The fact has long been recognized that the maximum distortion in the television receiver may be isolated in the detector and low-frequency amplifying stages. If, then, at one fell stroke, we can deprive the receiver of these appendages—and they are *appendages*—we would do a goodly job for ourselves. Now a properly-designed radio-frequency amplifier for television may be made to pass a band of frequencies sufficiently wide to take in the sideband components resulting from modulation of the carrier by the television signal. At the present stage in the game, where we employ 60 x 72-element scanning, at a "repetition-frequency" of 20 per second, this amounts to a band width of about 90 kc. By the judicious use of regeneration, and of band-selector circuits, a pass-band quite as wide as this can be obtained. A response-characteristic of equal fidelity in the detector and low-frequency circuits is more or less problematical. The writer quite frankly hazards the guess that no commercially-available television receiver even remotely approaches the ideal in performance. In the arrangement to be described, the radio-frequency amplifier is continued through the number of stages requisite to the attainment of a high signal-voltage level, and the resulting voltage is applied directly to the plates of a neon tube or "crater lamp". Neon tubes of special design, built to avoid the appearance of a negative charge on the glass wall, may be successfully operated at carrier frequencies. The eye will not observe these variations, but variations in brilliancy (due to the modulation of the carrier's *envelope*) will be quite clearly noted.



Hook-up of four screen-grid and power amplifier stages to neon tube. The input stages are the same as those employed for normal operation using a detector. One of the features of this circuit is the elimination of the distortion caused by the detector.

In Fig. 1 there appears the characteristic curve of a neon discharge tube, with the light intensity plotted for arbitrary values of carrier amplitude. The actual variations in light intensity, as noted by the observer, will be proportional to the variations in the carrier envelope due to the modulation. The picture's brilliancy should be proportional to the amplitude of the modulation envelope and not to the actual carrier amplitude; the effect being variable with the percentage modulation in the transmitted wave. In order to avoid distortion of the relative brilliancy of the scene, a negative biasing potential must be provided, and of such magnitude that the lamp will go completely dark when the carrier amplitude is swung to a certain minimum value. When the carrier is unmodulated, the lamp will be illuminated to an average brilliancy, as indicated in the figure. The amplitude of the output voltage, and the required power output, will depend largely upon the design of the light source. A '47 pentode, a '10 tube, or a '45 should give satisfactory service in the output circuit. It would also be possible to employ one of the 7.5-watt screen-grid tubes at this point.



Characteristic curve of a neon discharge tube, with the light intensity plotted for arbitrary values of carrier amplitude. When the carrier is unmodulated, the tube will be illuminated to an average brilliancy.

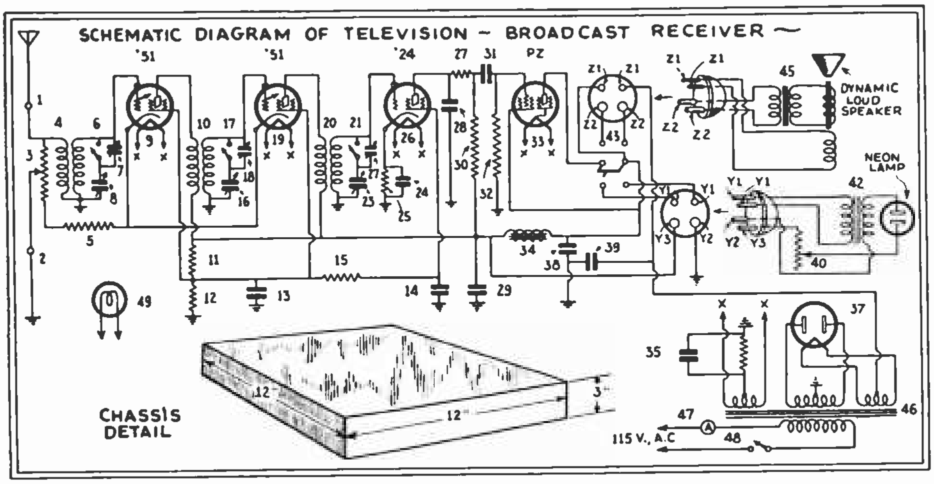
For larger output power, where a "crater lamp" is used in conjunction with projection-type scanning apparatus, the choice is still among the tubes noted above, but they are operated in parallel—in push-pull or as Class "B" linear amplifiers. This last method of operation will permit of a large power output, far beyond that of the same tubes operated in push-pull or in parallel. Although the mode of operation is not that of the push-pull amplifier, the method of connection is the same; except that the grid bias is so great as to cause the plate current to fall to zero during no-signal periods. The excitation or signal amplitude must be such that the grid bias is exceeded by a large amount during each signal cycle. When so operated, the output of a pair of '10 tubes is of the order of 30 watts.

The input circuits must, however, be

(*Continued on page 56*)

4 TUBE TELEVISION and BROADCAST Receiver

By H. G. CISIN, M.E.



Wiring diagram for the combination broadcast and television receiver. To receive television waves the midget condenser short-circuiting switches 6, 17 and 21 are opened, reducing the tuning capacity for the shorter waves, by placing two condensers in series across each inductance as shown.

THE versatile receiver described in the present article performs two separate and distinct functions. It may be used to bring in television signals; or it may be changed over, by means of a simple switching arrangement, to operate as a standard broadcast receiver.

You will enjoy using a set like this one, which Mr. Cisin especially designed and built around standard radio parts. It is A.C. operated, receives on two wave bands—"broadcast" and "television". Economical to run—only 4 tubes. All coil, condenser and resistor data are given.

Simple 4-Tube Circuit Used

In spite of the fact that this set serves a dual purpose, the circuit is the last word in economy and simplicity. The multi-tube idea for television receivers has been discarded. Instead, a simple four-tube circuit is used, which is highly efficient. The Television-Broadcast receiver has three tuned stages. The first two are R.F. stages, employing '51 variable-mu tubes. A '24 screen-grid tube functions as a power detector. Only a single audio stage is required. Resistance coupling is used between the detector and the audio output stage, for which a PZ pentode is employed. The rectifier is a full-wave '80 tube.

The change-over from television reception to broadcast is accomplished by short-circuiting the three small variable (equalizing) condensers (7, 18, 22), which are in series with the main tuning condenser sections (8, 16, 23). When these condensers are in series, the total capacity is reduced to the correct value for tuning in the short-wave television stations. Closing the three switches (6, 17, 21) cuts the small variable condensers out of the circuit, and permits the receiver to tune in stations between 200 and 550 meters.

The large tuning condenser is a three-gang Cardwell variable condenser, with shielding between sections. A special Electrad potentiometer is connected in the cathode and antenna circuits for smooth, accurate volume control, with which the "on-off" switch is combined. Standard, precision "Conoid" (or equivalent broadcast coils) coils are used at (4), (10) and (20). Aerovox electrolytic condensers are used at (35), (38) and (39). Aerovox mica and by-pass condensers are also specified. Durham metallized resistors are used at various points throughout the circuit; the use of these accurate resistors is highly important, as incorrect values give poor results and in some cases, may even prevent the receiver from functioning.

Rapid Shift From Neon Tube to Speaker

A double-pole, double-throw switch is provided, which permits rapid change-over from neon lamp to loudspeaker. The speaker field serves as an audio choke. The Trutest power transformer (46) supplies all necessary voltages. The self-adjusting Amperite (47) improves television as well as broadcast reception, and also protects tubes and set components from the ill effects of line-surges and high or low voltages. Arcturus tubes were selected for this set by the writer, after extensive comparative tests.

The Television-Broadcast set is laid out on a 12" x 12" chassis, with all wiring out of sight. Corwico Braidite hook-up wire is used, in accordance with standard practice for quality receivers. A special feature of this receiver, is the use of an I. C. A. impedance-matching transformer between the pentode output tube and the neon lamp; this transformer is essential for high-quality television reception.

The Television-Broadcast receiver, used in conjunction with the I. C. A. "Visionette", brings in excellent pictures. The "Visionette" kit consists of a new television-model motor, a 60-hole, 16" scanning disc, a special magnifying-lens system, a mirror-screen, a neon lamp, a "shadow box" and a compact metal housing. The motor has an induction-type squirrel-cage rotor, and a synchronous

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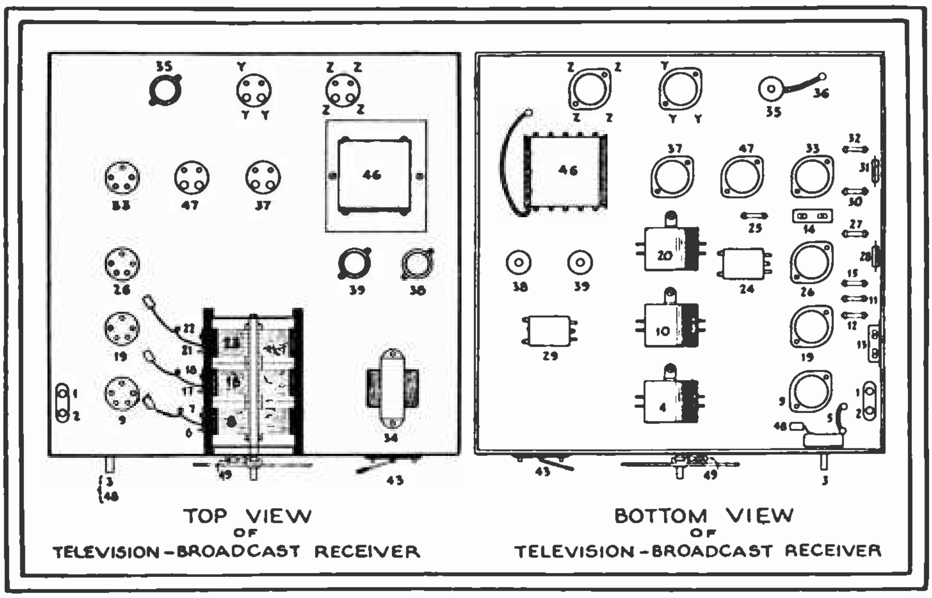
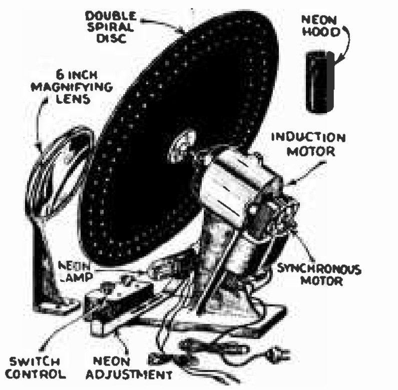


Layout of parts in building 4-tube combination television and broadcast receiver.

The PIONEER Receiver and Scanner

By JOHN J. FETTIG*

One of the very latest television scanners and receivers intended for "home use" is here described in detail. The scanner uses a flat-plate neon tube; together with accelerating and synchronous motors.



The Pioneer scanner, fitted with accelerating and synchronous motors. The image is viewed through the lens at the left.

EVEN though a successful combination aural and vision receiver can be built, of what advantage is it? As the receiver can not be used for sight and sound at the same time, one must have another receiver to receive the synchronized sound accompaniment of the television image. The writer believes it best to concentrate on the design of an image receiver for that specific purpose, and do the job well.

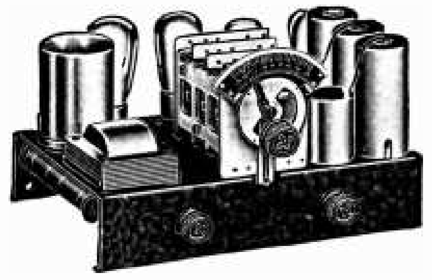
As the readers of this magazine are mainly interested in television-image reception the Pioneer image receiver will be discussed in this article.

Tubes Used in "Image" Receiver

It will be noted from the schematic diagram that the television receiver consists of two stages of transformer-coupled radio-frequency, using '35 type tubes; a grid-leak detector employing a '27; and three stages of resistance-coupled audio-frequency amplification using '27s in the first two stages and a '47 pentode in the output stage. The primary of the antenna coil is both inductively and capacitively coupled. The remaining two coils have their primaries wound directly over their respective secondaries.

By analytic comparison of detectors, it was found that most tubes (especially when used as power or grid-bias detectors) dropped off very rapidly in frequency response after passing 10,000 cycles; but the '27, employed as a grid-leak detector with sufficient plate voltage, had only a gradual drop in frequency, after passing 11,000 cycles. While it is admitted that a power detector will give a greater undistorted output than a grid-leak or "square-law" detector, it can be proven that a detector such as used in this receiver will more readily pass the high frequencies required in television; so that, even though the power output be lower, the detail of the image will be greatly improved. The only advantage to be gained from using power detection is the fact that fewer audio stages are required. The writer, for years past, has advocated a smaller number of stages of audio in a television receiver; but, weighing the loss of detail against less power from the detector, I think most television fans will agree with me, that it is much better to have an image that shows eyes, nose and ears, than to have an image that shows black dots for eyes and a blur for a nose!

* Engineering Dept., Pioneer Television Co.



The Pioneer television receiver, which employs a pentode tube in the output stage.

Three stages of resistance-coupled audio is rather hard to keep from motor-boating (oscillating); but, with proper values and placing of parts (and that includes by-passing of the different circuits and the use of decoupling resistors in the detector and first two audio plate circuits) this draw-back can be avoided.

A.F. Amplifier Response 15 to 70,000 Cycles!

Careful attention has been given to the audio amplifier, and its frequency response is flat from 15 to 70,000 cycles. The oscillograph on which the receiver was tested did not go higher than 70,000 cycles; but as this is more than 20,000 cycles above what is needed for present-day sixty-line pictures, it was felt that sufficient tolerance was allowed. The '47 power pentode makes a very efficient output tube, and its power output is 2.5 watts, as against 1.6 watts given by a '45.

The Pioneer scanner is unique in that the image is viewed from the *bottom* of the disc, rather than from the top, which is the usual practice. This enables the operator to view the image from either a standing or sitting position, without straining his neck in order to do so.

In the mechanical design of the scanner, the author has had the privilege of working with a leading mechanical engineer who has long been connected with the mechanical side of radio. He has designed many of the indispensable and most useful instruments used in aviation radio today. His experience in this field has made possible a televisor that is rugged and efficient in mechanical design.

Scanner Disc Has Square Holes

The scanning disc is sixteen inches in diameter, containing a *double spiral*, of twice sixty holes, each .0116-inch square. This double spiral facilitates the framing of the image. The neon lamp is mounted on a movable bracket and can be moved up, down or sideways through the use of a conveniently-located lever. When an image is out of frame vertically, the lamp is raised either up or down; so that any hole in the first spiral may become the top hole or line of our image. The lamp is masked, except for an opening the size of our image; this mask prevents the holes that are not in

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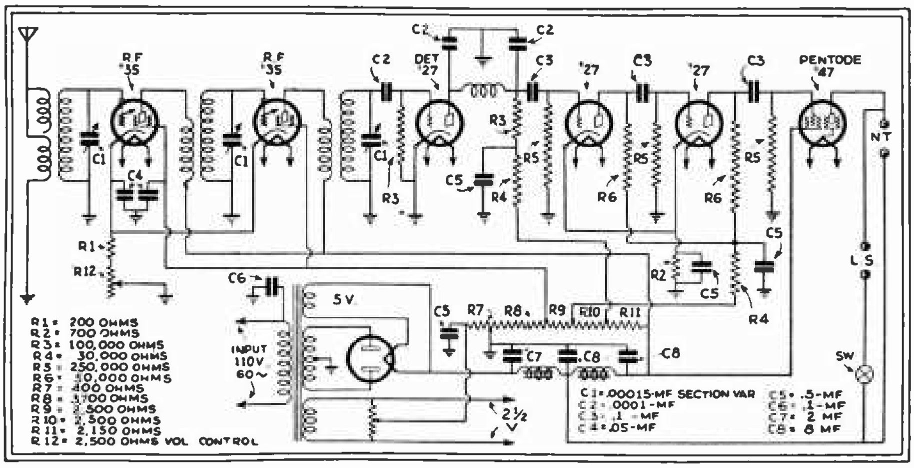


Complete circuit of the Pioneer television receiver, which employs two stages of R.F., detector and three A.F. stages.

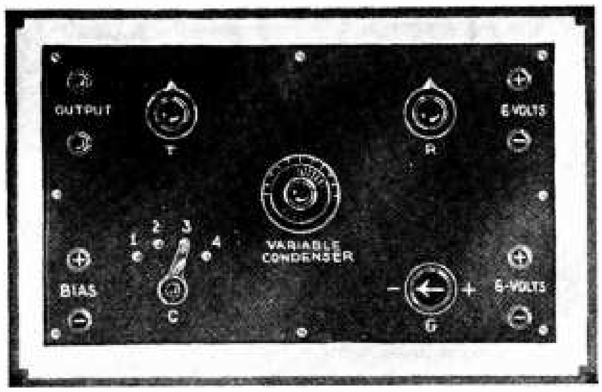


Fig. 6—Front panel view of thyratron oscillator.

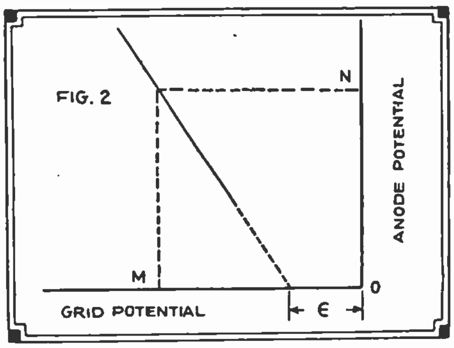
THYRATRON OSCILLATORS *for* Cathode Ray *Scanners*

The latest type "sawtooth" oscillator for cathode ray scanners, is that employing the thyratron tube as here described in detail by the author.

By M. RAPPAPORT, E.E.

THE fundamental principle upon which the thyratron "sawtooth" or "right-triangular" wave oscillator operates is not very different from that of the *neon tube oscillator. The latter employs a neon tube for the purpose of discharging the condenser and, thereby, acting as a synchronous switch; the former uses a thyratron tube which synchronously discharges the condenser.

Fig. 1 is a simplified diagram of a thyratron oscillator. The thyratron is essentially a rectifier tube, whose action depends upon its grid. The operation consists of passing through the tube a current in the form of an arc, whose starting is controlled by the grid. When the discharge has once commenced, the grid can no longer influence it. The thyratron operation is therefore a periodic removal of the anode potential to stop the discharge, and the control of the recharge by means of the grid. When



Graphical representation of the action in a thyratron.

the thyratron tube is employed for the purpose of producing a "sawtooth" wave, the potential is removed by discharging the condenser through the thyratron, and reapplied by recharging it with a battery.

How Thyratron Operates

The thyratron is a three-electrode tube into which, after it is exhausted, mercury vapor is inserted. The gas performs the function of changing the pure electronic discharge into an *arc*, thereby making the thyratron an electro-statically-controlled, mercury-arc rectifier. From its controllable-rectifier characteristic, the thyratron naturally falls into the category of pure electrical relays; it is instantaneous in operation and its frequency may be kept under absolute control. The electrical relay characteristic of the thyratron depends largely upon its inherent nature, as represented in Fig. 2. In this diagram, the *abscissas* (horizontal scale) represents the grid potential, and the *ordinates* (vertical scale) the plate (anode) potential at which the electrical breakdown of the tube occurs. When the plate voltage is raised to a critical value (which depends upon the

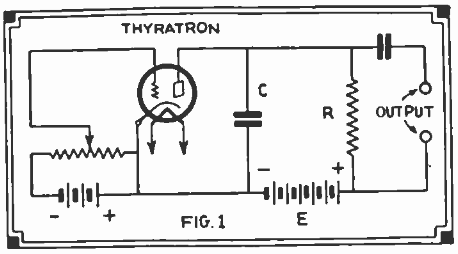


Fig. 1—Simplified diagram of thyratron oscillator.

grid potential), an arc will appear. In other words, the grid performs as a "trigger" which sets off the arc. The general characteristics of the Western Electric D-90279 tube are as follows:

(1) It fits into an ordinary vacuum-tube socket
(2) Is filled with mercury vapor
(3) While operating glows with a blue light
(4) The oscillations are audible

Normal filament current 1.7 amperes
Normal filament voltage .... 2.4 volts
Maximum plate current: direct....... 40 milliamperes
alternating .... 75 milliamperes
Anode-to-cathode drop .... 15 volts
Maximum voltage between heater and cathode .... 12 volts (for 256-A)
between grid and plate ....325 volts
Control voltage with 100 volts on anode 25 volts
Epsilon (see Fig. 7)—0.75 volts

The D-90279 is similar to the 256-A tube and is interchangeable with it when the proper socket is used. In this tube, the cathode and filament are connected inside; in the 256-A tube, these terminals are brought out to the base separately, thereby making five prongs.

The base connections of the D-90279 tube are shown in Fig. 3 with the larger prongs at the bottom.

In Fig. 2, assume that minus OM volts are applied to the grid. The condenser (C) as shown in Fig. 1 will charge up to ON volts; at which point the electrical breakdown of the thyratron will occur and current will flow out of the condenser and through the thyratron tube. At exactly the same instant, the potential between the anode and the cathode drops to about 20 volts and the discharge ceases. The battery (E) now builds up to the potential ON, as previously, and the cycle is repeated.

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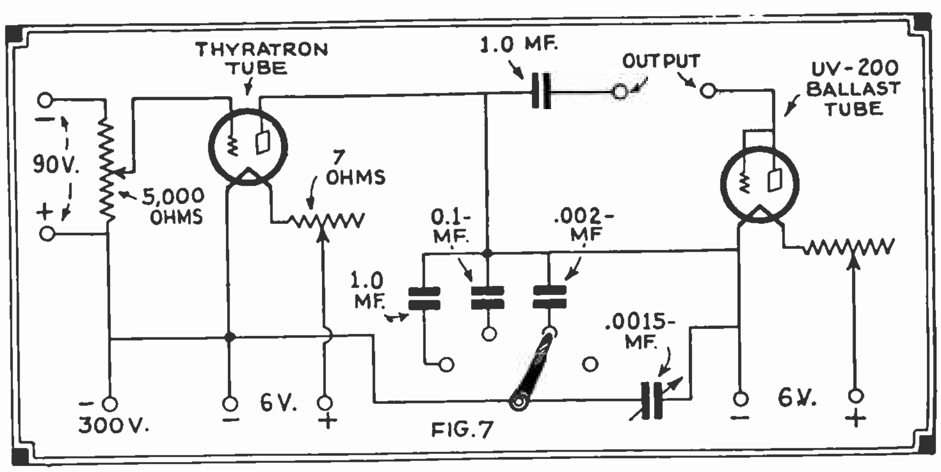

Complete hook-up of thyratron oscillator, using a UV 200 as a ballast tube.

