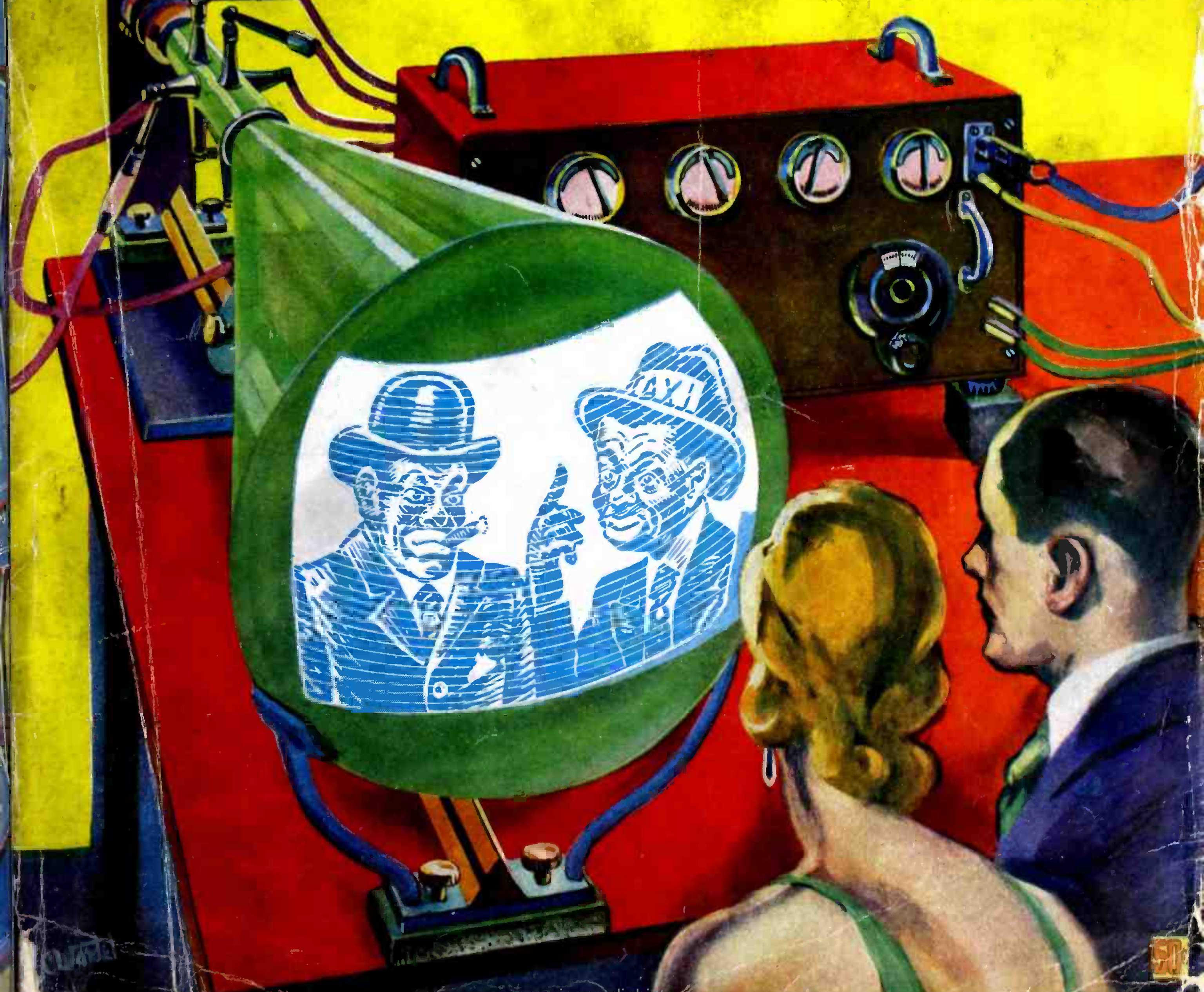
May — June

TELEVISION News

HUGO GERNSBACK Editor

FEATURES:



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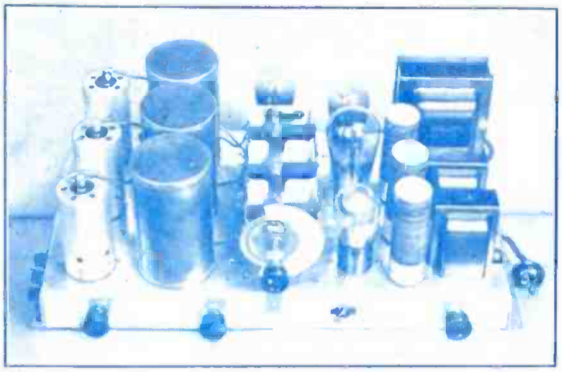

The SHORT WAVE RECEIVER shown here covers a wave length range of 15 to 550 meters and is regenerative for short waves and non-regenerative for Television reception. It employs two stages of screen grid radio frequency, one screen grid detector and three stages of audio amplification, two stages of resistance coupled amplification and a 245 power tube in the third stage, all parts being carefully shielded. This Short Wave Receiver is single dial control and has a minimum of A.C. hum interference especially below 50 meters so that it is possible to use ear phones. Will tune in stations all over the world under normally good conditions with loud speaker volume.

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Completely assembled in metal cabinet. .... **Price $110.00**

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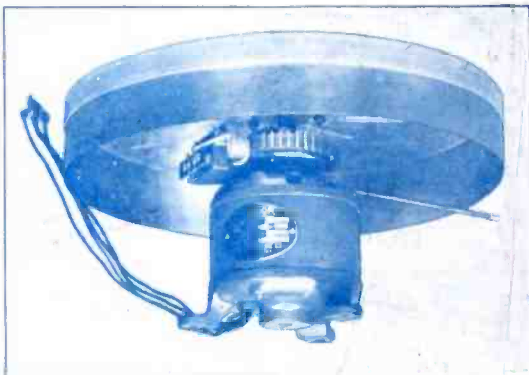

The TELEVISION KIT shown includes a special Television 1/15 H.P. Motor, Synchronizing Motor and all accessories including Television synchronizing Amplifier, Lens, Television Lamp and Cabinet; in fact, everything that is necessary for complete Television reception. These parts can be assembled and put into operation in about one hour. This is the only kit which receives horizontally, the perfect method of Television reception to eliminate all distortion and will automatically synchronize on any television signal. Can be easily adjusted for 45, 48 or 60 line pictures. This kit, in conjunction with the above mentioned Short Wave Receiver, will faithfully reproduce all half tone transmissions as the Short Wave Receiver has been especially designed for this work, covering a frequency band of 10 cycles to 40,000 cycles where the ordinary short wave receiver only covers a band of 100 cycles to 5,000 cycles. A transformer coupled receiver will not satisfactorily reproduce a half-tone television picture. All parts absolutely guaranteed.

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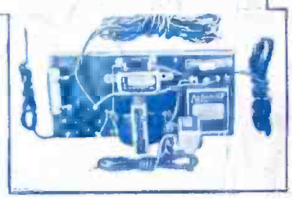

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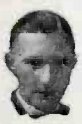

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HUGO GERNSBACK, Editor

H. WINFIELD SECOR, Managing Editor

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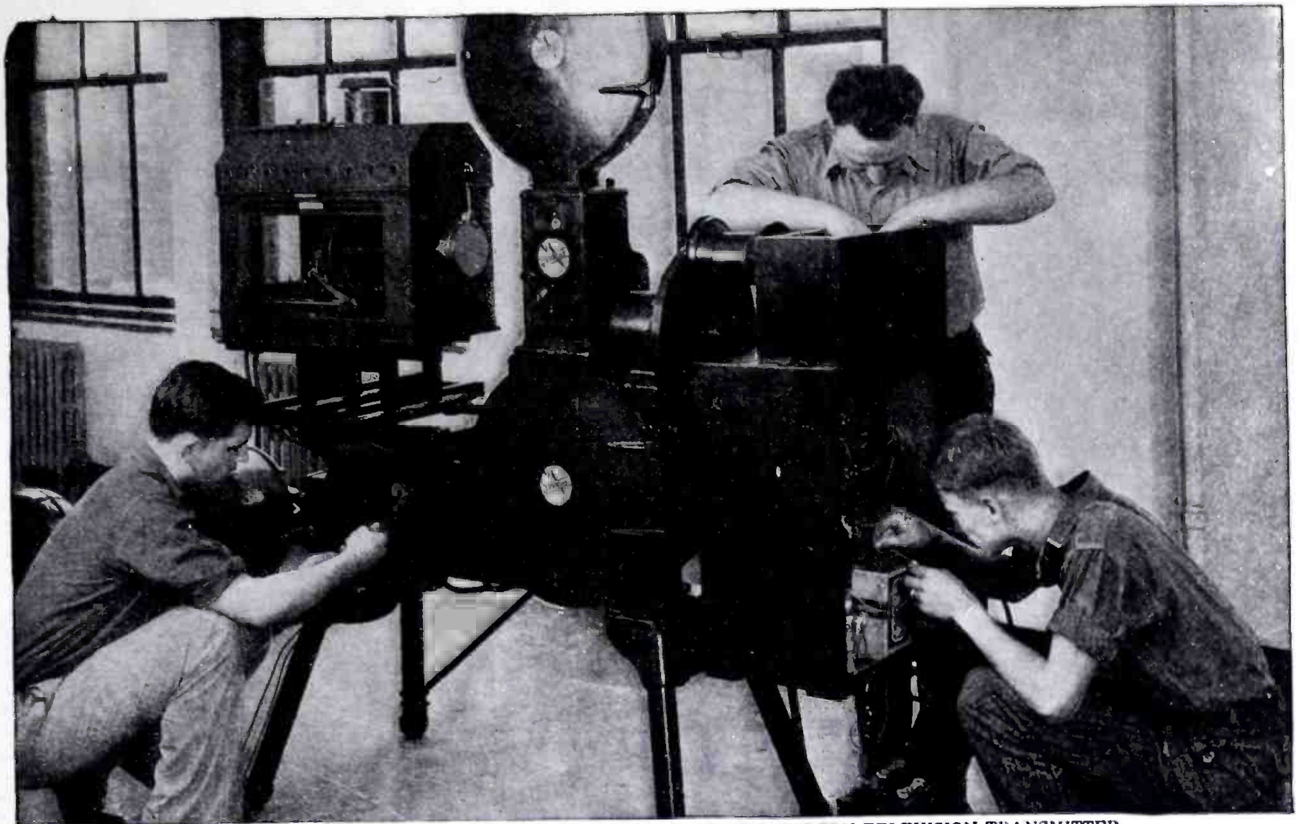

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RADIO TRAFFIC MANUAL AND OPERATING REGULATIONS, by R. L. Duncan and C. E. Drew. Flexible covers, size 9x6", 186 pages. Price **$2.00**

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 5½x8", 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**

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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.
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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.
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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.

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RADIO TELEGRAPHY AND TELEPHONY, by R. L. Duncan and C. E. Drew. Cloth covers, size 9½x6", 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.

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RADIO TROUBLE SHOOTING, by Ennor R. Haan, E.E. Flexible covers, size 6x9", 323 pages, 257 illustrations.
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This is a well illustrated and intensely practical handbook for all radio service men and operators, as well as set builders and testers. Some of the practical problems illustrated and discussed are, interference and noise problems—how to locate and remedy them; antenna circuit troubles and their effect on radio; batteries, chargers and eliminators.

DRAKE'S RADIO CYCLOPEDIA, by H. P. Manly. Cloth covers, size 6x9", 1035 pages, profusely illustrated.
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This massive cyclopedia covers radio apparatus—its operation and maintenance, the various subjects being alphabetically arranged. There are 1735 subjects in alphabetical order ranging from A-battery to zero-beat. This volume contains 1110 illustrations, diagrams, etc. There are 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.
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Radio apparatus, inventors and terms are all illustrated and described in this remarkable book which required the efforts of several engineers in its compilation. The subjects are alphabetically arranged and the illustrations are especially fine and clear.

TELEVISION TO-DAY AND TO-MORROW, by S. A. Moseley and H. J. B. Chapple. Cloth covers, size 8x5½", 130 pages, profusely illustrated
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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 5½x8¼", 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 9½x6", 144 pages, profusely illustrated.
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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 9½x6", 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.

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MAY - JUNE, 1931

TELEVISION News

VOLUME I
NUMBER 2

HUGO GERNSBACK, EDITOR
H. WINFIELD SECOR, MANAGING EDITOR

An Open Letter to the FEDERAL RADIO COMMISSION

Gentlemen:

THERE exists in the new art of television, at the present time, a condition which the general radio trade and the experimenters in television are most anxious to see remedied as soon as may be feasible. This condition is well-known to your honorable body but has not, I believe, yet received the attention it deserves.

From all indications, television has reached a most critical stage at the present time, and continued repression of the art will serve no good purpose.

At the present time, some twenty radio stations are already broadcasting television daily. Two of our largest broadcasting chains have fitted out their broadcast studios, and are ready to broadcast television.

A large chain of stores is already selling television parts to radio experimenters and to the public, and a number of radio stores are pushing television progressively.

Yet, anxious as are the broadcasters to go ahead and give the public the best service, the Federal Radio Commission has so far refused, for reasons not well understood by the radio trade, to allow the broadcasting of commercial programs.

It is believed that this unwarranted restriction should be removed at once, because it is actually preventing the normal growth of television.

No such impediment was placed upon radio broadcasting when it began in 1920, and no obstacles of this kind should be put before the television broadcast stations today.

While it is admitted by all intelligent investigators that television is not as yet ripe for the public at large, yet there are in this country today several hundred thousand serious experimenters who are willing and anxious to experiment with television. These experimenters are buying equipment and are entitled to a real program, which they cannot get today for the simple reason that television broadcasters are not allowed to put on commercial programs, which would ensure the quality of entertainment that they cannot afford on the present non-commercial basis. The present showings of films and poor direct pickups are not conducive to stimulation of the new art. What is needed is real talent, the counterpart of which we have in oral broadcasting today. This, however, can come about only if the Federal Radio Commission will remove the present restrictions.

It is also felt that the Commission should allow television transmissions on the broadcast band (that is, between 200 and 545 meters) after midnight, local time. It is a hardship to many experimenters in television to acquire a separate short-wave set, in order to do experimental television work, when actual television reception for experimental purposes could be accomplished after midnight with existing facilities.

Several years ago, that is, about 1927, a number of broadcasters were permitted to use the broadcast band for television purposes; but the Commission has since then objected to the use of these channels for such purposes.

It is felt by many that television in its final stage will certainly be accomplished (by some means not known today), in the broadcast band. For that reason the Commission should give the experimenters full facilities; at least after midnight, when the signals would not annoy the listening public.

While it is admitted by the trade that the present results achieved in television are by no means good enough to encourage the general public to buy complete television receivers (primarily because of the small size of the received image), yet it is felt by them that, if the various artificial obstacles were removed, experimenters would take hold of television just as they took hold of radio broadcasting from 1920 to 1924; and, when a sufficiently large number of experimenters become interested in the new art, rapid strides in television must be made.

It is to be hoped that the Federal Radio Commission will give this plea, which is that of the many television *interestants* of the trade, due consideration at its earliest convenience.

Hugo Gernsback

Publisher.

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HOW CHICAGO PUTS OVER TELEVISION

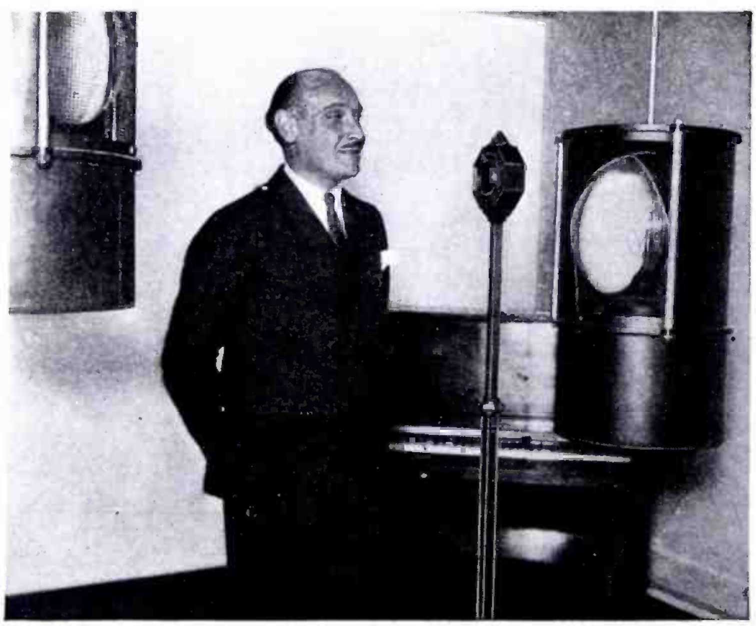
General view of the television transmitter used at W9XAP, showing the large group of photo-cells employed to "pick up" the image.

Chicago is very active in broadcasting television images as well as voice to accompany them. "Audiovision" programs are broadcast daily and are featured in the Chicago newspapers.

"LOOKERS-IN" residing within several hundred miles of Chicago have had many rare treats in the past few months, thanks to the elaborate television as well as combination "audiovision" programs that have been broadcast from station WMAQ, W9XAP, W9XAO and WIBO. Herewith is reproduced a typical daily program schedule which will be seen to be quite elaborate and extremely interesting. Two of Chicago's leading newspapers, *The Evening American* and *The Daily News*, carry each day television programs on their radio page.

Mr. Clem F. Wade, president of the Western Television Corporation, whose apparatus is pictured on these pages, stated in a recent interview

One of the television receivers of the type designed by the Western Television Corporation, in which the image is projected from a cabinet on to a translucent screen.



This picture shows how the large photo cells pick up the image of the man's face, while the microphone in front of him picks up the voice, both being broadcast simultaneously.

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TYPICAL DAILY SCHEDULE

At 12:00 Noon—WMAG synchronized with W9XAP broadcasting a religious service which consists merely of a preacher and he is seen and heard for ten or fifteen minutes.

Immediately following this, there are cartoons drawn by one of the Daily News staff artists. This program does not have sound and is like the old-fashioned chalk talks.

12:35 There are news flashes. This is a sight and sound or "audiovision" program which shows an announcer reading the news flashes. This is again followed by a staff cartoonist drawing silent pictures for fifteen minutes.

1:45 from WIBO and W9XAO there is an audiovision program featuring Wesley Long, who plays the guitar and sings blues songs. In this program the audience sees the performer in close-up and full length pictures.

3:00 Drs. Pratt and Sherman, the most popular local comedy team in the audiovision program from W9XAP and WMAQ.

4:00 In the afternoon, there are more cartoons from W9XAP.

4:15 More news flashes and audiovision program from the same station.

4:30 In the afternoon, Television Varieties, audiovision from W9XAO and WIBO. This program features ballet dancers, tap dancers, harmony singers; sometimes it carries tumbling acts, miniature minstrel show, jugglers and a Scotch Highlander act in costume.

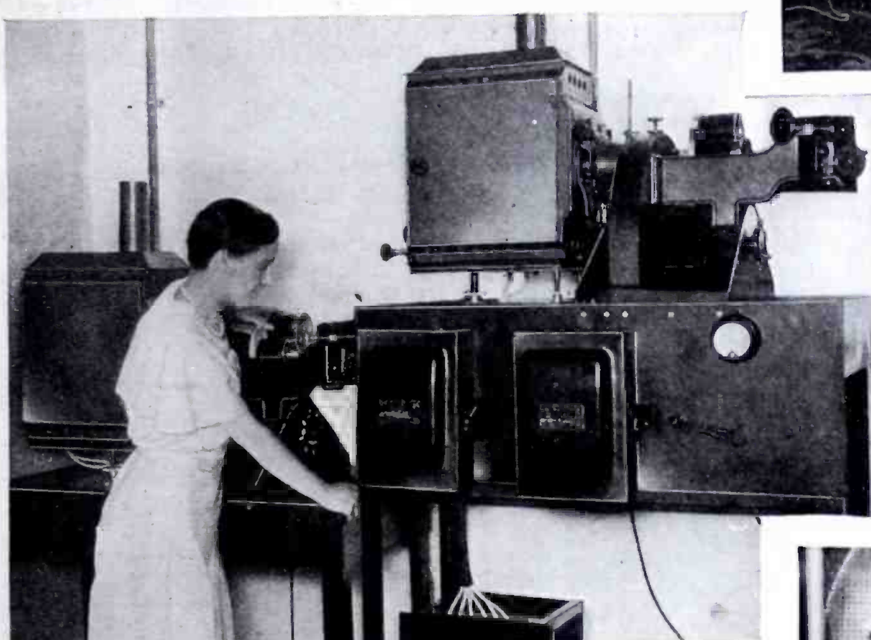
7:00 W9XAP has a silent show on the order of the old-silent movies.

7:30 More cartoons from W9AXO.

8:00 Synchronized sight and sound program from W9XAP and WMAQ, sometimes featuring stage stars, other times prominent speakers, some nights marimbaphone, violin solos, small plays, then a synchronized sight and sound program from W9XAO.

8:30 On the order of the programs from the same station at 4:30 in the afternoon.

Here we see the relative size of one of the huge photo-electric cells used at Chicago transmitting station W9XAO.



Photograph above shows complete television transmitter used in broadcasting television images from Chicago, and which have been picked up at points hundreds of miles distant.

Huge photo-cell picking up pianist's face image.

with the editor that they now know that the big problem in broadcasting television programs is "studio technique." Mr. Wade said:

"I know now that the big problem in broadcasting television programs is studio technique, placing of the microphones, especially the placing of microvisors (photo-electric cell units), the education of the radio entertainer to a realization that people see him; and the changing of lenses in the cameras to switch from full-length to close-ups and back again, are the present real problems. A television show requires sound to make it real entertainment. Even sight and sound pictures require action. It is no different than the movies. Action, action and more action is necessary! A couple waltzing slowly on a stage is a dull picture but tap dancers, ballet dancers, eccentric dancers, quick movements by the actors and any moving entertainer makes a television show just as it makes the movies.

"Full length pictures are good and are getting better. Lately from W9XAO and occasionally from W9XAP, we broadcast short *boxing exhibitions*. These are mighty good, even without sound, because there is plenty of action. Perhaps you might be interested in reception reports. The farthest report of good reception is from Albuquerque, New Mexico. There are other reports of satisfactory reception from Tulsa, Oklahoma City, St. Louis, Minneapolis, Iowa City, Kansas City, Toledo, Cincinnati, Detroit, and Pittsburgh. The man at Albuquerque insists that the picture is better than it is at Chicago. Personally, I think he's crazy but he certainly was able to tell us a lot about our programs and when this man came to Chicago, he identified announcers and artists he had seen at Albuquerque!"

The broadcasting of television images utilizing Western Television apparatus involves the use of a three-spiral disc—that is, a disc which con-

(*Continued on page* 156)

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A. B. Chamberlain, chief engineer of the Columbia Broadcasting System, and author of the present article.

COLUMBIA

By A. B. CHAMBERLAIN
Chief Engineer, Columbia Broadcasting System

New York City and the surrounding territory will shortly be served by a new and powerful television transmitter, which will be operated by the Columbia Broadcasting System. The very latest image pick-up system will be used. The engineers connected with this organization are conducting tests at various outlying receiving stations.

THE Columbia Broadcasting System, wishing to make its contribution as a large broadcast engineering organization, will soon have in operation an experimental television station, to be located at 485 Madison Avenue, City of New York. This new unit of the Columbia System will occupy four rooms adjacent to one another on the twenty-third floor of the Columbia building, and consisting of scanning room, studio, control room and transmitter room.

To date, other large laboratory groups have concentrated their efforts, so far as television transmission and reception equipment is concerned, on the design of suitable terminal equipment. The engineering staff of Columbia will undertake an exhaustive study of transmission characteristics, particularly as related to metropolitan areas. A special study of operating technique from the standpoints of organization, management and production will be made. Due attention to the improvement of basic terminal equipment will also be included in the experimental program.

In connection with the basic installation, it will interest the reader to know that only the most modern equipment will be used—equipment which is the product of many years of extensive laboratory experiments. Some of the more desirable characteristics included are indirect-scanning; sensitive pick-up equipment; audio- and radio-frequency equipment capable of reproducing within plus or minus 1 D.C. all audio frequencies

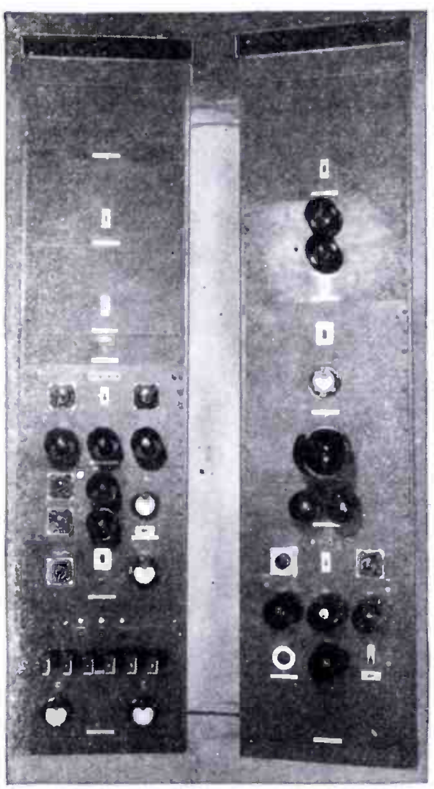

Fig. 3—Television amplifier and control unit, as well as monitoring unit to be used by the Columbia System.

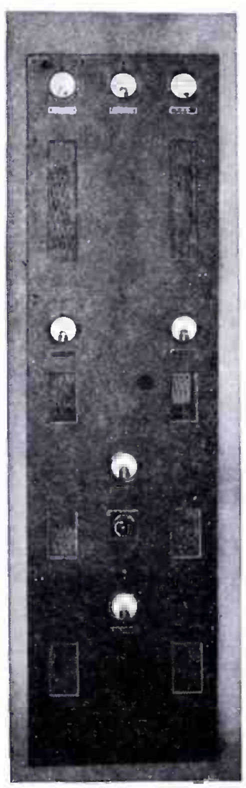

Fig. 4—Audio amplifier and modulator unit for 500 watt television transmitter.