* Described in the January-February, 1932, issue of "TELEVISION NEWS".

The DALPAYRAT LIGHT Projector for Television

THE main limitations and difficulties with the ordinary cathode-ray tube are: first, the limited size of the picture visible on the ground-glass end of the tube; second, the insufficient illumination; third, the inability to project light in order to re-

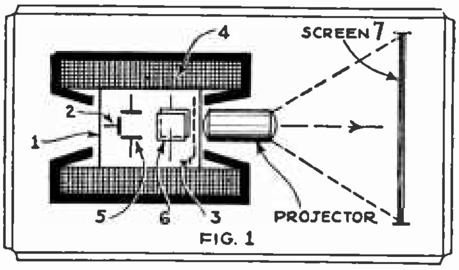

Fig. 1 shows a magnetic light projector using two sets of deflecting plates, controlled by "saw-tooth" oscillators. This projector is intended especially for receivers.

produce a large image upon a screen. The writer has designed a new type of electronic device, which he calls a *magnetic light projector* and which is calculated to have none of the above-mentioned objections.

Device Scans Electrically

This new device scans "electrically," without any moving parts; an intense beam of light is projected upon a screen to reproduce large and distinct pictures. This device, being used only to project a sweeping beam of light, is not limited to any number of lines or size of picture; for a simple adjustment of the deflecting-field circuits will change the rate of deflection, and therefore reproduces any number of lines imaginable.

Several types of these tubes have been designed by the writer, but only the two most interesting modifications will be discussed here.

Fig. 1 shows a *magnetic light projector* using two sets of deflecting plates, actuated by "sawtooth" oscillators.

Fig. 2 shows the same device modified to employ deflecting fields and other changes to obtain improved results. Figure 4 shows how a very small deflection of the light source produces a very large sweeping action of the light beam upon a screen, after passing through a suitable optical arrangement.

Construction of Tube

Referring to Fig. 1, 1 is a glass tube filled with a mixture of certain gases or vapors; 2 is the cathode which emits electrons when connected to a source of high D.C. potential. These electrons, under ordinary conditions, would shoot in all directions and especially between the cathode 2 and the positive anode 3. This anode 3, of fine wire screen closely meshed, attracts and collects the electrons emitted by the cathode; 4 is an electromagnet which entirely surrounds the glass tube, in such a way that its magnetic field, or lines of force, will be parallel to the flow of electrons. Magnetic fields have the property of deflecting or repelling electrons, and this phenomena is employed in this case in the following manner: The electrons emitted by the cathode 2 are immediately repelled from all sides, by the magnetic field, towards the center of the tube—the field density being lower along an imaginary line (which can be drawn lengthwise through the center of the tube) parallel with the lines of force and going from one pole of the magnet to the other. The electrons will be squeezed together and form a small stream or jet, which will be free to flow along that center line and reach the center of anode 3. The tube being filled with a gas (neon for example), and a sufficient voltage being applied on electrodes 2 and 3, a luminous discharge will take place. This

The new television light projector here described by its inventor, Henri F. Dalpayrat, provides a brilliant light, with electrical scanning means, which will project a large image on a screen. The device will scan at any desired frequency.

discharge can produce a luminous glow on anode 3 alone, assuming that the proper voltage is used, and that the tube is filled with gas at the right pressure; this single-electrode glow is similar to what happens in ordinary neon plate tubes.

How Glow Is Concentrated

Were it not for the magnetic field, the whole surface of anode 3 would glow; but, since the magnetic field "focusses" all the electrons towards the center of the tube, only that small portion in the middle of anode 3 which receives electrons will glow (a glow cannot take place where there is no transfer of electrons). This glow, being highly concentrated, produces quite an intense light, much like the one obtained from large crater tubes. Two sets of metallic plates 5 and 6 which are entirely glass-plated deflect the beam of electrons up and down and sidewise; thus displacing the small luminous spot on anode screen 3. This deflection is very small, as the beam of electrons encounters much resistance when it is forced to move against the magnetic lines of force which repel it. The complete picture is not reproduced upon anode 3; but the effect obtained is rather like a great number of luminous points regularly and evenly overlapping each other. This, at first sight, would appear to be a serious objection; but such is not really the case. By looking at Fig. 4, one can easily see how the optical lens assorts the different light beams and allows continuous, parallel, non-overlapping lines to be traced upon the screen.

Brilliant Light Produced

This device has the great advantage of producing an intense brilliant light, which it projects upon a screen, and does not require any moving parts. However, it was found necessary to alter this design for the following reasons: First, the distance between 2 and 3 was too great, and required too high a voltage to produce a glow; second, anode 3 being made of fine wire screen, became over-heated and rendered the device unsteady in operation. Third, the concentrating field being very powerful, offered too much resistance to the sweeping beam of electrons and also interfered with the action of the static fields around the deflecting plates.

Fig. 1 has, therefore, been shown and described to explain the important new principle as it was first conceived. The latest improved design shown in Fig. 2 was found to be superior in many ways. The construction is simpler, the device is smaller and cheaper, and its performance is much improved. In Fig. 2 we have a glass tube 1, placed within the hollow of an electromagnet 4. This tube contains only two electrodes, a cathode and an anode. The cathode is made of solid metal in contact with the glass bulb to dissipate the heat rapidly; one end is spherically concave. The concave surface is bare, while the rest of the cathode is totally insulated by mica sheets or by a coating of insulating material. The positive anode 3 is made of wire screen, the wires of which are very fine and loosely interwoven; so that the intersecting wires produce rather large, square clear spaces. This wire screen is coated with certain chemicals, so that the little heat produced by the concentrated glow discharge, will partially vaporize them and improve the brilliancy of the light. (A small amount of mercury can be put in the tube to obtain the same result.) The concave surface of the cathode may also be coated with a certain substance, giving off electrons

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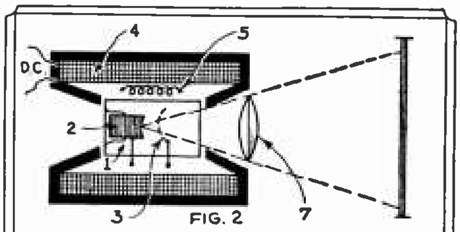

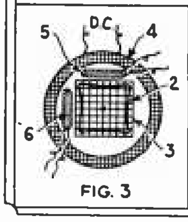

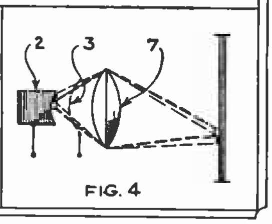

Various views of the Dalpayrat light projector. Fig. 4 shows how a small deflection of the light source produces a very large sweeping action of the light beam upon a screen.

An A.C. Operated *TELEVISION* TRANSMITTER

By L. R. CONRATH*

To know all about television today, one must understand how the images are "transmitted" as well as received. You can't do better than to read Mr. Conrath's article and the ones to follow, which explain the construction and installation of a modern transmitting scanner and amplifier.

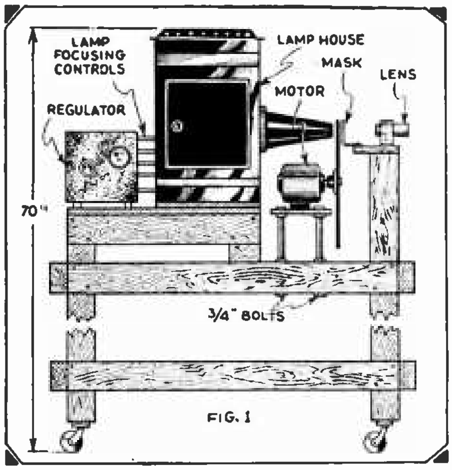

Fig. 1—Side view of lamp house, scanning motor and disc, mask and lens.

PART ONE

IN the past few years television transmitters of every conceivable description have been built, ranging from small, low power outfits laid out on a table-top, through truck-mounted assemblies designed for quick hops from one scene to another, and up to pretentious, permanently installed equipment, costing many thousands of dollars. The principle of operation is practically the same in all cases, and the results depend mainly upon the skill and care exercised in the design, and the mechanical refinements adopted in the construction of the apparatus.

The purpose of this, and two succeeding articles, is to describe in detail the construction of a semi-portable transmitter designed for both laboratory and demonstration purposes. The equipment was built with several primary considerations in mind: convenience of operation and maintenance, portability, economy, ease of construction, and quality of performance. How these objectives were attained will become apparent in the course of the discussion. Probably the most important point, in this connection, is the elimination of all A and B batteries for the operation of amplifier tubes, further reference to which will be made later.

Lamp House Construction

Let us begin with the source of light used in the "flying spot" scanner, and follow the process through the photo-cells, amplifiers, oscillator, and receiving set and lens-disc projector. The light spot scanning apparatus is arranged on a wooden framework mounted on rubber-tired, ball-bearing rollers, and constructed as shown in the drawing. The assembly consists of a lamp-house, a synchronous motor and scanning-disc, a mask with a suitable aperture and a high quality projection lens. The lamp-house was made from a used carbon-arc movie-projection lantern, by removing the carbons and their clamps and substituting an incandescent bulb, equipped with a porcelain socket and silvered-glass curved reflector. The carbon-adjusting controls were retained, and are used to focus the lamp, since they permit movement of the bulb in any desired direction.

A.C. Used On Lamp

In the original construction of the scanner a thousand-watt, 110-volt movie-projection lamp was used on direct current, but it was found that more light was desirable, so a 900-watt, 30 ampere, 30 volt bulb was substituted. This was equipped with a standard current-regulating transformer to convert the line supply of 110 volts A.C. to the required 30 volts A.C. It might be thought that the use of A.C. on the filament of this exciting lamp would produce an objectionable hum modulation in the signal, but such is not the case. The filament of this bulb is of very heavy construction and has a high thermal inertia which prevents its cooling appreciably between consecutive half-cycles. The illumination obtained with a bulb of this type is considerably greater than that obtained with the 110-volt bulb, because for a given power consumption the efficiency of the bulb increases with the current.

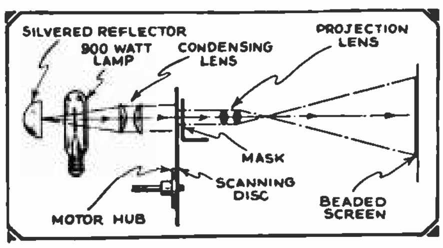

Fig. 2—Shows line-up of reflector, lamp, lenses and scanning disc; subject poses before the beaded screen.

The conical tunnel at the front of the lamp-house was removed and replaced with a longer one which tapers down to an opening just sufficient to cover the area determined by two adjacent holes and by the total radial displacement of the spiral of the scanning disc. The scanning disc is made of thin aluminum and the holes are of such a size that they do not overlap. If the holes are large enough to allow a considerable amount of over-lapping, the effect is to produce a picture in the receiver similar to that obtained with a soft-focus camera, so that for this reason it is necessary to sacrifice a certain amount of light to obtain sharp definition.

Mask, Lens and Screen Details

A forty-five hole, three spiral scanning disc is used in this particular set-up, although a sixty hole, single spiral disc may be substituted if desired. A small synchronous motor, of the single phase type, mounted on rubber silencers, is used to drive the disc. The mask is simply a piece of sheet metal with a right angle

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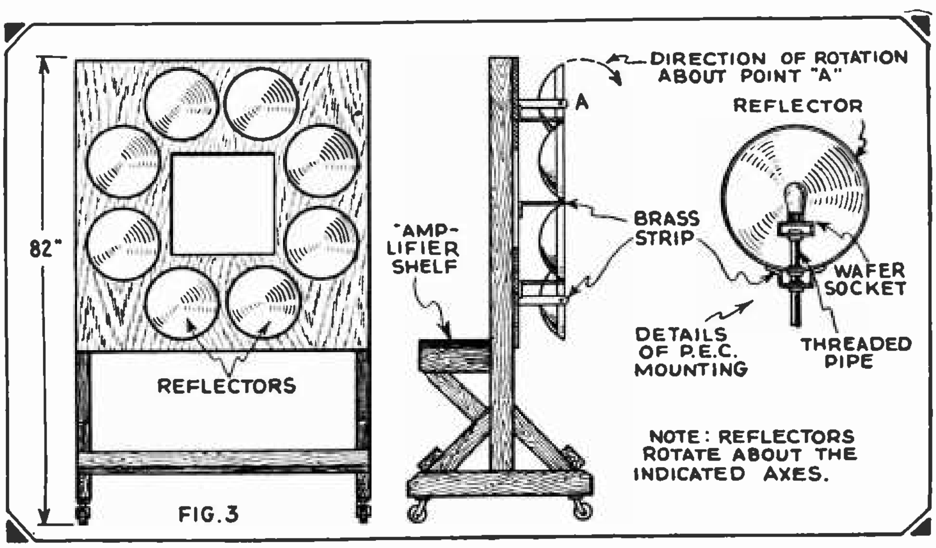


Fig. 3—Front and side view of reflectors and photo-cell mounts as used in the Trav-Ler television transmitter.

* Engineer, Trav-Ler Radio & Television Corp.

A New System *for* Television SYNCHRONIZATION

A positive method of television synchronization, by which the scanning apparatus is automatically synchronized to each signal as it is tuned in.

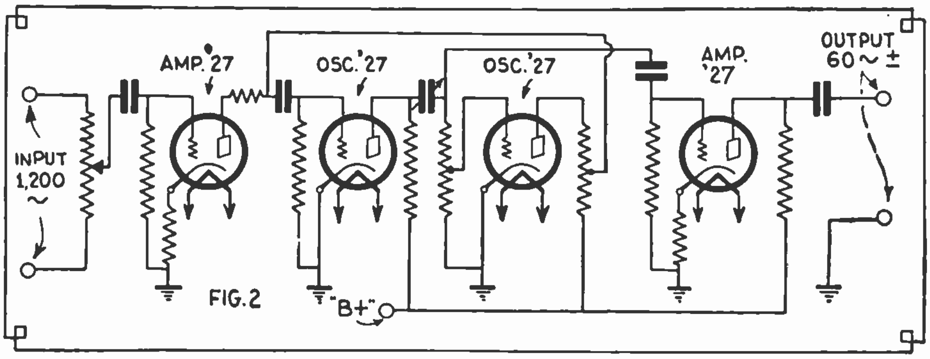


Diagram above shows connections of tubes, resistors and condensers in the multi-vibrator and amplifier circuits, used in establishing synchronization.

WHILE it is possible to synchronize the receiving scanner with that at the transmitter, by employing interlocking devices actuated by the scanning-frequency component of the picture signal, these have several marked disadvantages which have not so far been overcome. The first disadvantage is that the power available for synchronization is, of necessity, low; and two motive arrangements are required—one a motor of the usual form for providing the main rotating force, and the other a small synchronous motor which serves to hold the receiving apparatus in step with that at the transmitter. These devices are fairly familiar to all those interested in the art.

The second disadvantage is the fact that the synchronizing influence is removed when there is no signal on the air—or while the station is making its required announcements. The problem is to provide a synchronizing device capable of a large power output, and one which does not permit the synchronization to be lost during those short periods when the picture signal is not on the air.

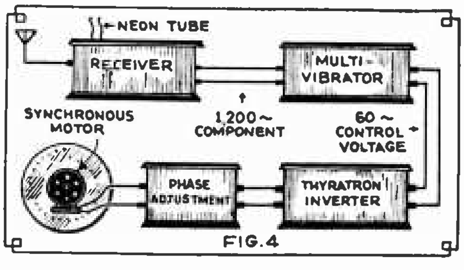
The device to be described is not so bulky nor so expensive as to render its use impracticable. It will maintain synchronism perfectly at all times, while the transmitter is actually sending out a television signal, and will immediately lock into synchronous speed when the tuning is shifted from one station to another. A method for phase adjustment or *lateral framing* has also been described, which employs electrical controlling means rather than the rotation of mechanical parts. The beauty of this invention rests in its adaptability to all forms of television, regardless of the motive power required—something which cannot be said of other systems.

The Thyratron Inverter

By this time the television enthusiast is probably familiar to a degree with the *Thyratron* tube, which is employed in so many circuits where small input forces are required to control large amounts of power. Properly connected thyratrons may be employed to convert D.C. to A.C. of a given frequency, or A.C. from one supply frequency to another and more desirable frequency.

In Fig. 1, there is shown the circuit arrangement of a *thyratron inverter*, similar to that supplied for the operation of A.C. receivers from D.C. supply lines, except that its frequency is controlled by an external source, rather than from the circuit constants of the thyratron arrangement itself. Application of a small 60-cycle voltage to the *input* terminals shown will result in an *output* having frequency and phase characteristics similar to those of the input, but of greater magnitude.

It will be noted that the operation of the thyratron is different from that of the *triode;* since its output does not follow variations in the grid voltage of the



Here we have the complete line-up of the new apparatus here described for maintaining positive synchronism of the receiving scanner.

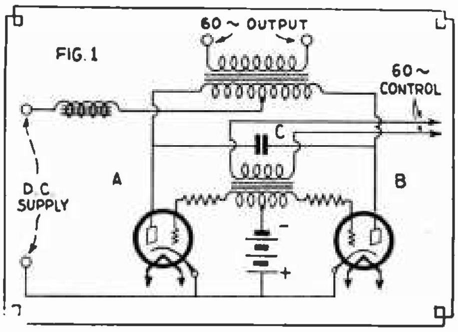
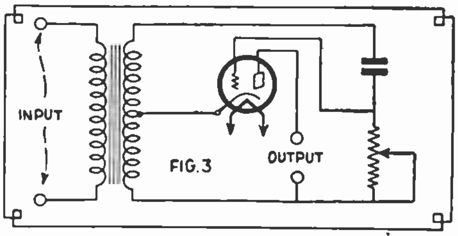


Diagram showing the connections for thyratron inverter.

tube. The grid is normally biased negatively, so that no plate current will flow; but when the grid is swung sufficiently positive the full plate current will be drawn. If, however, the plate voltage is removed and the grid permitted to become sufficiently negative, the current will not again flow upon restoration of the plate voltage, until the grid has once more been deliberately swung sufficiently positive for the plate current again to flow. It will be noted in the figure that the grid excitation will be positive in one thyratron, when negative in the other, because of the balanced-transformer arrangement. A study of the figure will show that, during the first half-cycle, tube A will be conductive, while the plate of the tube B will be at the line potential. In the next half-cycle, the grid of B will become positive



Circuit diagram is given above as used for making phase adjustment by thyratron control.

and tube B will be conductive. The plates are tied together by a condenser, C, of such capacity that it cannot discharge during the cyclic variation; and the tube, A, will have its plate voltage swung negative so that the flow of plate current will cease until the grid is again swung positive. If we are then able to supply a controlling force, definitely related in phase and frequency to the television signal, we would be able to effect synchronization.

The Multivibrateur

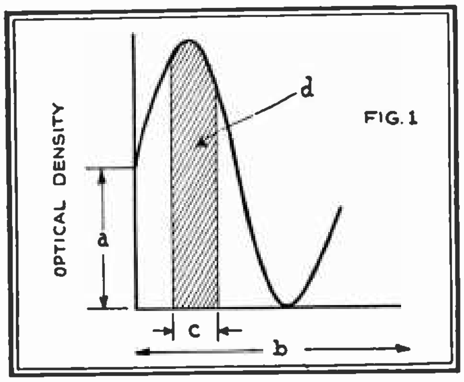
The "Multivibrateur" of Abraham and Bloch is a balanced oscillator having peculiar characteristics; the frequency of the output is determined by the constants of the circuit. Now a peculiar condition exists in this device—that is that by its use *submultiples* of a controlling voltage frequency may be produced. Let us suppose that our device is adjusted roughly to sixty cycles. Its output will contain the harmonics of sixty cycles over a wide range of multiplications; not only this, but if a controlling voltage having a frequency roughly equal to any one of the *multiples* of sixty cycles

(*Continued on page* 51)

Round Hole or Square?

The argument as to whether round or square holes are best for scanning discs, seems perpetual: here's an expert's opinion.

I'LL bet that you thought that question had been buried once and for all! Far from being settled, by the mere statement that the square aperture is better, because its inscribed circle has but .785 the area of the square itself, the question is back again, with new data to show how complex the little things may be, and how careful we must be if our television image is to get there at all.



If the length of the scanning aperture is "C", the value of the light passing through the scanning aperture (hole) will be proportional to the shaded area "d".

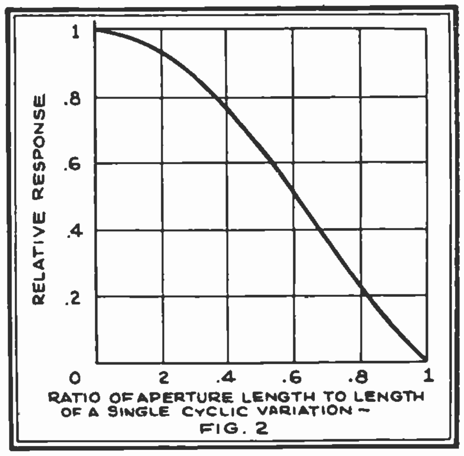
Since the light available at any instant is that through a single scanning aperture, it is certain that the paucity of the available light dictates the use of the aperture which gives the greatest light. If the answer must be either "Yes" or "No" we will let the laurels rest with the square aperture; but it is an unfortunate fact that the square aperture is about as far from perfect as ever an aperture can be.

Let us assume a standard image structure—60x72 elements at 20 images per second. We might also assume that the aperture is to be .020-inch square, and that the picture will consequently be 1.2 x 1.44 inches in size. The time required for the aperture to traverse a single image element will be 1/86400 sec.; and the maximum high frequency involved in the transmission of an image of this degree of detail will be 43,200 cycles. This is because of the fact that it takes two elements—one light and one dark—to make a complete cycle in the output of the photo-tube (a single cyclic variation in the "optical density" of the scene corresponds to a similar variation in the electric output of the cell). Let us suppose that, at one portion of the scene, there is a portion of a scanned line which varies in its optical density in a sinusoidal manner as shown in Fig. 1. Note that the optical density of the scene varies about an average value "*a*"; and that the length of the complete variation in density through a cyclic change (from the base value to a maximum value, back to the base value and then through a minimum before returning to the average value) again is "*b*." If the length of the scanning aperture is "*c*," the value of the light passing through the scanning aperture will be proportional to the shaded area "*d*."