Fig. 5—Radio frequency unit for 500 watt television transmitter.

Fig. 6—Power supply unit for Columbia television transmitter.

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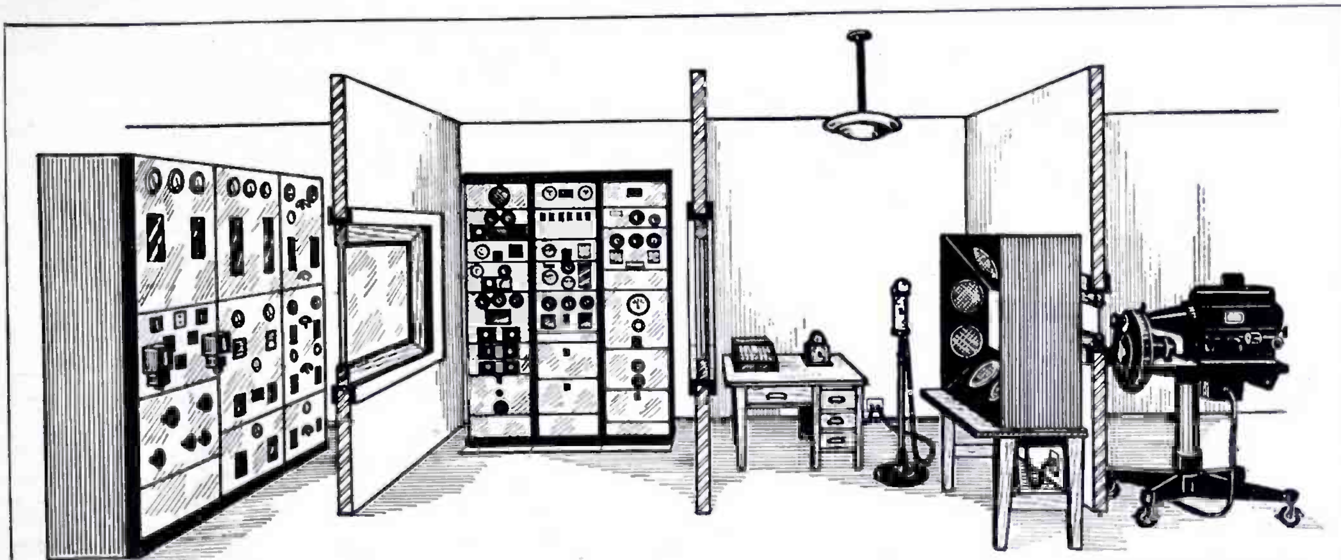
READY TO TELEVISE



General view of television transmitting station of the Columbia Broadcasting System, showing the transmitter and control rooms, together with studio and scanning unit.

from 20 to 50,000 cycles with minimum distortion; a complete three-point interlocking relay signal and control system; and a complete speech-input channel, including condenser transmitters.

Automatic-temperature quartz-crystal control and full 100% modulation on the peaks are but two of the many features incorporated in the new television radio transmitter.

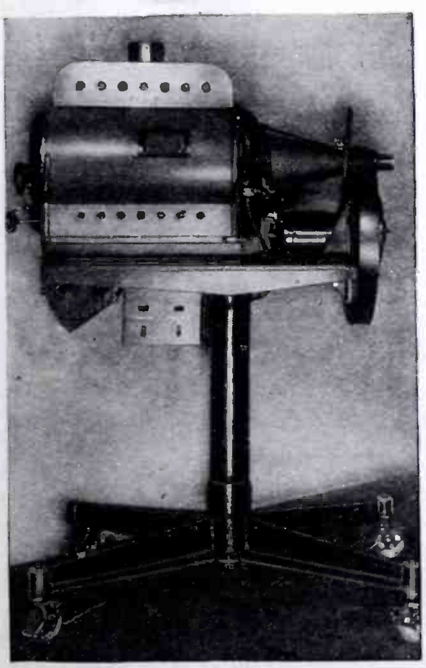


Fig. 1—Television scanner unit used by Columbia Broadcasting System studio.

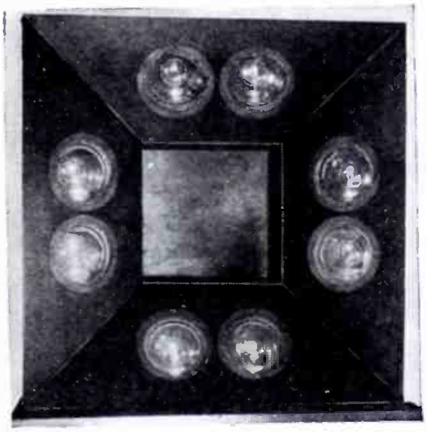


Fig. 2—Bank of eight photo-electric tubes used to pick up the image.

Fig. 1 shows the scanner unit which includes a low-intensity reflector carbon-type arc as a source of illumination. A scanning disc attached directly to a synchronous motor is housed in a dustproof compartment. Attached to the front of the disc housing is a projection lens which is used to focus the light, transmitted through the disc holes, on the object to be scanned. The lens' position is adjustable to facilitate proper scanning. There are 60 holes (each .012-inch square) in a spiral so arranged around the disc that the dimensions of the area scanned are in a 5:6 ratio.

Fig. 2 shows the photo-tube and amplifier equipment, commonly designated as the "pickup unit". Eight photoelectric tubes will be used.

(Continued on page 146)

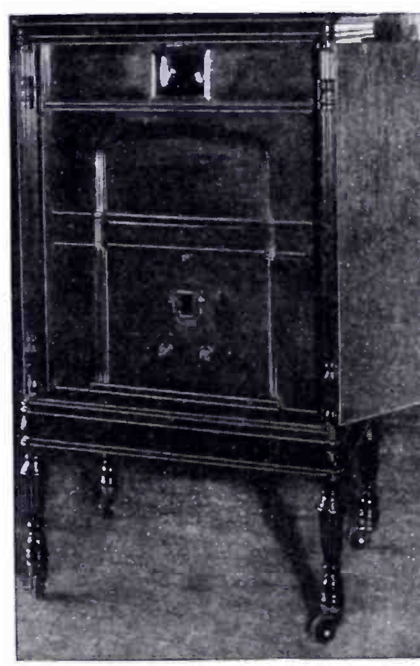


Fig. 7—Shows appearance of new television receiver designed by Columbia engineers, the image appearing in the lens at top of cabinet.

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How I Put the Cathode Ray to Work and Cause

ELECTRON BRUSH TO PAINT

By Baron Manfred Von Ardenne
Famous European Television Expert

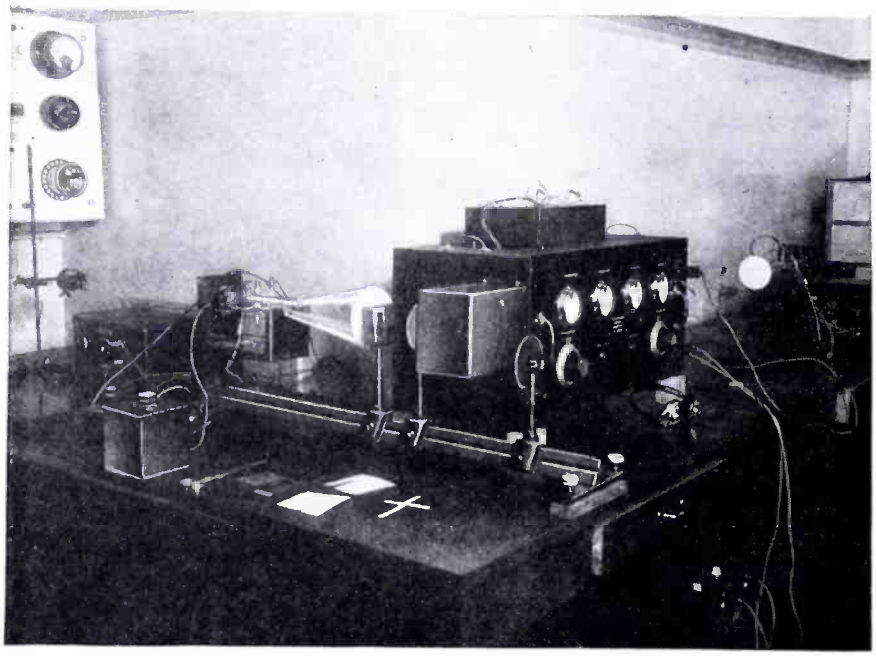

Fig. 3—Shows Von Ardenne's set-up of Cathode Ray tube for transmitting television images, the image in this case being on a photo negative, placed against the end of the tube.

THE Braun tube has a number of basic advantages as a television receiver. It operates quite without mass or inertia; it requires only minimum power for control and synchronizing. It fundamentally offers the commercial possibility of arriving on the market, in a suitable stage of development, for use in television receivers, whose cost will not exceed that of a modern radio set with loud speaker. The cathode-ray tube has long been proposed for television reception and has been used in many more or less successful laboratory experiments. In spite of these extremely advantageous characteristics, television has thus far been obtained only with mechano-optical means. The reason lies in the fact that perfect light control was not obtainable with the usual Braun tubes.

The Problem of Light Control

Even with the use of rather complicated methods, it has not heretofore been found possible to prevent the initial direction and concentration of the ray from being simultaneously somewhat changed, with changes of the intensity of the cathode ray. With other less complicated methods, the light control added also a change in velocity of the cathode ray. The difficulties described resulted in a condition whereby it was possible to show only silhouettes or very faulty pictures, which were much inferior to those attained by mechanical (disc-scanning) systems. By a new method, the author has succeeded in avoiding all the faults mentioned and in obtaining a light control with Braun tubes (of commercial make) which no longer results in picture distortion.

A Braun Tube Television Transmitter

After it could be seen, from static measurements on cathode ray tubes, that light control offered difficulties no longer, it was a question of building a transmitter which could be easily utilized with the receiving tube. Most promising of all seemed to be a transmitter operating also with Braun tubes. Indeed the work undertaken in this direction showed that a transmitter can be built in this way, with very simple means, which accomplishes about the same results as the usual mechanical (disc or mirror) transmitter, and is extremely easy to synchronize with the receiving tube.

The author's principle of the Braun-tube transmitter is made clear by Fig. 1. While the transmitting and receiving tubes are given the same horizontal and vertical potentials (line potentials and picture voltages), there result on the fluorescent screens of

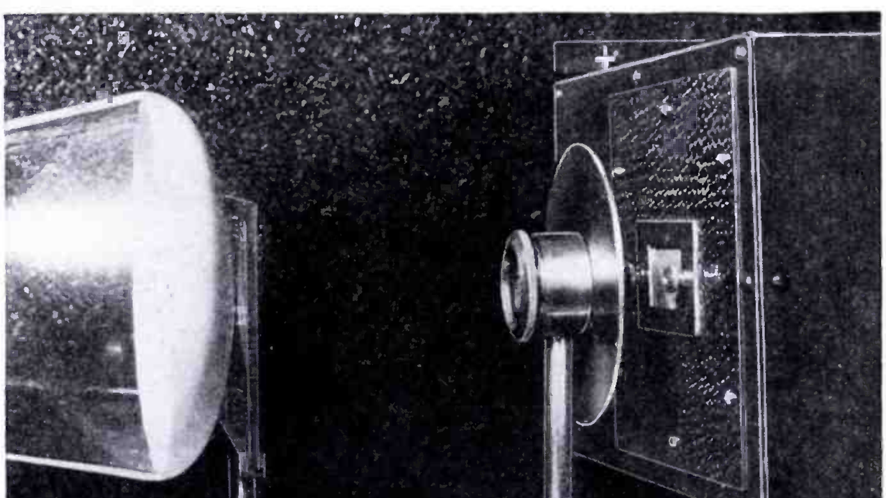

Fig. 2—Above shows close-up of transmitter Cathode Ray tube, with negative placed against it and the lens placed close to the window in the photo-cell compartment.

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IMAGE ON END OF TUBE

The latest results achieved in reproducing a television image with the Cathode Ray tube are here described by Baron Von Ardenne, who uses these tubes for both transmitting and receiving.

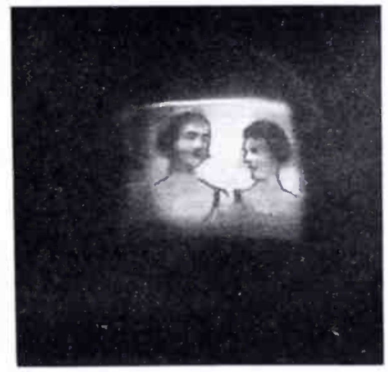


Fig. 5—Unretouched photo of image obtained by Von Ardenne on the fluorescent screen at the end of his Cathode Ray tube.

both tubes, in the case of suitably chosen frequencies, sharply-outlined rectangles. The luminous rectangle on the transmitting tube, visible in Fig. 1, is sharply reproduced on the *diapositive* or transparent-film strip to be transmitted by means of an optical device strongly illuminated. Behind the diapositive, visible in Fig. 1, is arranged a *photo-cell*, especially free from inertia, with an aperiodic amplifier following.

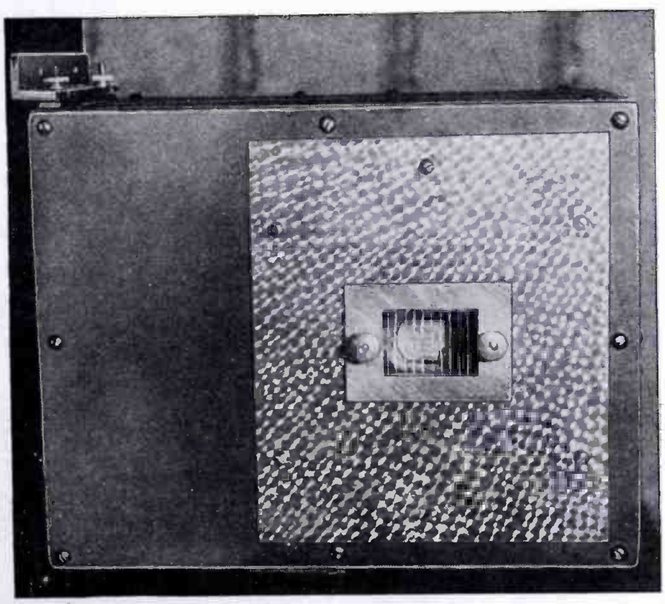
The rectangle on the fluorescent screen results from the fact that the cathode ray scans the corresponding surface very fast—about 20-25 times a second. To each momentary position of the fluorescent point there corresponds a stream of light, which strikes the photo-cell. The amount of the incident quantity of light depends only on the transparency of the diapositive (film image) to be transmitted, at the point where the fluorescent point is momentarily formed over the optical device. With sufficient inertia-less amplification of the photo-cell's current, there is available a potential of some ten volts, which serves for light control in the receiving tube. This extremely simple sending process could hardly have been employed hitherto, because the brightness of the fluorescent spot had been too slight to produce photo-currents which could be amplified without distortion. In no case was the amount of light sufficient to ensure the transmitting of half-tones.

The oscillographs developed in the author's laboratory for measuring purposes, with a brightness of fluorescent spot sufficient for continuous photographic registration, seemed to make possible basic advances here. In fact, the transmitter succeeded, even in the first experiments. The excess of light was not only sufficient for the transmitting of half-tones, but it further even permitted putting up with certain losses on the optical side.

Another optical arrangement frequently used for the experiments, in which a ground-glass screen is placed before the photo-cell, is shown in Fig. 2. Here the diapositive (film with image), together with the luminous rectangle formed behind it on the fluorescent screen, is reproduced through the optical device (lens) on the glass screen.

The total make-up of the Braun-tube transmitter in the laboratory of the author is shown in Fig. 3. At the left is the cathode-ray arrangement, completely operated from the electric light-line; while at the right is the aperiodic, multi-stage photo-cell amplifier. At the high factor of voltage amplification used, which is most efficient between 100,000 and 1,000,000, special couplings had to be used in the amplifier and an excellent design of shielding was required. The screening of the photocell by a series of wires may be seen from Fig. 4; which shows the individually-shielded box with the photo-cell and first stage of amplification.

Fig. 4—At right shows close-up view of the window in the shielded compartment, in which the photo-electric cell is mounted. The photo-cell compartment is supported at the end of the main amplifier, the whole affair resting on soft rubber blocks to absorb any extraneous vibrations.



The Pictures Obtained

After the connecting of the potentials (furnished by the photo-cell's amplifier) to the light control of the synchronized receiving tube, *there appears on the screen of that tube the picture sent by the transmitter.* According to the number of stages of the photo-current amplifier (or the receiving amplifier) the picture appears as a positive or negative. It is one of the most important properties of the new light control that, by a slight adjustment, the generally-undesired negative can be changed into a positive.

One of the first pictures produced a short time ago by the apparatus described is reproduced, unretouched, in Fig. 5, which shows two girls' heads. In spite of the inertia-less quality of the cathode ray tubes, of the very slight inertia of the special photo-cells used and of the aperiodic resistance amplifier used, the quality of the picture obtained is only about that of the usual mechanical (disc or mirror) system. The reason for this is not the light control (which should permit much better pictures) but, as measurements have shown, it lies in *an inertia of the transmitter.* This is in the fluorescent screen of the Braun tube which, after stimulation by the cathode ray, requires a certain time to become neutral again. With the most favorable screen materials, this time is about 1/10,000 of a second. This inertia is about the same as in former television systems, and it is therefore not surprising that better results were not attained. At present there are being built in the laboratory of the author some mechanical sending apparatus for very much higher numbers of pictorial elements (5,000 and 10,000 per frame). Results obtained with the latter apparatus will be reported in this magazine.

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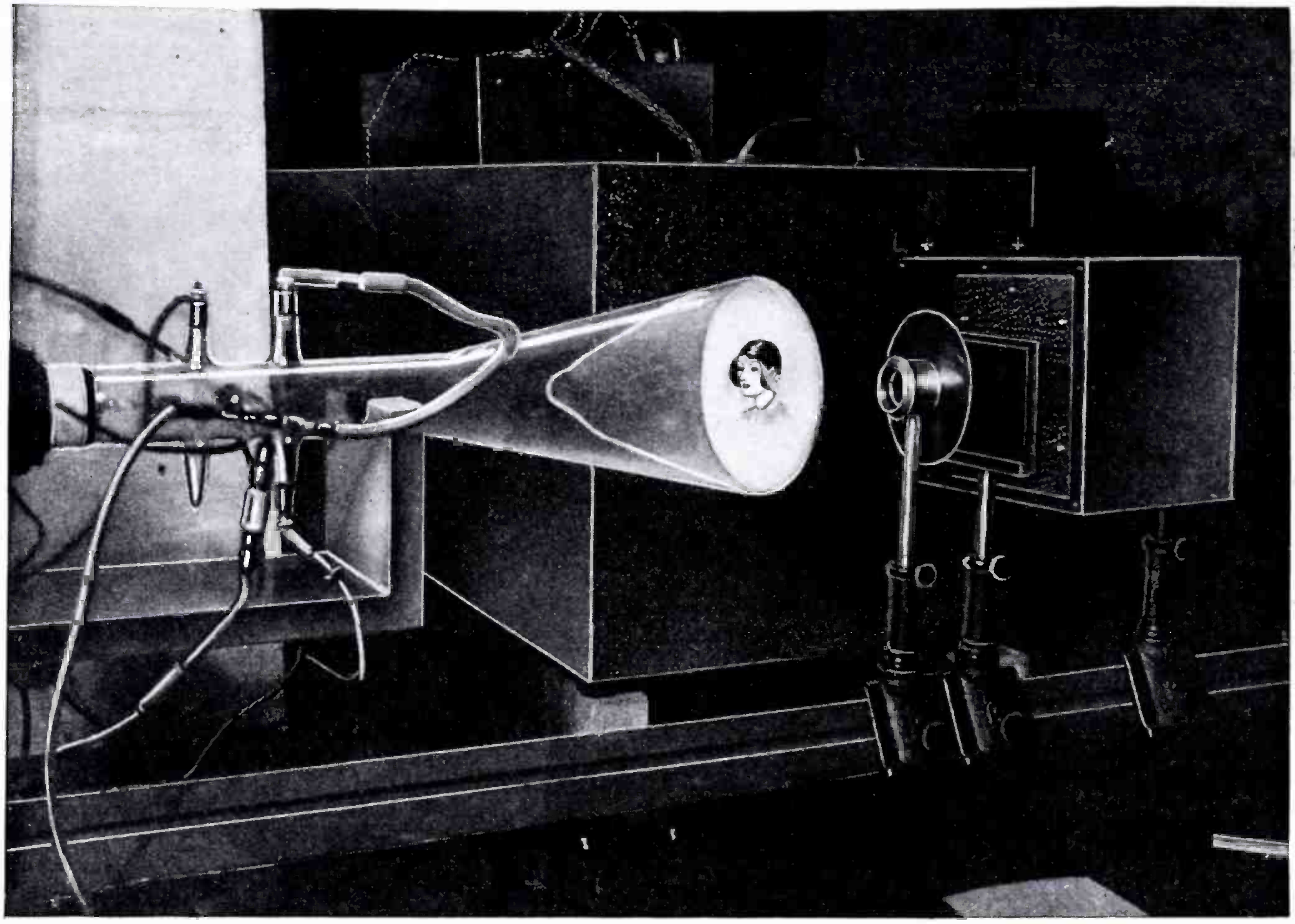

Fig. 1—Above shows Von Ardenne's Cathode Ray tube set up for "transmitting" an image on a negative, placed just behind the lens tube and in front of photo-cell shield box. Imagine the image to be transmitted in the position shown, and it will be seen how the cathode ray can scan the image and cause fluctuations in the photo-cell current.

The Pictorial Brightness Attained

Very noteworthy is the great brightness of the pictures attained with the Braun tube. The total energy peculiar to the cathode ray is reduced only by the losses in the fluorescent screen, and is converted into light energy. The efficiency is far better than with most mechanical systems. Even a power of a few watts suffices to produce pictures which can be observed even in bright rooms. With special tubes, containing a newly-discovered material for the fluorescent screens, projections could even be made successfully as large as 24 to 30 cm. (10 to 12 inches) on a side. The screen material mentioned gives a *bluish-green light*, can be kept free from afterglow, and is about ten times as bright to the eye as, for example, calcium-tungstate screens, and photographically about twice as effective as the latter. In contrast with zinc-silicate screens, the new material shows a similar gradation curve to calcium tungstate and gives sufficiently contrasted pictures. The size of the pictures thrown on the fluorescent screen is easily alterable, by changing the control potentials and the anode current used. One of the chief advantages of the Braun-tube apparatus over all mechanical systems lies in the fact that a constant development and improvement appears possible, when television has reached a popularity equivalent to that of radio. By exchanging the tubes, the owner can always adapt his set to the latest inventions. If transmitters in the course of development change to a higher number of pictorial elements, the main parts will not be worthless, as in mechanical systems but the greatest demands will be changes in condensers or resistances; all this in case the set does not automatically adjust itself to the characteristics of the new transmitter.

The prospects of television in general depend most strongly on the properties and technique of ultra-short waves.

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

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

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

Here are the rules:

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

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

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How the GERMANS TELEVISE

By Dr. Fr. Noack
(Berlin, Germany)

Among the unique methods of televising described, are those involving the use of mirror-wheels; unique methods of synchronizing the receiving apparatus with the transmitter are described as well.

TO obtain standard television apparatus, the following specifications have been adopted by the three German companies which are working in its development: clockwise scanning, as seen by the observer, from top to bottom; a ratio of 4 units of breadth to 3 in height for the image; a 30-line image reproduced at the rate of 12½ "frames" a second, or 750 a minute. In addition, each line of the image is to be scanned in the same time; that is, the holes in the disc are to be spaced at equal angles, between the radii.

It is noteworthy that this does not correspond to the system of scanning used in the English transmission (*or the American*). Its selection is dictated by the fact that broadcast waves must be used for television, under the present European allotment of 9-kilocycle channels, which cannot be changed for two years; and the modulating frequency is thereby automatically limited, which restricts the detail of the image.

The progress of television demands, primarily, low prices and easy operation of receivers; which we cannot have with the short waves, which would permit the use of higher frequencies, giving more detailed pictures. In addition to this, short-wave reception in the near neighborhood of the transmitter is subject to great fluctuations due to fading, echoing, etc. The ultra-short waves, according to Prof. Esau, the great authority on that subject, are not yet sufficiently understood for practical use.

While the technicians express the opinion that the pictorial quality of ordinary television, under these conditions, is too poor to satisfy the general public, we must make a start with what we have now. After all, the question is, what does the public want?

For these technical reasons, however, the Telefunken Co. is not at present undertaking to make televisors for general use; and the Deutsche Fernsehgesellschaft ("German Television Company") hesitates to do so. The Telehor Company is the only one undertaking this on a production basis. The systems developed by these three are:

The Telefunken Co. will retain the mirror-wheel system, which offers great possibilities of development, and almost unlimited illumination. Yet its price cannot be lowered, below a certain figure.

The Deutsche Fernsehgesellschaft system includes the scanning disc which is most familiar in England and America. An image-frequency (normally 375 cycles) is used to obtain synchronization.

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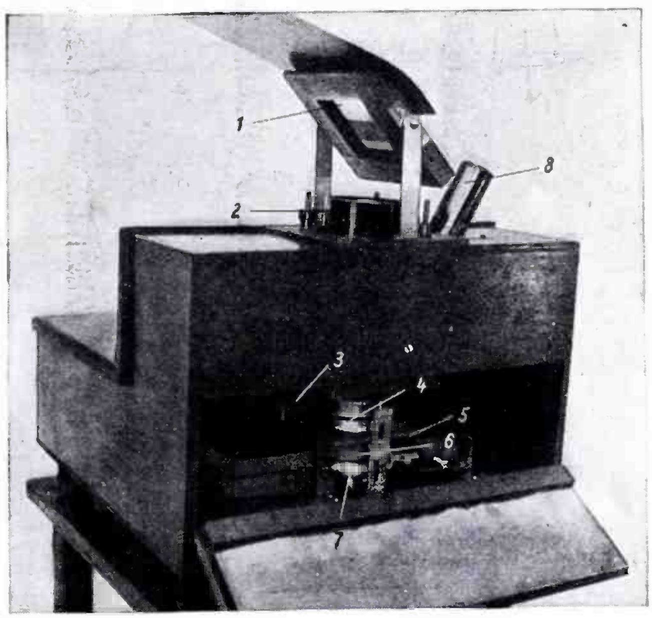

Fig. I (right)
The equipment shown here is a design of the Telehor Company, for the purpose of scanning images illuminated by daylight, to be broadcast through a portable transmitter. The mirror 1 reflects the rays from the object to be televised, through the lens 2 which concentrates them on the scanning disc 3. The lens 4, screen 5 and lens 6 pass on the ray to the photo-cell 7, which is connected to an amplifier. The tube 8 contains a magnifying glass through which the scanned image may be observed.

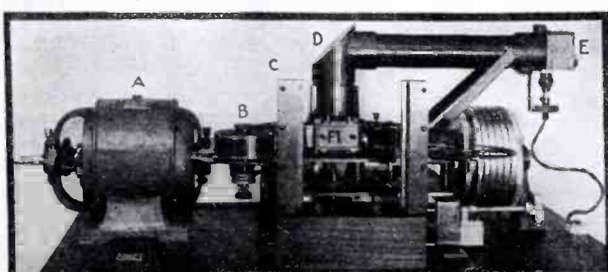

Fig. F (above)
A moving-picture television transmitter: A, motor; B, film reel; C, frame; D, mirror; E, exciter lamp; F1, photo-cell housing.

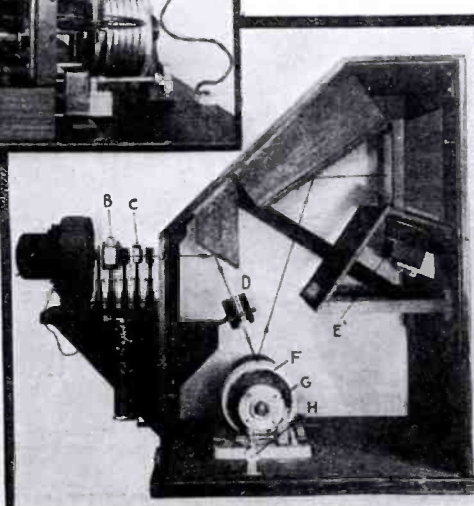

Fig. G (center)
Telefunken-Karolus television receiver: A, arc lamp; B, cooling cell; C, Kerr cell; D, lens; F, mirror scanning wheel; G, synchronizing motor; H. phase control; E, Dynamic speaker.

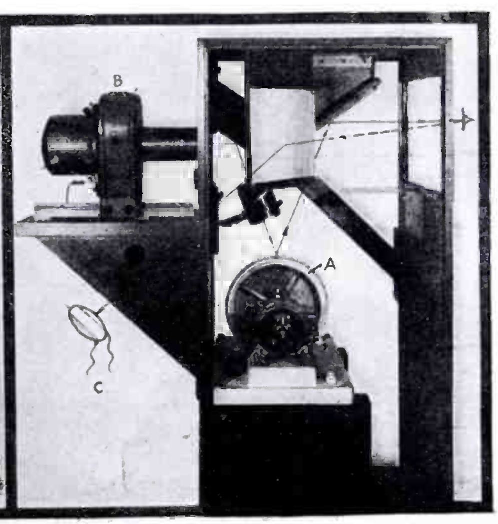

Fig. H (right)
The corresponding transmitter: B, arc lamp to illuminate subject; A, mirror-wheel, scanning subject with light spot. The illumination is reflected, as indicated by the dotted lines, to the photo-cell C, which is really in the triangular box.

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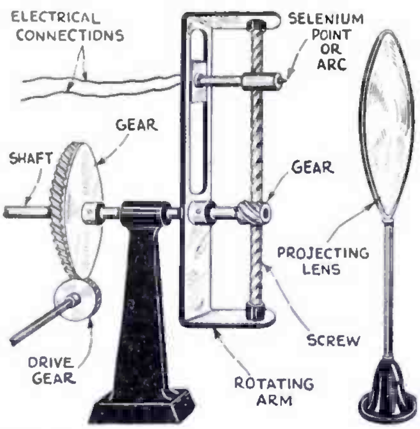
TELEVISION—
A CHALLENGE
To the Inventor

By C. P. MASON



The first television apparatus ever proposed (not built!) was to use a whirling selenium point for scanning at the transmitter and an arc to reproduce the image at the receiver. Fig. 1.

OF THE many scientific problems which the nineteenth century bequeathed to the twentieth for its final solution, television is perhaps the greatest and the most interesting. With a television technique which, today, is able to reproduce good-sized images with a fair degree of distinctness, we cannot claim that television approaches, as yet, the perfection of sound broadcasts. This backwardness is due, it is true, to the greater complexity of the task; yet the fact remains that the method and goal of television was indicated clearly to the world before the days of radio.

A little of its early history will clearly show how little of modern invention is due to single "bright ideas," and how much to long, patient experiment and research. The inventor is not the man who only conceives the fundamental idea; but the man who carries it through, step by step, to a successful conclusion. In a great and complicated art, to make a single decisive step forward, to perfect a single detail, earns enough distinction to be the goal of many a genius.

First Ideas of "Phototelegraphy"

With the announcement of the invention of the speaking telephone by Bell in 1876, the Centennial year, the minds of scientists and inventors throughout the world were turned at once to the possibility of sight, as well as hearing, at a distance. Three years before, a cable operator, named May, had detected the fact that the element selenium alters its electrical resistance, in presence of light; and the fact had been investigated scientifically by Willoughby Smith.

Immediately, inventive minds throughout the world grasped the implications of the two facts. Bell—and others, be it remembered—had shown that modulated currents can be used to actuate a receiver at a distance

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¶ Who invented Television?

¶ Nobody! answered the Wise man.

¶ Why? You ask:

¶ Because no one man devised the television apparatus we have today. Television is the product of many minds—as becomes apparent after reading Mr. Mason's illuminating article. Did you know that the full theory of modern television was printed in 1880?

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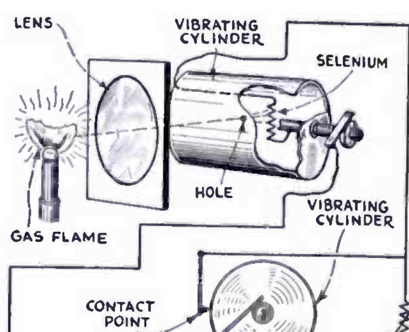
from the transmitter; and, since it was known that light could be used to vary the strength of an electric current, why could not light be recorded electrically at a distance? The number of inventors who conceived the fundamental principles of wired image-transmission is unknown; but there must have been hundreds of them.

It would appear that Prof. De Paiva, of Oporto, in Portugal, suggested something of the kind in 1878. In the following year Dr. Carlo Mario Perosino, an Italian physicist, presented to the Royal Academy at Turin the plans of a "telectroscope," or "telephotograph," for single-wire transmission of a scene to be focused on the rear surface wall of a camera, which a bit of selenium was caused to scan. The variation in the current passed through the selenium, and thence over a telegraph line, was to be impressed on paper which had been sensitized with potassium ferrocyanide. The transmission of line drawings, made with a suitable insulating ink, by telegraph, had been known for some years; although it had found no commercial application since its demonstration in 1862 by Caselli.

Dr. Perosini's system employed a reciprocating or slide-arm motion, which caused the selenium point to scan the image in the back of the camera horizontally, while vertical motion was obtained by clockwork. It is not probable, however, that a model was ever attempted. At the same time a Frenchman, Monsieur Senlecq, of Ardres, had a similar idea for an "electrical telescope," which he communicated to the press; and which received a few lines mention in *Les Mondes*, of Paris, and *Nature*, of London, early in 1879.

Mr. Senlecq had also the idea of tracing the ground-glass screen, of a camera, with a piece of selenium held between two electrical contact springs. But, at his receiver, he planned to use a pencil-point of graphite, moving in synchronism with the transmitting



The first apparatus which ever recorded an image electrically by its own light: the image cast through a hole in the first revolving cylinder on the selenium cell, was chemically reproduced on sensitized paper by the electrical contact point. Fig. 2.

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scanner. The pencil was to be connected with an armature diaphragm of soft iron, normally pressing it against the paper; when the current was strong, because of the greater conductivity of the selenium in a light area, the electromagnet of the receiver would draw back the diaphragm until the pencil cleared the paper. When, on the contrary, the selenium crossed a dark area, the increased resistance of the scanner would weaken the current; the magnet would lose its grip, and the pencil would make a full black line on the paper. Senlecq had also worked with the idea of the multiple cell. But, for various reasons, his invention, like those previously mentioned, failed to make much of an impression on the public mind.

A Year of Inventions

However, the announcement early in 1880 that Graham Bell had deposited with the Franklin Institute a sealed paper, discussing a system of "seeing by telegraph," commanded interest at once; because the inventor of the telephone had won his spurs in the field of practical achievement. At once those who had invented television systems bobbed up in all directions.

The first method to be described in detail in a magazine appears to have been that of George R. Corey, of Boston, Mass., on whose behalf the *Scientific American* stated that his plans had been in the publisher's hands for some time.

His first idea—and that which has occurred to everyone starting with the idea of television—was to imitate the construction of the human eye by a great number of sensitive points at the back of a camera chamber. Each of these was to be connected by a wire line with an electrode—a platinum or carbon point which would produce an impression on sensitized paper.

However, since a consideration of the number of lines required rules out such a system, except for a very short distance, he conceived also a system in which a scanning arm should carry a point, drawn back and forth over the length of the rod while it was revolved by a shaft to which it was fixed at right angles (Fig. 1). Two such systems, in synchronism, one scanning while the other reproduced a scene, would provide instantaneous photography, if not sight, at a distance.

"The art of transmitting images by means of electric currents," said the *Scientific American* of May 5, 1880, announcing this invention, "is in about the same stage of advancement that the art of transmitting speech by telephone had attained in 1876; and it remains to be seen whether it will develop as rapidly and successfully as the art of telephony."

In 1880, however, several improvements remained to be made in the art of telephony; and it is an interesting coincidence that in this same issue we find described the "zoogyroscope,"

(*Continued on page* 155)

First "Movie" Made of a Television Image.

Here are four frames from the first "movie" made of a television image; it was made in the General Electric Co. Laboratories at Schenectady, N. Y. The projected movie is said to be better than the original television image.

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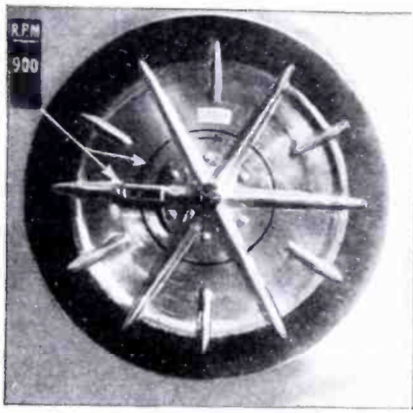
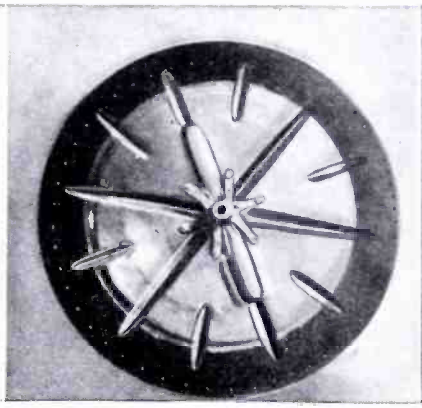




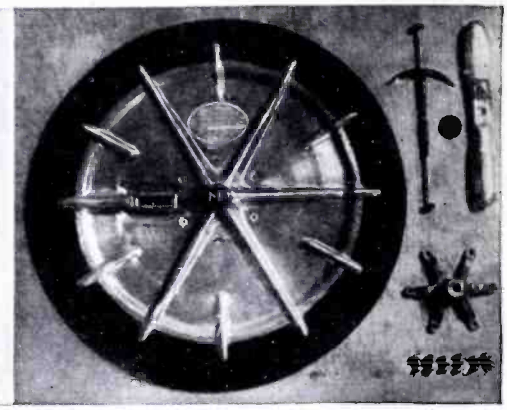


Fig. C Fig. D Fig. E

At the left, the front of the disc described by Mr. Clark, showing the spring-controlled indicator, which is here turned horizontally, and the ring on the disc to which it is to be adjusted. In the central picture, we see the back of the disc, with the sheath under which the indicator slides; and the right photograph shows the parts of the simple assembly.

This Disc Indicates Its Speed

Automatically

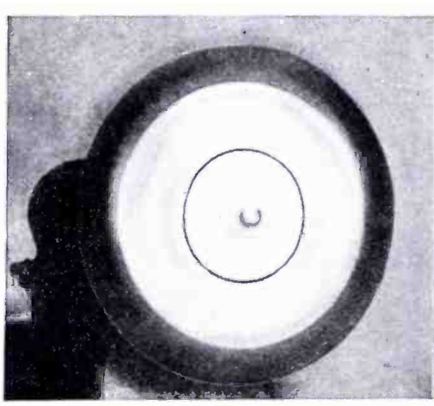
By PAUL L. CLARK

This novel scanning disc has a direct-reading "speed indicator" of the familiar centrifugal type built into it; this feature will be highly appreciated by the experimenter who has actually tried "looking in."

THIS die-stamped aluminum disc not only accurately scans the picture through its spiral of holes (which are cut square and with sharp edges, in order to obtain maximum illumination and also to secure sharply delineated television images) but it also has a speed-indicator, built into one spoke of the disc and held in place by the hub (which bolts directly to the shaft of the small driving motor, as illustrated in the photographs reproduced here).

The technique of receiving television images resolves itself into but a few factors; the most successful results being obtained by using a simple form of equipment made up of a minimum number of standard parts. The necessary elements are: (1) a short-wave receiver with two stages of transformer-, or three of resistance-coupled, amplification producing an output voltage above 180, at 10 to 50 milliamperes; (2) a neon glow-lamp; (3) a small variable-speed motor; (4) a speed-control rheostat for motor; (5) a scanning disc and speed-indicator.

The motor should be of the universal, or of the D.C. type (such as are used in household appliances) if the scanning disc is to be bolted directly to the motor; but if an induction or a synchronous motor is to be used, some sort of friction drive must be provided, in order that the speed ratios of the motor and the disc may be varied at will by the operator.



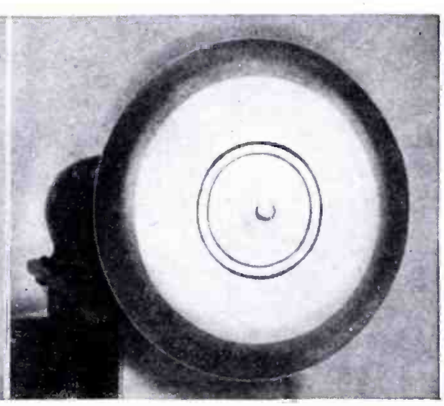


Fig. A Fig. B

At the left, the disc is rotating at 900 r.p.m., showing the appearance of the indicator under proper adjustment. At the right, the disc is off speed, and the speed-indicator ring fails to coincide with the permanent ring scribed on the disc.

Why Is Synchronization Necessary?

Provided the experimenter's equipment is complete, as outlined in the above paragraphs, synchronization—speed control—remains undoubtedly the only single factor affecting television reception. And it was with the idea of simplifying the speed problem of the television engineer, that this disc has been developed during the last year.

The standard scanning speed of stations now broadcasting television is 900 r.p.m.; and (by referring to Figs. A and B) it will be seen that the disc has built into it a speed-indicating element which shows when this speed is attained; 900 revolutions being the theoretical speed at which the picture should register upon the scanning disc. Slight adjustments on the speed-control rheostat, however, one way or the other, must be made by the experimenter, to get his speed in agreement with that of the similar disc at the television broadcast station. Considering the picture as accurately framed with the local and distant scanning systems running in perfect consonance, it is evident that, if this keyed-in consonance be lost by even the slightest disturbance occurring at either the sender or the receiver, the picture will "travel" across the field of view, causing a "mis-frame," and in the twinkling of an eye it will disappear unless speed correction be effected by adjusting the rheostat.

Framing the Image

The method in use by many progressive experimenters is to start up the small motor and slowly bring its speed to 900 r.p.m. by watching the indicator circle; at this speed the image should appear at the picture opening

(*Continued on page* 152)

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A MULTI-CHANNEL TELEVISION APPARATUS*

By DR. HERBERT E. IVES
Research Department, Bell Telephone Laboratories

This improved system of television provides three times the detail or definition of the image obtained with ordinary scanning, an image of three times the usual number of 4,500 or 13,500 picture elements being employed. Three separate circuits, each of which transmits a 40-kilocycle band, carry the three picture image frequencies. The idea involved is that the ordinary scanning beam is split up into three parts or subdivisions, giving us the equivalent of 180 lines per inch on the basis of the ordinary 60-hole disc. Three neon lamps and associated lenses form the individual image at the receiving end.

A bar to the attainment of television images having a large amount of detail is set by the practical difficulty of generating and transmitting wide frequency bands. An alternative to a single wide frequency band is to divide it among several narrow bands, separately transmitted. A three-channel apparatus has been constructed in which prisms placed over the holes in a scanning disc direct the incident light into three photoelectric cells. The three sets of signals are transmitted over three channels to a triple electrode neon lamp placed behind a viewing disc also provided with prisms over its apertures so that each electrode is visible only through every third aperture. An image of 13,500 elements is thus produced. For the successful operation of the multi-channel system, it is imperative to have very accurate matching of the characteristics in the several channels.

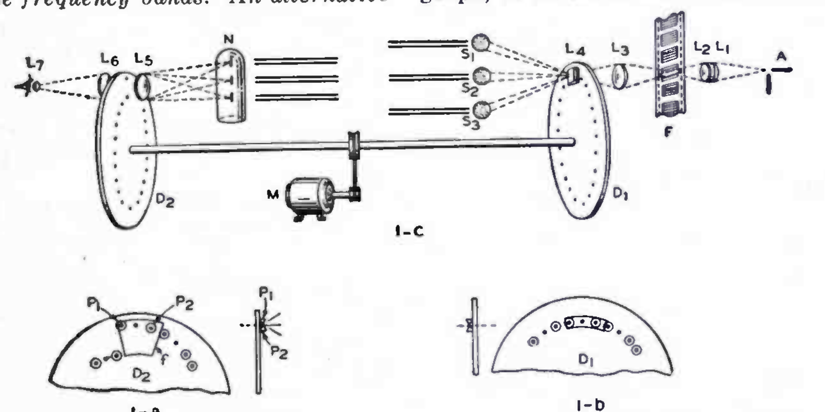

Fig. 1—Schematic of three-channel television apparatus. (a) Receiving end disc with "spiral" of holes provided with prism. (b) Sending end disc with "circle" of holes provided with prisms. (c) General arrangement of apparatus.

IF, in a received television image, the individual image elements are, as they should be, of such a size as to be just indistinguishable, or unresolved, at a given observing distance, the number of image elements increases directly with the area of the image. The number of such indistinguishable elements in everyday scenes, in the news photograph, or in the frame of an ordinary motion picture is astonishingly large. An electrically transmitted photograph 5 inches by 7 inches in size, having 100 scanning strips per inch, has a field of view and a degree of definition of detail, which, experience shows, are adequate (although with little margin) for the majority of news event pictures. It is undoubtedly a picture of this sort that the television enthusiast has in the back of his mind when he predicts carrying the stage and the motion picture screen into the home over electrical communication channels. In this picture, the number of image elements is 350,000. At a repetition speed of 20 per second (24 per second has now become standard with sound films) this means the transmission of television signals at the rate of 7,000,000 per second,—a frequency band of 3½ million cycles on a single sideband basis. This may be compared to the 5,000 cycles in each sideband of the sound radio program, or it may be evaluated economically as the equivalent of a thousand telephone channels.

When we examine what has been achieved thus far in television, we find that the type of image successfully transmitted falls very far short of the finely detailed picture just considered. Probably the most satisfactory example of television thus far demonstrated is the 72-line picture used in the two-way television-telephone installation of the American Telephone and Telegraph Company in New York.[1] Here the object to be transmitted is definitely restricted to the human face, which fills the whole field of view, and is adequately rendered by the 4,500 image elements used.

The gap between the 4,500 elements of this image and the 350,000 considered above is enormous, not only in figures, but in terms of technical possibility of bridging. Even if we are forced to content ourselves with relatively simple types of scenes for television transmission, still the fact must be squarely faced that a very much larger number of image elements must be transmitted than has thus far been found possible; and a far wider frequency band utilized than has ever been used in any communication problem. Now the situation is, simply stated, that *all parts of the television system are already having serious difficulty in handling the 4,500-element image*. Consequently, a *major problem in television progress is to develop means to extend the practical frequency range.*

It will be worth while to survey briefly the points in a television system where difficulty is now encountered when the attempt is made to increase the amount of image detail and the accompanying band of transmitted frequencies. Consider in turn the

* Jour. Optical Soc., Jan., 1931. Reprinted by permission from Bell System Technical Journal.

[1] Bell System Technical Journal, July, 1930, p. 448.

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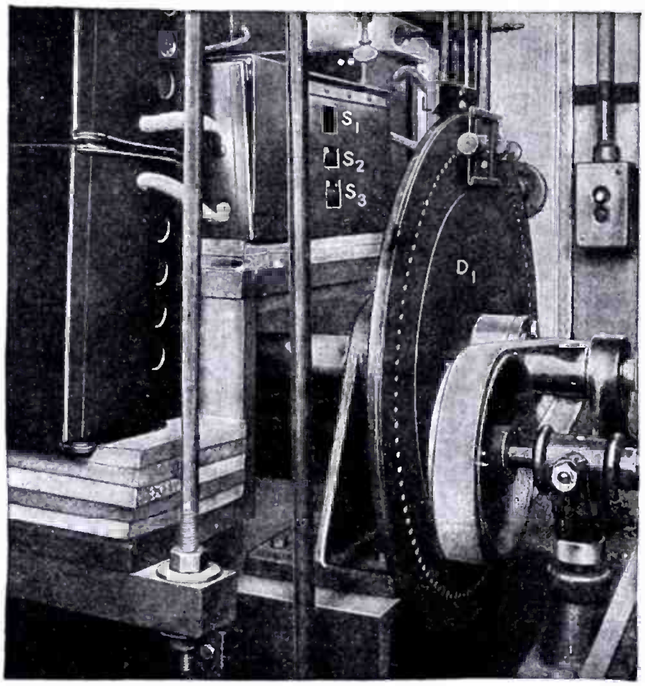

Fig. 3—Sending end of three-channel television apparatus, showing sending prism disc and photoelectric cells.

scanning discs at sending and receiving ends, the photoelectric cells, the amplifying systems, the transmission channels, the receiving lamps.

In the scanning disc at the sending end, which we shall assume arranged for direct scanning, increased detail means either loss of light or increase in the size of the disc. In either case, the factor of change involved is large. For instance, if the number of scanning holes is doubled in a disc of given size, providing four times the number of image elements, the holes must be spaced at half the angular distance apart, and twice the number of holes, imagined placed end to end, must be included in this half diameter scanning field. The holes will therefore be of one-quarter the diameter or 1/16 the area. The light falling on the photoelectric cell at any instant is the light transmitted by one hole; in this case, 1/16 the amount with the disc of half the number of holes. In general, the light transmitted by the disc to the cell decreases as the square of the number of image elements. If the disc is enlarged so as to hold the transmitted light unchanged, its diameter increases directly as the number of image elements. It is obvious that any considerable increase in the number of image elements—such as ten times—demands either enormously increased sensitiveness in our photo-responsive devices, or quite fabulous sizes of discs. Perhaps the most pertinent conclusion from this survey is that the disc, while quite the simplest means for scanning images of few elements, is entirely impractical when really large numbers of image elements are in question. As yet, however, no practical substitute for the disc of essentially different character has appeared.

Turning now to the photoelectric cell. The question of adequate sensitiveness to handle a large number of image elements is intimately connected with the method of scanning, as has just been brought out, so that no simple answer is possible. It is, however, probable that a very considerable increase in sensitiveness over anything now available must be anticipated, whatever scanning device is adopted. In the matter of frequency range there is definite information. In cells depending on gas amplification (such as argon or neon) a characteristic behavior is a falling off of output with frequency, greater the higher the voltage used, which, becoming noticeable at about 20,000 cycles, may at 100,000 cycles be so considerable as to constitute a practical block to transmission. Vacuum cells are free from this failing, but are much less sensitive. Systematic experiment and development of photoelectric cells with particular reference to extending their range of frequency response is indicated as a necessary step in the attainment of a many-element image.

Taking up next the circuits associated with the photoelectric cell, we find, in general, that the higher frequencies progressively suffer from the electrical capacity of cells and associated wiring and amplifier tubes. This in turn calls for auxiliary equalizing circuits, with attendant problems of phase adjustment, and for increased amplification. Amplifiers capable of handling frequency bands extending from low frequencies up to 100,000 cycles or over offer serious problems.

Communication channels, either wire or radio, are characterized by increasing difficulty of transmission as the frequency band is widened. In radio, fading, different at different frequencies, and various forms of interference stand in the way of securing a wide frequency channel of uniform efficiency. In wire, progressive attenuation at higher frequencies, shift of phase, and cross-induction between circuits offer serious obstacles. Transformers and intermediate amplifiers or repeaters capable of handling the wide frequency bands here in question also present serious problems.