Were the shaded area infinitely narrow (that is, if the scanning aperture were infinitely fine), the effective variations would be directly in accordance with the actual changes in the light density of the scanned scene. Our scanning aperture is not of this infinite degree of fineness, however; and the resulting variations are altered in such a manner that a "smoothing out" effect occurs. The failure of the aperture to respond to all variations in optical density because of its size is plotted graphically in Fig. 2. Here it may be seen that, as the width of the aperture is decreased in comparison with the length of a cyclic variation in optical density, the response approaches the ideal, which is obtained only with an aperture having an infinitely small width. In a system such as ours, the ratio as given on the curve is 0.5; for the aperture is half the width of the smallest cyclic variation to be scanned. It may be seen that the loss at this ratio is 40%. This is actually a falling off in the response at the higher frequencies and, when we consider carefully the fact that the distortional effect is present in both the transmitting and receiving apertures, we can calculate the fact that at 43,200 cycles there is a loss of 64%, due solely to this aperture distortion.

It is usual to specify the performance of the ideal television channel as being "flat" with regard to frequency-discrimination over a range from 20 to 43,200 cycles, within plus or minus 20%: yet here we have a loss of over 60%, without having paid the slightest attention to the balance of our channel, which must be 100% perfect, if we are to retain even the small response remaining. The manner of calculating the response over two circuits, each having a loss of 40% is described in the article entitled "How Shall We Amplify the Television Signal?" in the May-June issue of TELEVISION NEWS.

Returning to the curve in Fig. 2, we see that, if the loss per scanning device is to be limited to 20% (or 36% through the combined scanning arrangements) we must so proportion our aperture that it is not less than 0.35 of the length of a single cyclic variation, or not greater than 0.7 times the length of a single picture element. In order to achieve this result with the specifications just set down—that is, for a picture 1.2 x 1.44 inches in size (this disc was described fully in the May-June issue) we would require an aperture not .02-inch square but .02-inch high by .014-inch wide. This effects a reduction in our "average brightness" to a point slightly below that of the original round aperture, but we have gained a decided advantage, insofar as the quality of the signal produced is concerned. In optical scanning systems this loss in light can be readily overcome by the simple process of scanning with the image of an aperture of the correct shape, behind which the maximum light has been concentrated by means of condenser lenses. Such an optical system can be made to have an extremely high efficiency.



Curve showing relative response compared with the ratio of aperture length to the length of a single cyclic variation.

Despite the pessimistic contents of this article, we must not be too discouraged; for even were the aperture greater than 0.5 the width of the smallest cyclic variation desired, we might achieve a correction "electrically" by designing amplifiers which would compensate for the loss in the high frequencies, caused by the coarseness of the aperture. Such amplifiers are quite easily made—even where a relatively steep rising characteristic is desired—and are satisfactory for use in television circuits, provided minor resonances are not permitted to exist. Just as an example of this, let us consider a '24 tube with a 5-henry inductance in the plate circuit. The gain through the tube at 50 cycles would be only 1.6; the gain at 5,000 cycles would be 160; and, at 50,000 cycles, the gain would approximate the amplification factor of the tube. It may readily be seen, therefore, that an amplifier circuit having a rising characteristic of such a character as to compensate for losses at the high frequencies is not a difficult assignment.

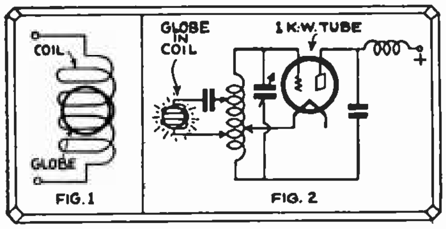
It is an unfortunate fact that, in all of the television stations of which the writer knows, there are no efforts made to compensate for the losses apparent at the scanning aperture.

A POWERFUL LIGHT SOURCE for TELEVISION

By C. H. W. NASON

A new idea in high-power light sources for "large-image" television projectors is here described, employing an electrodeless gas-filled bulb.

THE present trend in television development seems to be toward the production of a "large image," regardless of the fact that the detail contained therein is not increased or improved over that obtainable with the usual scanning disc, or simple projection-type apparatus. The sole difficulty attendant upon producing a large image—where, as we have stated, no increase in detail over that obtainable with the usual equipment is involved—lies in obtaining a modulated light-source of sufficient brilliancy.



Arrangement of gas-filled globe in high frequency field, providing a new source of light for television systems.

If we are to take the apparatus demonstrated at the recent New York Radio Show as a criterion, we can readily assume that bulk is no detriment, so long as the desired brilliancy is forthcoming. The particular apparatus, demonstrated at the show, utilized to feed the light-source a power output stage which comprised twelve fifty-watt tubes in a parallel arrangement. According to press releases subsequent to the demonstration, the trouble experienced was due to overheating of the lamps employed, and lamps now in process of development will be water-cooled. The lamps employed gave the usual pinkish light peculiar to neon.

New 100,000 C.P. White Light Source

Some time ago the writer experimented with a light-source having all the attributes necessary for use in the projection of a large television image. These features were: high intensity, modulation capability, and white light. The lamp is capable of an intensity of 100,000 candle-power, with a power expenditure of 5000 watts—an efficiency about 20 times as great as that obtainable with the usual incandescent lamp employed in the home—and sufficiently intense to produce an image in excess of twenty feet on a side were such proportions desirable. While the writer claims some credit for the application of the idea to television, and for devising certain circuits necessary to the adaptation, the principle of operation is quite old; and it seems peculiar that other investigators have not paid attention to its rather obvious advantages.

The "Electrode-Less" Discharge in Gases

J. J. Thomson—he of early electronic fame—was first to describe the effect of discharging a condenser through a coil, in which there had been placed a partially-exhausted glass container; this was in 1891. The general arrangement is shown in Fig. 1, where a simple globe has been placed in the field of a solenoid. In order to understand the mechanism of the discharge within the globe, we must first accept the fact that (because of the cosmic radiation) there will be at all times certain free electrons and free positive ions within the envelope, prior to the excitation of the coil. The positive ions possess the property of moving when subjected to an electric field. When set into motion by the field set up by the excitation of the coil, the positive ions and electrons will be set into motion, and will gain sufficient momentum or acceleration to produce further ionization of the gas atoms by collision. The effects of the collision are to change the energy level of the excited atoms—the process being attended by the giving up of the energy of impact in the form of an electromagnetic manifestation—in this case *—light.*

1,000-Watt H.F. Oscillator Needed

In order to achieve our aim we must first have a source of high-frequency energy, which may well be a vacuum-tube oscillator, having a maximum power capability of the order of perhaps 1000 watts. This is ɔt a great deal of power when we consider the fact that a 1000-watt oscillator is much more readily handled than a bar.k of fifty-watt, low-frequency amplifier tubes.

By making a more complex arrangement, similar to a regular short-wave transmitter, with an output capability of 1000 watts and modulated at a low level of amplification—perhaps with a crystal-controlled oscillator for the primary excitation—a very flexible apparatus can be achieved. For our purposes we may merely assume an oscillator, having a variable power output, so that the effects of varying the power may be studied. The arrangement of the oscillator is shown in Fig. 2. By varying the plate voltage, it is possible to obtain the characteristic curve of the discharge tube for various power levels, by coordinating the electrical measurements with those obtained with a standard Macbeth *Illuminometer.*

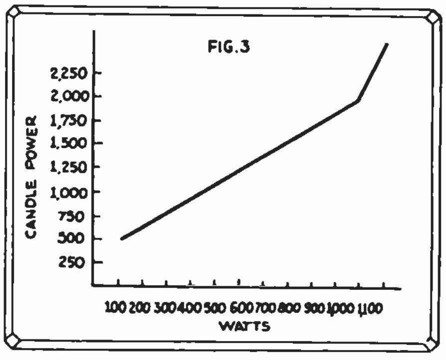
The tube used contains mercury vapor, together with one of the noble gases at a very low pressure. The function of the gas is to assist in starting the discharge without heating the mercury, and it has absolutely no effect upon the subsequent discharge. Strange to relate, the light output is that of mercury vapor, with no traces of the spectra of the gas employed in starting the discharge, once the mercury-vapor discharge takes place.

The Writer's Experiments

The tubes used by the writer were mainly filled with *argon*, although some experimental work was carried out using neon alone, without the mercury. In Fig. 3, there is shown a graph of the *luminous intensity* as plotted against *power input* to the oscillator. It will be seen that a linear relation holds good over the entire range of values covered. In a preceding paragraph, it was stated that the intensity was of the order of 100,000 candle-power, with a power expenditure of but 5,000 watts. This is quite true; but at a certain power-level, the slope of the characteristic curve bends sharply, and the resulting distortion makes the arrangement of doubtful value in television, unless highly-involved circuits are employed. These circuits are still of a confidential character and cannot at the moment be divulged.

The reason for the sharp bend in the characteristic curve is that the gas enters a *second* energy-level, in which the illumination increase is much more pronounced for a given change in the applied electric field. It will be seen from the figure, that the characteristic is fairly linear up to 2000 candle-power, and the efficiency is still at least twice that of the average incandescent lamp.

This device lends itself to use in *large-image* projection apparatus, where the bulk of the contributing apparatus is not a draw-back. Little work has been done in adapting the principle to use in smaller projection televisors, but the promise of success in this field is indeed great.



Graph showing ratio between candle-power and watts (power input) to the oscillator, a linear relation holding good over almost the entire range.

The BRAUN TUBE as a TRANSMITTER

Cathode ray tubes are coming rapidly into the spotlight—their use for transmission is new: Here is some interesting information on this angle.

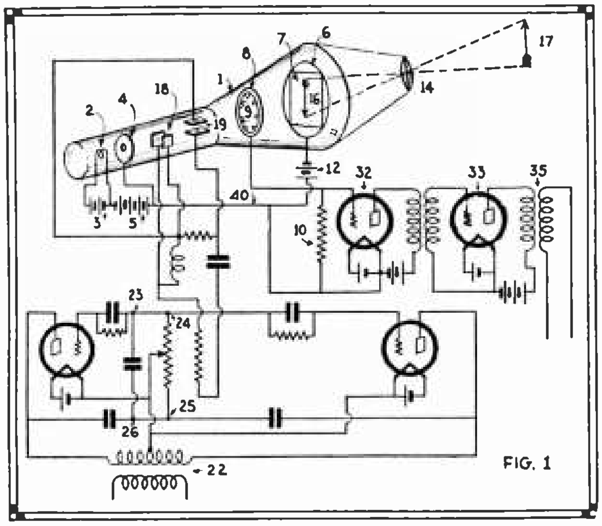


FIG. 1

Transmitting arrangement for cathode ray tube after Sabbah's method. The image falls upon photo-electric screen 7.

C. A. SABBAH, of Schenectady, N. Y., has been able to attain encouraging results in the field of television with a Braun tube. The transmitting arrangement is shown in Fig. 1. The Braun tube is marked 1; the cathode 2, is heated by a battery 3; the anode 4 has the form of a diaphragm. The pencil of cathode rays which passes through the diaphragm is deflected in the usual manner, by means of two pairs of plates, 18 and 19, set at right angles; the scanning takes place in a spiral order.

The pencil of cathode rays strikes a transparent screen 6, placed in the opposite end of the Braun tube. This screen is coated with a thin layer, 7, of a photoelectric substance, like caesium, sodium, or potassium and the image of the object is projected on this screen by means of a lens 14. The photoelectric layer must be very thin so that its resistance shall be sufficient to prevent the electrons, liberated by the light striking it, from moving over its surface at a velocity greater than is necessary. But the resistance of layer 7 must not be so great that it does not be kept charged by the thin plate 6. The rate at which it must disperse the arriving electrons depends on the velocity of scanning by means of the cathode rays. Layer 7 is connected, through battery 12, with anode 4 by means of conductor 40.

When the cathode rays strike any point of the metal layer 7, they are reflected, and according to Sabbah, the reflection varies with the degree of illumination of the photoelectric layer. This is based on the conclusion of Rupp: that is, for the motion of the electrons there is a law analogous to that governing the propagation of light—that all material which absorbs well produces a good reflection also.

Among the various metals which Rupp examined with regard to this property of reflecting electrons, he did not compare caesium, potassium, or sodium; there is no doubt, however, that these have the property of reflecting cathode rays. The rays reflected by the photoelectric layer are then gathered by the collector 8; this is ring-shaped, provided with points (9), and connected with the grid of the amplifying tube 32. After having undergone amplification by tube 33, the current produced by the television impulses is conveyed by means of a transformer (35) to a modulator. The circuit shown in the lower part of the diagram serves to control the deflection of the cathode rays by means of the electrodes 18 and 19.

Prof. Zworykin's Transmitter Scheme

Another who has used the Braun tube is Prof. Zworykin, whose design is very similar to that of Sabbah, described above. The plan is given in Fig. 2. The front part of the Braun tube, only part of which is represented, is narrowed to a neck at point 28. Against this indentation of the glass is placed a plate (35-36-48); so that part of the tube becomes an enclosed space (34), in which is placed a grid (37). This plate or screen is made in three layers: one of metal (35); one of insulating material (36);

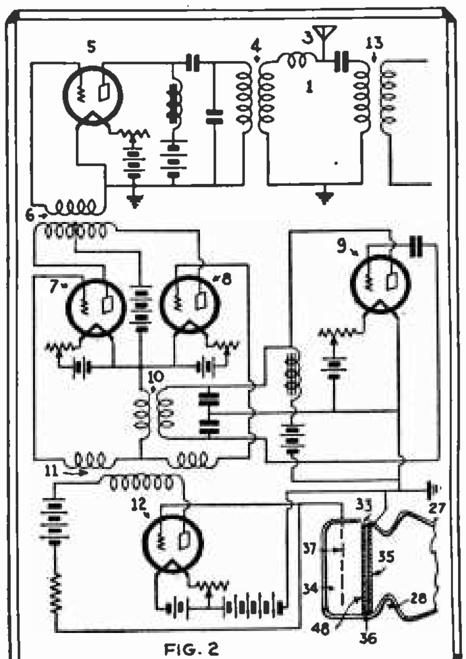


FIG. 2

Zworykin's plan for using cathode ray tube as a transmitter—48 is photo-electric layer.

and one of a photoelectric substance (48) which is on the side toward the objective. The metal layer consists of a sheet of aluminum, while the insulating layer is of aluminum oxide or magnesium oxide. Layer 36 is covered, by means of distillation, with a thin layer of potassium, after the evacuation of the tube. The process of distillation is stopped before the layer reaches a silvery luster. It is essential that it have a grayish opaque appearance, being made up of minute metallic spherules, each of which becomes by a later chemical process, a little photoelectric cell.

This process consists of introducing hydrogen into the tube, in such a way that a chemical compound is formed with the alkali metal. This combination with hydrogen is obtained by means of an electrical discharge, and results in a colloidal metal, of very intense color. The best results are obtained by stopping the discharge when the blue color tends toward violet. Then the hydrogen is drawn off and the tube is cleaned by means of argon gas. Finally, pure argon is left inside.

On layer 48 is projected the image of the object to be transmitted. This produces, on the application of the correct potential to the grid 37, an electronic emission from those parts of the layer 48 struck by the light. This electron flow is further intensified by the effect of the layer of oxide.

Scanning by means of the cathode ray is done by one of the systems noted. The current, which passes from the grid to screen 35, undergoes amplification by means of tube 12. The anode circuit, to which are connected tubes 7 and 8, is intended for modulation and, at the same time, is connected to the oscillator 9. The modulated high-frequency current is carried to the amplifier by transformer 6, and then to the antenna circuit by transformer 4. The oscillations which are utilized for the purpose of scanning are also conducted to the transmitting circuit.—*La Radio per Tutti.*

CRYSTAL DETECTORS
in
Television Receiver Circuits!

Clearer Images and Other Advantages

In the Next Issue

By R. WILLIAM TANNER, W8AD

TELEVISION COURSE

By C. H. W. NASON

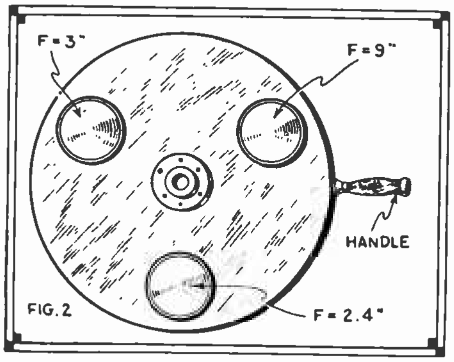


Fig. 2—Several lenses mounted in turret head, so as to make any one available instantly for use on image "pick-up".

IN our previous lessons we have covered the theory of optics in a fair degree, and have considered the practical aspects of the lens-disc, the Weiller wheel, and other apparatus more or less peculiar to the art of television reception. While most of the equipment described has been used in transmitters as well, the methods in use in this country today are fairly well limited to the "flying-spot" scanner, such as employed at the C. B. S. studio and the direct-pickup apparatus or Television Camera usually thought of in connection with the "Jenkins System".

Now the main difference between these two systems is that one, optically, parallels the motion-picture projector; while the other is the optical equivalent of the "movie" camera. We must then consider the optics of both the camera and the projector when studying the optical characteristics of television transmission apparatus.

The Flying-Spot Pickup

In the flying-spot system—sometimes termed "indirect-pickup"—the subject is scanned by a moving spot of light and a photo-cell or bank of cells is used to pickup the reflected light. The optical system is skeletonized in Fig. 1, where the essential portions of the system are given. The light-source may be a D.C. arc or a high-intensity filament-type lamp —depending upon the voltage supply available and the type of cells employed in the studio. Light from this source is concentrated by means of a reflector and a condenser-lens system, as shown, and in such a manner as to just cover an aperture having the same size as the image subtended by the first and last apertures in a highly accurate scanning disc. Since we will find the motion-picture lens most readily obtainable for our purpose, we might just as well assume the use of motion-picture apparatus throughout. This will permit our assuming the use of projection lenses of the class found in theater supply houses in every large city.

By inserting the scanning disc in the plane usually occupied by the film we

LESSON 7

In this lesson Mr. Nason discusses the optical and electrical details of the "flying spot" and "direct pick-up" types of television scanners used for transmitting the images.

may project an image having the same aspect-ratio as the ordinary motion-picture "frame", and focused in the plane of the subject being transmitted. While it might be possible to employ the usual 16-mm. home-movie apparatus in an amateur version of the equipment, the light available would not be great enough to warrant the attempt, as the lack of light would have to be compensated for by the sensitivity of the photo-cell and amplifier.

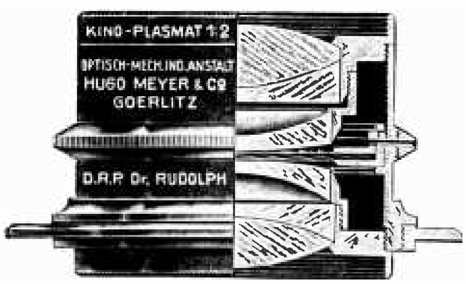


Fig. 3—Cross-section of Plasmat (Hugo Meyer) lens, suitable for use on television pick-up camera.

Length of Throw, Scanned Area, Etc.

Many students will have noted the fact that the projectors employed for "flying-spot" scanners have multiple-lens turrets, with apparatus for rapid change-over. The lens used in each program depends upon the character of the scene —*i.e.*, when a close-up view is being scanned, the head and shoulders or the head alone of the artist may be required to fill the entire scanned area. For this reason, the lenses are adapted for quick change-over in the interests of better program technique. The distances between lens and disc, and between lens and screen, and the size of the scanned area, will depend on the *focal length* of the lens, just as in the case of our elementary optical structures. In order to avoid chromatic or spherical aberration, and to form a perfect image of the scanning disc's apertures in the plane of the subject, it is necessary that high-quality projection lenses be employed—that is such lenses as are employed in the finer motion-picture theaters. If this is not done, the light at the edges of the image will be poorly distributed, and other forms of distortion may enter into the problem. Our own problem is that of *television*, and we cannot compromise results by the use of inferior optical equipment.

Lenses employed in television service are called upon for considerable amplification, and it is not surprising that a high-quality lens is necessary. In passing, it might be noted that high-quality lenses will always be found to have "bubbles". Contrary to expectation, this is a sign of excellence, for the glass used must be continuously stirred while molten, in order that the heavier constituents may not filter to the bottom. This does not permit the bubbles to rise to the surface.

The motion-picture "frame". used for *silent films* is now practically obsolete, and the disc and the optical apparatus should be designed with the equivalent aperture of the *sound-film* frame in mind —that is—0.615 x 0.820 inch. In order that the normal aspect-ratio of television (1.2:1) may not be departed from a diversion from this may be accepted without injuring the efficiency of motion-picture apparatus when in television service. We may then accept an image size of 1 x 1.2 inches at the plane of the disc. This gives us the size of the *object*, from which we may calculate the distances and the focal lengths of the lenses involved.

Suppose that, for head and shoulders of a single person, we require a field 20 × 24 inches in size. This means a magnification factor of 20. Suppose, again, that we require a half-length view of two persons in a field 40 × 48 inches, and a consequent magnification of 40. Then, again, we may require a "full-length" view which would involve a field perhaps 100 × 120 inches, with a magnifying power of 100. This last might require a special lens if a short length of throw were needed. We can start our calculations, for the lenses required, with certain known factors; for we may determine the fact that the first two conditions should be obtainable with the same length of throw, and that we will want our subject in either case to be about ten feet (120 inches) from the lens.

Focal Length of Lens—How Found

Knowing the magnifying power, and the distance required in each case, we may readily calculate the focal length of the desired lens from the formulas already given. We can accept a longer

Fig. 4—Complete optical line-up in a "television camera"—which picks up image illuminated by artificial or natural light.

throw for the large field of view; for we must move our photo-cells up into the scene of action, and also must change the equipment slightly, so as to gain a higher sensitivity when picking up from the large field. Tabulating the data, and calculating the other distances from the equations given in previous lessons, we find that the distances are as tabulated below, where the two equations given in Lesson 6 are used. That is:

$AB : A^1B^1 = p : q = M$ and

$1/p - 1/f = 1/q$

Then

Field	Throw	Lens (focal length)	Distance (lens to disc)
20x 24	120"	9" approx.	6"
40x 48	120"	3" approx.	3"
100x120	240"	2.4" approx.	2.4"

As might be expected from what we have studied before, the difference, between the distance from disc to lens, and the focal length of the lens, becomes quite small for large values of magnification; and we must accept the next closest lens obtainable and adjust for focus in approximately the plane desired. The lenses may be mounted on a turret head, as shown in Fig. 2, so that a ready change-over is provided.

In the first two cases it would be possible to use photo-cell mountings as shown in Fig. 2; but, as the field of view widens, it is necessary that we employ the system used by Jenkins, where the cells and their directly associated amplifiers may be transported about the studio to strategic points for pick-up.