At the receiving end of the television system, conditions are similar to the sending end. The neon glow lamp, commonly used for reception, is already failing to follow the television signals well below 40,000 cycles, and, in the case of the 4,500-element image above referred to, the neon must be assisted by a frequently renewed admixture of hydrogen, which again cannot be expected to increase the

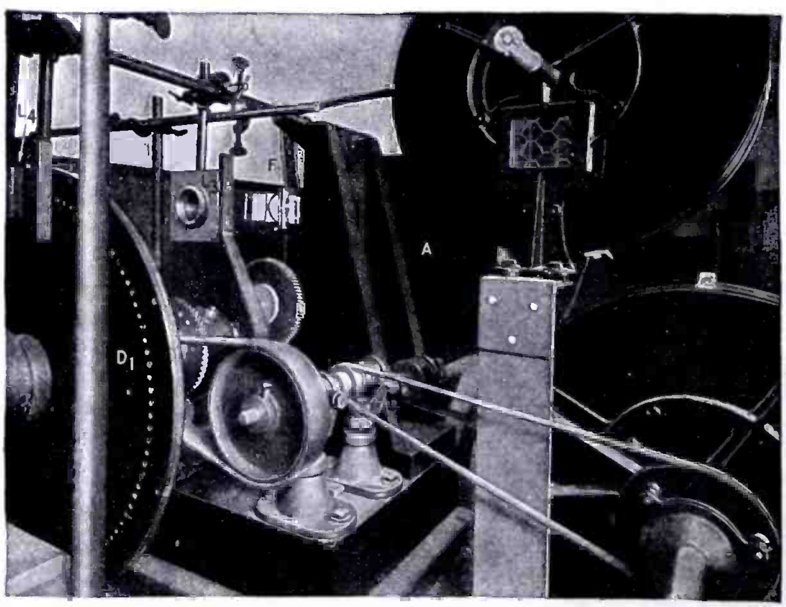

Fig. 2—Sending end of three-channel television apparatus, showing film driving arrangements.

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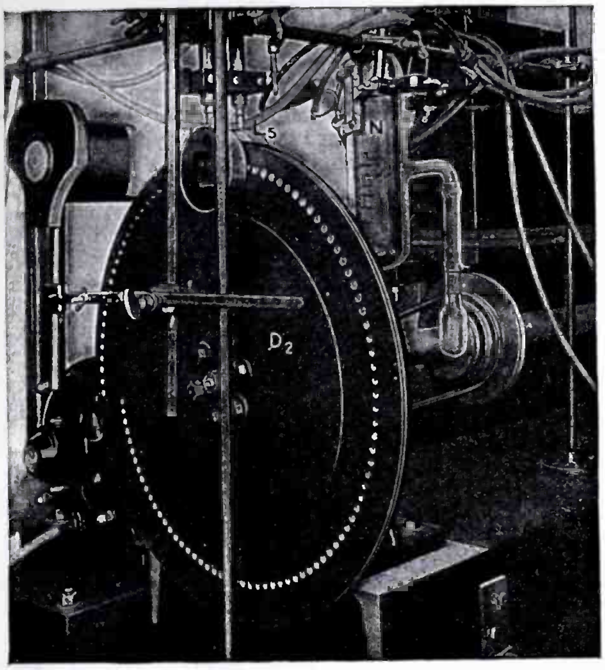

Fig. 4—Receiving end of three-channel television apparatus.

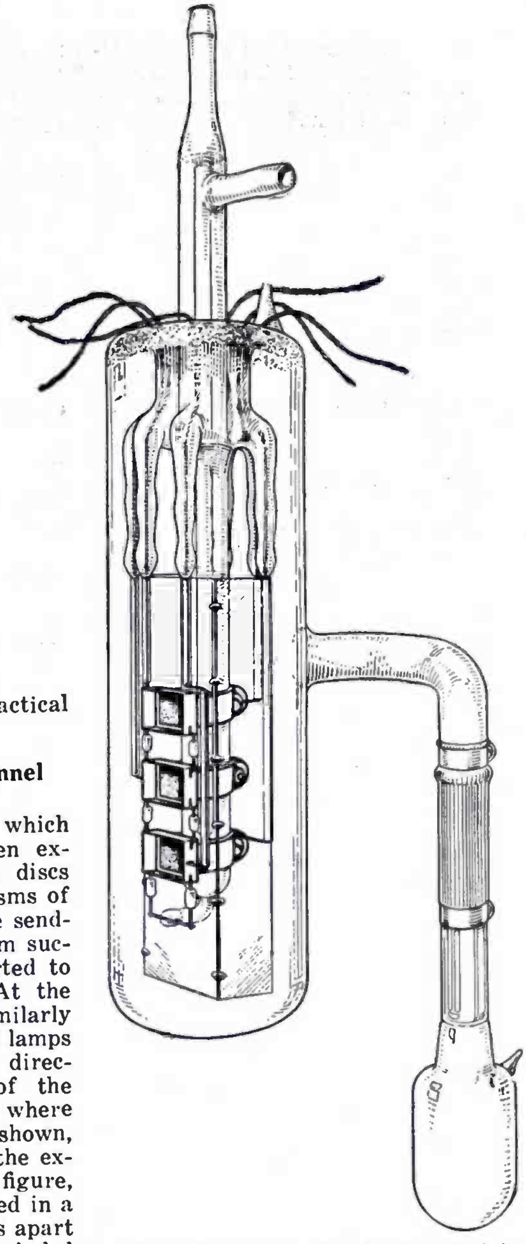

Fig. 5—Three-electrode neon lamp used for three - channel television reception.

frequency range indefinitely. In the scanning disc, as at the sending end, increasing the number of image elements rapidly reduces the amount of light in the image. With a plate glow lamp of given brightness, the apparent brightness of the image is inversely as the number of image elements.

From this rapid survey, it is clear that at practically every stage in the television system, we encounter serious difficulties when a large increase in image elements is contemplated. It is not claimed that these difficulties are insuperable. One of the chief uses of a tabulation of difficulties is to aid in marshalling the attack upon them. But the existing situation is that if a many-element television image is called for today, it is not available, and *one of the chief obstacles is the difficulty of generating, transmitting, and recovering signals extending over wide frequency bands.*

One alternative, which prompted the experimental work to be described below, is the *use of multiple scanning, and multiple-channel transmission.* The general idea, which is obvious from the name given to the method, is to divide the image into groups of elements, the various groups to be simultaneously scanned, and to transmit the signals from the several groups through separate transmission channels. In place of apparatus to generate and transmit a frequency band of n cycles, we arrange m scanning processes each to provide frequency bands of n/m cycles width; n/m being chosen as within the limits set by the available practical elements of a television system. It will appear that the method which has been developed does provide an image of manyfold more image elements than heretofore, and may make easier the problem of transmission over practical transmission lines.

Description of a Three-Channel Apparatus

The multi-scanning apparatus which has been constructed and given experimental test uses scanning discs over whose holes are placed prisms of several different angles. At the sending end, the beams of light from successive holes are thereby diverted to different photoelectric cells. At the receiving end, the prisms similarly take beams of light from several lamps and divert them to a common direction. The mode of action of the prisms is illustrated in Fig. 1*a*, where a three-channel arrangement is shown, which is that actually used in the experimental apparatus. In the figure, the disc holes are shown disposed in a spiral, at such angular distances apart that three holes are always included in the frame f. Over the first hole of a set of three is placed a prism P_1 which diverts the normally incident light upward; the second hole is left clear; the third is covered by a prism P_2 turned to divert the light downward. If we imagine the prisms removed and a single channel used instead of the three that are proposed, it is clear that the holes would have to be spaced three times as far apart so that no more than one would be included in the frame f at one time. The diameter of the holes, and the radial separation of the first and last in the spiral would be unchanged. Quite apart, therefore, from the smaller frequency bands which are sufficient to carry each of the three sets of signals, which is the principal objective sought, there is realized in this arrangement a reduced size of apparatus for the same size of disc holes.

Studying more closely the division of the light into three sets of beams, it is important to note that the signals transmitted by any one of the three sets of holes are continuous—as one hole of a given prism series passes out of the frame the next of the same series comes in. The signals generated in each photoelectric cell are accordingly exactly like those of a single-channel system.

Before describing the details of the apparatus, the general relationship between the number of image elements, band width, number of channels, and shape of picture may be developed. For this purpose, let the following symbols be used.

B = frequency band available in one channel, in cycles per second.

F = repetition frequency of images, per second.

C = number of communication channels.

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n = total number of scanning holes.
a/b = ratio of tangential to radial dimensions of frame.
a = angular opening of frame.

We shall assume that the picture elements into which the frame is imagined divided are symmetrical in shape, i.e. either circles or squares. We then have that

the number of picture elements in the radial direction = number of holes $= n$;

the number of picture elements in the tangential direction $= (a/b) \cdot n$.

Now the number of signal cycles corresponding to this number of elements is $(1/2) \cdot (a/b)n$.

The number of cycles per second in one transit along the frame $= (1/2) \cdot (a/b) \cdot n \cdot F$;

over the whole picture it is $(1/2) \cdot (a/b) \cdot n \cdot F \cdot n = (1/2)\ (a/b)Fn^2$;

and the number of cycles per second for each channel $= (1/c) \cdot (1/2)\ (a/b)\ Fn_2 = B$.

The angular opening of the frame $a = 360/n \times C$.

The number of picture elements $= n^2 \cdot (a/b)$.

These formulæ may be utilized upon assuming values for any of the variables, to fix the values of the other. In the present case, it was decided for reasons of simplicity to restrict the number of channels to 3. The band width was chosen as that found feasible in the two-way television system, namely 40.000 cycles. The picture shape chosen was that of the sound motion picture, for which $a/b = 7/6$. The repetition frequency assumed was 18 per second, again following closely that of existing experimental synchronizing apparatus. Substituting these values in the formula rearranged to give n, we get for the number of holes,

$$n = \sqrt{\frac{2Bbc}{aF}} = 108$$

and for a,

$$\frac{360}{108} \times 3 = 10 \text{ degrees},$$

for the number of picture elements,

$$n = (108)^2 \times \frac{7}{6} = 13{,}608.$$

In utilizing the prism disc principle at the sending end, direct scanning, in which the object is imaged on the disc, was chosen, since beam scanning would introduce the problem of separating the light reflected from the object from the several spots simultaneously projected from the disc. Since the light going through the disc must be separated into several beams to be directed into separate photoelectric cells, the full aperture of the image forming lens must be divided by C, the number of channels, with a consequent proportional loss of light to each cell. (This loss counterbalances the decreased size of disc above noted.) It therefore becomes necessary to insure a very high illumination of the object. In the present case, it was decided to use motion picture film to provide the sending end image, since this can have a large amount of light concentrated through it by an appropriate lens system.

The use of motion picture film permitted a simplification of the transmitting disc, which is illustrated in Fig. 1*b*. This consists in arranging the scanning holes in a circle instead of a spiral, and producing the longitudinal scanning of the film by giving it a continuous uniform motion at right angles to the motion of the scanning holes. The continuous motion of the film also avoids the loss of transmission time that an intermittent motion demands for the shutter interval.

Are You Familiar
with
CATHODE RAY TUBES?

More articles in the next issue explaining their use in Television. The Cathode Ray Tube is going to solve our scanning problems. Better be versed in its technique.

At the receiving end a spiral of holes is used as shown in Fig. 1*a*. There again, because of the division of the light into three beams, the angle which can be subtended by the light source (neon lamp) is much restricted. In consequence, the neon lamp cathodes are of small area, and a lens system has been used to focus their images on the pupil of the observer's eye. Other methods of receiving, which promise to be less restricted as to position of observation, are possible, however, as discussed below.

With this survey of certain of the more important features of the system, we may proceed to a more detailed account of the apparatus as constructed. The general arrangement of parts is shown in Fig. 1*c* and in the photographs, Figs. 2, 3, 4 and 5 in all of which the symbols are uniform. Both sending and receiving discs were, for simplicity of operation, mounted on the same axis, driven by the motor *M*. This means that no question of synchronization entered. Synchronization is in fact a separate problem, having nothing to do with multi-channel operation and has been very completely solved in connection with other television projects.[1] If it should be decided to transmit the multi-channel image to a distant point, the apparatus could be cut in two and each end, after separation to the desired distance, operated by synchronous motors controlled in approved fashion. Similarly, no long transmission lines were included.

Starting at the extreme right end of the schematic drawing Fig. 1*c*, we have an arc lamp *A*, a cylindrical lens L_1, a condensing lens L_2, the two lenses together concentrating a line of light on the film *F*. Between the film and the disc is a lens L_3 which images the film on the disc. Directly behind the disc D_1, with its circle of prism covered holes, is a second cylindrical lens L_4 which concentrates the transmitted light laterally, upon the three photoelectric cells S_1, S_2, S_3. By virtue of this lens arrangement, the light falls upon the cells in three small practically stationary spots. Additional apparatus not shown in the diagram but visible in the photographs are gears by means of which the film is driven from the disc axle through a differential, which permits the film to be framed up and down. The light beam is directed through the film at right angles to the axis of the discs by means of two prisms, whereby certain conveniences in driving and handling the film are attained.

The photoelectric cells are similar to ones previously described. The amplifier system was substantially identical with that used in the two-way television system, and need not be described again. Similarly, the amplifiers at the receiving end were the actual set used in the three-color television apparatus previously described.[3]

At the receiving end, the three sets of signals were supplied to the three electrodes of a special neon lamp *N*, shown in Fig. 5, which is provided with a hydrogen valve to enable it to respond to the higher frequencies. Condensing lenses L_5 and L_6 image the three electrodes at the eye, where another lens L_7 is placed at the eye to focus the face of the disc D_2. By this system, nine electrode images are formed, of which three are superposed at the eye, and the successive scanning holes are seen illuminated by each electrode in turn. This viewing arrangement, by which the image is visible to only a single eye, is adequate for an experimental investigation of the multi-channel method, but some other scheme would of course be needed if the method were developed into a practical form. Of several schemes, mention will be made here only of the possible use of a triple grid of neon tubes, using a triple distributor of the type used in displaying images to a large audience in our initial work in 1927.[4]

Discussion of Results

The three-channel apparatus, when all parts are properly functioning,

3 *Journal of the Optical Society*, February, 1930, p. 11.

4 *Bell System Technical Journal*, October, 1927, pp. 551-652.

(*Continued on page* 147)

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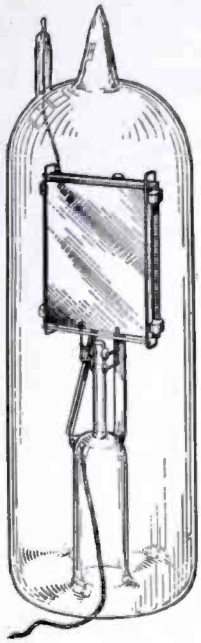

GLOW DISCHARGE TUBES for TELEVISION

By H. W. WEINHART
Special Research Dept., Bell Telephone Laboratories

Here is a very interesting resume of the trend in developments of the glow discharge tube, used in reproducing the image at the receiver. Water-cooled tubes as well as many other interesting types are described, including the latest Beryllium-Neon lamp.

Fig. 1—The earliest television tube had flat plate electrodes.

SINCE the historic television demonstration by Bell Telephone Laboratories on April 7, 1927, and the showing of television in color early in 1929 when objects were reproduced with their true color values, many advances in the efficiency of the equipment have been made. Some of these were incorporated in the two-way television apparatus shown this spring. Notable among them are the changes made in the glow discharge lamps used at the receiving end. The lamps used with the present equipment permit much greater power input than those of the earlier demonstrations and their structure has been changed quite radically.

It is essential that glow discharge lamps for television uses contain some of the noble gases, such as argon and neon, which produce a light of high intrinsic brightness that may be modulated with sufficient rapidity to follow the incoming signals. For monochromatic television neon is usually employed. For television in color, which requires the three basic colors, red, green, and blue, the neon tubes may also be used but only for part of the reproduction. Behind a suitable filter, they supply the red component. For the blue and green, however, argon is employed because of its richness in both blue and green lines of the spectrum. Suitable color filters are also used with them. For monochromatic television no color filters are required; the image is reproduced in the pinkish glow of the neon lamp.

All such tubes are constructed with two electrodes, and the glow forms on the cathode. Its quality depends not only on the material of the electrode but on its structure and its treatment during manufacture. The material of the anode requires less care in preparation. For it the chief consideration is position relative to the cathode.

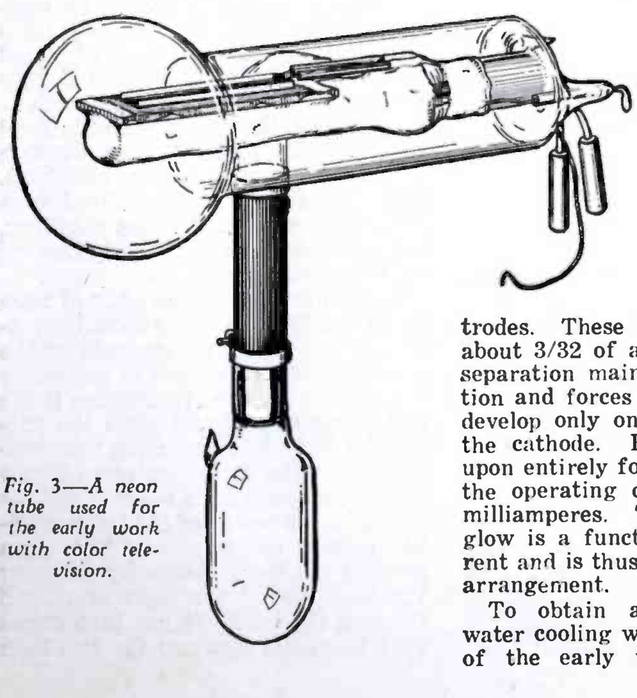

Fig. 3—A neon tube used for the early work with color television.

Lamps used for the early television demonstration (Figure 1) had flat plates for electrodes. These are separated by only about 3/32 of an inch and this small separation maintains effective insulation and forces the glow discharge to develop only on the outer surface of the cathode. Radiation is depended upon entirely for cooling, which limits the operating current to about fifty milliamperes. The brightness of the glow is a function of the anode current and is thus limited by the cooling arrangement.

To obtain a greater brightness, water cooling was resorted to and one of the early water-cooled tubes is shown in Figure 2. The cooling of the cathodes of such tubes is not a limiting factor, and currents as high as 500 milliamperes may be used, giving a very bright glow on the cathode surface. A nickel-plated hollow copper cylinder is employed for the cathode and the glow occurs on one end. The other end is sealed to the

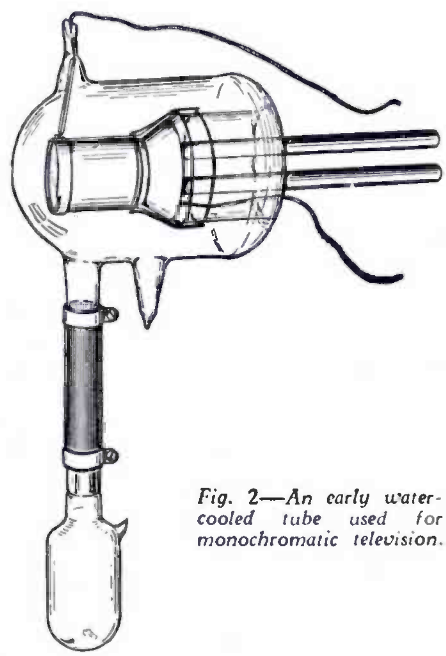

Fig. 2—An early water-cooled tube used for monochromatic television.

glass container and has two tubes entering it for water circulation. Surrounding the cathode is a glass shield which restricts the area of glow to the end, and also serves as insulation between anode and cathode.

One of the lamps used with the early demonstrations of television in color is shown in Figure 3. A single piece of tubular nickel-plated copper, closed at one end and flattened along one side, forms the cathode. Its open end is sealed to a glass tube through which water is passed for cooling. The glow forms over a rectangular area of the flattened surface; on the rest of the surface glow formation is pre-

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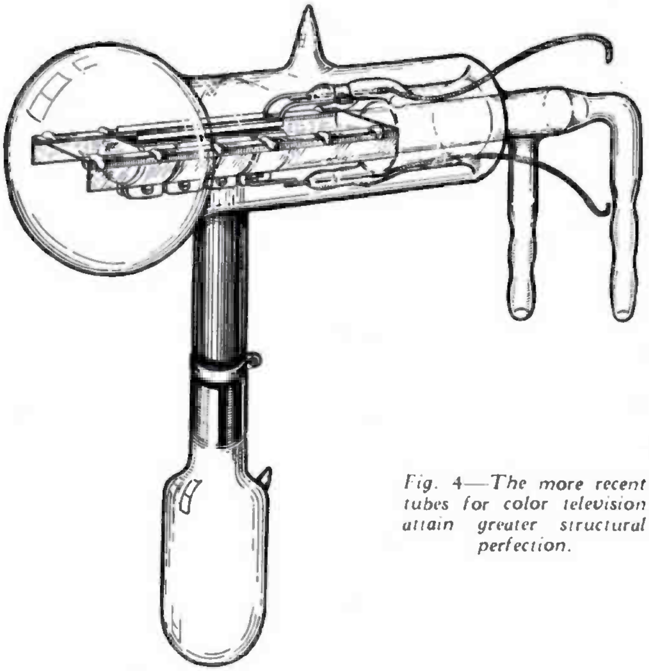

Fig. 4—The more recent tubes for color television attain greater structural perfection.

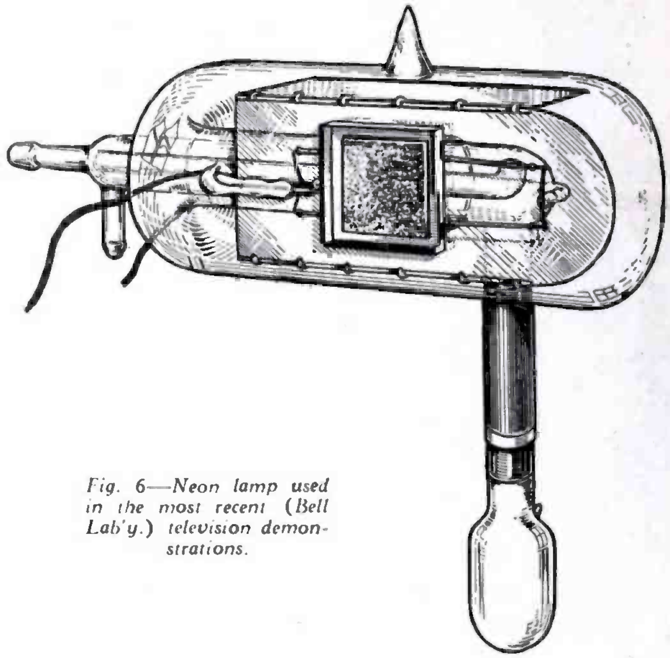

Fig. 6—Neon lamp used in the most recent (Bell Lab'y.) television demonstrations.

vented by a protective coating of lavite and insulating cement. The anode is a metal strip bent into a rectangle open at one end, and the tube is mounted so that the cathode is viewed nearly end on through the open end of the anode. A rubber stopper, not evident in the illustration, is inserted in the glass cylinder that supports the cathode, and glass tubes passing through the stopper allow the cooling water to enter and leave.

This early lamp possessed many objectionable structural features which have been eliminated in the tube for television in color, shown in Figure 4. The cooling water for this tube is not in direct contact with the cathode but is confined to a glass tube to which the cathode is tightly clamped. A mica shield replaces the lavite and cement insulation and by providing a long insulating path prevents the glow from forming anywhere but on the flat rectangular area. The anode is similar to that of the earlier tube but supported in a slightly different manner.

The bulb shown attached to both of these tubes is used for supplying small quantities of hydrogen which has been found essential for the efficient operation of all television lamps. After the lamp has been in operation over a period of time, the glow discharge develops a sluggishness which causes fuzziness or poor definition of the image produced. If a small amount of hydrogen is allowed to mix with the gas in the tube at this time, the sluggishness immediately disappears and good definition is again obtained. Such hydrogen admission is required periodically during the life of the tube.

The construction of the admission system is shown in Figure 5. Two porous plugs, one sealed in an extension of the lamp and one in the end of the hydrogen supply bulb, are normally sealed with mercury but when pressed together permit the passage of hydrogen into the tube.

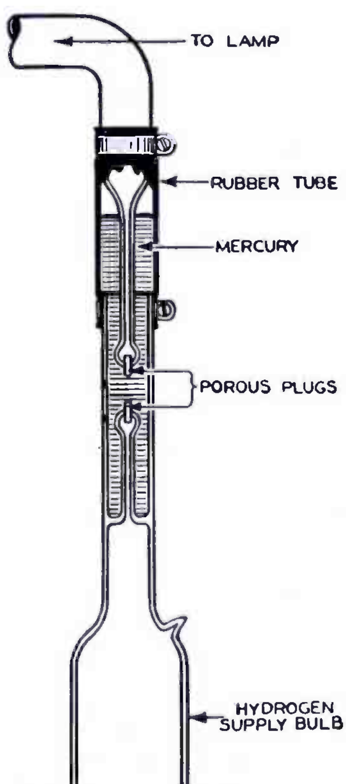

Fig. 5—A hydrogen valve attached to the television lamp, permits hydrogen to be admitted as required from time to time.

Lavite is used for the plugs and is heat treated until it is porous enough to pass hydrogen but not mercury. After the supply bulb is formed, the glass tube around the porous plug, with a short piece of rubber tubing attached to its upper end, is filled with mercury to prevent air leaking into the bulb, which is then evacuated, filled with hydrogen, and sealed. After this the upper end of the rubber tube is attached to the lamp, as shown in the illustration, so that the two plugs are about a quarter of an inch apart. When hydrogen is required the supply bulb is raised until the two porous plugs are in contact, when hydrogen may pass into the lamp.