Cells Act as Floodlights

Strange as it may seem, the cells act in the manner of floodlights and their reflectors. Where small cells in reflector mountings are used, they must be directed at the subject being scanned in the same manner as a floodlight in the case of photography. Indeed the writer was once called in to straighten out a "flying-spot" installation which had excellent over-all characteristics, but for the fact that the cells "cast a shadow" in the center of the field of view. Another possible source of trouble is the use of cells having color characteristics unsuited to the light-source employed.

The writer can tell another tale of an engineer who clung violently to a red-sensitive caesium cell of high output, only to place it in an installation where mercury vapor lamps were used as illuminants. The result was zero signal, until the writer was called in and, with his assistant, replaced the expensive mercury flood-lamps by two old incandescent motion-picture lamps, fastened to a six-foot board, and with oil cans cut up to serve as reflectors. The result was an instantaneous signal of entirely satisfactory character. This was, of course, with the *television camera*, where flood lighting is necessary.

The Television Camera

When we consider the fact that the amount of light available through a camera lens is infinitely small, and that, in the case of *direct pick-up* apparatus, this light is reduced to 1/4320 of its original value by passage through the scanning disc's apertures before striking the cell; ;it is hard to conceive of the practicability of such a system. It is, however, possible to employ a scanner of this type in nearly all classes of work.

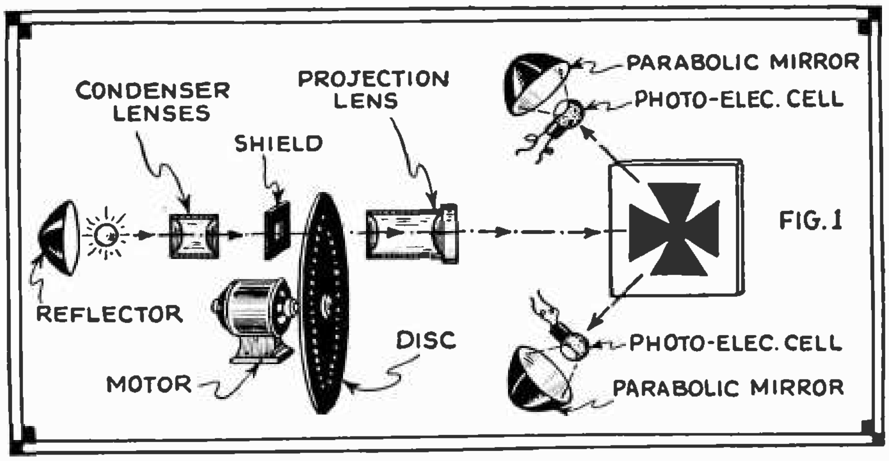


Fig. 1—Optical system used in the "flying spot" television image pick-up arrangement. The light ray passes out through the scanning disc and lens on to the subject, the reflected light rays being picked up by the photo-cells.

The Camera Lens

The measure of the efficiency of a camera lens is its "speed". A lens having a speed of f-1.5 is about as efficient as may be obtained. (The value is determined by the ratio between the focal length and the aperture.) A lens of such high efficiency must be carefully corrected for distortion of both geometric and color values; and this can be done only by making up the composite lens from a number of smaller lenses of differing curvature and color transmission. In order that the student may understand the reason for the high price of such a piece of equipment, a cross-section of a Plasmat lens is shown in Fig. 3. The multiple structure of the composite lens is plainly shown.

A camera lens forms a *real* or inverted image; outside its focal length, by an amount dependent upon the distance between the lens and the subject. At an infinite distance the object would form an image in the focal plane. By obtaining a lens having a known focal length, and having a focusing mount, we may place the lens approximately at its focal length from the scanning disc and use the focusing arrangement to change the focus of the image over wide ranges. In several direct pickup installations the writer has used the Hugo Meyer Kino Plasmat lens—f-1.5, 2". The lens must be stopped down to form the correct image-size in the plane of the disc, by means of a shield or aperture close to the rotating disc. For purposes of calibration, a white card may be cemented to the disc—being certain that the card covers none of the apertures and the focusing adjustment calibrated for various distances between lens and scene. The complete optical structure of the device is shown in Fig. 4.

Fig. 5—Latest Jenkins pick-up "camera" suitable for "outdoor" work. It employs a new specially sensitive photo-electric cell.

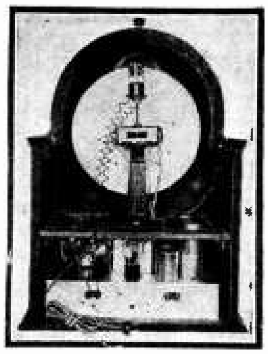
Note that the disc is followed in optical sequence by a simple lens, which serves to focus all the rays on the sensitive wall of the photo-cell. This lens may be quite close to the disc, but must be approximately its own focal length removed from the cell wall.

Amplifier for the Television Camera

Because of the low level of intensity at which the signal leaves the photo-cell in the *direct-pickup* system, it is essential that the amplifier be shielded from all electrical or mechanical disturbances likely to cause difficulty. *The electrical shielding may be carried out by placing the amplifier inside a well-soldered and well-grounded copper shield —and by placing the batteries in a similar shield not too remote from the amplifier.* The leads (wires) feeding the amplifier must be shielded by metallic braid soldered to the shields at both ends, and grounded along its length at as many points as possible. The amplifier may well be placed within a second "iron" shield for protection against electro-magnetic disturbances, but this is not always a necessity.

Mechanical shielding of this input amplifier may be carried out by placing the completed amplifier within a balsa-wood box, before placing it in its final housing. All tubes should be mounted on sponge-rubber cushions and stabilized with lead shields far heavier than that of the tube itself. Remler used to supply a shield

(Continued on page 57)



Rear view of latest model "See-All" scanner and receiver.

New "See-All" *TELEVISION* MODELS

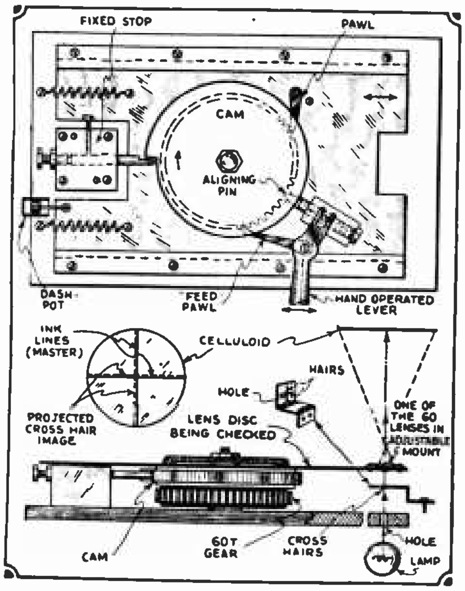
New hole disc and lens disc television scanners are here described—also the ingenious method invented for checking up the optical alignment of the lenses in a disc.

Front view of new scanner and receiver shown on opposite side of page.

ONE of the most progressive lines of television receivers seems to be the "See-All", the tuning and amplifier circuits of which were illustrated and described in the last issue of TELEVISION NEWS. The accompanying photographs are front and rear views of the latest model "See-All" scanner and receiver; all of the apparatus being mounted in a handsome walnut cabinet. By simply rotating, or moving up and down, the small knob on top of the cabinet, the flat-plate neon tube is focused and the picture framed vertically. The scanning disc has square holes, thus permitting a maximum amount of light transference and a brilliant image, which is greatly magnified by the lens mounted in the front of the cabinet. The television signal is tuned in by the dial observed in the lower center of the cabinet; which also contains knobs for adjusting the brilliancy of the image, motor control, etc. This machine, as built into the cabinet shown, is complete and will tune in any television signals within its range (all television wavelengths are covered from about 90 to 200 meters.)

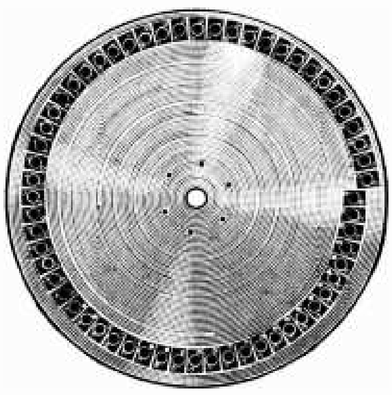
The newest "See-All" television model projects a picture about 8 by 10 inches on a screen in front of the cabinet. A new style of lens-disc is employed, together with a neon crater tube. One of the accompanying illustrations shows the appearance of the "See-All" lens disc. Each of the sixty lenses is securely mounted in a square brass mounting plate; the individual lens mounts being adjusted in a special optical checking machine, and then screwed tightly in position on the disc. One of the accompanying drawings shows a most interesting optical and checking machine, devised by Mr. Pollack, of the Television Manufacturing Co., of America.

By means of Mr. Pollack's device it has now become possible to accurately, yet rapidly, check every individual lens for its optical alignment on the disc, before it is screwed fast. This, or some equivalent method, of checking each lens on the disc for its optical alignment must be carried out; a disc in which the lenses are "mounted by guess" is liable to yield a very distorted or "blurry" image. This point can be seen in a moment; when one considers that any slight deviation of the center of the lens, will be greatly magnified by the beam of light passing through it; as it is projected 18 inches or more before it strikes the screen on which the image appears. In other words, a thirty-second of an inch difference between the true and incorrect lens centers on the disc, may show up as a band or blur on the screen and having a width several times this value.



Top and side views of clever device used in optically checking all See-All disc lenses for optical alignment.

The action of the optical focusing machine devised by Mr. Pollack is very clever. A strong source of light, such as a 100-watt lamp at the bottom of the machine, causes the image of two cross-hairs to be thrown upward through the individual lens being examined at the moment, onto a small screen mounted above the lens-disc. The lens-mount is adjusted on the disc until the cross-hair images (one is drawn on the screen) coincide on the screen; and it is then tightened in position.



Appearance of finished See-All lens disc of the type used in their crater-tube projector. Each lens can be adjusted separately.

Underneath the platform, on which the lens-disc is secured, there is a special gear with 60 teeth, and into these teeth is pressed a toothed pin pushed against the gear by a strong spring. Each time the operating level is moved the ratchet rotates the toothed disc one tooth, or 1/60 of a revolution. Because of the careful design of the pin just mentioned, the gear and its lens disc are accurately lined up each time. The whole supporting table on which the lens-disc is secured is moved forward slightly, each time a new lens is moved into position for checking; and when the 60th lens has been checked, the mechanism is so designed that the supporting turn-table jumps back, ready to start with a new disc on the outer-most or No. 1 lens. A dash-pot is mounted at the rear of the machine, to absorb the recoil when the main carriage jumps back after focusing the last lens.

TELEVISION R.F. COIL DATA

The following data is supplied by Radio Pictures, Inc., of New York, N. Y.

R.F. coil data for a range of 1,500 to 3,000 kc. (or 199.9 to 99.9 meters), for use with variable condensers of .00025 mf., (250 mmf.); coil inductance 37 microhenries.

Secondary, 25 turns No. 28 B & S enamelled magnet wire, wound on insulating tube, 1½ inches outside diameter.

Primary (for shield grid tubes), 20 turns No. 36 B & S gauge enamelled magnet wire.

For ordinary element tubes, 12 turns No. 36 enameled wire.

For antenna primary winding use 10 turns No. 32 enamelled wire.

Wind primary over the lower end of the secondary coil, with a layer of insulating paper between. Two stages of R.F. are recommended for local reception, and three to four stages of R.F. for distant reception.

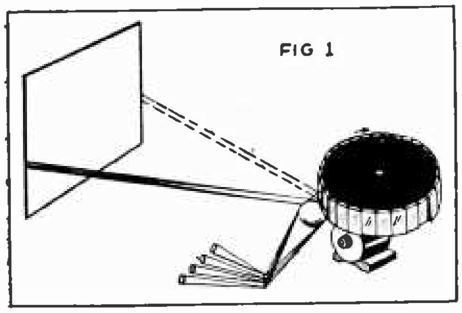
$5.00 Award for Best Image Photo

Until further notice, we will pay $5.00 for the best amateur photograph of a television image, the prize-winning photograph to be selected by the editors, who will act as the judges, and their opinion will be final. Do not send films; only prints. Address photographs to: "Image Photo" Editor, TELEVISION NEWS, 98 Park Place, New York, N. Y. Closing date for entries for next issue, March 10th, 1932.

Digest of Television Patents

Important television patents are here illustrated and reviewed by an expert.

Patent No. 1,694,301, issued to E. F. W. Alexanderson and assigned to the General Electric Co. Issued December 4, 1928.

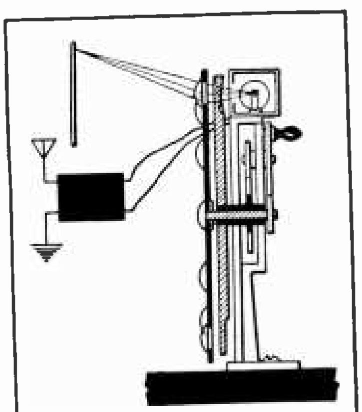


Scheme for improving detail in television image.

This patent provides for the transmission of images of a high degree of detail by the use of a multiple channel for transmission. In the one specification illustrated by the figure, and which is illustrative of the entire patent, the light from four sources, operated by four separate television receivers, is focused by means of lenses so that it is reflected from the plane surfaces of a Weiller mirror-wheel, and appears as four images positioned adjacent, one to the other, on the field of vision. This results in a finer detail in the received image, due to the number of simultaneous channels provided. If, then, we have a Weiller wheel with sixty surfaces, and employ four transmission channels, the number of scanned lines will be 240. The system is that employed in the H. M. V. apparatus demonstrated some months ago in England and described in the Mar.-Apr. 1931 issue of TELEVISION NEWS. Naturally, the arrangement may be applied to transmission as well as to reception by the use of direct pickup. Indirect or flying-spot scanning is not possible with this arrangement.

Patent No. 1,530,463, issued to Charles Francis Jenkins of Washington, D. C., March 17, 1925.

Here is an interesting variation of the ordinary lens-disc as now employed for the reception of images. This is evidently a forerunner of the prism-lens disc. Here a series of lenses, set regularly about a circumference, are employed to focus an image of the light-source on the screen, and to give the horizontal component of the scanning motion; while a prism of continuously varying angle, cut into a glass disc, provided the vertical motion of the ray. The hand crank shown is, of course, merely symbolic of the fact that rotating motion is imparted to the device.

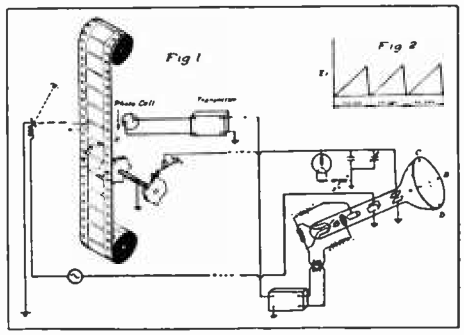


One of the Jenkins patents on lens discs.

Patent No. 1,786,812, issued to Vladimir Zworykin and assigned to the Westinghouse Elect. and Mfg. Co. Issued Dec. 30. 1930.

This is Zworykin's patent covering his cathode-ray receiver operating in conjunction with a film scanner—the film being scanned by the sinusoidal motion of an oscillograph mirror in the horizontal sense, and in the vertical sense by the uniform downward motion of the film.

For wire-line transmission, as shown in the figure, the output of the photocell is amplified and fed to a perforated disc in the cathode-ray tube's structure, in order to modulate the intensity of the ray impinging on the fluorescent screen, in such a manner as to cause its brilliance to vary in accordance with the optical density of the scanned film. A *sinusoidal* voltage, effecting the lateral scanning at the transmitter, is also transmitted to the receiver and is applied across one pair of deflector plates, to effect the lateral scanning of the cathode-ray beam—in the sense *AB* as shown in the figure. A commutator, geared to the film-advance mechanism, makes contact at each frame of the film, discharging a pair of condensers, across which the other pair of deflecting plates are connected. The capacity of the condenser arrangement is shown variable. This is in order that the time of charge of the condensers may permit the charge on the condensers to reach a certain level before the next discharge occurs. The wave-form of the condenser charge, as it increases and is instantaneously discharged, is shown in Fig. 2. This results in a complete scanning of the field in the vertical sense during the charging cycle. The time-constant of the system is such that the increase in the condenser charge is a *linear function* and the discharge through the commutator is sufficiently rapid so that the condenser becomes completely discharged in the time required for the film to move through the distance between the image frames of the film.



A Zworykin patent covering cathode ray receiver.

It should be noted that, by providing a similar discharging condenser arrangement for the lateral scanning at the receiver, a scanning disc could replace the oscillator arrangement shown in the figure at the transmitting point.

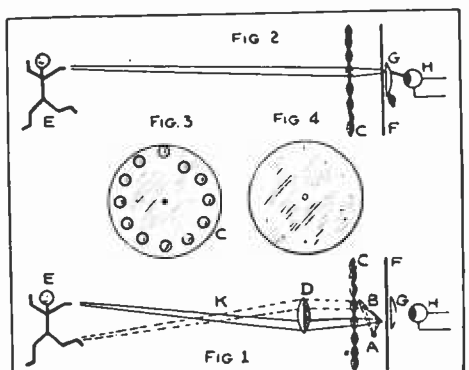
Patent No. 1,785,262, issued to Charles Francis Jenkins of Washington, D. C., December 16, 1930.

This patent covers a duplex scanning disc, in which a lens-disc is used to increase the efficiency of the "flying spot" type of scanner. In the four figures, *A* is a source of light; *B* a mirror for changing the direction of the light beam; *C* a lens-disc through which the scanning light passes and is focused in the plane of the scanned subject; *D* a large lens in alignment with the light coming through the scanning disc; *E* the object to be scanned; *F* a second scanning disc have elemental apertures; *G* a lens between the apertured disc and the photocell *H*.

Figs. 1 and 2 show the side elevations at the two sides of the system. In Fig. 1, omitting reference to *F*, *G* and *H*, we have a simple "flying-spot" scanner employing a lens-disc to focus the scanning ray in the plane of the scanned object. The optical system used to focus the light spot in this plane includes the lenses within the disc and the additional lens *D*.

In Fig. 2, we have the elevation of the receiving side of the disc (in normal procedure of the present day, these sides would be the top and bottom of the disc rather than the right and left sides). Here the light reflected at any instant

(*Continued on page* 48)



Duplex scanning disc scheme.

The TELEVISION QUESTION BOX

Edited by
C. H. W. NASON

Spectrum of Radiation

Del Rogers, W. Frankfort, Ill.:

(Q. 1.) Please tell me where I can get complete information on the *Spectrum of Radiation*. I would like to become well informed on each division of the Spectrum. I would also like some information regarding the uninvestigated intervals or blank spaces and why they remain uninvestigated.

(A. 1.) I fear that you are laboring under a misapprehension regarding the uninvestigated regions of the spectrum. You will see from the figure that pretty nearly everything involved is well known to the scientist—though of course a great deal of work must still be done before we thoroughly understand the behavior of the various forms of radiant energy.

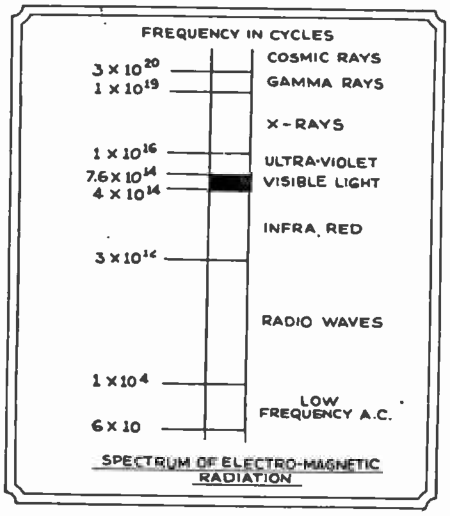


Chart showing frequency range in cycles for various rays and waves.

Extra Fast Photo-Cell

J. N. Ryan, Jr., Wichita, Kansas:

(Q. 1.)—Is there a commercial photo-electric cell capable of following variations in light intensity at the rate of 4,000,000 per minute? If so, where can they be obtained and what is the approximate price?

(Q. 2.)—I would like to know the names and addresses of manufacturers of the highest-grade television equipment. Does any one make a high-powered neon lamp suitable for the clear reception of images about twelve inches square? I mean for home use and not for a complicated laboratory experiment.

(Q. 3.)—Will the manufacturers of the apparatus noted above furnish information as to the auxiliary apparatus required to operate the photo-cells and neon tube, such as transformers and power equipment? If not where can I obtain this data?

(Q. 4.)—I read in a recent article that a wide range of frequencies were required to transmit a large number of picture elements. I have always considered the operation of the photo-cell as varying the current transmitted and not the "pitch" of the radio note. Why is this method used instead of the varying volume method? This would require no change in frequency.

(Q. 5.)—As I have not kept up with the technical side of new developments, I would like to get a good technical book on the subject. Can you recommend one?

(A. 1.)—High-vacuum photo-cells will follow variations of the frequency you require; this corresponds to about 60,000 cycles. The gas-filled cells depend for their high output on the fact that the gas is partially ionized, and becomes conductive when the photo-electric effect takes place. This results in an amplification of the current obtained. The gas ionization does not follow as rapidly as does the electron emission from the photo-electric surface, and a loss at the higher frequencies results. High-vacuum cells require two or more stages of amplification to bring the output up to the level of a gas cell of otherwise similar character. Write to the Cable Radio and Tube Corporation (Brooklyn, N. Y.) for prices on these cells—they may be obtained only on special order—and specify the light with which they are to be used; as the color sensitivity of the cell has a great deal to do with its efficiency, when operated with a particular light-source.

(A. 2.)—There are no manufacturers of the class of television equipment you require. If there is nothing available of a standard character which suits your needs, you will find among our advertisers many who will be glad to undertake special work for you. The Cable Company also makes high-intensity neon lamps in a variety of models suited to various picture sizes.

(A. 3.)—Power equipment — transformers, etc., for television does not vary greatly from that of radio broadcast requirements. The old stand-bys will serve, if it is remembered that less "hum" is tolerable in television than in radio. The highest class of apparatus must therefore be employed!

(A. 4.)—The idea of *frequency* involves the element of time as well as of amplitude or volume. You have already asked for a photo-tube following high-frequency variations in light intensity and you must see that the premise of amplitude alone will not cover the entire effect within the circuits. The television signal has components varying from the picture frequency up to a frequency depending upon the number of picture elements per second—this is actually determined by multiplying the number of picture elements per frame, by the number of repetitions per second, and dividing by two. For a sixty by seventy-two element image, repeated twenty times per second (the general standard at present) the frequency range extends from 20 to 43,200 cycles.

(A. 5.)—I can recommend S. Gernsback's RADIO ENCYCLOPEDIA as covering a review of the entire field, and Keith Henney's PRINCIPLES OF RADIO for a non-technical discussion of the many technical problems involved.