For the more recent work on monochromatic television the type of lamp shown in Figure 2 has been displaced by the one shown in Figure 6. As with the latest lamp for color television, the cathode is clamped in good contact with a glass tube through which the cooling water circulates. The glow discharge is confined to a flat square surface by mica shielding, and the anode is a metal strip fencing off this active area.

The uniformity of the glow of neon tubes and the sputtering from the active surface depends very much on the use of proper technique in preparing the cathode surface. Sputtering is the dislodging of material from the surface by impact of ions from the glowing gas. The matter released leaves the surface with high velocity and deposits on the inside of the bulb directly in front of the glow. This soon renders the lamp useless by reducing the intensity of the light as viewed through the bulb. It has been found that beryllium sputters far less than

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View showing one of the Bell Telephone Laboratories in which research on television glow tubes is conducted. The Bell physicists and engineers have the finest facilities imaginable for carrying out experiments based on their newest ideas and theories. Dozens of laboratories such as this one are constantly devoted to the study of new problems in television, radio, telephony, etc.

other materials and so is used for the final plating of the surface.

In preparation the cathode is first baked at 800° centigrade in a vacuum for an hour, which anneals the copper without oxidation. The flat surface is then sand-blasted and nickel-plated but not polished. The rough surface allows the final plating to adhere tightly. Beryllium is not easily worked. It can neither be electroplated nor readily deposited by cathode sputtering so it is necessary to deposit it by the method of vaporization and condensation. This is done in a high vacuum to prevent oxidation and to leave the surface as free from gas as possible.

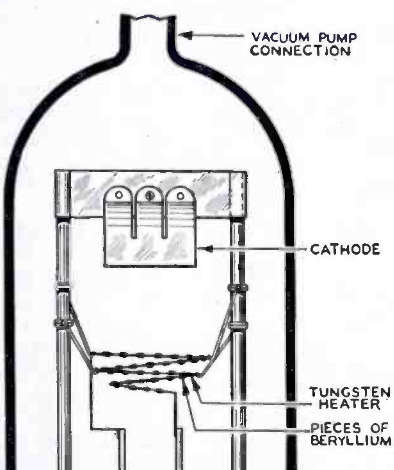

Fig. 7—Beryllium vapor is condensed on the nickel-plated cathode in a high vacuum.

A special tube shown in Figure 7 is used for the purpose. The cathode is mounted face downward over a tungsten filament to which have been welded a large number of pieces of beryllium. The filament is then raised to a high temperature when the beryllium forms melted globules which slowly vaporize. Some of this vapor condenses on the nickel-plated cathode where it forms a thin and uniform coating. In transferring the cathode to the neon tube, care is exercised to keep the surface free from dust, moisture, or finger marks.

After assembly, the tubes are sealed to a vacuum pumping system and evacuated to a low pressure. During this period the entire bulb is baked at a high temperature and then allowed to cool. Neon or argon is then admitted through a porous plug system similar to that used for admitting hydrogen, and a glow discharge is started. During this operation the current used is always at least 100 milliamperes more than the anticipated operating current so as to provide sufficient local heating to degas parts of the tube and to release any remaining gases from the cathode.

After treatment in this manner, the impure gas is pumped out, water is circulated in the cooling system, and fresh gas is admitted to the pressure that produces the most efficient glow on the cathode surface. The tube is then sealed off from the vacuum system and is ready for use. (*Reprinted by courtesy "Bell Laboratories Record," October*, 1930.)

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

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

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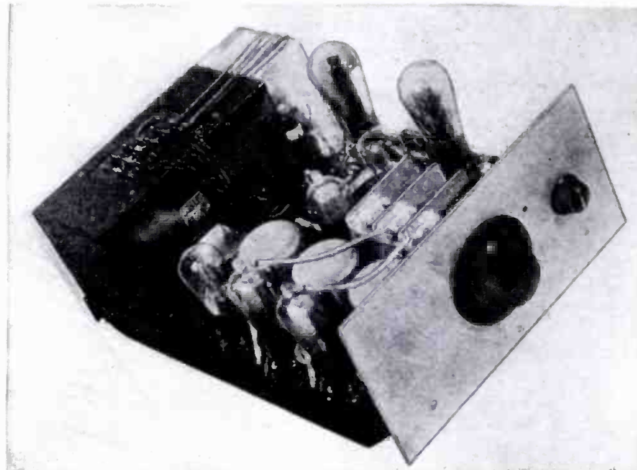
How to Build the New Jenkins Television Receiver

By H. G. CISIN, M.E., and CHAS. E. HUFFMAN

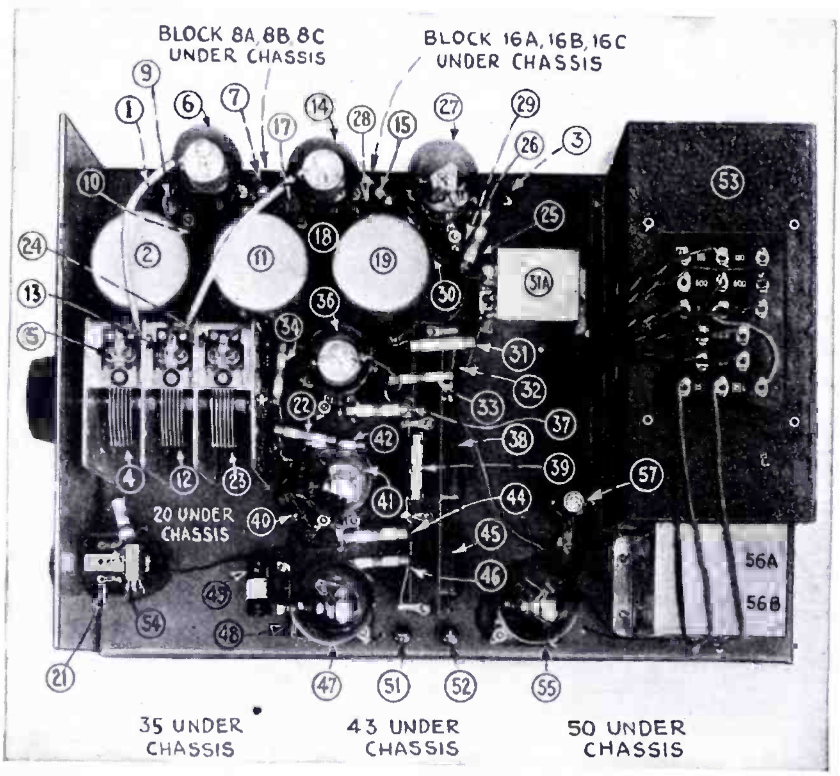
The article herewith by Mr. Cisin, well-known radio author, and Mr. Huffman, engineer with the Jenkins Company, covers in detail the construction of a thoroughly tested and proven A.C. Television Tuner and Amplifier. This receiver is the very latest development of the Jenkins laboratories and has demonstrated that it is selective and yet thoroughly capable of passing a sufficiently wide band of frequencies to ensure a very faithful image at the scanner, not a weak "black and white" silhouette.



The latest A.C. operated television receiver (tuner, detector and amplifier, not scanner) developed by the Jenkins engineers. It provides simple one-dial tuning and has an excellent pick-up range, thanks to two high-gain, screen grid R.F. stages. The output stage employs a '45 tube. Set is available completely wired or in kit form.

IN the last issue of TELEVISION NEWS, an article covered in detail the building of a Home Televisor. Some of the readers of that article appear to have received the false impression that the television receiver, required for use with this televisor, must be necessarily a complicated and expensive piece of apparatus.

Fortunately, just the reverse is true. Instead of being complicated, the television receiver is extremely simple; instead of being expensive, it costs less than most good radio sets. Best of all, the design of the television receiver has been improved and simplified, until a minimum number of parts produce a maximum amount of service and satisfaction.



Close-up view of new Jenkins A.C. television receiver, which includes R.F. tuner, detector and special wide-band A.F. amplifier, together with plate and filament supply.

Television fans and custom set builders will be especially interested in the new television receiver kit, just announced by the Jenkins Television Corporation, which has been designed to co-ordinate with and supplement the televisor kit described by the writer in the last issue of TELEVISION NEWS.* However, it is universally adaptable, also, to all standard televisor outfits.

Receiver Kit Result of Careful Research

The new kit has many points to recommend it to set builders. First of all, it has been produced only after many months of careful study and research. It has been tested carefully under various conditions and will give most excellent results; all the experimenting has been completed at the Jenkins laboratories. When the kit reaches the set builder, it is merely necessary to follow the simple set of instructions and the receiver, when completed, is certain to work and work extremely well.

A second feature of the new kit is the fact that it is composed of the very highest quality components obtainable. There is a definite necessity for using such fine parts; in ordinary radio reception, the ear passes over numerous slight imperfections; but, in television, the eye being more sensitive, will notice very slight deviations from the normal. For this reason, it is almost axiomatic that poor parts

*Article was written by Mr. Cisin, and appeared on page 16, TELEVISION NEWS, No. 1 (March-April).

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must never be used in television equipment.

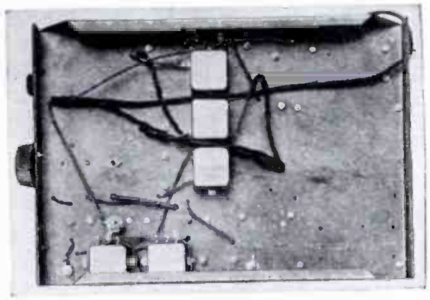
Kit Easy to Wire

A third important feature of this kit is the ease with which it can be put together and wired. Hardly any mechanical skill is required, since all the difficult operations have been performed at the factory. For instance, the metal chassis is received by the builder, bent to the proper shape and with all mounting holes drilled. Photographs, diagrams and detailed instructions are furnished with the kit; and these explain each operation so clearly, that even a novice will experience no difficulty whatsoever in successfully completing the receiver.

Details of the Receiving Circuit

The circuit of the Jenkins television receiver comprises two impedance-coupled stages of tuned radio frequency using screen-grid tubes; a grid detector, for which a 427 tube is used; and three resistance-coupled audio stages. The first of which utilizes a screen-grid tube, the second a 427 tube, while the output stage employs a 445-type powe tube.

The three R.F. coils are enclosed in aluminum shields. Coil (2) is a specially designed Jenkins television antenna coupler, while coils (11) and (19) are special Jenkins television impedance coils. The three circuits, consisting of the two R.F. stages and the detector, are tuned by a shielded three-gang condenser, having 11 plates in each section. Three small equalizing condensers permit the three tuned circuits to be adjusted and matched accurately, so that only a single dial is needed for tuning. The double grid and plate circuits of the two R.F. screen grid tubes, (6) and (14), are



Bottom view of television receiver.

carefully isolated, to prevent unwanted interaction of circuits, by means of 300-turn R.F. chokes; and the latter are by-passed to ground by small fixed condensers. A convenient feature here, is the use of two condenser blocks (8A, 8B, 8C) and (16A, 16B, 16C), each containing three 0.1-mf. by-pass condensers.

A choke, (30), is interposed between the detector and the first audio stage to keep R.F. currents out of the audio portion of the circuit; it is by-passed by a small mica condenser (29).

For providing the correct grid bias on the three screen-grid tubes, 500-ohm resistors in each case are connected between cathodes and ground. Of course, each cathode resistor is by-passed by a suitable fixed condenser. In order to furnish the required bias for the 427-type second audio tube, a 2,000-ohm resistor is placed in the cathode circuit. The grid bias for the power tube is obtained by means of the voltage drop in the 2,000-ohm resistor (49), connected in series between ground and the center point of the wire-wound 50-ohm resistor (48).

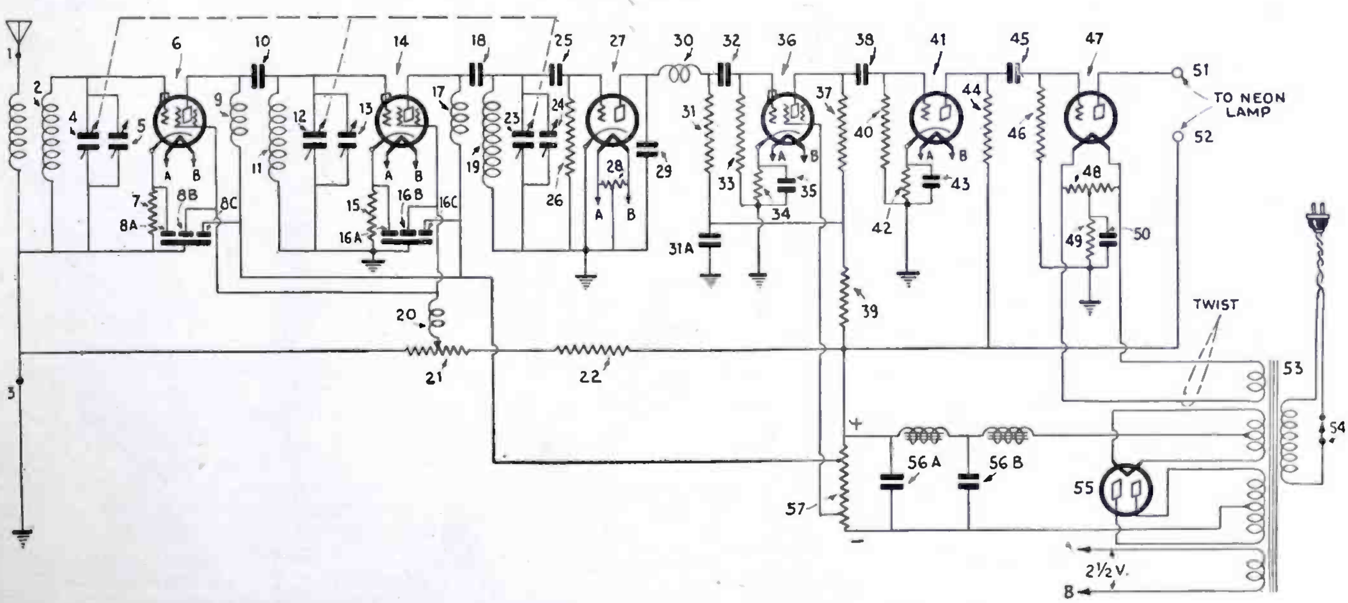
Volume is controlled by means of a 25,000-ohm potentiometer (21), connected in such a way that the voltage on the outer grids of the two R.F. screen-grid tubes may be reduced from normal operating voltage to zero, by turning the knob of the potentiometer. This method is highly efficient and gives very smooth control. The power switch (54), is mounted on the volume control shaft, thus eliminating an extra control.

Includes Complete Power Pack

The power supply equipment of the receiver consists of four essential components. The plate voltage for the rectifier tube (and for the receiver), the 5-volt filament supply for the rectifier, 2½ volts for the power tube's filament and a separate 2½-volt source for the other tubes, are all obtainable from the power compact (53); which contains also the two 30-henry chokes which form a part of the filter system. The alternating current is rectified by means of a full-wave 480-type rectifier tube (55). The two heavy-duty filter condensers (56A) and (56B) are contained within a single casing for convenience in assembling. A 1-watt enamelled tapped resistor (57) serves the purpose of a voltage divider. Only two taps are taken from this resistor; one supplying the 180-volt plate supply to the two R.F. screen-grid tubes and the other furnishing the correct outer-grid voltage to the first audio screen-grid tube. The other screen-grid voltages, plate voltages, etc., are obtained by reducing the maximum "B" plus voltage to the desired values by means of the voltage drops in various individual metallized resistors.

Binding posts are provided; for aerial and ground connections at (1) and (3), and for the output connections to the neon lamp terminals of the televisor at (51) and (52).

(*Continued on page* 145)



Complete wiring diagram of new Jenkins television receiver. The numbers correspond to those on the photo of the set shown on opposite page. List of parts appears at end of article. This receiver was designed and tested in the Jenkins television laboratory under actual "image reception" conditions of all kinds. No regeneration is used in this receiver.

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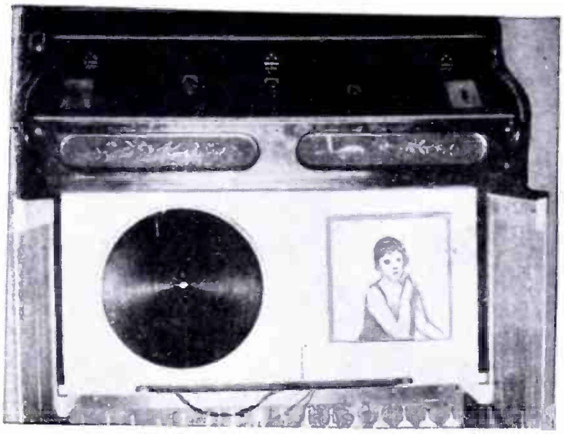


Loud speaker on left, image on right.

Television Image and Voice

Recorded on and Reproduced from Film

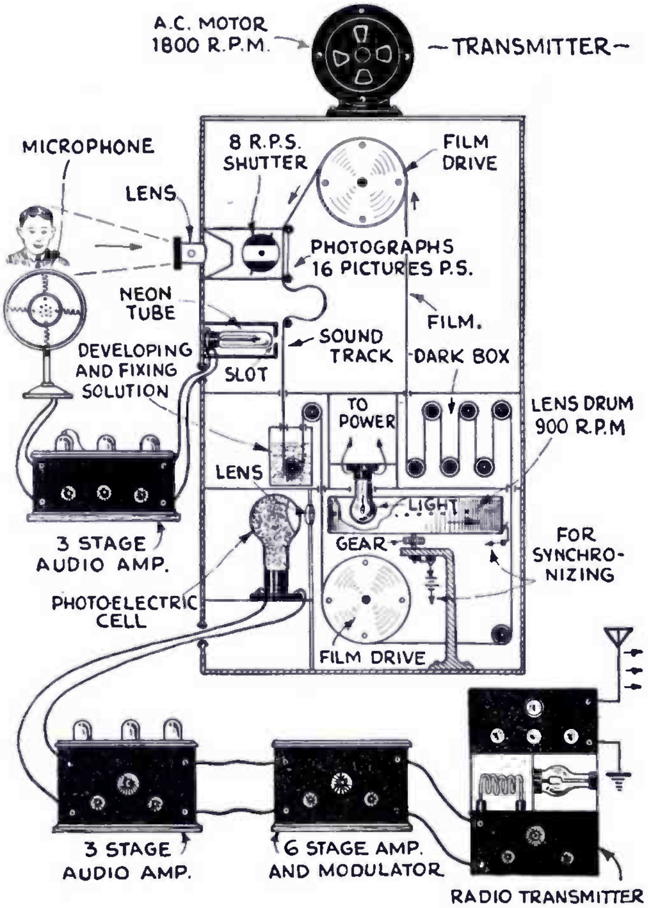
By WILLIAM SIRAWATKA

INTRODUCTION

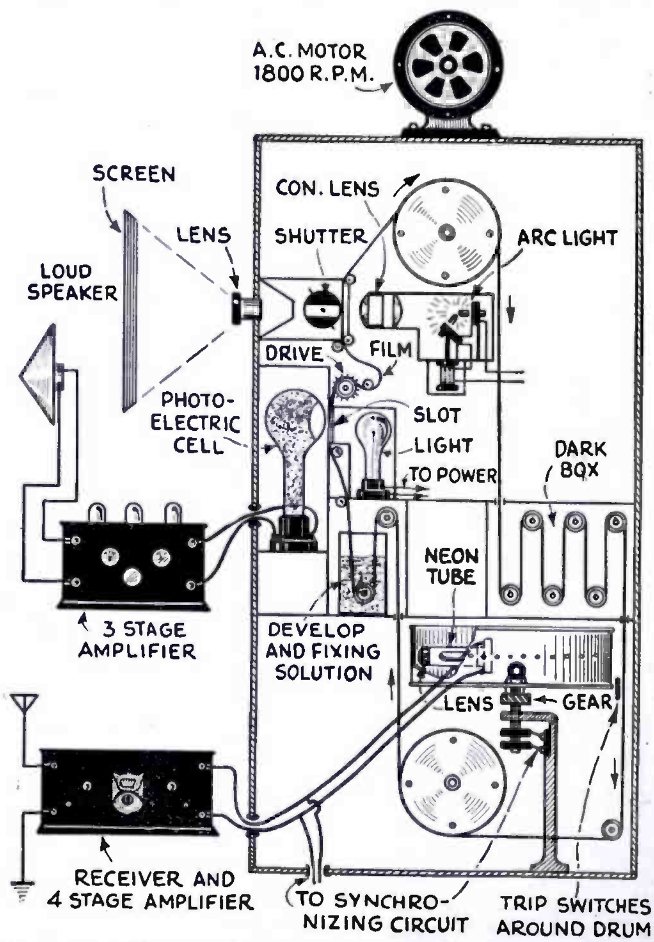
The accompanying article by Mr. William Sirawatka, is published because it seems to contain the essence of a new idea. Briefly, the inventor proposes to record both picture and voice images on film, develop it and later project the magnified picture image on a screen, accompanied by the voice. Both picture and voice are recorded simultaneously. The film is used over and over. In its present form, however, it leaves a number of interesting problems for the student; one of which is represented by the fact that, while the pencil of light at the transmitter is scanning the picture image, it is not scanning the voice-track on the film and, in consequence, there will be gaps in the voice record. This gap can be closed by lagging characteristics in the voice amplifier, possibly; or, also, by optical or mechanical methods which would change the speed of the film at the point where the voice is recorded on it.—EDITOR.

ONE of the limitations of television today is the size of the received images. This is partly so because the scanning disc limits the illumination which can pass through a single one of the tiny holes when revolving at high speed. But, by photographing the image on a motion-picture film, and then passing a bright light through the film, a much greater illumination is passed on to the photo-electric cell, which enables it to respond better.

As you will see from the illustrations I am able to receive and project



Transmitter: Voice and image are recorded on film, then broadcast.



Receiver: Film records image and voice, then reproduces them.

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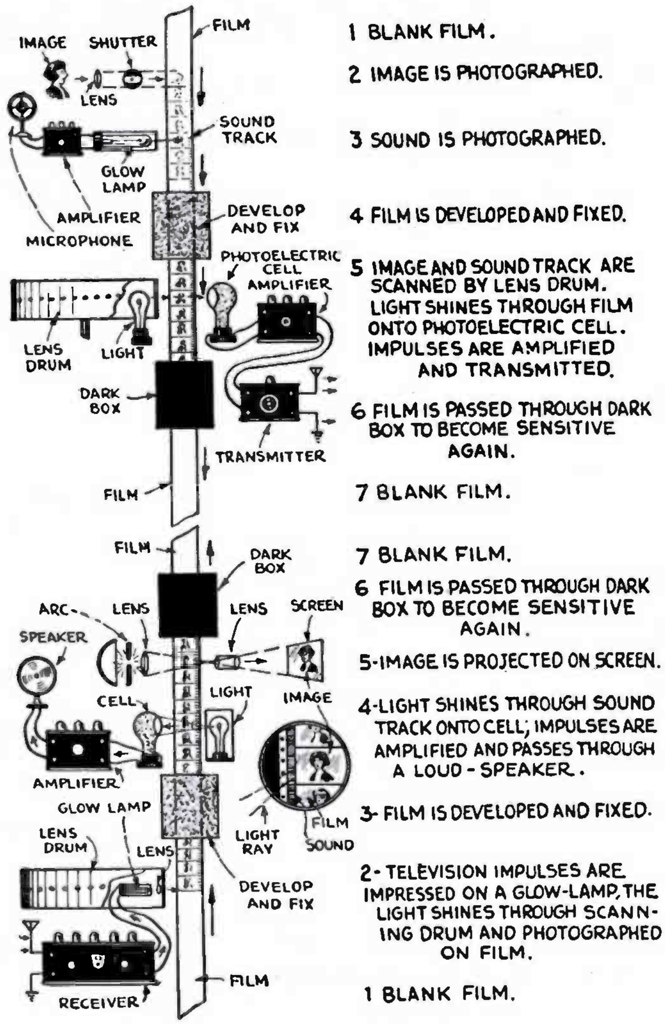
the image onto a screen of any size. On my receiver the screen is 12"x12". I also intend to transmit and receive sound in conjunction with the image.

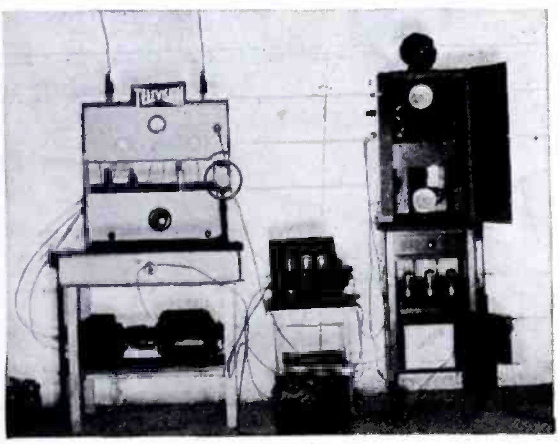
Recording Television Image

The person to be televised is photographed by a special motion-picture camera, incorporated in the television apparatus. At the same time, the sound is resolved into electrical vibrations which are changed into light and photographed along the edge of the film. This sound track, 1/8-inch wide, runs down one side of the film; it consists of the usual light and dark bands or lines, and the spacing of these lines at each point depends on the pitch of the sound. The greater the contrast between the light and dark lines, the louder the sound. In the diagram you will see how this is done. The film is developed and fixed, and then run through the television apparatus, which consists of a hollow metal drum which is studded with 48 separate little lenses, which concentrate an intense pin-point of light through the film. Behind the film is a sensitive photo-electric cell which receives the light. The drum revolves at 15 revolutions per second; the separation between the lenses is equal to the width of the film.

How the movie film records image and voice (sound track) at transmitter and receiver is shown clearly in diagram at right.



Below: Appearance of Mr. Sirawatka's film—television apparatus used in his experimental research.