Multiple Images

Robert Thomas, Bridge Hampton, Long Island:

(Q. 1.)—I have a television receiver, and all I can get is eight images—four on the top and four on the bottom. How can I overcome this trouble—is it in the receiver or in the location?

(A. 1.)—There are two possibilities—either your motor is operating at the wrong speed, or the visible area of the neon tube's plate is too large. Check the motor speed by means of a neon pilot lamp and stroboscope, in the manner previously described in this journal. If the speed is correct carefully judge the size of a single image, as you see it, and cut a tin shield, with this size aperture, to fit over your neon lamp. I doubt whether the trouble is in the motor's speed; check this quickly and simply by getting a protractor and holding it up before the disc. A single image should be of such size that its two edges make an angle of six degrees with the driving shaft as shown. The shield is also shown in this figure. If the angle is much less than six degrees, the motor's speed is too slow.

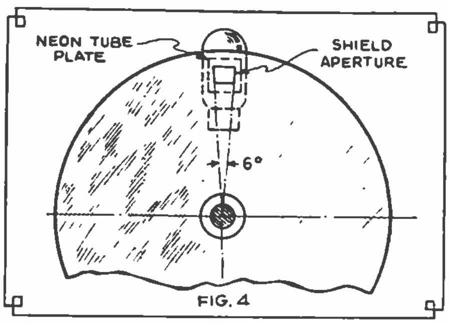


FIG. 4

A shield cut from tin or brass is needed in all scanners.

Lens Questions

Hugo Worch, 1110 G Street, N.W., Washington, D. C.

(Q. 1.)—What size is the picture behind the lens, that is broken up in the Jenkins Direct Pick-up Camera? What is the focal length of the lens? What make? Does the disc contain lenses or just holes? What size is the hole?

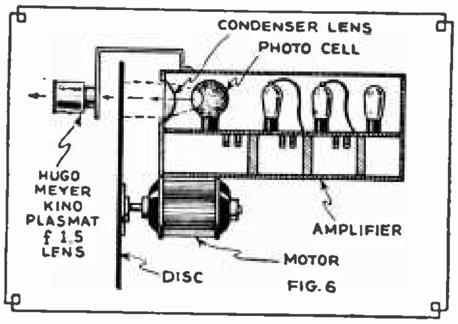


FIG. 6

Arrangement of lenses in "direct pick-up" camera.

(A. 1.)—The image formed is the same size as a standard frame of a motion-picture film. The lens is of as high a "speed" or efficiency as can be obtained (*speed* is the ratio of focal length to aperture); the speed of the lens used is about f-1.5. I do not know what type of lens the Jenkins people use, but in my experience the best has been the Hugo Meyer Kino Plasmat f-1.5,2" lens. The American office of this concern is at 245 West 55th St., New York City. The disc is a simple scanning disc of high accuracy, so scaled as to give an image of the same size as the motion-picture film "frame." The size of the individual aperture is dictated by this consideration also. The diagram gives the layout of the units in a direct-pick-up camera.

Can He Receive Signals?

Chas. Tice, Boulder City, Nevada:

(Q. 1.)—What is the nearest television station to me—and can I expect to get good signals in this locality? Please advise me as to whether it would be worth while for me to build a television receiver.

(A. 1.)—First ask about town until you find someone with a short-wave receiver. See if they can receive the television signals from Chicago, New York or Washington, with reasonable strength. If so, you can be assured that a television receiver will pick up images in your locality.

Where to Obtain Lenses

Richard Trehy, Woodside, L. I.:

(Q. 1.)—Please give me the names of firms supplying lenses suitable for setting in a scanning disc. My receiver is of your design and published in the May issue of TELEVISION NEWS. I get good results from all stations in this area, but have synchronizing trouble with W3XK.

(A. 1.)—A New York dealer has a quantity of excellent lenses at a price far below their actual replacement value; these were made for the government during the war. (Name furnished upon request.)

The Romance of Theatrical Television

By HERBERT S. FUTRAN

(*Continued from page* 13)

effect of the shock of the disc's vibrations on the lamp, was built. The press never knew that the demonstration they had witnessed that night had been given with a glow-lamp whose refractory element was broken, whose socket was cracked and whose filament was running cold instead of hot. It was that same lamp, too, which was used in the succeeding demonstrations during the week.

On Wednesday afternoon, the first public demonstration was given before a large crowd which greeted the demonstration effusively, and the newspapers that night carried stories of Sanabria's triumph. The large arena was jammed Wednesday night and the stage was set for a triumphal showing. Shortly after the demonstration started, however, the sound system, which had been installed especially for the television demonstration, failed to function; and the audiences were shown just the visual portions of the program.

Watson! Who Cut Those Wires?

The sound engineers searched all night for the trouble and it was not until dawn that they located the cause of the system's failure. The wires had been cut with a pair of wire cutters! The damage was hastily repaired and the demonstration proceeded on Thursday though, during the evening's performance, the intercommunicating telephone system failed to function and the engineers were forced to work in the blind. It was found by the electricians later that once again the wires had been cut, for the second time within forty-eight hours!

Nevertheless, the show went on and the newspapers hailed the demonstration as epochal. The precious glow-lamp was guarded as closely as a king's treasure, and special guards stood watch every minute of the day and night over the wires and equipment. When the last demonstration was given on Saturday night, every man in the Sanabria organization breathed a sigh of relief and then, with the same thought, all returned to the hotel to sleep.

Sanabria had planned his apparatus with an eye to the future when television would come into the theatre as a regular medium of entertainment. He had visualized the future as a "television era" with visual broadcasting supplementing the other popular forms of entertainment. Mr. B. S. Moss, owner of the Broadway Theatre, who had seen the Madison Square Garden demonstration, was the first producer wishing to take advantage of this remarkable development and he invited the young inventor to show his apparatus in four demonstrations daily, beginning October 14, as a regular adjunct to the Broadway Theatre's "varieties" entertainment. So Sanabria, who was the first to show a "ten-foot" television image, would be the first to show television in still another field, this time as a vehicle for theatre entertainment.

It was then the thirtieth of September. Everyone had hailed his demonstrations unreservedly, but Sanabria himself was not yet satisfied with his results. He felt that much greater brilliancy was necessary before a serious impression would be made by television on the public. In an interview which appeared in the *New York Times*, he said that he intended to return to New York, in time for the theatre showings, with a completely new lamp.

Airplanes Enter the Scene

His associates said it was impossible to develop a new lamp in three weeks; others had been working for years. Nevertheless, his last-words before boarding a west-bound airplane were: "I'll see you in three weeks with a new lamp." And on the eighteenth of October he called New York to report that the new lamp had been developed by Taylor, under his supervision.

A historic preview of the Sanabria equipment was held on October 21, when television was used for the first time to transmit a presentation in one theatre to the stage of another. A notable audience was invited to the Broadway Theatre to see the reception of fragments of the then-current Theatre Guild production, from the Guild Theatre in 52nd Street.

The apparatus had been received from Chicago the day before the demonstration, and was installed in the Guild Theatre. The technical installation, however, could not be made until after the performances in the theatres that night. Thus, it was not until after two o'clock in the morning that preparations for the demonstration, scheduled for eleven o'clock, could get under way.

Because of this lack of time, it was impossible for the engineers to install the auxiliary circuit by which the glow-lamp was modulated. Under normal conditions, with this circuit installed, the one glow-lamp which Sanabria brought from Chicago would have been sufficient for a series of demonstrations but, without the auxiliary circuit? . . . It was impossible to make predictions.

Nevertheless, the next morning, the doors of the Broadway Theatre opened to a noted audience and, when the time for the demonstration approached, the theatre was packed. Sanabria doubtfully made his way to the monitor's position in the balcony and really prayed. He suffered from what he himself called "television fright". Among all those who knew the technical condition, there was a grim tenseness. The engineers busied themselves with their tasks. The writer was with George Gruskin, president of the Sanabria Television Corporation, in the lobby of the theatre. The two of us sat disconsolately on the steps leading into the theatre, woefully contemplating the scene of the busied preparations. Then, still without a word to one another, we rose, walked into 52nd Street and stopped at the nearest orange-drink hut, where we silently imbibed three orangeades, and then returned to the theatre.

Minutes passed and the preliminary ceremonies started. There were speeches through which Sanabria squirmed and then, finally, the time for the television program had arrived. The engineers over in the Guild Theatre reported that all was well and, suddenly, the picture was flashed on the screen. All breathed easier though the program had only just now begun. There was still a half hour to run. Sanabria became so intense that he was unable to see the picture and asked someone seated next to him to inform him of the quality of the image so that he might convey the information to the engineers.

Then, suddenly, the lamp became overheated, for lack of the auxiliary circuit, and the dreaded event occurred; the lamp blew out! The engineers notified Carveth Wells, who was officiating as master of ceremonies, and asked him to entertain the unseen audience while they sought to restore the lamp. Carveth Wells was familiar with television and its difficulties; he had officiated at Madison Square Garden when the demonstrations had hinged on a broken lamp. So, for several minutes, he nobly entertained the audience with his inimitable "jungle tales" until the engineers, almost gleefully reported they were ready to continue. Then the program was finished and the audience knew only that a lamp had become heated and it was necessary to cool it down.

All of the transmitting apparatus was then moved to the Broadway Theatre, where it was installed in a glass studio. During this two-week engagement, more than twenty lamps were used. Each of them tended to develop a high pressure because of unsatisfactory refractories. On one occasion, Taylor flew back to his laboratories in Chicago when the supply of effective lamps was down to one! He arrived late in the afternoon, worked feverishly all night, and was again on a plane, returning to New York, the next morning. Just before the show following Taylor's arrival, the one lamp with which the engineers had been left blew out and one of the new lamps was used. Despite all of these difficulties, fifty-six consecutive performances were given with only two interruptions of fifteen seconds each during which lamps were changed.

The success of the Broadway Theatre engagement brought a request from Baltimore for a series of demonstrations; and it was arranged that, for the week commencing November 14, the unit was to appear at the Hippodrome Theatre in that city. The apparatus was installed in the theatre without delay and, on the opening day, the engineers were all comfortably awaiting the moment for their performance. They stationed themselves at the apparatus, when again the seemingly impossible occurred.

It is necessary, in the Sanabria equipment, to start the motor which revolves the scanning mechanism before the power is turned on. On this day the engineers were "tuning up" their equipment and conversing over the telephones when the man at the power switch asked Copple, at the scanner, whether he was ready for the power. Just then there was a great deal of shooting on the stage—one of the "sound effects" of a vaudeville act on the bill that week—and the engineer, deafened by the report, thought that Copple had given his O. K., whereupon he threw on the switch.

The motor, however, was at a standstill and the power coming through at that time broke the clutch that served as a connecting rod between the scanning disc and the motor. Sanabria rushed back-stage to view the damage. The clutch was a total loss; it was impossible to restore the finely machined steel casting in less than several days. But the show had to go on, and minutes were slipping by swiftly. Something had to be done immediately.

Sanabria, without a word of explanation, took the clutch and rushed from the theatre, leaving all those on the stage to wonder at his action. More minutes passed and still Sanabria did not appear. Then, suddenly, he walked hurriedly through the stage door and held up the part. Instead of a finely made steel clutch, he had substituted a piece of rubber hosing. The disc was set in place and was bound with light wire. When, a short time later, the orchestra blared into "Pomp and Circumstances", the cue for the television performance, the engineers were on the stage at their equipment; Sanabria was at his monitor's position; and the show went on according to schedule.

For twenty-eight successive performances thereafter, the apparatus functioned without a single interruption, and Sanabria's hastily improvised rubber-hose clutch served perfectly. Because of the record in showmanship, Newark expressed a desire to see the revolutionary apparatus. The Loew State Theatre in that city would show it during the week of November 21. Everyone, except Sanabria, said that it would be impossible to transport this equipment from Baltimore, where the last showing was at ten-thirty on the night before the twenty-first, in time for the opening. Sanabria, however, merely said, "Of course, we'll do it."

So, on the night of November 20, immediately following the last television performance, the engineers began to disassemble the equipment for the eight-hour trek to Newark. The engineer in charge at Baltimore called Newark to report that the dismantling was proceeding according to schedule and the truck was to start within twenty minutes. It was then eleven o'clock; which meant that the apparatus should arrive before nine and the performance would open on schedule—a remarkable achievement for so complex a mechanism.

In these theatre demonstrations, the lens disc (which in itself weighs twelve hundred pounds) was hoisted on to a platform eight feet high. Thus, all that remained to be done in Baltimore was to sling the block and tackle about the disc and lower it to the floor. Then again the totally unexpected occurred; the rope broke! The enormous disc crashed eight feet to the floor, tearing up the flooring. Its lenses were smashed; its weighty casting was cracked; the disc was bent beyond repair.

Baltimore called George Gruskin in New York. It was almost one o'clock. There was another disc in Chicago, but it could not be shipped in time for the showing on Saturday. The theatre owners were called, and they agreed to allow the show to open Sunday; but after Sunday? . . . The public was expecting to see television.

So Mr. Gruskin tried to find Walters—in charge of the Sanabria laboratories in Chicago—but Walters was nowhere to be found. It was learned, about two o'clock, that he had driven to Macomb, about two hundred miles from Chicago, to visit relatives. Finally, he was roused from his bed and told to return to Chicago immediately. "But I just got here an hour ago," Walters protested. Nevertheless, in a very few minutes he was in his car and tearing back to Chicago.

The railroad officials were then called, and they suggested the express which would get the disc to New York sometime Monday morning. The Sanabria officials protested that the disc must reach Newark no later than Sunday morning. The railroad officials regretted their inability to assist, but there was no other solution. There followed a period of arguments and debates and persuasion and then finally the point was won. The disc could be loaded on the Broadway Limited, the crack flyer of the Pennsylvania Railroad.

Walters reached Chicago, obtained a truck and rushed to the station with the disc, arriving just in time to load before the train departed. He breathed a sigh of relief when the locomotive pulled from the train-shed; Mr. Gruskin breathed a sigh of relief when they heard his report over the telephone a few minutes later. Martin Wagner, manager of the travelling presentation unit, received the information at Newark, only to discover that the train would not stop at Newark long enough to unload the disc. If the apparatus were sent into New York along with the train, it would be well after mid-day when the disc would be received from the terminal—and mid-day should have found the apparatus in operation at Newark.

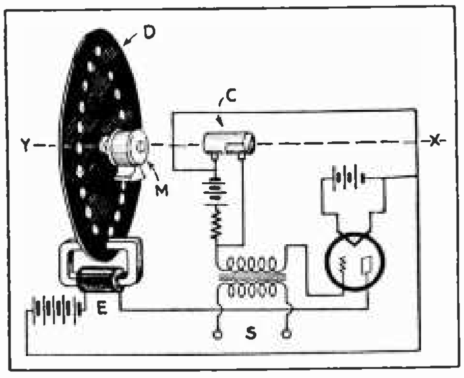
So Wagner made a hurried visit to the railroad officials and asked that the train be halted at Newark for a longer period. No one, the officials argued, ever halted the Broadway Limited. But this was different, Wagner insisted, and he finally won his point; the Broadway Limited would stop so that Newark might see its first demonstration of television in the theatre—and when the scheduled time for the performance rolled around early Sunday afternoon, the equipment was ready.

All of this has occurred within the past few months. It adds another chapter to the romance and adventure in the theatre. But television, taking its place behind the footlights, has abided by the rule of the stage that the show must always go on. Sanabria himself views all of these experiences philosophically. "Large-screen television," he says, "is the racing car of television. Every part of the apparatus is pushed to its utmost in order to achieve a perfect performance.

"The theatre has served as a laboratory in which we have discovered that there is a great public interest in television and, also, have learned what must yet be done before television reaches its full development. I have felt a certain satisfaction in the performance of our apparatus; but much more must be done if the future of television is to be assured for the near future. The mechanical scanning system used in our presentation apparatus has served us well; but the remarkable progress being made with a cathode ray system leads me to believe that this newer system will shortly take a formidable position in television effort.

"At my laboratory I have experimented with various forms of electrical scanning and have established, to my own satisfaction, at least, that this system merits earnest consideration. The fundamental fact of public interest in television has been amply demonstrated in the response to our presentations in theatres; and I feel that the great expense and labor connected with these demonstrations has been once more rewarded by this response which will expedite the realization of television as a commonly-accepted medium of entertainment."

Motor Synchronized By Means of a Brake



Belgian patent No. 372,169 of July 24, 1930. *Compagnie pour la fabrication des Compteurs et Matériel d'Usines à gaz, Montrouge* (France). (Registered in France, No. 368,430, March 10, 1930, and April 8, 1930.)

The patent covers the principle of a system of synchronizing by means of a brake, functioning at the frequency of the synchronizing oscillation. It prescribes a mode of accomplishment by combining, in the same braking arrangement, an action functioning with the rotation of the axle of the synchronizer, and an action caused by the incident tension.—*La Radio per Tutti.*

A Simple Synchronizing System

(*Continued from page* 23)

Slight Adjustment Needed Only

The writer has used a device of this type for hour after hour with no other adjustment than a slight touch on the knob. This usually did not involve any actual motion of the control—just a slight pressure in the direction required. By means of one of the small neon night lamps and a stroboscope pattern on the disc, it will be a simple matter to bring the motor up to speed, without tuning in the signal. Naturally, if the transmitter and receiver discs are not on the same network, a small adjustment will be required after the station is tuned in; but the adjustment can be made closely enough at the outset to require very little adjustment later on. This particular design lends itself admirably to a cabinet design; for the motor may be mounted on a shelf and the control knob brought out through the side of the cabinet.

Flywheel Steadies Image at Receiver

(*Continued from page* 23)

that "hunting" causes the setting of the rheostat to be shifted almost constantly. After experimenting with several intricate governors, the simple expedient of mounting a heavy disc on the motor shaft was adopted. Since the scanning disc is mounted on the shaft, a double-shafted motor was obtained, and the flywheel mounted on the back end. The best results were obtained from the system shown. In this system, the disc floats free on the shaft, being attached by the spring shown on the end of the shaft. This allows a slight movement with a ready storage of energy to correct for changes in the armature speed. A weight of about five pounds gives the best results.

Digest of Television Patents

(*Continued from page* 43)

from the subject, is picked up by the lens within the disc, focused roughly on the apertured disc, and then gathered to the photo-cell by the lens *G*. The result is a scanning system combining the best features of two methods of transmission. The reason for the interposition of the lens *D* in the scanning system is that the lenses within the disc must function so as to obtain the correct focal distances in the light-gathering process. The discrepancy in distances involved in the scanning and gathering functions is counteracted by the use of the additional lens *D* in the scanning operation.

A Simple Lens Disc Projector—How to Build It

By IVAN BLOCH, E.E.

(*Continued from page* 16)

inches, which may be cut from a "kneeling-pad" obtained at the *fire-and-ten* store. The bottom of the bracket is screwed on, as shown in Fig. 6; the screw-heads being pulled into the rubber slightly to avoid direct contact with the motor frame and the shelf on which the projector is mounted.

The televisionist who wishes to synchronize with distant stations, or whose A.C. voltage supply is out of phase with that at the transmitter, must change the above motor design in that which concerns the motor and brackets. Instead of a synchronous motor, a *variable-speed* motor is used, with a phonic wheel and synchronizing magnets (as explained in previous issues). In this instance, the framing is accomplished by rotating the synchronizing magnets about the rotating phonic wheel; and therefore the motor is to be mounted directly on the rubber mat, for its frame does not rotate. The framing may be done with a small rod, extending through the side of the cabinet or by some gearing arrangement.

The Image Screen and Support

The material for the screen may be of ground glass, tracing cloth, translucent sheet rubber, or of special translucent material such as that used in motion-picture projection where the projector faces the audience. Naturally the latter is the best; as its angle of distribution is great and its opacity is such as to give best results.

As our image will be 10" by 12", the screen frame will be slightly larger, as shown in the dimensioned Fig. 7. The material of the frame may be either wood, steel or bakelite. In case the screen material is flexible, care must be taken to stretch it evenly over the frame.

The "shadow box" arrangement shown in Fig. 8 is best made with ¼" pine veneer. All joints must be carefully fitted to prevent extraneous light from filtering through. Once the box is constructed, the inside of it is to be well painted with the optical black paint with which the disc was coated, to prevent reflective interference.

If the televisionist wishes an adjustable screen, Fig. 8 shows such an arrangement. In this instance, no shadow box is required.

The Cabinet

Here the esthetic taste of the televisionist will come into play. The photographs and figures of the author's model show the screen as a part of the cabinet, giving an image about 8" by 9.5".

As indicated in Fig. 8, space is allowed for the television receiver. This is optional and, if no provisions are desired for the receiver, the whole cabinet is lowered by a few inches, so that the lower edge of the disc is a half inch or so from the bottom board.

The cabinet may be built of pine veneer. For the front panel, the sides, top and shelf, ⅜" stock will do; the back panel may be of ¼" stock. The bottom board must be strong and hence ½" to ⅞" stock is required.

An opening 7½" by 9½" is cut out of

the front panel as in Figure 8. Into this opening the shadow box is fastened by means of small brackets, as indicated. The sides of the shadow box should be slightly countersunk, so that the brackets do not interfere with the image. For adjustable screens, two holes are drilled in the front panel, slightly below the center line of the screen-box opening, and one hole on each side, with suitable bushing-supports for the sliding support rods.

The shelf on which the projector is mounted is to be rested on small blocks screwed and glued into the sides of the cabinet; at the proper height to bring the top of the shelf 10¾" from the center line of the 7½" by 9½" opening. Screws are to fasten the shelf to the wooden blocks later on.

The assembly must be systematic. First, a small rotary switch is mounted on the front panel so that it will be in a symmetrical position with regards to the framing knob and control rod. The motor connections are now made, leaving about three feet of lamp cord for the connection to the switch. By means of four screws, the rubber mat with the attached motor brackets and motor is fastened to the shelf; so that the end edge of the motor frame is in line with the edge of the shelf, as indicated in Fig. 8. Obviously, the motor and assembly should be lined up so that a perpendicular line through the center of the aperture passes parallel to the motor axis and directly above it. The motor condenser may be mounted next to the motor on the shelf; all wires are taped and enough slack is left to the motor connections proper to allow frame rotation of a few degrees.

The shelf is now mounted on the small blocks and screwed down. The framing rod should protrude through the front panel, and a knob is attached to it.

The next step is the placing of the disc on the motor shaft, which has well been vaselined to reduce end-play vibrations. The spring is secured to the collar.