Scanning

As the drum revolves, the light beam travels horizontally across the film; when it runs off the left edge, the beam of the next lens starts at the right, but at a point a trifle above where the first started. The film is moving down at the same time, while the drum is turning to the right; 48 beams of light travel across each picture in 1/15 of a second. The light beam scanning the film including the *sound track* falls with varying intensity into the cell, which is connected to an amplifier which is connected to the transmitter.

The film used is *phototropic* in effect. In other words, it has the property of fading out and regaining its sensitiveness when passed through a dark box. The film is coated with an emulsion of sulphide of zinc and mercury salts.

The developing and fixing solution does not spoil the phototropic effect.

An 1800-R. P. M. synchronous A.C. motor is used to run the shutter and sprockets that drive the film and also the scanning drum.

The film is then passed through a (*Continued on page* 149)

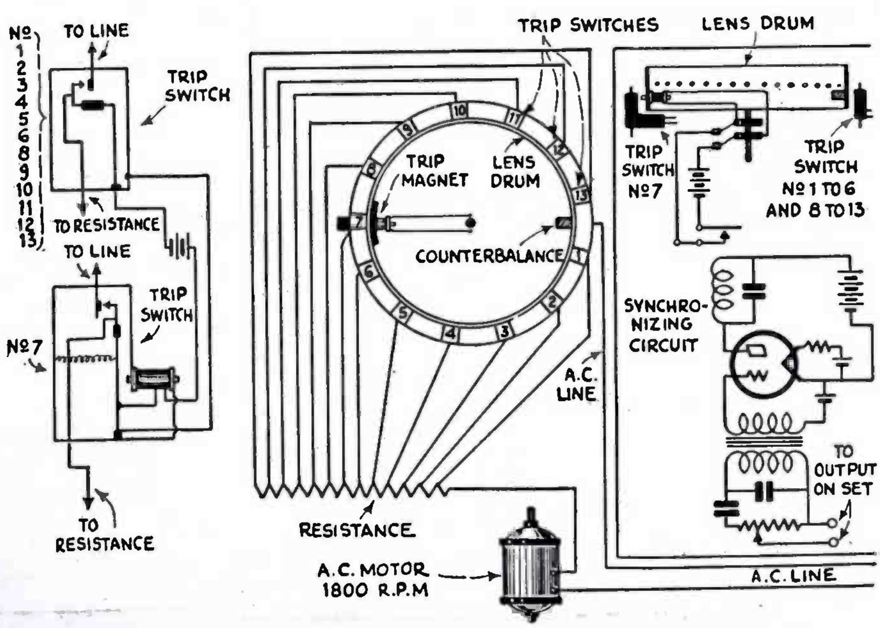


Diagram showing part of the synchronizing system employed by Mr. Sirawatka.

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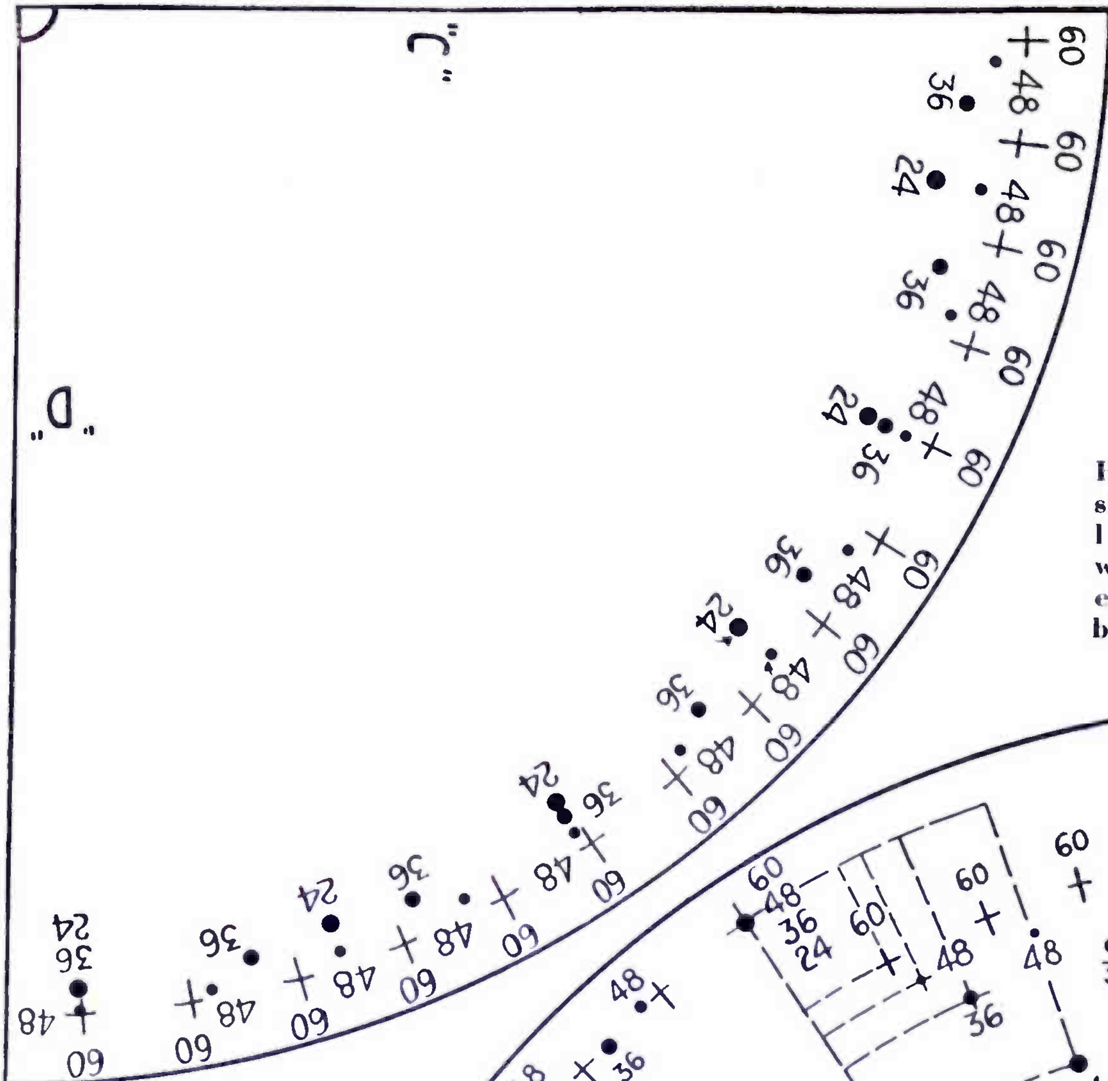
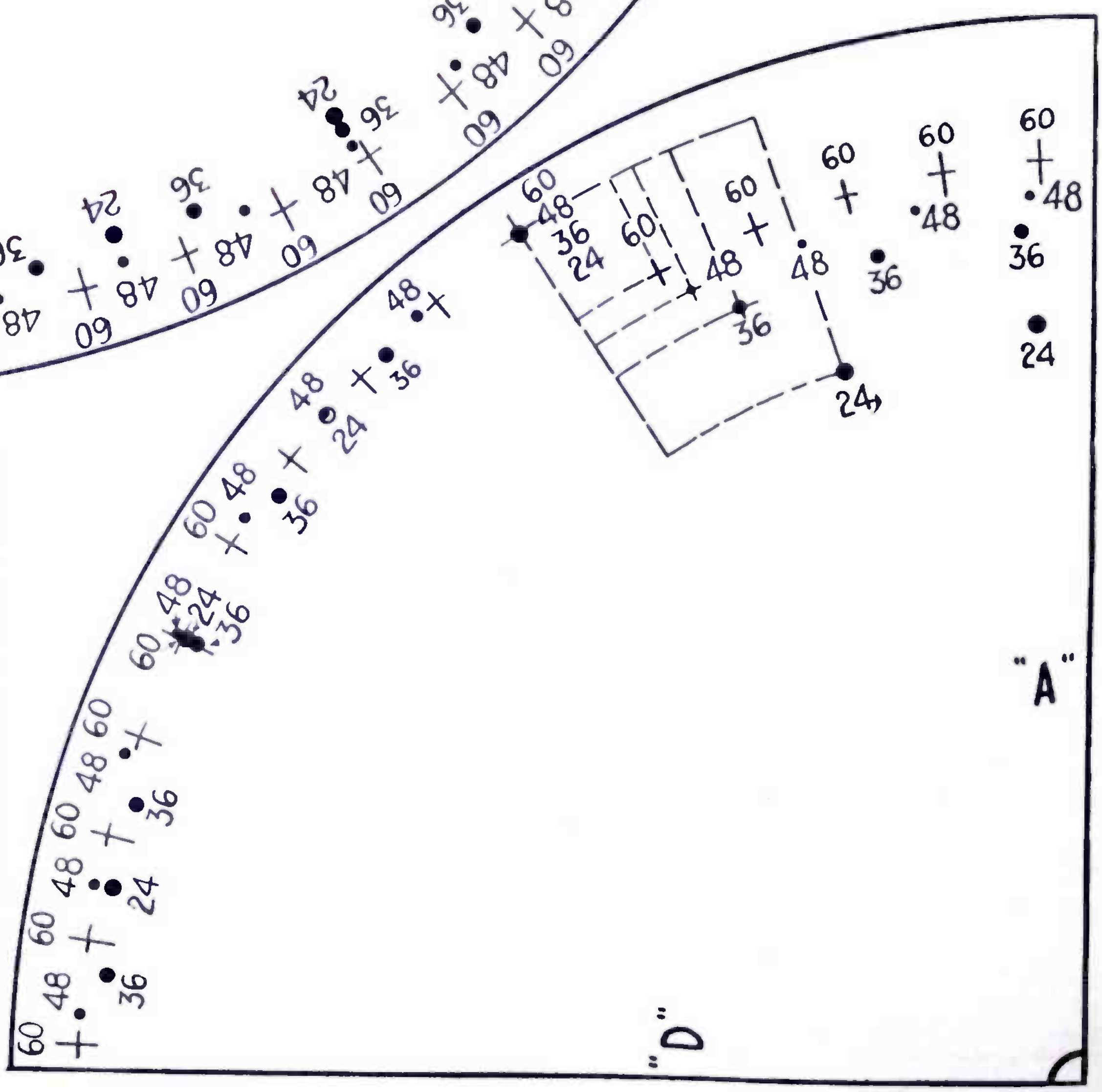
The Television Constructor Will Find These Charts Very Useful

FULL TEMP *for* Lay

Here are the full size scanning disc layout charts which television enthusiasts have been looking for.





The four quarter-circle charts here reproduced may be traced or transferred by carbon paper in such a manner that when the similarly labelled sides such as A-A, B-B, etc., are placed together, you will have a complete template or chart for television scanning purposes. While discs have been layed out which contained 24, 36, and other numbers of holes on the same disc, the present design cannot be used in that manner and each spiral of holes should be layed out on a separate piece of disc material. It is only necessary to change discs when you switch to a transmitter using a different hole frequency.

(See page 131 for data on 60x72 element image.)

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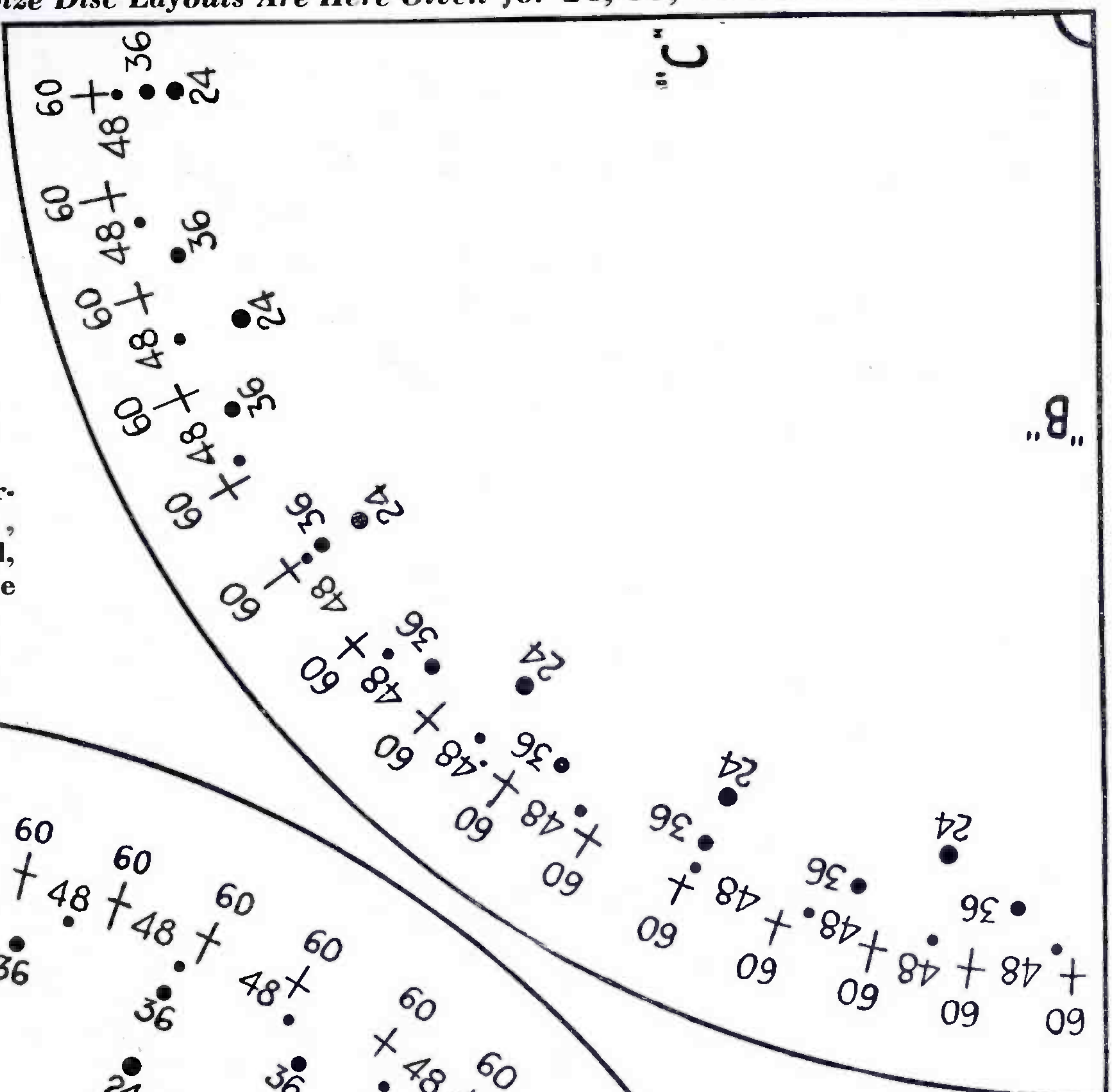
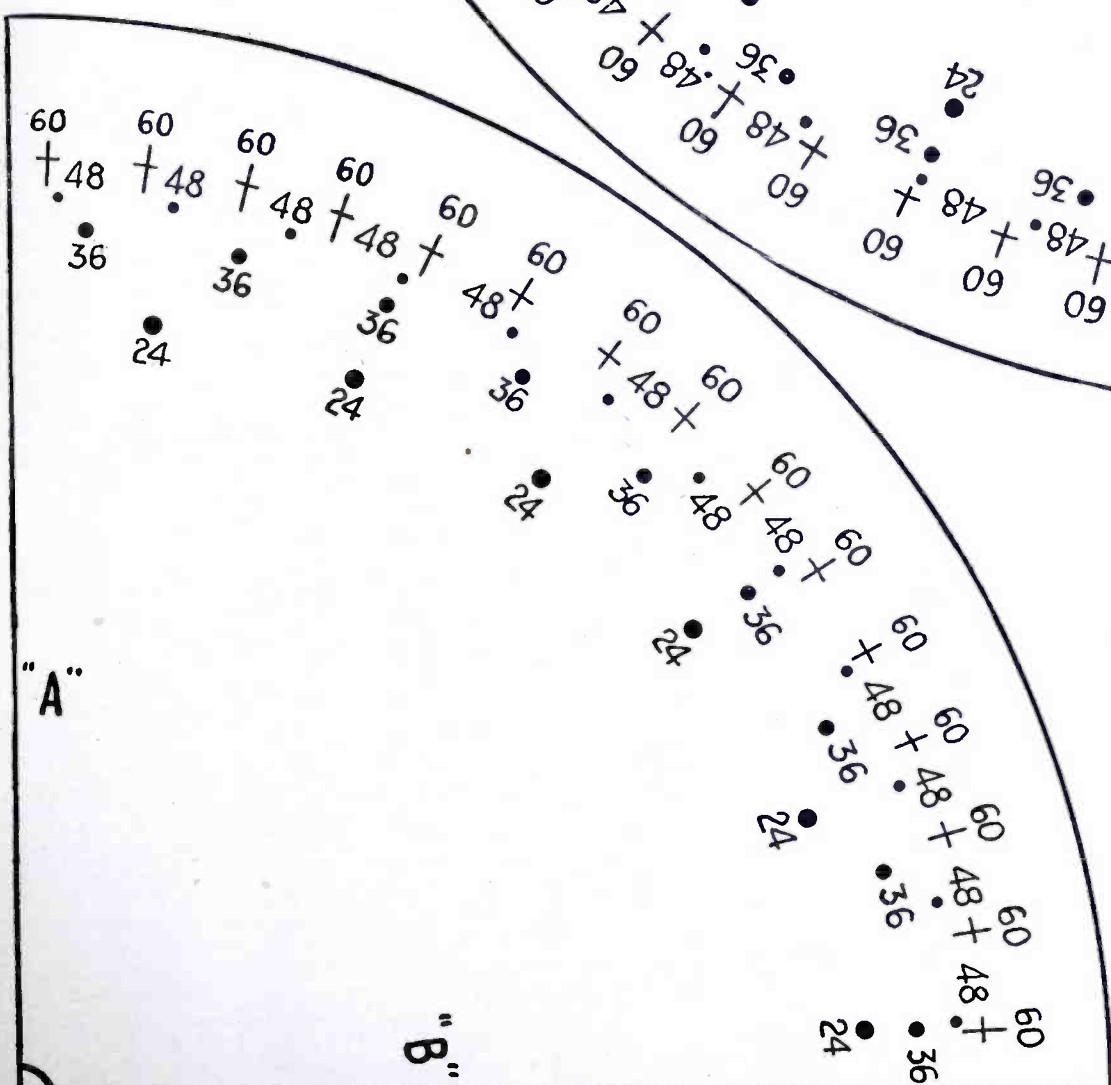
Full Size Disc Layouts Are Here Given for 24, 36, 48 and 60 Holes

SIZE LATE DISC out

The four quarter-circle charts, when matched, form a complete template.





It will be apparent, after a little study of the accompanying charts, that one cannot drill all of the holes on one disc of metal, as the various holes corresponding to the different series such as 24, 36, etc., would interfere with one another: a separate disc should be used for laying out each spiral of holes. Aluminum, about 1/32 inch or less thick, has been used and also fibre as well as other materials. Be very careful to check up the spacing between the holes where the division line between quarter patterns fit together. This can be done very easily with a strip of paper containing spacing marks.

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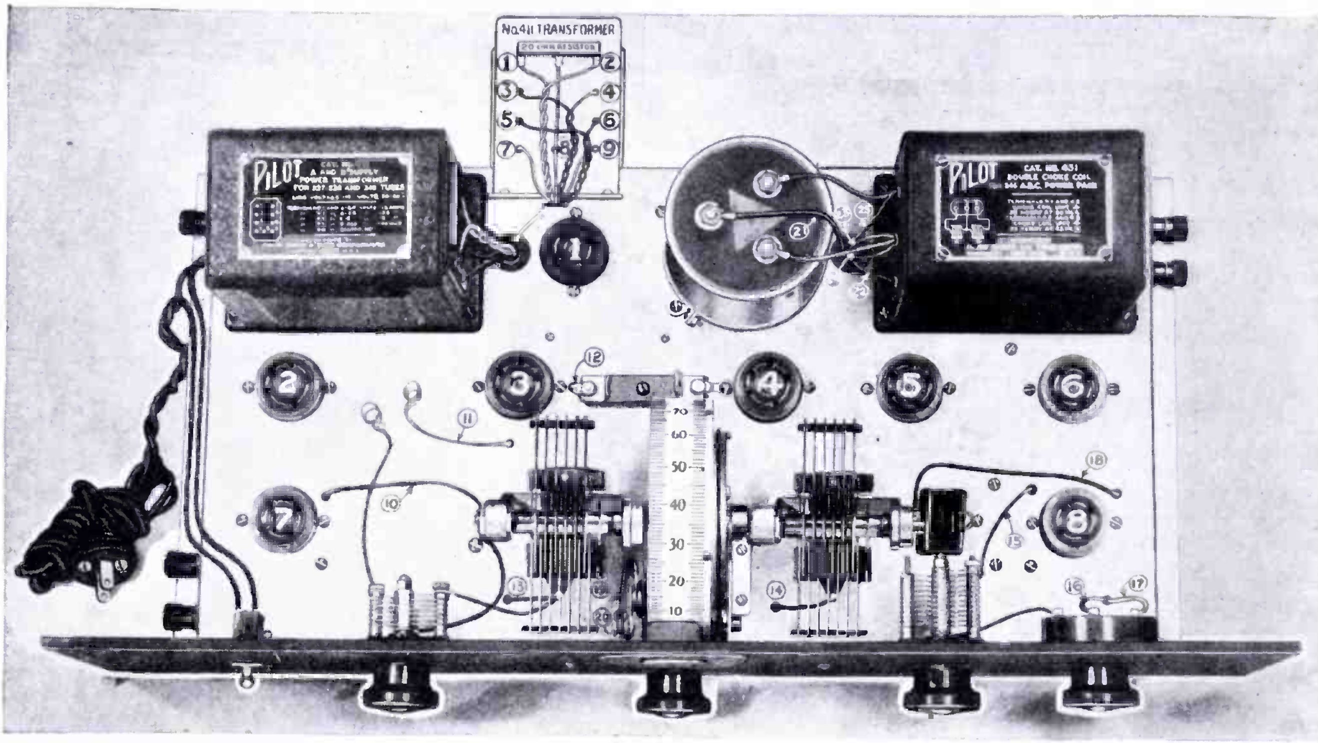

Top view of the Baird Universal Television and Short Wave Receiver chassis, showing single dial tuning drum.

Complete Instructions for Building the

BAIRD UNIVERSAL TELEVISION *and* SHORT WAVE RECEIVER

THIS article describes in detail the assembly and operation of the *Baird* Universal Television Kit and *Baird* Combination Shortwave and Television Receiver which has been especially designed for use with the Television Kit.* This kit has been especially designed for the individual who wants television in his home without spending a prohibitive sum of money, and is offered with the assurance that, although lacking in the finer constructive details of higher priced receivers, it nevertheless will receive a television picture with good detail.

We will first go into complete description of the assembly and operation of the *Baird* Combination Shortwave and Television Receiver. This receiver will tune from 15 to 550 meters for the reception of music, television images or code. It is simple to construct and will operate from 110-115 volts 50-60 cycle current with a minimum of A.C. hum interference, especially below 50 meters, where this

The range of this television set is 15 to 550 meters. The short wave tuner can be used for voice reception, independently of the television scanner mechanism. The Baird scanner has a spiral of holes spaced around the wall of a narrow cylinder. A special synchronizing motor is used in addition to the main driving motor.

would be most evident. The regeneration control is smooth and the quality of music and voice reception will be found excellent, due to resistance coupling in the audio stages. The outfit described here must be built very carefully and instructions must be followed implicitly, as the quality of the picture to be received depends entirely upon the final construction and operation of this receiver.

For television reception this receiver must be non-regenerative and transformers cannot be used for audio amplification. It is necessary to cover a frequency band of about 10 cycles to 30,000 cycles and the average transformer only covers a frequency range of 100 cycles to 5,000 cycles.

This receiver is especially useful as it is not limited for use only as a shortwave-television receiver. It has been so designed that by simply changing the plug-in Octocoils it becomes a highly efficient regenerative receiver covering a wave band from 15 to 550 meters. The Baird Combination Shortwave and Television Receiver, therefore, is universal in the full sense of the word, in the fact that not only will it work as a non-regenerative television Receiver but can give you selected programs of voice and music from all parts of the world.

Capacities and other values have been figured out with utmost care and the set-builder's work will be much easier and much less open to eventual trouble if he confines himself entirely to the use of material described herein. Substitution may throw the complete receiver out of balance. If you want to experiment, do it later. Build this receiver exactly as we describe it, using only the parts which we recommend. Then, if you think you can

* Manufactured by the Shortwave and Television Corp., Boston, Mass. This company also operate a television broadcasting station, W1XAV, 2850-2950 K.C., at Boston, Mass. (38 hole disc.)

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improve your ultimate results, you at least will have a standard from which to work.

Wherever we mention Combination Shortwave and Television Receiver we mean that this shortwave receiver will tune in not only shortwave and the broadcast band, but the radio television signal as well. The receiver is for receiving the broadcast; the television *kit* is the actual scanning equipment for SEEING the picture. *Both receiver and kit are required.*

General Assembling Instructions

Refer carefully to assembly and wiring diagrams Nos. 1 and 2 and it will be seen that there are eight sockets

List of Parts for Baird Shortwave Receiver

All necessary supplies and parts for building the Baird Universal Shortwave and Television Receiver, as well as the Television Unit, are now on sale at all S. S. Kresge 25c. to $1.00 Stores.