The Lamp Support and the Focusing Device

The centers of neon-crater lamps vary in position, with regard to the socket base, for various lamps. It is necessary to provide adjustments up and down, right and left, forward and backward and angularly about the base of the lamp. The simplest, most efficient and cheapest device is an ordinary physics' laboratory clamp, which may be purchased at any good chemists' supply house for 35c.

A support is needed, for which dimensions are shown in Fig. 9; this may be made of cold-rolled steel. The clamp is mounted as shown.

The lamp holder and clamp are fitted together, and the lamp placed in the jaws of the clamp, held by the base. A socket is attached to the lamp and wires soldered to it.

By shifting the lamp and holder, a position wil be found on the under side of the top of the cabinet, where the holder may be screwed down securely and allow adjustments to be made at the lamp. The lamp's center should be somewhere on a vertical line drawn through the motor's axis. By moving the lamp forward and backward, a position will be found where the spot of light on the screen will be sharp and clear when the lamp is lighted. Rotate the disc by hand and move the lamp up and down until the top lens in the spiral projects a spot of light at the top of the screen, and the bottom lens in the spiral does the same for the bottom of the screen. After a few minutes of adjusting and focusing, the lamp will be in the correct position.

Turning the motor switch on will cause the disc to rotate at synchronous speed and, if signals are modulating the light of the lamp, an image will appear on the screen. It may be out of frame; the first step is to frame it vertically by stopping and starting the motor rapidly, by means of the motor switch. A little practice will allow the televisionist to gauge exactly how long to stop and start the motor. Invariably, the image will now be out of frame *horizontally.* To frame it, the control knob is rotated slowly until the image is "centered."

The televisionist is now in possession of his screen projector and he will congratulate himself on the excellent results, which a roomful of people can comfortably watch.

The circuit of the television receiver need not be changed radically to operate the neon crater lamp. The author used a Shortwave and Television Co. receiver, with the following changes: R.F.—Changed the two 224 for two 251 (variable mus), changed the existing volume control from the screen grid legs, to the cathode legs of the two R.F.'s, changed the 224 detector to a 227 detector with corresponding changes in resistances in circuit. The output tube of the set is a 245 and it is only necessary to place a variable Electrad resistor of about 5,000 to 10,000 ohms in series with the output side of the receiver and the crater lamp as indicated in the diagram. The necessity of the resistance in series with the lamp is twofold: First, to limit the current through the crater lamp to its operating value of 25 M.A., and secondly to increase the load on the 245. The impedance of the neon crater lamp is variable and may range from a negative value of about 200 ohms to a positive value of 200 ohms; by placing such a resistance as will load the output circuit no matter what the lamp impedance may be at that time, the set then delivers close to its maximum output.

(*Note: the author will be glad to answer any questions addressed in care of* TELEVISION NEWS *as to constructional details, as well as for reliable information as to where lenses, discs, brackets, etc., may be obtained. Kindly enclose return postage.*)

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A New System for Television Synchronization

(*Continued from page* 36)

is applied across the input terminals, the multivibrateur output will lock with the new force. That is to say, if our oscillation frequency is not truly sixty cycles but about 59 cycles, and an external voltage having a frequency of 1,200 cycles is applied to the input terminals, the basic frequency of the multivibrateur

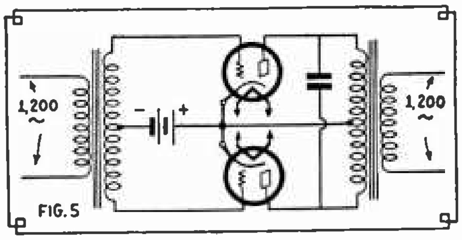


FIG. 5

Use of thyratrons in the thermionic brake.

will become the direct submultiple of 1,200 or sixty cycles. This arrangement is used in the production of harmonics of a frequency standard. In this case a 1,000-cycle multivibrateur is used to drive a synchronous clock, driven by a 1,000-cycle motor. If then a 100,000-cycle control voltage is impressed, the 1,000-cycle output will become interlocked with the 100,000-cycle control; and the variations of the clock from the true solar time over a period of days will indicate the constancy of the 100,000-cycle source. The multivibrateur will then have harmonic contents of high order, enabling the measurement of high-frequency devices directly from the 100,000-cycle standard which has been measured accurately by the clock's variations.

Just how this is used in our synchronizer is readily seen. The multivibrateur is roughly adjusted for a sixty-cycle output, and drives the scanning motor at a synchronous speed, through the means of the thyratron inverter. The multivibrateur is then supplied with the 1,200-cycle scanning component of the television signal, by means of a single-stage tuned amplifier, thus definitely establishing the sixty-cycle output of the multivibrateur as a subharmonic or submultiple of the scanning component. The result is that the motor will be in synchronism with that at the transmitter. If, then, our multivibrateur has a basic frequency not far away from a true sixty cycles, the result of removing the controlling force during announcements or while tuning from one station to another will be that of shifting the speed by the extent indicated by the difference between the normal output frequency, of the multivibrateur, and the frequency obtaining when the television signal exerts the controlling force. The variation will not be so great that the speed will not instantly come under control again upon restoration of the controlling force.

While this effects a sure-fire control of the motor speed it does not provide for phasing or for lateral framing of the received image. A simple control, involving the use of a thyratron as a phase controller, serves to accomplish this. This well-known use of the device is demonstrated in Fig. 3. As the resistance is varied between infinity and zero, the phase of the voltage across grid and cathode is retarded through 180°.

It should be remembered that the power available from a thyratron inverter, employing the new type '91 thyratrons recently made available, is but 150 watts. This is sufficient to drive a 1/5th-horsepower motor—although it will not bring a 1/5th-horsepower synchronous motor up to speed. On the other hand, the force available, when applied to a synchronous motor of that power, should be sufficient to effect synchronizing control over the speed of a motor of five horsepower or more.

Use of the Thyratron With the Thermionic Brake

Through the use of a variable-speed motor and a 1,200-cycle generator supplying the plate circuits of a pair of thyratrons—or, less preferably, a single thyratron—a tremendous synchronizing force may be exerted when the motor speed becomes synchronous with that of the transmitter. This action is identical with that described as the "thermionic brake" in these columns some months ago. The difficulty in this case is, again, that the synchronizing influence is removed during no-signal periods. This means that the motor speed must be reduced below the synchronous speed when the television signal is removed. Synchronism would again obtain as soon as the 1,200-cycle component is again available, and the motor speed is allowed to reach that of synchronism. The circuit arrangement is indicated in Fig. 5. One fact, however, renders it possible to apply the thermionic brake principle to thyratron circuits—the possibility of employing the multivibrateur to obtain a signal-controlled, 60-cycle voltage for application to the thyratron grids and a sixty-cycle alternator to supply the plate voltage. This is shown in Fig. 6.

The thyratron grids are negatively biased and excited in opposite phase through a transformer. The plate voltage is obtained from an alternator driven by the scanning motor. Operating at 60 cycles, 1,200 R.P.M., and with the motor approaching the synchronous speed, a time will arrive when the upper tube has its grid positive when the plate of that tube is also positive—a heavy plate current drain will result. When synchronous

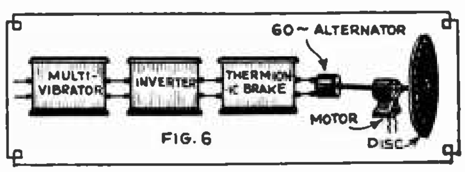


FIG. 6

Line-up of multi-vibrator, inverter and thermionic brake, locked control circuit.

speed is reached, the grid and plate will go positive in the upper tube at the same instant and, in the next half-cycle, the same condition will obtain in the other or lower tube as shown in the sketch. The result will be a continuous load on the generator and a tendency to prevent the motor from passing through synchronous speed. By operating the plate circuits at sixty cycles, and the grids at 1,200 cycles, it would be possible by accurate proportioning of the circuits to control the device directly from the 1,200-cycle supply.

An A. C. Operated Television Transmitter

By L. R. CONRATH

(Continued from page 35)

bend in it so that it can be screwed to the wooden lens-support. The mask is mounted between the lens and the disc and is as close to the disc as is practicable. The aperture in the mask is a trapezoidal hole in which the parallel sides are horizontal and the other two sides, when projected, intersect to form an angle of eight degrees. The width of the top of the aperture is equal to the distance between the two adjacent holes of the spiral which are farthest from the center of the disc. The light projected through this aperture gives a field bounded by arcs and radii. A beaded screen, of the type used in home movie-projection outfits, is placed behind the person or object being scanned. This screen, being a good diffusing medium, and having a uniform, white surface, assures a clean background behind the reproduced picture, which is therefore free from spurious shadows. The projection lens is situated a few inches in front of the aperture, this distance depending upon the focal length of the lens. For close-up views, a six-inch focal length lens is used. It is mounted by means of a strip of heavy metal clamped around the hollow cylinder, in which it slides.

Photo-Cell Rack

The light from the scanner is projected through a square hole in the photo-cell rack, which is constructed as shown in figure 3. The photo-cell rack is built of two-by-four lumber, with the exception of the P.E.C. board and the amplifier shelf. The rack, like the scanner, is mounted on casters, so that it may be easily moved. The method of mounting the cells is shown in figure 3. Eight caesium-oxide gas-filled cells are used, in which the photo-emissive deposit is on a semi-cylindrical cathode which is placed at the focal point of the reflectors, with its concave surface towards the plated surface of the reflectors. The eight cells are connected in parallel by a shielded cable which runs through the threaded brass pipe which supports the cells and reflectors.

Reflectors—How Made and Arranged

The reflectors are arranged in four groups of two, each of which can be moved independently of the other three, in order to focus the light, from the subject being televised, on the cells, to the best advantage. The reflectors are 13 inches in diameter and are dished to a depth of 4½ inches. They are made of spun brass and have a highly polished chromium plated finish on their interior surface. The backs of the reflectors, the photo-cell rack, and the scanner framework are all painted black for the sake of appearance.

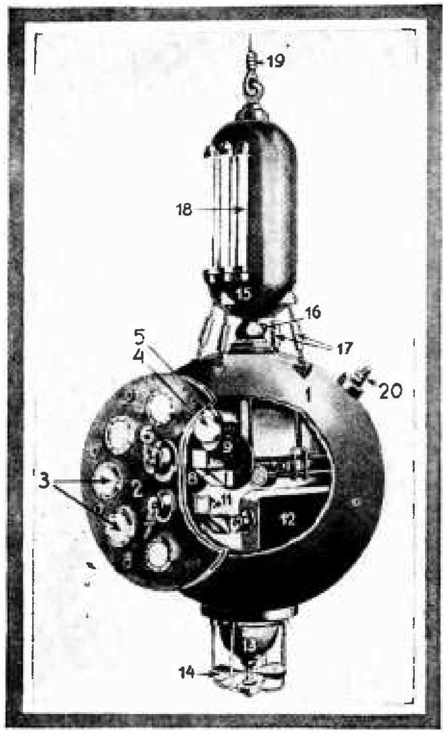
The shielded cables from the cells run through the P.E.C. board to a common point where they are spliced and a single cable runs from there to the input terminals of the photo-cell pre-amplifier which is located on the shelf behind the P.E.C. board. This amplifier and the main panel amplifier which follows it, will be described in the next article of this series.

(To be continued)

Sub-Sea Television

By H. WINFIELD SECOR

(*Continued from page* 8)



The Hartmann sub-sea television camera which is provided with a scanner 9, and lens 6, together with a second lens 7, prism 11 and movie camera 12. The electric motor 13 and propeller 14, help to pull the device down to the desired depth in the water.

denizens of delicate structure can be studied by the television camera, as well as recorded by the film camera mounted inside the steel ball.

Referring more specifically to the "television camera," the electrical current for operating the lights and the camera, as well as the television scanner motor, may be supplied over insulated electric cables leading down from the tender ship on the surface. If desired, batteries may also be placed within the steel ball to supply some of the current.

The numbered parts of the Hartmann sub-sea television camera are: 1—Steel water-tight ball. 2—Metal front disc carrying quartz lenses. 3—Lenses behind which are placed powerful lamps, 4, with reflectors 5. 6—Represents the lens which carries the sub-sea image to the television scanner 9, while 7 represents the lens for the motion picture camera 12. A double prism or periscope 8, carries the image to the television scanner disc, 9, and photo-cell 10, placed behind the disc. Prism, 11, carries the scene to the movie camera, 12, with its load of film, which may be color-sensitive; the camera records the view whenever desired through a second periscope or prism arrangement, 11.

Of course, the weight of the Hartmann submarine televisor will ordinarily cause it to sink, but Dr. Hartmann makes further use of an electric motor, 13, driving a propeller, 14, which exerts a downward pulling force on the device. An additional bank of powerful lights, 18, are contained in the chamber, 15. The steel sphere can be made to rotate either by the spinning motor and screw on the bottom, or else by a second propeller mounted on the side of the apparatus. On top of the sphere is a tank, 15, in which air is stored at high pressure; the pressure regulating valve, 16, varies the air pressure inside the large sphere and thus equalizes the water pressure constantly being exerted on the outer surface of the sphere. A relief or safety valve is provided at 20. Due to the special arrangement of the air equalizing means, the whole exploring device will rise to the surface if the cable should break.

Practical Hints on Cathode Ray Scanners

By M. RAPPAPORT, E.E.

(*Continued from page* 20)

filament, is applied to the cylinder, excellent electronic concentration is obtained. As a result, the electronic beam passes through a two-millimeter (.08 inch) aperture in the anode, without encountering any screening losses as in the Western Electric tube.

The system employed for preventing the divergence of the cathode-ray beam is exactly the same as that in the Western Electric tube, where a trace of inert argon gas having a pressure equivalent to approximately .001 millimeter of mercury is employed.

As explained in connection with the Western Electric tube, the brilliancy of illumination on the fluorescent screen varies with the anode potential. The Von Ardenne tube is designed to handle much higher anode voltages than that of the Western Electric Company's, and as a result much better insulation between the electrodes is imperative. It therefore becomes necessary to bring out all connections direct from the control electrodes, as shown in Fig. 7, instead of through the socket in the base of the tube as done by the Western Electric Company. Only the connections from the cathode and the Wehnelt cylinder are taken through the base.

The life of the Von Ardenne tube is considerably longer than that of the Western Electric tube; with care the life of the former tube will be almost two thousand hours, while that of the latter is several hundred hours.

The brightness of the image produced on the fluorescent screen of the Von Ardenne tube, is far more intense than that of the Western Electric tube; because of the very much larger anode potential the former tube is designed to handle. With an anode potential of about 2,500 volts on the Von Ardenne tube, *an image of such brightness is produced as to permit viewing it in a well lighted room.* The image on the Western Electric tube must be viewed in a darkened room.

By the increased anode voltage in the Von Ardenne tube, the velocity of the electrons is greatly increased, and as a result the sensitivity of the tube is decreased. It naturally follows that the Western Electric tube has greater sensitivity than the Von Ardenne tube. The electrostatic sensitivity of the Von Ardenne tube with an anode potential of, say, 500 volts is approximately 25 volts for one inch deflection; at 2.500 volts, the sensitivity is about one-fifth that at 500 volts.

The following table gives the operating characteristics of the Von Ardenne tube:

Filament voltage, 0.7 volts;
*Filament current (average), 1.5 amperes;
Anode, D. C. voltage (maximum), 2,500 volts;
Anode, current, 50 to 100 microamperes;
Focusing-cylinder, or Wehnelt-cathode, D. C. voltage, 50 to 400 volts;
Focusing-cylinder, or Wehnelt-cathode, current, 0 amperes.

The operating characteristics of the Western Electric cathode-ray oscillograph tube are:

Filament voltage, 2.0 volts;
Filament current, 0.85 to 1.15 amperes;
Anode voltage, 400 volts D. C. maximum;
Anode current, approximately 0.6 milliamperes maximum.

*The exact filament current is marked on each Von Ardenne tube.

Thyratron Oscillators for Cathode Ray Scanners

By M. RAPPAPORT, E.E.

(*Continued from page* 33)

Principle of "Sawtooth" Oscillator

Now let us consider the principles upon which a "sawtooth" oscillator which may be applied to television scanning are based. A very much simplified circuit is shown in Fig. 4. When the cycle commences, there is a very small potential across the condenser, a rather high potential across the ballast tube, and an opposing potential equivalent to the sum of the first two contained in the battery. When the condenser commences to charge, the voltage across it starts to rise. Correspondingly, there is a decrease in potential across the ballast tube as the resistance decreases. In other words, the potential drop across the tube is assumed by the potential rise at the condenser. Both voltages vary *exponentially* with time. The discharge takes place when the ignition voltage is reached.

When the ballast tube is operated at a rather high filament temperature, it becomes saturated; that is, an increase in plate voltage does not cause a further increase in current. The characteristic curve is illustrated in Fig. 5 which shows the plate current plotted against the plate voltage. If the upper portion of this curve is used in the operation of the ballast tube, it may readily be seen, the variation of the plate voltage over the portion *ab* does not change the current flow. By changing the filament current of the ballast tube, the characteristic may be shifted and operated over a different potential.

Factors Affecting Action of Thyratron

The following factors influence the action of the thyratron oscillator:

(1) Increasing the filament current in the ballast tube increases the frequency of oscillation.

(2) Decreasing the capacity of the condenser, undergoing the periodic charging and discharging, increases the frequency.

(3) Decreasing the grid bias on the thyratron increases the frequency.

(4) A frequency range of from one cycle per second to the upper audio frequencies is obtainable.

A view of the front panel may be seen in Fig. 6, while the schematic diagram of connections is shown in Figure 7.

R is the rheostat in the filament circuit of the ballast tube,
T is the filament rheostat of the thyratron tube,
G is the grid-circuit potentiometer,
C is a tap switch furnishing various capacities for frequency control; having a 1.0-microfarad condenser connected to the first tap, 0.1-microfarad to the second, 0.002-microfarad to the third. The fourth serves as a dummy tap.

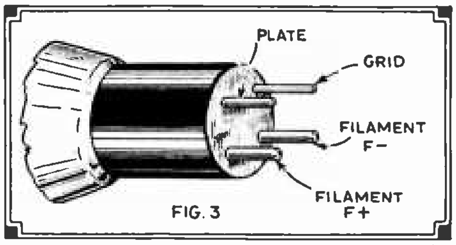


Fig. 3—*Base of a Thyratron.*

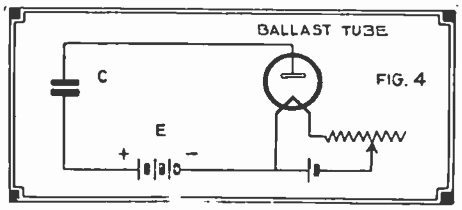


Fig. 4—*Simplified Oscillator Circuit.*

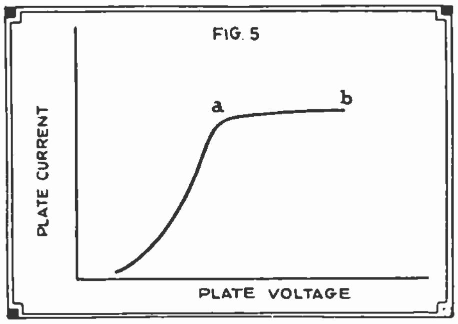


Fig. 5—*Saturation curve of ballast tube.*

(1) Set G negative.
(2) Turn C to tap 1.
(3) Turn T to the first turn on the rheostat and, after a few seconds, increase T until the rated current of about two amperes flows.
(4) Allow the thyratron to heat up for about thirty seconds.
(5) Turn on the ballast tube.

The Dalpayrat Light Projector for Television

(*Continued from page 34*)

readily: thorium for example. These extra electrons can be used to decrease the internal resistance of the tube and allow the passage of more current, in order to increase the intensity of the luminous discharge. This decrease of internal resistance cannot be obtained by placing the anode nearer to the cathode, as this would increase the capacity between those electrodes, and the glow might take place where it is not wanted.

Theory of Operation

The theory of this tube (in Fig. 2) is somewhat similar to that previously described. When a high potential difference is maintained between 2 and 3, the cathode emits electrons which are attracted by the anode; a current then flows from the anode to the cathode; and a glow discharge occurs. The tube is designed and adjusted in such a way that the glow will take place on the concave surface of the cathode. The electrons leaving the cathode are focussed into a thin line or jet at the center of the tube, as already explained, under the action of a powerful magnetic field supplied by the electro-magnet 4.

In a gas of low electrical conductivity, like neon, the current will flow only through the beam of electrons, and only that portion of the cathode which emits them at any given time will glow. The source of voltage applied on the electrodes, and the magnetic field, being continuous and steady, a small luminous spot of great intensity will appear exactly in the center of the concave surface. The concave surface of the anode can be either smooth or very finely stippled with small pin-point like cavities. The focussing field produced by electromagnet 4 can be increased to confine the luminous glow to one or more cavities; in that case the cavities will help to concentrate the glow into a smaller area, and the light thus produced will be more intense. However, a smooth surface is satisfactory for all practical purposes.

It is well to remember that every particle of gas contained in the tube, as well as all the elements enclosed in this tube, is continually permeated by the magnetic field of coil 4 and for that reason it is very important that no iron or any other magnetic substance be used within the tube or near its immediate vicinity. The only iron permissible near the tube is the iron casing totally surrounding magnet coil 4, to offer a path of lower resistance to the lines of force and to increase the field strength within the tube, by concentrating the lines of force where they are mostly needed.

Principle of Scanning

Fig. 3 shows a schematic drawing of the new principle of scanning used in this invention. Looking at one end of the completed device, one could locate the magnet coil 4, and an extra pair of coils 5 and 6, which are placed between the tube and the magnet coil as shown. The object of coils 5 and 6 is to vary the focusing field by increasing its strength when current flows through them. These coils must not affect the focusing field when no current is applied on them; for that reason, those coils do not have any iron cores, as the iron would absorb the lines of force and distort the focusing field. Without a signal and with the oscillators shut off the luminous spot would be at rest in the center of the concave surface of the cathode 2; and a steady beam of light would be projected forward by lens 7 in Fig. 2. Now, when a signal is received, and coils 5 and 6 are connected to specially designed "saw-tooth" oscillators, the focusing field will be increased or decreased intermittently within certain areas around the tube. These repelling actions, acting at right angles to each other and at a different rate or frequency of repulsion, will displace the focal point of the total magnetic field, and therefore the concentration point of the electrons; thus scanning the luminous spot over the surface of the cathode. In Fig. 2 only one deflecting coil 5 is shown; the exact position of both coils can be better seen in Fig. 3. The curvature of the surface of cathode 2 is very important, indeed quite essential; for a small motion of the luminous spot on this surface produces a greater angular displacement of the beams of light applied on lens 7, and thus a larger and wider sweeping action of the luminous beam upon the screen is obtained. A special combination of lenses is to be used in front of lens 7, to increase the divergence of the light rays in order to illuminate a large screen placed very near to the lenses. The cathode is made of solid metal, so that it will not become easily over-heated. Fig. 4 shows how two light points may overlap on the surface of the cathode, but will appear separated on the screen, when this screen is adjusted at the proper distance. This idea has been enthusiastically approved by many television experts, who believe that it has decided advantages which will help solve many difficult present-day television problems.