The following is a complete list of parts to be used in the construction of the *Baird* Combination Shortwave and Television Receiver:

1 *Baird* 8" x 21" Metal Panel
1 *Baird* Aluminum Chassis, drilled and punched, with static shield plate base—complete
2 Sets *Octocoils*
2 only Broadcast *Octocoils*
1 only Special Television *Octocoil*
1 Type 1285 Drum Dial with dial light
2 MLW 150 Hammarlund Variable Condensers
1 Type J-13 Midget Variable Condenser with knob
1 Type J-23 Midget Variable Condenser with knob
1 Type 609 Toggle Switch
1 Royalty Electrad 50,000 ohm Potentiometer
4 Type 216 Tube Sockets

in this receiver numbered 1 to 8. No. 1 is the socket for the BH Raytheon tube which rectifies the current in your power pack. No. 2 is a screen grid R.F. stage ('24 tube). No. 3 is a screen grid detector ('24 tube). Nos. 4, 5, 6 are three stages of resistance coupling with type '27 tubes in sockets 4 and 5 and a '45 power tube in No. 6. Nos. 7 and 8 are for the plug-in *Octocoils*. In beginning your assembly have the chassis top side up in front of you with the No. 1 socket furthest from you (Diagram No. 1). This relative position should be maintained whether you have your chassis top side or bottom side up. If this is followed the assembly and wiring of your receiver will be much more simple.

Every effort has been made to make Diagrams Nos. 1 and 2 as clear and concise as possible. If there is any question about the exact location of any particular item in the instructions, you should have no difficulty in clarifying your mind by careful scrutiny of the diagrams.

There are a few small holes in the chassis through which the rubber covered wire has to be drawn. In all of these places we suggest using a short piece of spaghetti to draw your wire through so as to prevent the sharp edge of the hole cutting into the wire.

Assembly

Mount a type No. 216 socket into No. 1 hole with the two filament holes to your left. Nos. 2, 3, 4, 5 are all type No. 217 sockets and should be mounted with the grid hole, which is the single hole by itself, towards you. Before inserting the screws for the No. 4 socket put one terminal lug under the head of the left hand screw on the top side of the chassis. Put a lug under each mounting nut of the No. 5 socket on the bottom side of the chassis. No. 6 is a type No. 216 socket which should be mounted with the two filament holes toward you and a lug under the left hand mounting nut on the bottom side of the chassis. Nos. 7 and 8 are each type No. 216 sockets which should be mounted with the filament holes furthest from you.

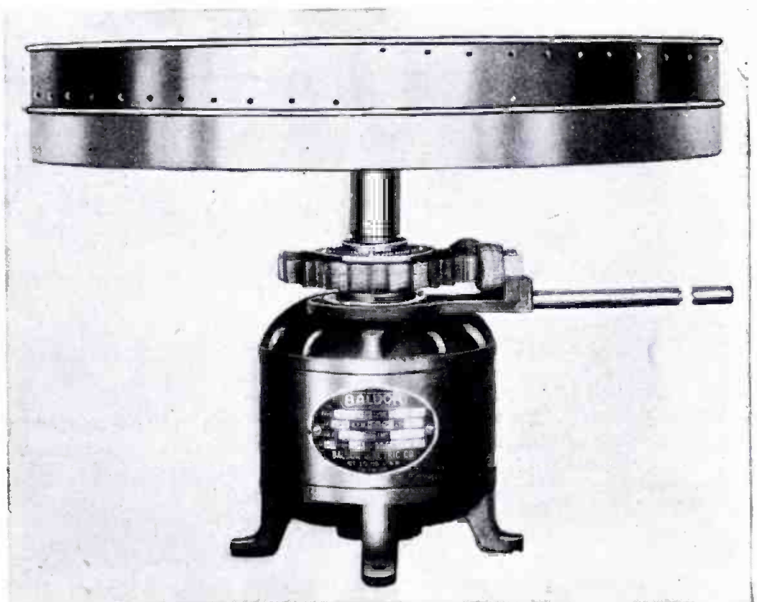

Fig. 5—The Baird Television scanning unit, ready to insert into cabinet.

Next, mount the No. 1049 grid leak holder between sockets No. 3 and 4, putting a lug under the mounting nut on the bottom side of the chassis. Take a No. 1450 .02 Aerovox condenser, bend one of the lugs at right angles and fasten it to the chassis with a screw and nut through the hole half way between No. 5 socket and the edge of the chassis nearest you. The location of this condenser can be seen in diagram No. 1. Then mount the No. 1285 drum dial in the location as shown in diagram No. 1.

Turn your chassis upside down, still keeping No. 1 socket furthest from you. Take three No. 260 Aerovox .25 condensers and screw them to the No. 1001 bakelite strip. Be sure to use the flat head screws furnished in the No. 1000 assembly package. Mount the bakelite strip with the condensers onto the chassis in the holes provided, using two nuts on each screw between the chassis and the strip so as to separate the strip from the chassis; have the terminals of these condensers pointing towards the row of five sockets.

On the back edge of the chassis mount two No. 1165 midget jacks as shown in diagram No. 2. The jack nearest the top left hand corner is insulated from the chassis and must be mounted with fibre bushing washers which are furnished in the No. 1000 assembly package.

Next, mount a type 261 2-mf. Aerovox condenser, which is the condenser with only two terminals, between sockets Nos. 5 and 6 and the jacks which you have just mounted with the leads pointing in as shown in diagram No. 2. Then mount a type 261 XX 2-mf. condenser between the jack and No. 1 socket. This is the condenser with three terminals, which terminals will point towards the No. 1 socket. Mount a type 261 XX 2-mf. Aerovox condenser between No. 7 socket and the bakelite strip as shown in diagram No. 2. Mount one No. 260 .25-mf. Aerovox condenser, with the terminals towards you, between Nos. 3 and 4 sockets.

Mount a No. 1450 Aerovox .00015-mf. condenser just to the right of the bakelite strip with the threaded fibre bushing furnished in the No. 1000 assembly package, being sure you use the right length screws so that the screw holding the condenser to the fibre bushing will not strike the other screw coming through from the chassis. Mount a No. 1450 Aerovox .02-mf. condenser on the left hand mounting screw of No. 7 socket and another condenser, type 1450, .02-mf., Aerovox. to the right hand mounting screw of No. 3 socket.

Mount your binding posts so that the two posts marked "Antenna" are

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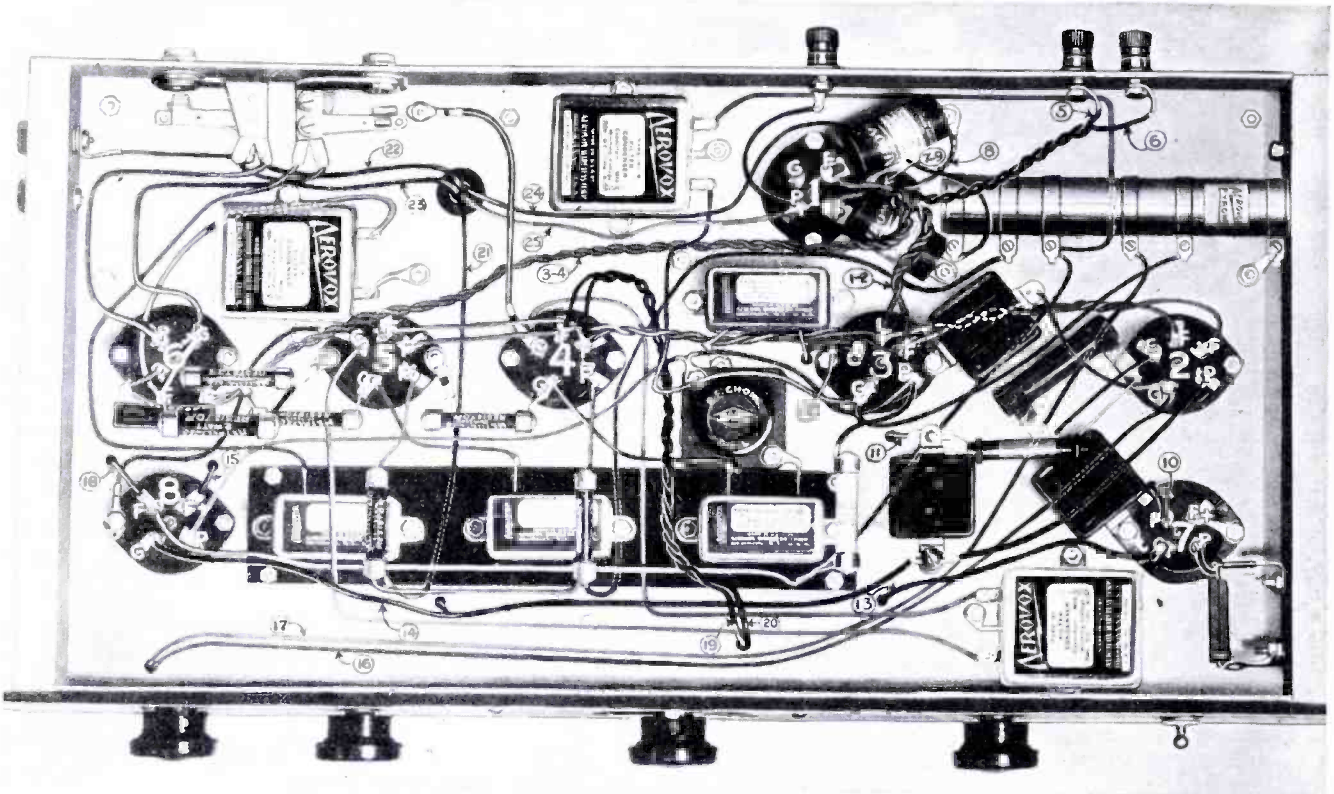

Fig. 2—Showing bottom view of the Baird Universal Television and Short Wave Receiver chassis, assembled and wired.

on the bottom right hand corner. Both must be insulated from the chassis, using the small fibre washers furnished for this purpose in the No. 1000 assembly package. Place one lug under each nut. Mount one plain binding post directly in back of socket No. 1, and two plain binding posts a little to the right, as shown in diagram No. 2. These are all to be mounted with insulating washers and terminal lugs.

Your ground binding post is mounted to the right side of the chassis in the hole nearest the right hand further corner. A No. 996SW Aerovox voltage divider resistance is mounted in the hole near the ground binding post with a 5-inch mounting screw and nuts, keeping the terminals pointing towards the row of five sockets and being sure that the end of the voltage divider marked with the Aerovox name is mounted nearest the frame of the chassis. This is distinctly shown in diagram No. 2. Now in the top left hand corner mount two plain binding posts; the furthest one from you, that is the one nearest the corner, must be insulated from the chassis with the fibre washer furnished in the No. 1000 assembly package, and a lug must be put under this nut.

Next, mount the No. 100 *Baird* television choke as shown in diagram No. 2 between Nos. 3 and 4 sockets so that one of the terminal lugs on this choke will rest against the terminal lug of the first type 260 condenser on the bakelite strip.

Attach to the left hand mounting nut of the No. 2 socket a Pyrohm No. 992 400-ohm resistor, so that the other terminal lug of the pyrohm rests on the terminal of the .02 No. 1450 condenser which is connected to the mounting nut of No. 7 socket.

Turn your chassis over again so that you are looking down on the top with the No. 1 socket still furthest from you, and mount the No. 411 power transformer in the further left hand corner, the 9 terminals facing No. 1 socket, putting a lug under the nut of the screw nearest you on the bottom left hand corner of the transformer.

Take two rubber grommets from your assembly package and insert in the half inch holes in the chassis near the terminal lugs of the 411 and 431 units (diagram No. 1).

Mount a No. 431 double choke coil in the right hand corner of the chassis with the terminals pointing in towards the No. 1 socket and put a lug under the mounting nut of the bottom left hand screw, which is the one nearest socket No. 5. Then place mounting ring on your Aerovox 3-section E5-888 electrolytic condenser and screw to the chassis between the No. 431 double choke coil and No. 1 socket.

Turn your chassis over again so that it is now bottom side up with No. 1 socket furthest from you and mount an Electrad 4,000-ohm wire grid resistor onto the top right hand mounting nut of the No. 431 double choke coil, this mounting nut being between the non-insulated jack and type 261 XX condenser. Now mount two type 1070 .02 Aerovox condensers on the two mounting nuts of the No. 411 power transformer which are nearest the No. 1 socket, so that the other ends of the 1070 condensers will rest on the filament terminals of the No. 1 socket. Also, put a lug under the mounting nut of the 1070 condenser furthest from you. All this is shown clearly in diagram No. 2.

Again turn your chassis over so that you are looking down on the top of it with the No. 1 socket furthest from you. Mount one Hammarlund No. MLW150 .00015 condenser to the left side of the drum so that the longest parts of the plates are towards you, and insert two 1-inch No. 10/32 screws from the under part of the chassis, placing the two 7/16-inch long fibre spacers found in No. 1000 assembly package between the condenser and chassis frame to hold it rigid, threading the screws into the threaded holes in the bottom of the condenser.

Next, take a No. MLW150 .00015 Hammarlund condenser and remove the brass shaft by releasing the two set screws on the rotor and insert in its place the bakelite rod found in your assembly package. Then mount this condenser into the right side of the drum and support the condenser to the chassis with the two other 7/16-inch spacers, being sure to use the two fibre shoulder washers between the heads of the screws and the chassis for this purpose. This condenser must be mounted with the bakelite rod and

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fibre washers exactly as described, as it has to be insulated from all metal, otherwise it will be short circuited. Connect the loose end of the .02-mf. 1450 Aerovox condenser mounted on the chassis to the Hammarlund condenser with a machine screw.

This completes the mounting of all parts on the chassis before soldering. Now take the 8 x 21 inch metal panel and mount a No. 609 toggle switch on the extreme left. In the next hole to the right mount a J-13 midget condenser. On the extreme right mount an Electrad Royalty 50,000-ohm potentiometer and in the next hole to the left mount a J-23 midget condenser. Attach the drum escutcheon plate over the window in the panel and connect the metal panel to the chassis with the three mahogany color oval head screws provided in the assembly package.

Wiring Instructions for Baird Short-wave and Television Receiver

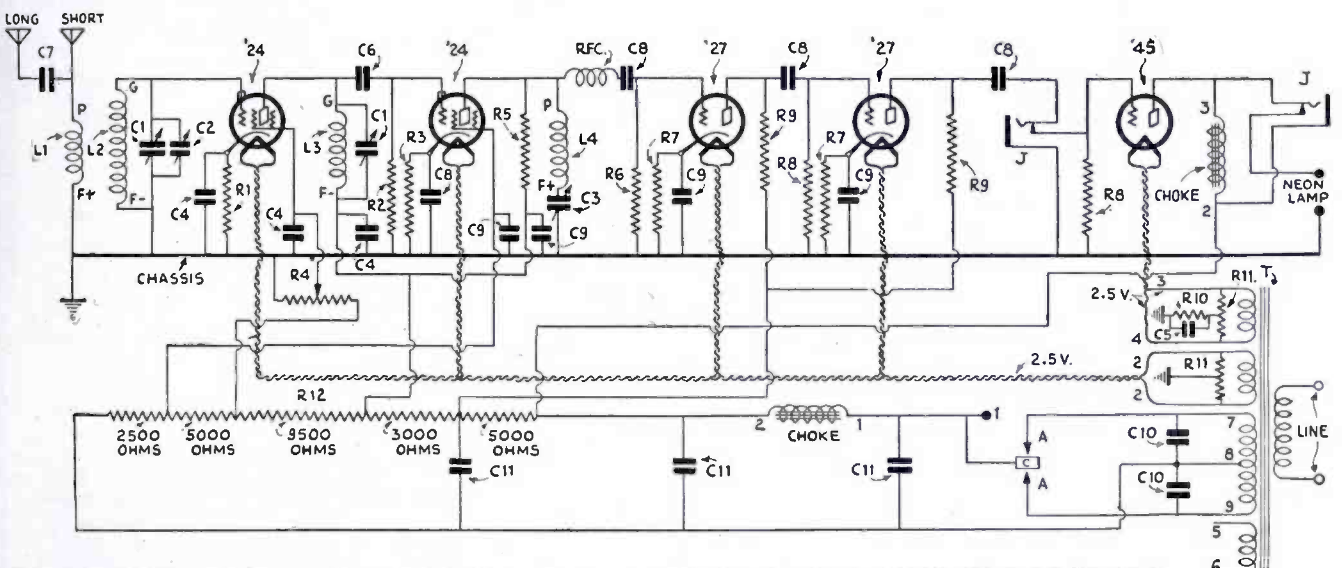
NOTE.—Remember that in running wires always follow the shortest possible lead from one point to another. The diagrams have been drawn so that it will be easy for you to follow in wiring but do not necessarily indicate the length of wire.

The first wiring to be done should be the heater and filament wires. Twist together several feet of connecting wire. The two terminals marked F on sockets Nos. 2, 3, 4, 5 are connected in parallel with the twisted wire. On socket No. 3 solder one pair of twisted leads to the same pair of terminals. Run this pair through the hole with the rubber grommet near No. 1 socket up to terminals 1 and 2 on the 411 transformer, across which a 20-ohm center-tap resistor is also soldered. Now take another pair of twisted wires and solder to terminals 3 and 4 on the 411 transformer; bring through grommet hole and run over to the two F terminals on socket No. 6.

Solder a pair of twisted wires to terminals 5 and 6 on the No. 411 transformer; run these wires through the grommet hole and solder one lead to each binding post (wires No. 5 and 6 on diagram No. 2). Solder a pair of twisted wires to terminals 7 and 9 on 411 transformer; bring through grommet hole and up to the two terminals marked F in socket No. 1, at the same time soldering the two type 1070 condensers to the same terminals. Solder another pair of twisted wires on the pair of F terminals on socket No. 4, which are marked 19 and 20 on the diagram and run through hole in the panel up to the dial light and solder to the two terminals. Across the F terminals on socket No. 6 solder a 20-ohm center-tap resistor.

We will now proceed to wire the three type 260 condensers on the bakelite strip. First, solder the two lugs that are touching between the first No. 260 condenser and No. 100 choke. The other terminal on the condenser goes to the G post on No. 4 socket. At the same time solder a .5 meg metalized resistor from this G post to the ground lug under mounting screw on No. 5 socket.

Next, connect the right-hand terminal of the middle type 260 condenser to the P terminal on No. 4 socket. A 50,000-ohm metalized resistor is laid across this 260 condenser as shown in the diagram and one end of it is soldered to the same terminal on the condenser. The other terminal of this condenser goes to the G post on No. 5 socket and at the same time solder a .25 meg metalized resistor from this G terminal to the lug under the mounting screw of No. 6 socket. Connect the right hand terminal lug of the third type 260 condenser to the terminal lug marked P on No. 5 socket and at the same time solder a 50,000-ohm metalized resistor on the same terminal lug of the condenser. Connect the other side of the 260 condenser to



WIRING DIAGRAM No. 3—BAIRD UNIVERSAL SHORT WAVE AND TELEVISION RECEIVER

L1-L2—Octocoil, No. 7 Socket, connect as shown.
L3-L4—Octocoil, No. 8 Socket, connect as shown.
C1—MLW No. 150 Hammarlund Variable Condenser.
C2—J-13 Midget Variable Condenser.
C3—J-23 Midget Variable Condenser.
C4—No. 1450 .02 mfd. Aerovox Bakelite Moulded Condenser.
C5—No. 261 2 mfd. Aerovox Non-Inductive By-Pass Condenser.
C6—No. 1450 .00015 mfd. Aerovox Bakelite Moulded Condenser.
C7—No. 1450 .00005 mfd. Aerovox Bakelite Moulded Condenser.
C8—No. 260 .25 mfd. Aerovox Condenser.
C9—No. 261XX 1 mfd. Aerovox Condenser.
C10—No. 1070 .02 mfd. Aerovox 1,000v. DC Buffer Condenser.
C11—3 Section Aerovox No. E5-888 Electrolytic Condenser.
R1—No. 992 400 ohms Pyrohm Aerovox Resistor.
R2—5 megohms 1-watt Resistor.
R3—50,000 ohms 1-watt Resistor.
R4—50,000 ohms Royalty Electrad Potentiometer.
R5—100,000 ohms 1-watt Resistor.
R6—.5 megohms 1-watt Resistor.
R7—4,000 ohms Electrad Wire Grid Resistor.
R8—.25 megohms 1-watt Resistor.
R9—50,000 ohms 1-watt Resistor.
R10—1,500 ohms International 2-watt Resistor.
R11—No. 354 Center Tapped Resistors, 20 ohms.
R12—Aerovox No. 996SW Special Voltage Divider, 25,000 ohms.
J—Frost 3-contact Jack.
R.F.C.—No. 100 Baird Television Choke.
Choke—No. 431 Double Choke.
T—No. 411 Power Transformer.
C—Cathode of B.H. Raytheon.
A—Anode of B.H. Raytheon.

Connect Anodes to Filament Prongs on No. 1 Socket. Connect Cathode to Plate of this Socket.

R3 is replaced with a 201A Fixed Rheostat which acts as a short circuit when regeneration is used.

Windings 5 and 6 light power tube in synchronizing amplifier.

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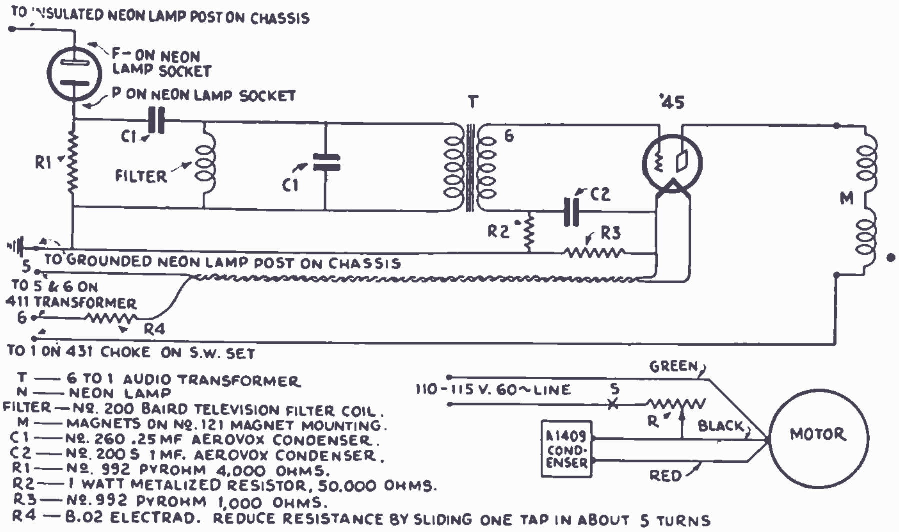

Fig. 4 (above)—Shows wiring diagram of Baird synchronizing amplifier for television unit and Fig. 4A (below) shows electric motor connections for television unit.

the lug of the right hand midget jack with which the tip of the phone plug makes contact. Now connect the second or middle lug on the same jack to G on socket No. 6 and at the same time connect a .25 metalized resistor to the same terminal on the socket and the other end of the metalized resistor to the left hand mounting nut of socket No. 5.

To the same mounting nut of socket No. 5 solder one end of a 1,500-ohm, 2-watt metalized resistor and the other end of this resistor to the center tap of the filament resistor on socket No. 6. From this same point run a wire to one of the terminal lugs of the type 261 2-mf. condenser. Solder the other terminal lug on this condenser to the lug under the mounting nut right beside it. Connect P on socket No. 6 to the lug on the left hand midget jack, with which the tip of the phone plug makes contact, and continue through the grommet hole to No. 3 terminal on the No. 431 choke coil (No. 22 wire on both diagrams). Connect a wire from the frame lug on the left hand midget jack through the grommet hole to post No. 2 on the No. 431 choke coil (No. 23 wire on both diagrams). Continue this wire back through the same grommet hole and run it over to the end terminal nearest socket No. 1 on the Aerovox voltage divider (No. 24 wire on both diagrams).

Connect the remaining lug on the left hand jack to the insulated binding post in the top left hand corner.

Wires Through Holes

In all cases where a wire goes through a hole in the chassis, the same number appears on such wire on both diagrams Nos. 1 and 2, so the wire can easily be traced. Where the text refers to a numbered hole, it means the hole with a wire of that number going through it.

Connect the plain binding post near socket No. 1 to P on socket No. 1, and continue wire from there through the same grommet hole to terminal No. 1 on the No. 431 choke coil (No. 25 wire on both diagrams), and continue this up to one of the terminal posts on the Aerovox electrolytic condenser. Connect terminal No. 2 on the No. 431 choke coil which already has two wires coming from it to another terminal on the electrolytic condenser. This leaves the terminal open on the electrolytic condenser No. 21, which should have a wire run down through the grommet hole (wire No. 21 on both diagrams), and goes back between sockets 4 and 5 under the bakelite strip and hooks onto the open side of the 50,000-ohm metalized resistor which is laid across and connected to the last Aerovox 260 .25-mf. condenser. Continue this same wire to the 50,000-ohm metalized resistor to the middle type 260 condenser. Continue the wire back under the bakelite strip to the second terminal of the voltage divider.

Did You Know That
It Is Important to Connect
NEON TUBES CORRECTLY?
In the next issue
C. H. W. NASON,
Television Engineer,
Tells You How and Why!

If you are using the Dongan double choke, No. 7512, you will find three leads, two black and one yellow, that correspond to terminals 1, 2 and 3 on the No. 431 double choke. The two black leads are the same as terminals 1 and 3 on the No. 431 choke, and are interchangeable; the yellow lead corresponds to terminal 2 on the No. 431 choke.

Connect one end of a 10,000-ohm metalized resistor to the terminal lug marked P on the No. 3 socket. Also to the same terminal connect a piece of wire and continue to the open end of No. 100 choke and from there to P on socket No. 8. Solder a wire to one of the outside leads of type 261 XX condenser near socket No. 1 and run to terminal No. 3 on the voltage divider. Continue to the other end of the 100,000-ohm metalized resistor which you have just connected to socket No. 3 and then continue along to the left hand terminal marked F on socket No. 8. From there continue the same wire, No. 18, through hole to the junction where the .02 condenser is connected to the frame of the .00015-mf. variable condenser.