Radio Frequency Operation of Neon Tubes

By HARRY WALDRON

(Continued from page 30)

designed with particular care, to avoid disturbance of the characteristics of the preceeding stage due to the fact that grid current is drawn during the periods when the grids are driven positive. The power output obtainable under these circumstances is in excess of that required for normal conditions; and we will pass over this phase of operation with the comment that those desirous of so great an output power are either capable of the design or are unsuited to the performance of the task they have set themselves.

Receiver for Large Radio-Frequency Output

So far as the input circuit is concerned, the receiver for R.F. operation of the discharge tube is in all respects similar to the receiver employed in normal operation. Indeed, all circuits are similar, save that a sufficient number of R.F. stages must be employed to feed the output tube. All that this requires is the addition of a sufficient number of tuned circuits—perhaps five instead of three condensers, arranged in a gang control, being required. Because of the high output level, it is essential that sufficient shielding be provided to prevent feedback between the output circuit and the antenna. This, ultimately, requires that the leads connecting the neon tube to the receiver proper be threaded through braided metal shield, which is thoroughly grounded. Should we assume that a single '45 will give sufficient output for our particular purpose, we may proceed under the premise that a total of four screen-grid stages will be sufficient to provide the necessary input to the output stage. A receiver based on this assumption is shown schematically in Fig. 2.

Superheterodyne for R.F. Operation

The first thing to strike the average reader will be the fact that seven tuned circuits are employed in the receiver shown in Fig. 3. When we consider the fact that this is a purely experimental receiver, built to establish the accuracy of a theory and not for commercial distribution, this will be seen to be a pardonable fault. In commercial work it will be necessary in the interests of economy to go to the superheterodyne for an answer to the problem of simplifying the circuit structure. In this case the number of tuned circuits would be readily reducible to four.

Of these two would be for the operation of an input band-selector; one for the detector tuning; and the fourth an offset-cut condenser, tuning the oscillator for single control. While some work has already been done on this adaptation of the design, the experimental data are far from complete. So far, we have been unable to determine the correct intermediate frequency to be used in an attempt to obtain the maximum band width with the maximum R.F. gain per stage. The data will be complete within a short time, and will then be presented for the approval of the amateur.

Light Beam Television

(*Continued from page 6*)

Still Shorter Waves

"The logical progress of this development," said Dr. Alexanderson, "is that in the future we shall explore still shorter waves, until we finally arrive at the light waves, which we know travel in straight lines and which can be accurately controlled by such optical means as mirrors and lenses.

"When it was decided to take up experimentation on this subject, Dr. Irving Langmuir of the research laboratory was consulted about the probabilities of being able to modulate a source of light at the required high frequencies of from 100,000 to a million cycles. Dr. Langmuir, who has done much research work with arcs, believed that this could be accomplished by using a high-intensity arc. It was concluded that a most desirable light would be a high-intensity arc of the type where the light comes from the arc rather than from the crater. In the 10-ampere arc lamp used for the first test, most of the light was from the crater, and comparatively little light in the arc. The lamp was used in such a way that the light from the crater was eliminated, and the arc used was therefore quite a weak source of light. The current from our standard television pick-up was superimposed upon this arc, and the light from the arc intercepted by a photo-electric tube at a distance of 130 feet. A photo-electric tube was then used to control our regular television projector. The television image transmitted in this way had the same sharpness of detail as the one ordinarily obtained without the interposition of the light beam."

In 1927 a picture three inches square on the screen was achieved by Dr. Alexanderson; in 1928 the first radio-television drama was broadcast from Schenectady; in the fall of 1929 a picture 14 inches square, not simply black and white like a silhouette, but with all the gray shades for depth and detail, was produced; in 1930 Dr. Alexanderson sent television signals to Australia and back, and after travelling 20,000 miles a rectangle still had four corners: and in the same year television first appeared as part of a regular performance at a theater in Schenectady with an image on a screen seven feet square.

Talking Light Beams

Modulated light has also been used in many previous experiments by the General Electric Company. For instance, there is the talking beam of light that has been used at meetings and convention demonstrations, and the ship-to-shore communication of last summer with a similar talking light beam.

Various other radio and pure research findings of other General Electric scientists, also are reflected in the new experiments with light-transmitted television. For instance, there is the work of Dr. Langmuir and W. F. Wesendorp with a fog-penetrating light for aviation, wherein it has been demonstration that a photo-electric tube is sensitive to modulated light, even if the atmosphere is so foggy or hazy that the light source cannot be seen! This has led to the belief that, in event of local broadcasting with modulated light, haze and fog will not seriously interfere with signal reception.

Television Course

By C. H. W. NASON

(*Continued from page 41*)

of a satisfactory character; but these may no longer be available, save through salvage houses.

Lighting for the Television Camera

The lighting for the television camera depends, as in the case of the *flying-spot* apparatus—upon the color sensitivity of the cells employed. Here it is not possible to employ a combination of several types, and the demands of sensitivity seems to dictate the use of the caesium—oxygen cell.

The color sensitivity of this cell is toward the red end of the spectrum, with a slight though pronounced peak in the violet. Its characteristics are almost those of the orthochromatic or panchromatic film now used for motion-picture work; and the incandescent lamps employed in motion-picture work are excellent for the purpose. A pair of 1,000-watt lamps, with suitable reflectors, will serve for the usual form of work where too wide a field of view is not covered. These lamps may have sufficient thermal inertia to permit their being operated from A.C. supply lines, in installations which do not require a high response in the lower frequencies. In professional installations, however, it is essential that D.C. supply be employed.

While on the subject of lighting, it might be noted that in the case of arc lighting, as employed in *flying-spot* systems, it is sometimes necessary to filter the D.C. supply. This may usually be accomplished by means of a bank of batteries across the line.

A Drum Scanner

By MILTON TREUHAFT

(*Continued from page 21*)

on the hypothenuse as becomes clear.

Slip a thin needle into one of the 60ths, so that it just touches both lines. Now put a blot of india ink over the whole thing and let it dry thoroughly. When you remove the needle from the line, you will have an accurate drill, the depth of which is gauged by a thin ring of india ink.

All that is left to do now is to punch the holes and glue the ends of the belt together. This can be accurately done by the use of thin flaps.

The drum may be mounted upright, provided a mirror is used to reflect the image as shown.

N. Y. Sun 2nd Prize Winner

(*Continued from page 25*)

finished the cathode wiring should next be attempted, followed by the connecting in of the various resistors and condensers.

The set is connected to the supply line, in this instance a 110-volt A. C. system. The tubes are allowed a few seconds to warm up. Then the tuning dial is rotated to a point representing approximately 150 meters or 2,000 kc. In this vicinity careful tuning will soon reveal a rather high-pitched buzzing note. This is a television signal. Tune to the signal and manipulate the volume control until the signal is somewhat louder than would be desired from a sound receiver.

The Pioneer Receiver and Scanner

By JOHN J. FETTIG

(*Continued from page* 32)

use from showing. To frame the image horizontally, the lamp is moved from side to side. This method is much simpler than that of having only one spiral in the disc; in which case the motor would have to be stopped and started until the top hole in the disc corresponded with the top hole in the transmitting disc.

Two Motors Used

The disc is brought up to speed by the use of an induction motor. Once up to speed, this motor is thrown out of the circuit by means of a switch, and the Pioneer synchronous motor then takes up the work of driving the disc at 1,200 R.P.M. The absence of speed controls tends to make operation of the scanner fool-proof.

There are only two knobs on the control panel, and both operate switches. The S.P.S.T. switch on the left controls the 110-volt line-current; while the right-hand S.P.D.T. switch is used to change over from the induction to the synchronous motor. The image can be viewed either directly from the disc, or through a six-inch magnifying lens which is mounted in a holder tilted at the same angle as the disc, and at its proper focal length (9 inches) it will magnify the image to three times its normal size. The scanner is constructed to use a one-inch square plate neon lamp. Any lamp with this size plate will suffice; although the writer has found that a better percentage of modulation is obtained by the use of the Speed *wall-electrode* neon tube.

Television in Politics!

(*Continued from page* 22)

leaders in Washington, has been authorized to make the offer.

It would be the first time in history that such a broadcast had been made outside a studio except experimentally, William Hedges, manager of the station, said. Station W9XAP has been operating for a year and a half; its power is 2,500 watts, with a receiving area of 500 miles.

"We are able to broadcast over television the features of three or four persons at once," said Clem F. Wade, president of the Western Television Company, which would supply equipment for the broadcast. "In close-ups the faces would appear as clearly as in newspaper halftones."

The Boston Television Station

By HOLLIS S. BAIRD

(*Continued from page* 11)

red shades. The output of these cells goes directly to a two-tube "head" amplifier in the base, where a '24 tube is used for voltage amplification and a '71-A to feed the line to the control room. The arc throws its light through a drum, instead of the conventional disc, and gets away from the "keystone" or wedge-shaped picture of a disc. When this picture is also received on a drum, the scanning at both ends will be done in straight lines instead of the curved lines of a disc. Since these curved lines would be inverted by the projection lens at the transmitter, the shape of the subject would be slightly distorted. This is particularly noticeable if the subject is well known to the person watching him over the receiver.

In the projection room at the rear of the studio, we also see the motion-picture transmitter, for sending silent film, shown in another photo. This is not used a great deal, because of the inability to obtain a suitable variety of film which transmits well on sixty lines.

We now go into the *transmitter* room. Here we see the amplifier racks, which contain the speech and main television amplifier, and also a *monitor* for the picture, which can either be switched to the amplifier or to a picture off the air. (The monitor is not shown in the photograph.) The television amplifier gives uniform amplification from 20 cycles to 10,000 cycles and has a rising characteristic from there up to 40,000 cycles, to make up for the higher frequencies attenuated in the photo-cells because of their gas, and inter-electrode capacity. One of the photos shows two transmitters: W1XAU, the further one, transmits voice with 500 watts, on 1,550 kilocycles. The one in the foreground, W1XAV, is capable of nearly 3,000 watts, but is licensed for only 1,000 watts. W1XAV will be on the 1,600-1,700 kilocycle band after February 1.

Over in a corner (not shown in the photo) there is the small transmitter of the ultra-short-wave station W1XG. This has been transmitting regularly on 45 megacycles (66.63 meters) since October, 1931, with the usual 60-line picture. 120-line scanning equipment is

(*Continued on page* 60)

TELEVISION TIME-TABLE

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

Location of Transmitter	Lines and F.P.S.	Call Signal	Frequency in kilocycles (meters in parentheses)	Power (watts in antenna)	Licensee and Address
California: Bakersfield	—	W6XAH	2,000 (150) to 2,100 (142.9)	1,000	Pioneer Mercantile Co., 1526 Twentieth St.
Gardena (near)	—	W6XS	2,100 (142.9 to 2,200 (136.4)	500	Don Lee (Inc.).
Los Angeles	—	W6XAO	43,000 (6.97) to 46,000 (6.52), 48,500 (6.18) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	——	Don Lee, Inc.
Illinois: Chicago	48	W9XAA	2,750 (109.1) to 2,850 (105.3)	1,000	Chicago Federation of Labor.
" "	45-15	W9XAP	2,000 (150) to 2,100 (142.9)	500	Western Television Corp., 6312 Bway.
" "	24	W9XR	2,100 (142.9) to 2,200 (136.4)	2,500	Chicago Daily News
Downers Grove	24	W9XAO	2,850 (105.3) to 2,950 (101.7)	5,000	Great Lakes Broadcasting Co., 72 W. Adams St., Chicago.
Indiana: West Lafayette	—	W9XG	2,750 (109.1) to 2,850 (105.3)	1,500	Purdue University, 400 Northwestern Ave.
Iowa: Iowa City	—	W9XAZ	2,000 (150) to 2,100 (142.9).	500	State University of Iowa
Maryland: Silver Springs	60-20	W3XK	2,000 (150) to 2,100 (142.9). Voice on W3XJ, 187 meters. Time 5-6, 9-11 E.S.T. eve.	5,000	Jenkins Laboratories, 1519 Connecticut Ave., Washington, D. C.
Massachusetts: Boston	60-20	W1XAV	2,850 (105.3) to 2,950 (101.7). Voice on W1XAU, 104 meters.	1,000	Shortwave and Television Laboratory.
New Jersey: Camden	Varies	W3XAD	2,100 (142.9) to 2,200 (136.4), 43,000 (6.97) to 46,000 (6.52), 48,500 (6.18) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	500	R. C. A. Victor Company (Inc.)
Passaic	60	W2XCD	2,000 (150) to 2,100 (142.9)	5,000	De Forest Radio Co.
New York: Long Island City	—	W2XBO	2,750 (109.1) to 2,850 (105.3)	500	United Research Corp., 39 Van Pelt Ave.
" " "	60-20	W2XR	2,100 (142.9) to 2,200 (136.4), 2,850 (105.3) to 2,950 (101.69), 43,000 (6.98) to 46,000 (6.52), 48,500 (6.19) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	500	Radio Pictures, Inc., 3104 Northern Blvd.
New York	60-20	W2XAB	2,750 (109.1) to 2,850 (105.3). Voice on W2XE, 49.02 meters.	500	Columbia Broadcasting System, 485 Madison Ave.
" "	60-20	W2XBS	2,100 (142.9) to 2,200 (136.4)	5,000	National Broadcasting Co. (Inc.), 711 Fifth Ave.
" "	60-20	W2XCR	2,000 (150) to 2,100 (142.9). Voice on WGBS, 384.4 meters	5,000	Jenkins Television Corp, 655 5th Ave.
New York	60-20	W2XDS	43,000 (6.98) to 46,000 (6.52), 48,500 (6.19) to 50,300 (5.96), 60,000 (5) to 80,000 (3.75)	2,000	Jenkins Telev. Corp., 655 Fifth Ave.
" "	—	W2XF	43,000 (6.97) to 46,000 (6.52), 48,500 (6.186) to 50,300 (5.964), 60,000 (5) to 80,000 (3.75)	5,000	National Broadcasting Co., (Inc.)
Schenectady	Varies	W2XCW	2,100 (142.9) to 2,200 (136.4)	20,000	General Electric Co.
Pennsylvania: East Pittsburgh	60	W8XAV	2,100 (142.9) to 2,200 (136.4)	20,000	Westinghouse Electric & Mfg. Co.
" "	60	W8XT	660 (455)	25,000	Westinghouse Electric & Mfg. Co.
Wisconsin: Milwaukee	45	W9XD	43,000 (6.97) to 46,000 (6.52), 48,500 (6.18) to 50,000 (5.96), 60,000 (5) to 80,000 (3.75)	500	The Journal Co. (Milwaukee Journal).
PORTABLE Massachusetts: Boston	60-20	W1XG	43,000 (6.977) to 46,000 (6.522), 48,500 (6.186) to 50,300 (5.964), 60,000 (5), 80,000 (3.75)	30	Shortwave & Television Corp, 70 Brookline Ave.
New Jersey: Passaic	60-20	W2XAP	2,000 (150) to 2,100 (142.9)	250	Jenkins Television Corp.
Bound Brook	Varies	W3XAK	2,100 (142.9) to 2,200 (136.4)	5,000	National Broadcasting Co., Inc.
New York State:	Varies	W2XBT	43,000 (6.977) to 46,000 (6.522), 48,500 (6.186) to 50,300 (5.964), 60,000 (5), 80,000 (3.75)	750	National Broadcasting Co., Inc.
United States: (Throughout)	60-20	W10XG	43,000 (6.977) to 46,000 (6.522), 48,500 (6.186) to 50,000 (5.964), 60,000 (5), 80,000 (3.75)	500	De Forest Radio Co., Passaic, N. J.

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

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

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

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

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

The Boston Television Station

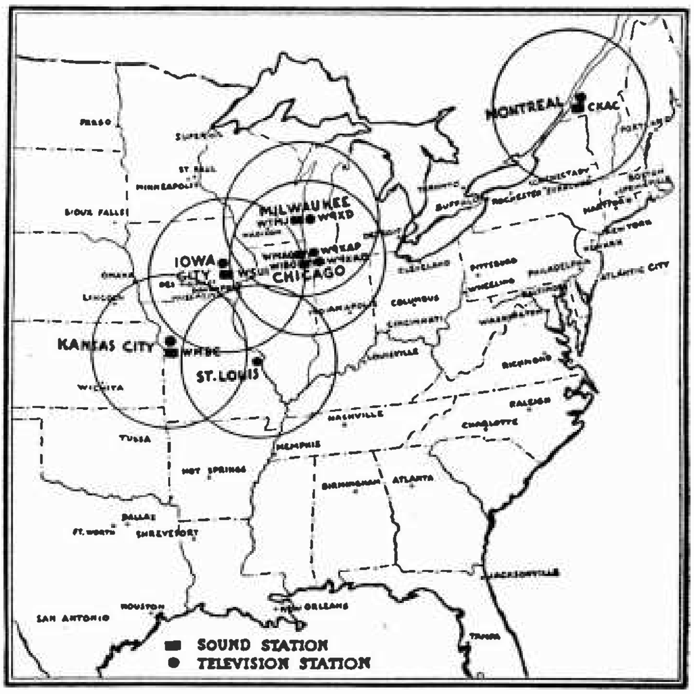
(*Continued from page* 58)

now under construction for this station and will be in operation shortly. W1XG uses 30 watts at present, but has just received an increase to 200 watts. It has a portable station license, and the transmitter may be taken to any location for making field tests.

In June, 1931, a lamp department was installed to make our own neon tubes. We have developed a source of pure white light for the 8 by 10 inch projector, in addition to point-source (crater) neon lamps; and we are now constructing our own cathode-ray tubes, built around new methods of modulation, which has probably been the biggest single problem in cathode-ray development.

New "Telecasters" in Mid-West and Canada

The midwest has had to be satisfied with television images radiated from Chicago, and once in a while "seeing" eastern images from New York or Washington, D. C., stations. But as the map shows, this section of the country (and also Canada) is now or soon will be served by five new telecasting stations.



THE television stations shown on the map are either using or will use the system developed by the Western Television Corporation. News of the success achieved by western broadcasters spread across the Canadian border with the result that the Dominion's first television station is under way. It will be located in Montreal and operated by the French newspaper, *La Presse*, in conjunction with its sound station, CKAC.

A marked contrast in television practice between the east and the west lies in the fact that all western stations are either working or have perfeced plans for working in conjunction with a sound station in the broadcast band. Most of the eastern stations operate synchronized television programs on experimental channels, if synchronization is attempted.

The unparalleled expansion and advancement of the art in the central states is due in part to the advantages afforded by terrain and the presence of far-flung power networks, so accurately controlled or actually tied together over such extensive areas, as to practically eliminate the problem of synchronization between transmitter and receiver. This is a marked advantage in television. an art that depends upon absolute synchronization between the mechanical parts at the transmitter with the corresponding ones at the receiver.

Regular reports from observers living hundreds of miles from the broadcasting stations attest the high degree of consistency and the lack of difficulty in synchronization.

Up to 400 and 500 miles television pictures are received with remarkable clarity and with freedom from distortion except at times when atmospheric conditions create interference.

On the basis of the experience of the Chicago stations, it is safe to assume that the area within a 200 mile radius of a television transmitter located in the central states will receive fairly consistent results nine months out of the year. Therefore, the three stations located in Chicago and Milwaukee, and the three in St. Louis, Iowa City and Kansas City will supply a variety of television entertainment to millions of homes in the central west.

Fire in Jenkins Plant

AN electric arc which burst the vacuum tube enclosing it started a fire in a neon and argon gas purifier in the Jenkins television plant at Passaic, N. J., on Jan. 21. The arc, which, with the aid of oxygen fed into it, purified the gases, set the adjoining walls ablaze and the flames spread rapidly.

The main manufacturing plant was not threatened, however.

In addition to other valuable apparatus and equipment, Station W2XCD, which nightly broadcasts a television program under the operation of the Jenkins Television Company, a de Forest subsidiary, also was destroyed. Officials of the de Forest company announced that the broadcasting would be continued from the New York Station at 655 Fifth Avenue.

A New Crater Tube Development

By HARRY ROSENTHAL

(*Continued from page* 26)

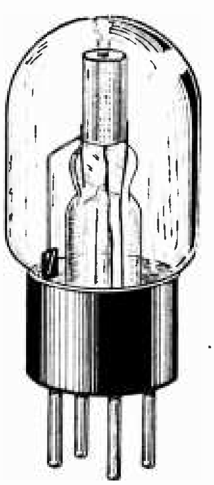


Fig. 4—Picture at left shows finished crater tube of new type, described at length in the accompanying article. The main feature of this tube is the placement of the light source in front of the anode, so as to realize a maximum brilliancy. The tube has a four-pin base that fits into a standard radio tube socket

light, as the entire light available is concentrated to a point or "ball". This is largely outside the hole in the anode, with the ionized gas coming from the cathode within the tube, a design method of both electrical and mechanical novelty. Both the type of gas used and the pressure must be controlled carefully, if the desired result is to be obtained.

The hole in the cathode is about .07" in diameter and about ¼" deep—the ratio of width to depth being about 8 to 1. Under these conditions full advantage of the theoretical possibilities may be taken and the true point-source obtained.

The cathode may be made in whole or in part from one of the alkali metals in order that the advantage of lower striking potential may be achieved. Certain of these metals have the added advantage of cleaning up the gas impurities as well. This latter feature is important if long life and uniform operation are to be obtained.

By using such metals as Beryllium and Magnesium, a good clean-up of impurities may be achieved. After several hundred hours such tubes still show excellent characteristics.

Contrary to general practice, the alkali metal cathode is not of such great mass as to prevent vaporization—rather a slight evaporation of the metallic vapor is desired, so that the spectral lines of the discharge will contain not only the characteristics of the gas with which the tube is filled, but of the metal also.

Television images obtained with such a tube are of an unusual brilliance and clarity.

4-Tube Television and Broadcast Receiver

By H. G. CISIN

(*Continued from page* 31)

toothed rotor, both on the same shaft. The induction rotor brings the motor up to speed, and the synchronous rotor is then brought into the field by means of a convenient lever. If the image happens to get out of frame, a touch of the lever promptly brings it back again.

Complete List of Parts Required for the Television-Broadcast Set

1—Electrad Volume Control, type R1 201 (3), with toggle "on-off" switch (48).
1—Electrad 200-ohm Flexible Grid Resistor (5).
1—Electrad 400-ohm Flexible Grid Resistor (36).
1—.00035-mf. (each section) Cardwell Triple Variable Condenser, type 317-C Shielded (8, 16, 23).
3—Toggle Switches (6, 17, 21).
1—.0001-mf. Aerovox Mica Condenser, type 1460 (28).
1—.006-mf. Aerovox Mica Condenser, type 1460 (31).
2—0.1-mf. Aerovox Metal Can Condensers, type 260 (13, 14).
2—1-mf. Aerovox By-Pass Condensers, type 200 S (24, 29).
2—8-mf. Aerovox Dry Electrolytic Condensers, type E5-8 with M't'g Rings or G5-8 with screw M't'g (38, 39).
1—25-mf. Aerovox Dry Electrolytic Condenser, type E25-25 or G25-25 (35).
1—Shielded Conoid Antenna Coupler (4).
2—Shielded Conoid R.F. Coils (10, 20).
1—5,000-ohm I.R.C. Metallized Resistor (Durham) type M.F.4 (27).
1—7,500-ohm I. R. C. Metallized Resistor (Durham) 2 watts, type M.R.4 (12).
1—20,000-ohm I. R. C. Metallized Resistor (Durham) 2 watts, type M.R.4 (11).
1—25,000-ohm I. R. C. Metallized Resistor (Durham) type M.F.4 (25).
1—50,000-ohm I. R. C. Metallized Resistor (Durham) type M.F.4 (15).
1—100,000-ohm. I. R. C. Metallized Resistor (Durham) type M.F.4 (30).
1—1-meg. I. R. C. Metallized Resistor (Durham) type M.F.4 (32).
3—Small Equalizing Condensers, cap. 2 to 35-mmf. (7, 18, 22).
1—I. C. A. Output Coupling (Impedance Matching) Transformer, No. 1377 (42).
1—Trutest Power Supply and Filament Transformer, No. 66952 (46).
1—Trutest 30-Henry Choke (34).
4—Five-Prong Wafer-type Sockets (9, 19, 26, 33).
4—Four-Prong Wafer-type Sockets (37, 47) (Y1-Y2-Y3) (Z1-Z2).
2—Four-Prong Plugs (Y1-Y2-Y3) (Z1-Z2).
1—Double-Pole, Double-Throw Switch (43).
1—Amperite, Self-Adjusting Line-Voltage Control, type 5A-5 (47).
1—Full-Vision Dial, with 2½-volt Pilot Light (49).
1—Roll of Corwico Braidite Hook-up Wire, solid core.
1—Pair of Twin Binding Posts (1, 2).
2—551 Arcturus Variable-Mu Tubes (9, 19).
1—124 Arcturus Screen-Grid Tube (26).
1—PZ Arcturus Pentode-Power Tube (33).
1—180 Arcturus Full-Wave Rectifier Tube (37).
1—Dynamic Speaker, Wright DeCoster "Infant" Model, with 750-ohm field (44), and with pentode-type output transformer (45).
1—Aluminum Chassis, 12 to 14 gauge, 12" x 12" x 3" high.

1—Weston Portable Milliammeter, range 0-100-ma., model 280.
1—Electrad Super-Tonatrol No. 2, used as Current Regulator for Neon Lamp (40).
1—Insuline I. C. A. "Visionette" Kit consisting of Special Television-type Motor, 60-hole 16" scanning disc, Neon Lamp (41), Lens Magnifying System, Mirror Screen, Shadow Box and Metal Housing.

NOTE: Numbers in parentheses refer to parts in diagrams.

(COIL DATA: Secondary: Wind 75 turns of No. 29 enameled magnet wire, on a 1-inch dia. form. One-eighth inch below it, on the same form, wind 14 turns of No. 29 wire for the antenna coil (primary); for the primary coils (on the R.F. transformers) which connect in the plate circuits of screen-grid tubes use 35 turns of No. 29 magnet wire. The secondary data given are for .00035-mf. variable condensers tuning 200 to 550 meters.)

Vision Transmitters for Amateurs

A total of 27 *television broadcasting transmitters* for *amateurs* were sold during the Chicago Radio-Electrical Show by Western Television Corporation, according to Clem F. Wade, president. Sales were made in the following states: Texas, Ohio. Indiana. Illinois. Iowa. Wisconsin and Kentucky. Sales were also made in New Zealand and Mexico.

Western Television introduced at the exposition a specially constructed television broadcatsing set for use of amateurs who now hold Federal Radio Licenses.

"We feel especially elated at the acceptance of this new product by the amateurs," stated Mr. Wade. "With the amateurs exchanging pictures with each other as they do signals and voice at the present time, the interest in television will grow many fold within a short space of time."

Televising Sun's Eclipse

By D. E. REPLOGLE

(Continued from page 7)

Columbia Chain-Station W2XAB, Doctor Fisher held a board with a black background upon which were mounted white and black circles representing the positions of the sun and the moon. Slowly, the dark circular body approached the white one, until finally in dumb show, the eclipse was total. Gradually, a slender rim of the white reappeared until once more the sun at the studio shone forth in all its effulgence and glory.

This image was picked up by the flying-spot equipment at the studio and propagated through space by the television transmitter.

At the Museum, Mr. Replogle and his associates had installed a huge screen of ground glass. The radiovision equipment called into use consisted of a standard "stock" Jenkins receiver. The output of this receiver was fed to a heavy duty amplifier, operating a special De Forest crater lamp. The light intensity of this lamp was strong enough after its projection through a three foot Jenkins lens disc to travel ten feet to the screen. This screen carried the broadcast from the station in the manner of motion picture projection—brilliant the light and perfect the detail of shadow and light—so that the audience witnessed the eclipse as it occurred under the deft and capable management of Doctor Fisher. Mr. Caldwell delivered the lecture at the Museum, where the peculiar brilliance on the screen and the slowly advancing shadow of the moon into the orbit of the sun became highly effective, as he gave a vivid description of the event science has charted according to its calculations, to transpire during the month of August this year.

Folks were interested. Following this flight into the sublime, the matter of radiovision reception took the center of the stage. There was a special program of half-tones picked up from Jenkins Station W2XCR. Another came in from Jenkins Station at Washington, W3XK. The half-tones aroused considerable enthusiasm. Pictures from the Washington station were good, but floated by, because of differences in the respective power systems controlling broadcast and reception. Radiovision advanced considerably farther on the road toward its ultimate destiny under the egis of scientific demonstration and the more popular programs of the day.

At the conclusion of the various features the auditors were invited to come up on the stage. The members of the Jenkins staff explained the functions of the Jenkins equipment, which was used in this demonstration.

Over 25,000 Men *have been trained under my supervision for the* Better Jobs in RADIO

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R. L. DUNCAN, *President*
Radio Training Schools

As a graduate and a student under your supervision, I have only the highest praise and satisfaction to offer. Any man of ordinary intelligence wanting to learn Radio could not help but master it by your method of training.
GEORGE A. KRESS,
2997 Montclair Ave., Detroit, Michigan

I am a Projectionist in charge at the Andelus theatre, recently completed. You may quote me at any time or place; refer to me, if you wish, anyone who may be interested in this vast virgin field of all that pertains to Radio and its many allied industries, and I shall be delighted to champion honestly without any reservation, your courses.
A. H. STRENG,
3005 Woodburn Ave., Cincinnati, Ohio.

To study Radio under R. L. Duncan is to learn it properly and in a way that is pleasant and fascinating. Once again thank you for your kind assistance and helpfulness.
E. E. PRICE,
361 Cotean St., W., Moose Jaw, Sask., Canada.

Although it has not yet been a year since I enrolled for a course under your excellent supervision, I have opened a Radio Service Shop that is effective, successful and profitable. People come for my services from everywhere.
RUSSELL PEARCE,
936-18th Street, Des Moines, Iowa.

THESE MEN MAILED THEIR COUPON

IN hundreds of Broadcasting Stations . . . in Radio Manufacturing Plants throughout the country . . . in Radio Laboratories . . . in Wholesale and Retail Radio Stores . . . in Radio Servicing . . . in Sound Motion Picture activities . . . on hundreds of ships that sail the Seven Seas . . . and even in the latest Television developments—you will find ambitious men who have been trained under my direct supervision.

I have devoted the last twelve years exclusively to the training of men for all branches of Radio. Employers in the Radio field recognize my methods of qualifying men and young men. I have geared my training to the rapid growth and development of the Radio industry. My courses, text books, methods and equipment are based on years of practical experience.

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My courses include everything needed for thorough training. There are no "extras" or "specials" to cost you extra money. The lessons, text books, methods, correcting, grading and returning of examinations, all the extra help and personal consultation you need . . . everything is provided until you complete your training.

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Without incurring the slightest obligation on my part, please send me a copy of your latest book, "Facts About Radio."

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MARCH SPECIALS!!

WE are announcing an important new departure this month. Every month we will show on this page certain *STAR* ★ items, which are NOT LISTED IN OUR CATALOG. These are all specials of which the quantities on hand are not sufficient to catalog them. *Once sold out, no more can be had.*

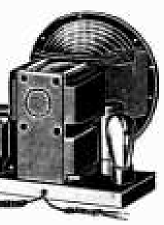
STOP SHOPPING. The lowest prices are right on this page. *No one undersells us.* We meet any price on ANY NEW Merchandise. Order direct from this page and save money. 100% satisfaction on every transaction. Take advantage of these special offers. ORDER NOW, TODAY.

NEW! "LITTLE GIANT" DYNAMIC SPEAKER

Absolutely the smallest dynamic speaker that will withstand the strain of modern output power tubes, ever manufactured. Suitable for use on midget, portable and automobile receivers. Measures but 6¼ in. long over-all, having a 4½ in. diaphragm and weighing but 4 lbs. The "Little Giant" has, under test, actually flooded a ten-room apartment with faithfully reproduced music of virtually original tone quality. Field winding has a resistance of 2500 ohms and may therefore be energized by using it as a filter choke in the power pack, thereby serving a double purpose. This last feature makes the "Little Giant" excellently suited for portable A.C. sets, since it does away with filter chokes and thus with considerable weight. Equipped with built-in output transformer to work from any standard output power tube arrangement. Specify the power tube or tubes used when ordering. Shipping weight 5 lbs. List Price $6.50.

No. 1549. LITTLE GIANT DYNAMIC SPEAKER..Your Price $2.50

★RCA VICTOR 11-INCH DYNAMIC SPEAKER



For 110-20 Volts 60 Cycle Operation

A superior, heavy duty unit embodying all the fine principles of construction and operation typical of all RCA and Victor radio equipment. Designed especially to accommodate large theatres, halls, armories and outdoor stadiums. Includes a completely shielded, heavy duty power transformer feeding a type 280 full wave rectifier which energizes the field coil with smooth, unfailing current. In addition this current is thoroughly filtered by an 8 mfd. electrolytic condenser which completely reduces hum to an absolute minimum. A special high quality output transformer, to operate out of any standard arrangement of power tubes, is furnished with each unit (specify the type of power tube or tubes employed when ordering). Both speaker and electric cords and plugs are supplied with speaker as is the '80 rectifying tube.

The over-all dimensions are 12" high, 12" wide and 8" deep. Provided with adequate mounting facilities.

A 9" corrugated cone insures strength and durability under the most powerful operating conditions. Capable of handling a tremendous amount of volume without distortion. Designed for 110-20 volts 50-60 cycles. Shipping weight—32 lbs. List Price, $25.00.

No. SP9056—RCA Victor Dynamic Speaker, Your Price.... $13.50

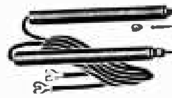
World-Wide Short-Wave Set NOT A CONVERTER

NEW

A perfect radio short-wave receiver for use between 18 and 200 meters. To put into operation, connect antenna, ground, 45-volt "B" and two No. 6 dry cell "A" batteries, and headphones to the posts provided, plug in a type '30 tube, and tune in! An ingenious circuit makes possible a 4-coil single-winding plug-in design. This little instrument has the same sensitivity as many big, shielded short-wave receivers costing ten times as much. A power amplifier may be added for any degree of volume. Complete with 4 plug-in coils. Has fine vernier dial for precision tuning. **Never has a first class short-wave set sold for so little money.** This short-wave set measures 5¼x7x4 in. high, over all. Ship. weight, 3 lbs. List price, $12.50.

No. 1666—World-Wide S.-W. Set. Your price.................. $6.25

★SERVICEMEN'S SPECIAL TEST PRODS



Here's what every serviceman and experimenter has been waiting for—test leads that CAN PIERCE THE TOUGHEST OF WIRE INSULATION AND TAKE VOLTAGE AND OTHER MEASUREMENTS WITHOUT THE NECESSITY OF STRIPPING WIRES. These test prods are so constructed that instead of the usual phone tips, adjustable chucks, capable of securely gripping steel phonograph needles, are permanently attached to the ends of the insulated handles. The use of these prods completely eliminates the introduction of errors in meter readings caused by poor-contact resistance or resistance resulting from the presence of dirt and grit. Five feet of flexible, color-coded leads securely soldered to the metal chuck insures permanent and positive electrical contact. The other ends of the test leads are provided with convenient U-shaped connection lugs. Shipping weight—½ lb. List Price, $1.40.

No. SP9055—Servicemen's Special Test Prods, Your Price......... $ .35

★FLECHTHEIM PORTABLE VOLTMETERS

Flechtheim superior built instruments have well earned a reputation of reliability for their unusual life and accuracy in actual use. These voltmeters which are available in two types, namely, 0 to 500 volts DC and 0-600 volts AC-DC, and which have an internal resistance of 60 ohms per volt are sturdily and attractively constructed in a nickel-plated, highly-polished protective shield case. The scales are evenly and accurately calibrated so that although the range is higher than 500 volts, the comparatively low voltage of 5 can be easily and quite accurately recorded. Each meter is of the portable type, being provided with convenient mounting rings for hanging on walls or test panels. Sold complete with 3 ft. flexible test leads provided with phosphor bronze, non-corroding test tips and non-breakable color-coded insulated handles. Shipping weight—¼ lb. List Price, $7.50.

No. SP9051—0-500 DC Voltmeter.
No. SP9052—0-600 AC-DC Voltmeter—Your Price $3.25

FREE 76 Page Radio Treatise No. 24

100 New Hook-Ups, etc. 675 Illustrations.

The new Winter edition of our RADIO SERVICE TREATISE, twice as large as our former one, has just come off the press. It is positively the greatest book in print—NOT JUST A CATALOG. It contains a large editorial section—a veritable book in itself—with valuable information NOT FOUND ANYWHERE ELSE. Among the wealth of new technical information listed in the editorial sections are the following: 1932 Complete Radiotron Characteristics SHORT-WAVE TUNERS and PHONO-PICKUPS.—Constructional Data of SERVICEMEN'S TEST OSCILLATOR—ALL ABOUT TONE CONTROLS—SHORT-WAVE ADAPTERS AND CONVERTERS—CONSTRUCTING A 3-TUBE SUPER-HET SHORT-WAVE CONVERTER. —MODERNIZING OLD RADIO SETS.—LATEST TYPE MULTI-MU AND PENTODE TUBES.— ALL ABOUT DC RECEIVERS.—VACUUM TUBES TREATISE.—And dozens of new radio experiments, hints to Servicemen, valuable tables of useful data, etc., etc.

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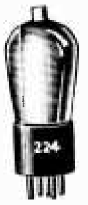
6 MONTHS GUARANTEED NEONTRON TUBES



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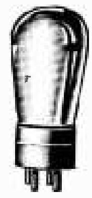


Choice	Choice of	Choice	Choice	Choice (NEW)	Choice (NEW)
226	112A	245	222	230	235
227	200A-199X	280	210	231	247
171A	199UV-120	171	250	232	238
201A	224		281		236-37
					551
60c ea.	69c ea.	70c ea.	1.58 ea.	1.08 ea.	1.08 ea.

R.C.A. LICENSED TRIAD AND PERRYMAN TUBES

These nationally advertised tubes are guaranteed UNCONDITIONALLY for six months. The prices are slightly higher than our NEONTRONS because these tubes are of much better quality. See listing above for tube numbers.

Choice Price	Choice Price	Choice Price	Choice Price	Choice Price	Choice Price
63c	80c	75c	$1.76	$1.15	$1.15

★MICROPHONE PRE-AMPLIFIER

An extremely compact and efficient unit designed to "boost" the weak microphonic currents to proportions which will correctly match the input stages of all type amplifiers. May be used with either one or two-button microphones. This pre-amplifier unit provides a "booster" circuit with transformer, variable volume control and battery receptacle and switch, all contained in a neat metal-shielded case beautifully stuccoed in black enamel and with polished aluminum face. The case measures 6½x7¾x1¼" deep and is provided with soft rubber feet. Sold complete with 4½ volt microphone battery. Shipping weight—10 lbs. List Price, $15.50.

No. SP9057—Microphone Pre-Amplifier. Your Price......... $7.50

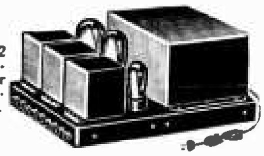
★6-VOLT BATTERY PHONO-MOTOR

At last a REAL battery motor—designed especially to meet the needs of semi-portable and portable address systems especially installations on moving vehicles. It will easily and economically operate from 6 volt storage battery or the equivalent in dry cells. Draws very little current. The entire meter is flexibly pivoted upon a cast metal frame and is held taut at all times by a compensating spring, thus assuring positive contact of the friction drive gear against the inside rim of the turntable.

This arrangement was designed to overcome the effects of bumps and jars experienced by moving vehicles. The motor is sold complete with 10 ft. turntable, mounting plate and motor switch and speed control. Shipping weight—10 lbs. List Price, $15.00.

No. SP958—6 Volt Battery Phono-Motor. Your Price............. $2.50

★WEBSTER "250" POWER AUDITORIUM AMPLIFIER



Contains 2 Stages Super Power A.F. Amplification.

NOW $18.00 Less Tubes

ONE OF THE MOST POWERFUL SUPER POWER AMPLIFIERS EVER MADE. 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! But most important of all, the QUALITY OF REPRODUCTION IS AS NEAR PERFECT AND LIFE-LIKE AS POSSIBLE! ITS POSSIBILITIES CAN BE SUMMED UP IN THREE WORD: ABSOLUTELY DISTORTIONLESS VOLUME! The full benefit of the 450 volts produced is obtained.

This famous amplifier is provided with a high quality input transformer for working from a phonograph pick-up or single or double button microphone.

The tubes required are 1 '26, 1 '50 and 1 '81 rectifier. Where the 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 DYNAMIC REPRODUCERS. This degree of power output provides satisfactory coverage for auditoriums having volume of 25,000 cubic feet when used with a dynamic speaker having a flat baffle board. 50,000 cubic feet when used with a speaker having a directional baffle or horn.

Over-all dimensions are 15" long by 10" wide by 6½" deep. Shipping weight—34 lbs. List Price, $45.00.

No. SP9059—Webster "250" Power Amplifier. Your Price... $18.00

★JEFFERSON POWERPACK —CHOKE UNIT

For '26, '27, '71A and '80 Tubes.

This unit consists of a standard Jefferson Power transformer and a 30 henry 500 ohm filter choke. Both are mounted in a sturdy, compact, metal case, equipped with convenient terminal strips and mounting flanges. JUST THE THING TO CONVERT OLD TYPE BATTERY SETS INTO MODERN ALL-ELECTRIC AC RECEIVERS. The power transformer will safely handle 5-226's, 2-227's, 2-171A's and an '80 rectifier. The filter choke is of standard design and has sufficient DC resistance to cut down the high voltage to the requisite 180 volts for the plates of the 171A power tubes.

Complete instruction for hooking up and wiring is supplied with each unit. Shipping weight—10 lbs. List Price, $10.00.

No. SP9053—Jefferson Power Pack Choke Unit. Your Price........ $2.75

Speed "295"—"Triple-Twin" New! Power Tube New!

Two tubes in one glass envelope! That's the remarkable feat accomplished in this new "Triple-Twin" power tube—the "295". Here is a double-action tube that IS IN ITSELF A TWO-STAGE DIRECT-COUPLED POWER AMPLIFIER . . . a tube around which it is possible to construct A REAL ONE TUBE RECEIVER THAT WILL ACTUALLY OPERATE A DYNAMIC SPEAKER.

Capable of producing large outputs with small signal inputs.—this with absolutely no distortion. Requires 2.5 volts on the filament at 1.0 amps. and 250 volts maximum on the plate. List Price $3.50

No. S699—Speed 295 "Triple-Twin" Power Tube. Your Price........ $2.40

WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN $3.00.

If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders.

If full cash accompanies order, deduct 2% discount. Send money order—certified check—U. S. stamps.

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Should you wish goods shipped by parcel post, be sure to include sufficient extra remittance for same. Any excess will be refunded.

A year ahead of other sets

Again PILOT advances the art of short wave reception, this time by introducing equipment which is totally new in mechanical and electrical design, and equally new in high standards of performance.

Recognizing the strange effects and erratic results experienced with S.W. reception, PILOT has bent every effort toward making extreme DX more certain and dependable, and in this new receiver had demonstrated tremendous progress.

To be sure, S.W. reception has not yet been reduced to the ease of broadcast set operation. You cannot put a piece of wire on the antenna post, give the dial a turn, and bring in Paris.

Skill, patience, and experience are needed to duplicate the results of those who have logged fifty foreign stations and more on PILOT S.W. sets and converters.

Don't believe all you read about "European stations at your finger tips." PILOT doesn't make such claims, but PILOT does guarantee its S.W. equipment to out-perform all other makes, for behind every design detail of PILOT S.W. sets are reasons dictated by the experience which has earned for PILOT its leadership in this field.

The DX hounds, the Dial Twisters, those who are willing to learn how, know that PILOT will bring in results up to the limit of their skill as operators.

Tell your B. C. L. friends to wait for PILOT'S S.W.-Broadcast set—new features, new results that make all other types obsolete!

If you preferto build your own equipment, send 50 cents for the new PILOT short wave catalog, and a year's subscription to RADIO DESIGN QUARTERLY. The new issue is just out, filled from cover to cover with construction articles, photographs, and circuits on the newest kind of S.W. receivers. There are simple types, complicated ones, some run from A.C., some from batteries—all designed by authorities in this field, all easy to build and inexpensive. M. B. Sleeper, under whose editorship RADIO DESIGN first appeared, is back in the editorial chair.

Write your name and address on a sheet of paper, wrapped around a 50c piece—one dollar for two years—and put it in the mail today. You will agree that RADIO DESIGN, with its new kind of articles, is the biggest radio value you ever bought.

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