Connect from G posts of No. 8 socket through to the mounted side of the .00015-mf. Aerovox condenser and continue on the P terminal on socket No. 2. Now, cut into this wire at hole No. 14 shown in diagram No. 2 and solder a piece of wire to it, running this wire through this hole to the stator post of the variable condenser. Connect a 5 megohm resistor to the left hand mounting nut of No. 2 socket and the other end of this resistor to the other side of the .00015-mf. fixed condenser and then run a wire from this same end of the condenser down through hole No. 11. Fit a screen grid tube into socket No. 3 and measure your wire so that it reaches just to the top of the tube and then solder a screen grid cap onto the end of this wire. Be sure that this wire is not any longer than you actually need for it to slip over the top of the tube. Connect the open end of the .02-mf. condenser connected to socket No. 3 to the G terminal on socket No. 2 and continue right back through the hole up to the center terminal of the 50,000 ohm potentiometer on the front panel (wire No. 16 on both diagrams).

Now connect a wire (marked No. 17 on both diagrams No. 1 and 2) to the potentiometer; bring through hole and run to the fourth terminal on the voltage divider. Solder a wire to the fifth terminal on the voltage divider and continue to G terminal on No. 3 socket. This wire continues to the remaining outside terminal on Aerovox No. 261 XX condenser located near socket No. 1. The small Pyrohm resistor No. 992 should be soldered to the .02-mf. condenser which is connected to the left hand mounting nut of socket No. 7, and a wire soldered to the junction of the Pyrohm and the condenser over to the post marked C on socket No. 2.

Solder a wire to the center terminal

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of the center-tap resistor between posts 1 and 2 on the No. 411 transformer and continue to post No. 8 on the same transformer and from there continue through the grommet hole to the lug under the 1070 condenser, (wire No. 8 on diagram No. 2). Put a 4,000 ohm wire grid resistor under the mounting nut of the 431 choke near the right hand jack and the other end of this resistor solder to terminal marked C on socket No. 4. From this same terminal run a wire across to the outside terminal of the other 261XX2-mf. condenser near the .00015-mf. grid condenser. Connect the other outside terminal of this same condenser to the terminal marked C on socket No. 5 running this wire under the bakelite strip and from this same terminal C connect a 4,000-ohm wire grid resistor to the left hand mounting nut of socket No. 8. Connect the antenna binding post nearest socket No. 7 to terminal marked P on socket No. 7. Solder lug under right h nd mounting nut of the same socket to right hand terminal marked F (F+ on diagram No. 2). Connect a .00005-mf. fixed condenser across the two antenna binding posts.

Now to connect the two terminals on the type 260 .25-mf. condenser between sockets 3 and 4. The left hand terminal is connected to the lug under the mounting nut of the grid leak holder. The other terminal is connected to the terminal lug marked C on socket No. 3 and also through the hole No. 12 on diagram No. 2 to the terminal on the grid leak holder near socket No. 3. Connect a wire to terminal marked G on socket No. 7; follow through hole No. 13 on diagrams No. 1 and 2 and connect on terminal lug of the stator plates of the .00015-mf. variable condenser and then onto stator of the J-13 midget condenser. Connect the rotor lug, or the one underneath the plates of the J-13 condenser, to the rotor side of the .00015 condenser and continue through hole No. 10 on diagrams No. 1 and 2 to the remaining F terminal on socket No. 7. Connect the last terminal of the voltage divider to the lug on the mounting nut nearest to it. Solder lug under mounting screw of socket No. 4 to grid leak holder diagram No. 1. Attach wire to left hand side of J-13 midget condenser with a lug, and solder a screen grid cap on the other end of the wire, leaving it just the right length so that it will slip over the cap of the 224 tube in socket No. 2. Connect the remaining terminal on the 50,000 ohm potentiometer to the rotor lug on the J-23 condenser.

Run a wire from the stator of the J-23 midget condenser through hole No. 15 on the Diagrams No. 1 and 2 and connect to remaining F (F+ on diagram No. 2) terminal on socket No. 8. Take the cord leading into the 411 power transformer and cut one of the wires about four inches away from the transformer. Now solder an additional piece to each of these ends; run them along the base and up to the AC switch on the panel as shown in diagram No. 1. These two added wires should be twisted together, although they are shown untwisted in the diagram.

Either a dynamic or magnetic speaker may be used with this receiver. If an AC dynamic type is used it must have its own power supply. A No. 66A Utah or No. 410 Magnavox is recommended.

Aerial

If you already have a good aerial for your broadcast receiver it may not be necessary to erect another for your Shortwave Receiver as you may be able to get *two different programs off the same aerial at the same time.*

However, this will not always be the case and in order that you may decide whether or not you can use the same aerial it will be necessary to try out the Shortwave set on all the coils; first with your regular radio receiver still connected and then disconnected to see if it is taking away any volume from the Shortwave Receiver. If there is any appreciable increase in volume when you disconnect your broadcast receiver, it will be necessary to use a separate aerial for best results.

Tubes

The *Baird* Combination Shortwave and Television Receiver uses the following tubes:

1 BH Raytheon Rectifier
2 No. '24 Screen Grid Thbes
2 No. '27 Tubes
1 No. '45 Tube

Caution

Use only *rosin* core solder and no paste or acid in making your joints. If you see any flux flowing from your solder across any part of the chassis or units which you are soldering, be sure to wipe them off immediately with a piece of cloth dipped in alcohol.

Be very, very careful to follow the diagrams when wiring; leaving nothing to chance. The wires that go through holes in the chassis are all carefully numbered so as to give you a better idea of where they go. Wherever there is any doubt, we have repeated that same number on both diagrams to show the junctions.

The Television kit consists of the following parts:

1 Type 120 Baldor Variable Speed Vertical Motor 1/15 H.P.
1 Type A1409 Special Oil Impregnated Aerovox 2 mf., Condenser
1 Type GR150 Centralab Giant Power Rheostat, with knob
1 Type 121 Magnet Mounting with two washers, one lock ring and bar
1 Type 122 Synchronizing 48 Tooth Wheel
1 Type 123 Television Spider, without belt
1 Type 124 48-hole Television Belt
1 1" Plate Neon Lamp
1 Type 216 Socket
1 AC Switch
1 Type 125 3" Square Magnifying Lens
1 Fixture Cord and Plug
1 Television Cabinet

Remember that in running these wires always follow the shortest possible lead from one point to another. The diagrams have been so drawn that it will be easier for you to follow in wiring, but do not necessarily indicate the length of wire.

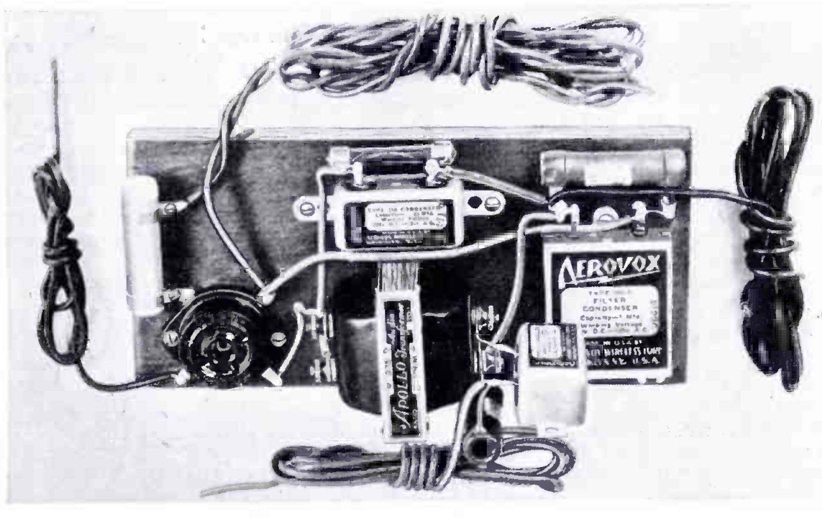

Diagram A—Showing synchronizing amplifier for television unit, assembled and wired.

Instructions for the Assembly of the Baird Universal Television Kit

The assembly of the Television Kit will now be gone into in detail, and it is surprising how simple the assembly of this kit is. There are very few parts in the construction of the kit, but it must be borne in mind that they must be put together with extreme care, as in the assembly it will be found that the synchronizing tooth wheel (Fig. 8), when assembled onto the magnet mounting (Fig. 6), the distance between the outside edge of the gear teeth and the outside edge of the magnets is only five thousandths of an inch. Although these parts have been made with precise care, you should, nevertheless, be very careful

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Fig. 6—At left, shows adjustable magnet mounting, forming a part of the special synchronizing motor as shown also in Fig. 5. A toothed rotor rotates between the poles of the two magnet coils and acts to preserve synchronism.

in making the assembly, taking pains to see that each item is placed exactly as the instructions are outlined, taking your time doing this.

To assemble the Television Kit remove 7" bar from the No. 121 magnet mounting and lay to one side; take the No. 121 magnet mounting, with the magnets turned up as shown in Fig. 6, and slip over the shaft of the motor so that this holder fits onto the projection on the top of the motor frame with the magnets on the right (see Fig. 5). Now, place the spring washer, which is the thin bent washer, on top of the magnet mounting; over this washer place the ordinary steel washer and then force the lock ring into the groove which can be seen on the motor just above where the washer fits, by putting one open end into the groove and forcing the ring over the edge and into the groove. When this lock ring is placed in position, the magnet holder will revolve but will not move up or down. In fitting this magnet holder onto the motor be very careful that you do not damage the magnets or force the magnet mounting in any way. Now, carefully slip the synchronizing tooth wheel No. 122 over the shaft as far as it will go without forcing. This Synchronizing Tooth Wheel will now be lined up so that the top and bottom edges of the teeth are in direct line with the laminations on the magnet. Attached to the Synchronizing Tooth Wheel by two springs is a brass collar. This brass collar should be fastened to the shaft by the set screw, leaving about the thickness of a sheet of newspaper between the collar and the Synchronizing Tooth Wheel, so that this wheel will move freely on the shaft. Slip the spider onto the shaft but do not tighten, and place the assembly in the cabinet so that the whole assembly will be centered inside the cabinet; then remove the spider and screw the motor securely to the bottom of the cabinet; using the six rubber bushings (found in Assembly Package No. 1000). Place one bushing under and one over each foot of the motor; place an iron washer over each top bushing, and then fasten motor to cabinet with screws, making sure that no part of the screws touch the iron of the motor foot. (This can be done by putting a bit of rubber tubing around each screw.)

Mount a GR150 Centralab Giant Power Rheostat in the bottom right hand corner of the front of the cabinet and a 110-v. A.C. switch in the bottom left hand corner. You should mount a small piece of asbestos between the GR150 Rheostat and the front panel. Take the type No. A1409 Aerovox condenser and place in the further left hand corner of the cabinet near the leads coming out of the motor. There are three leads to this motor and they are colored red, black and green. Splice and solder the red one to either one of the leads of the Aerovox condenser and tape with rubber tape.

Connect the black wire to the other lead of the condenser and at the same time splice and solder to this joint a lead which goes to one terminal of the A.C. switch. Connect the other terminal on the switch to one terminal on the 150-ohm Giant Rheostat. Now take your fixture cord and plug; splice one side to the remaining terminal on the 150-ohm Giant Rheostat, and the other side to the green lead on the motor.

In all places where splicing is done, be sure to use rubber tape and not friction tape, so as to come within the Underwriters' Rules on wiring.

Mount a type No. 216 socket inside the lid of the television cabinet in the place marked for it so that when the neon lamp is placed in this socket and the lid closed the neon lamp will be hanging down into the cabinet. Have the filament terminals on socket pointing towards the front of the cabinet.

Synchronizing Amplifier

Before we proceed any further with the Television Kit it will be necessary to assemble the Synchronizing Amplifier, Diagram A. The parts necessary for the construction of this amplifier are as follows:

1 6 to 1 Dongan Audio Transformer
1 Type 200 *Baird* Television Filter Coil
1 Type 200s Aerovox 1 mf. Condenser
2 Type 260.25 Aerovox Condensers
1 Type 992 Aerovox Pyrohm, 4,000 ohms
1 Type 992 Aerovox Pyrohm, 1,000 ohms
1 Type B.02 Electrad Resistor, 25 Watt, 2 ohms
1 Metallized Resistor with pigtails, 50,000 ohms
1 Type 216 Socket (for Type '45 Power Tube)

This synchronizing amplifier consists of one stage of power audio frequency amplification, which takes the 720 cycle note out of the neon circuit and amplifies it enough to operate the small synchronous motor on top of the larger motor. This synchronous motor is composed of course, of the magnet holder and synchronizing tooth wheel with the magnets.

The above parts should be mounted on a small baseboard about 4" by 10", a layout of which can be very clearly seen in diagram A. The wiring should be done as follows:

We assume that you have mounted your parts exactly as shown in the diagram, with the socket in the top right hand corner. First connect a piece of wire from G terminal on the socket to the grid lead on the transformer.

Connect one side of the 200S Aerovox condenser to the other side of the secondary of the transformer, and to the same connection on the transformer, solder one end of a 50,000-ohm metalized resistor. Connect the other end of this resistor to the end of the 1000-ohm Pyrohm nearest you. Connect the right hand F terminal on the socket to the end of the 2-ohm Electrad resistor nearest the socket. Before screwing the other end of this Electrad 2-ohm resistor to the baseboard, loosen the tap and slide it in toward the center about four or five turns of wire, so as to reduce its actual resistance. Connect the other side of the 200S Aerovox condenser to the left hand F terminal of the socket, and from there continue to the side of the 1000-ohm Pyrohm furthest from you.

Fig. 7—Shows appearance of the special vertical type, scanning drum motor.

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Connect one end of the primary side of the transformer (it does not matter which) to the nearest terminal lug of the type 260 .25-mf. condenser; from there continue up to the nearest terminal lug on the No. 200 *Baird* Television filter coil, and from there continue to the first terminal lug of the second 260 .25-mf. condenser. Connect the other side of the primary of the transformer to the second terminal lug of the first 260 .25-mf. condenser; continue up to the other terminal lug of the No. 200 filter coil, and from there continue to the end nearest you of the 4,000-ohm Pyrohm. Connect the other side of the same 4,000-ohm Pyrohm to the terminal lug nearest to it on the second 260 .25-mf. condenser. Solder a piece of wire about 12" long to the P terminal on the socket.

Solder a piece of wire about 3 feet long to the end nearest you on the 4,000-ohm Pyrohm. This we will call lead "A." Twist together two pieces of wire each about 3 feet long, and solder one side to the left hand F terminal on the socket and the other side to the end nearest you on the Electrad 2-ohm resistor. These we will call lead "B." Solder a piece of wire about 3 feet long to the 4,000-ohm Pyrohm on the end furthest from you, which we will call lead "C."

Now, take this amplifier and place it in the further right hand corner of the television cabinet and screw it securely to the base of the cabinet, with the socket toward the front of the cabinet.

The two plain binding posts in the further right hand corner of your Shortwave Receiver, are the connections for the neon lamp. The one furthest from you is insulated, and the one nearer to you is grounded to the metal chassis. Take the 3-foot lead "A" on your amplifier, put it through the hole in the back of the television

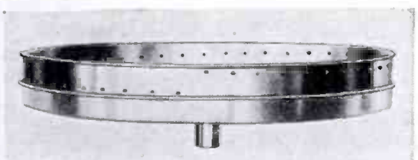

Fig. 9 above—Shows the Baird rotating television spider, with scanning belt. Note the small holes spaced along a spiral.

cabinet, and connect it to the grounded plain binding post we have just mentioned. Take the 3-foot twisted leads "B" connected to your amplifier through the hole in the back of the television cabinet and insert into the two plain binding posts on the back of the chassis near the 411 power transformer.

Connect the other end of the 12" length of wire, which has already been soldered to the P terminal on the socket, to either one of the terminal lugs on the No. 121 magnet mounting. Solder a 3-foot length of wire to the other terminal lug of this same magnet mounting, run this wire through the hole in the back of the television cabinet, and attach it to the single plain binding post just in back of the No. 1 socket on the Shortwave Receiver. Solder one end of a piece of wire (about 5 feet long) onto the F—or left hand F terminal lug of the socket in the lid of the television cabinet. Tack this lead inside the lid and down the back of the cabinet so that it will not hit anything. Bring it out through the hole in the back of the television cabinet, and connect it to the insulated neon lamp binding post on the Shortwave Receiver. Take the 3-foot lead "C" on the amplifier, which is connected to the 4,000-ohm Pyrohm, and tack it along the back of the television cabinet; run it across the lid, and solder the end to terminal P on the socket on the lid of the cabinet.

In giving you the lengths of the wires which run from your television cabinet to your Shortwave Receiver we have approximated the distance at which you might want to keep the receiver from the kit. There is, of course, no harm in putting both units as close to one another as possible. If this is done, the leads coming from the television cabinet can naturally be made correspondingly shorter.

Now to continue with the assembly of the Television Kit:

Replace the magnet holder bar into the magnet holder which you originally removed, putting it first through the slot in the right hand side of the cabinet. Next, take your No. 124 48-hole television belt and carefully place inside the spider. Do not bend or force in any way and the belt will rest into the spider in such a way that the lowest hole in the spiral of holes will be about 3/16 of an inch above the edge of the spider. Carefully place the spider over the shaft of the motor and fasten to the shaft with the screw, reaching this screw through the 3" opening in the front of the cabinet. Then put the 3" magnifying lens into the chute which was furnished with the cabinet and screw the chute to the 3" hole in front of the cabinet with the screws and angles provided. Make sure that everything fits snugly into the cabinet and there are no wires projecting which will catch into any moving parts.

NOTE: It must be explained here that there are varying standards of Television transmission; although the committee on standards of the R. M. A. are making every effort to standardize Television transmission all over the country. A log of the number of lines used and pictures per second now being transmitted by various stations will be found on page 158.

In the *Baird* Universal Television Kit, the different speeds are taken care of by the rheostat which controls the speed of the motor. The 48-hole belt furnished with this kit is the one most commonly used by various stations. A 45 line picture is now being transmitted in Chicago, and one or two stations are transmitting a 60 line picture. These two latter belts and synchronizing tooth wheels are accessories to the *Baird* Television Kit.

Operating Instructions for Combination Radio and Television Receiver

The operation of the *Baird* Television and Shortwave Receiver varies depending on whether you use it for shortwave, television or broadcast reception. In using green, brown and blue *Octocoils*, which cover the wave bands from 16 to 100 meters, the grid leak holder on the chassis should have a 201A fixed rheostat inserted in it, as we do not want a power detector for these wave bands. On these wave bands all stations will be tuned in,

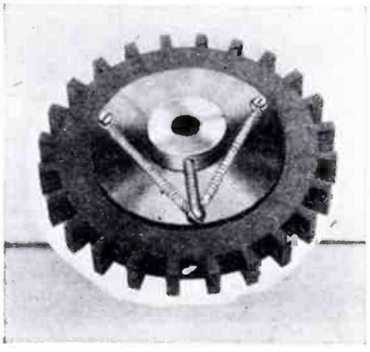

Fig. 8—Shows appearance of the synchronizing motor toothed wheel, with balancing controls.

using regeneration which is controlled by the J-23 midget condenser. The 50,000 ohm Electrad volume control will probably not be varied and should be turned full on to the right on these bands, unless you tune in a particularly strong signal which the regeneration control will not cut down. The J-13 midget condenser is just a trimming condenser and will not require any adjustment after it has been set for each pair of coils.

The jack in the further right hand corner of your chassis is the loud speaker jack and the other is the phone jack. The two binding posts on the right hand side of the chassis near those jacks are, as we have said before, the connections for the neon lamp and which have already been hooked into the television kit when you followed previous instructions.

The red coil covers from 100 to 200 meters. If you want to tune in this band when you are not using the television kit you may still leave the 201A fixed rheostat in the grid-leak holder and use the regular red *Octocoils* in sockets No. 7 and 8.

To tune the broadcast band, remove the fixed rheostat and put in a 50,000 ohm resistor using the regular broadcast coils. To tune in a picture you

(*Continued on page* 147)

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New Television Process *of* THE TELEHOR CO.

By DR. FRITZ NOACK
(Berlin-Germany)

Mirrors instead of scanning holes in the revolving disc, form the basis of this newest German system of television. Mirrors, as Dr. Noack points out, possess certain advantages which are herein described.

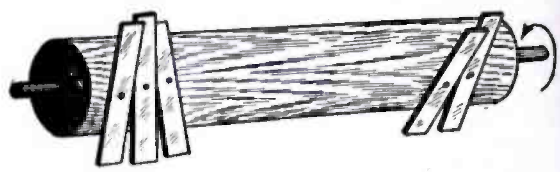

Fig. 1—Precursor of the new Telehor television process. The little mirrors are fastened on a roller, at mutually different angles.

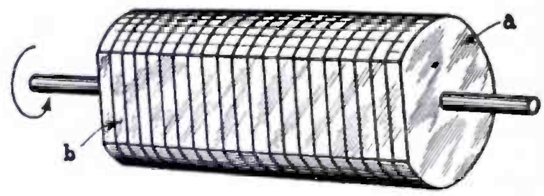

Fig. 2—The mirror roller. Several metal plates or glass plates of the same thickness are placed in layers, one on another, and are ground at b in the same plane, polished, and silvered (as mirrors).

THE Telehor Company of Germany has quietly worked out a new television process, which is extremely interesting, because it is amazingly simple. It is interesting to learn in what way the inventors developed this process, and the principle involved will also become clear.

The *projection* on a screen of television pictures has, as you will at once concede, an extraordinarily great deal in its favor; because it is only by projection that a number of persons can look at the pictures. In all processes employing the Nipkow scanning disc, there is invariably the disadvantage that the observer must sit in front of the televisor, in the direction of the *optical axis*.

The Mirror Wheel

For projection purposes there probably come first for consideration all those processes that use a mirror. The Telefunken system, which uses the Weiller mirror-wheel, has extraordinary advantages. This process has been described before and those familiar with it will remember that a mirror is necessary for each pictorial line; and that the width of the mirror is determined by the height of the picture projected. It is patent that, if one wants to use a large number of lines, the diameter of the mirror-wheel must assume unusually large dimensions. For the purposes of *home television* there is therefore a limit to the size of mirror wheels.

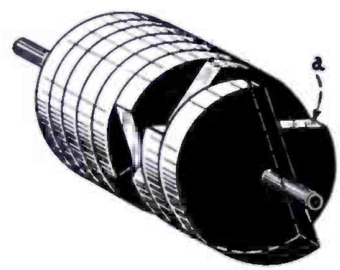

Fig. 3—The individual plates are turned at mutually the same angle, so that the individual mirror surfaces (a) form equal angles with one another.

In the case of the Weiller mirror-wheel, the little mirrors are fastened on the periphery of a large wheel. Suppose we set up the individual mirrors on a roller, which needs to have only a small diameter; here the length of the axis is dependent on the number of mirrors. In Fig. 1 such a model is represented in diagram.

Now it is not easy to fasten individual mirrors (as in Fig. 1) on a mandrel and at the same time be able to adjust them correctly and accurately. Therefore the inventors of the new Telehor system conceived the idea of setting several circular glass discs side by side on a shaft (Fig. 2), polishing off a part of the periphery parallel to the axis, and silvering it (as a mirror) and then turning the individual discs a little with relation to one another (Fig. 3).

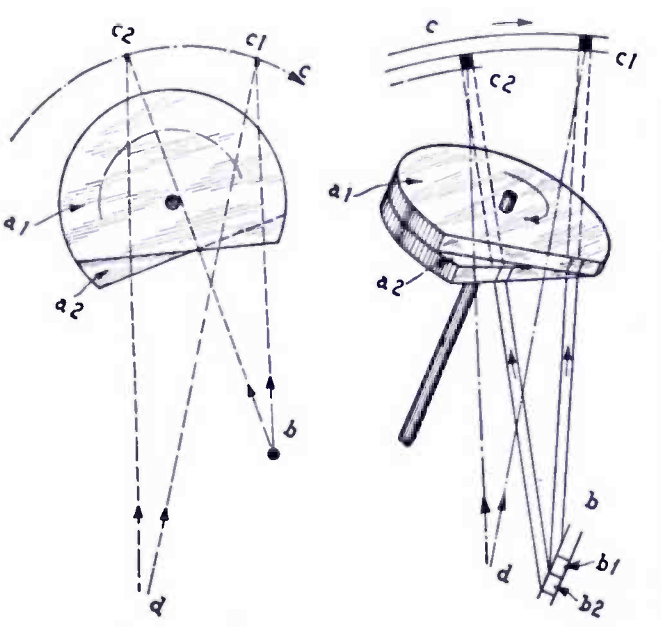

Fig. 4 — The formation of the pictorial lines: a1 and a2 are two plates with mirror surfaces, b the light thread of a thread glow lamp; b1 and b2 two adjoining pieces of the light thread of the glow lamp; c the plane in which the image becomes visible behind the mirror surfaces of plates a1 and a2, c1 and c2 two dot-shaped images of the two pieces of glow lamp thread b1 and b2, produced (apparently, according to the eye) in mirrors a1 and a2; d the position of the observer, who is looking into the "mirror pack."

The Improved Mirror System

The intention was to make a dot-shaped source of light radiate on these individual mirrors, as in the Telefunken process. It became apparent, however, that the arrangement can be used much better in the following manner:

Suppose we arrange the axis of the set of mirror vertically and then set up at a certain distance from the set of revolving mirrors a filament-type

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glow-lamp, (Fig. 4), which produces a vertical line of light. Now if one looks at this line in the rotating set of mirrors, there will be observed in the set of mirrors (with sufficiently rapid rotation), a surface of light, exactly as with a luminous-plate glow-lamp. In fact, each individual mirror describes a line of light before our eyes. The little mirrors are so co-ordinated, and the distance of the revolving set of mirrors from the filament of the glow-lamp is so chosen, that, just as one mirror has produced a line of light, the second mirror at once begins to function. The lines of light are described horizontally and are placed parallel to one another, exactly like the lines of light observed with a Nipkow disc. Of course each mirror forms only a small part of the thread Assuming that we use 30 mirrors and each mirror has a width of 2 mm. (.08 inch), then the whole set of mirrors would be 60 mm. (2.34 inches) broad; and that is exactly the necessary length of the line of light given by the glow lamp. Then each individual little mirror reproduces a bit of the filament 2 mm. (1/25-inch) long, *i.e.*, 1/30 of the total thread length.

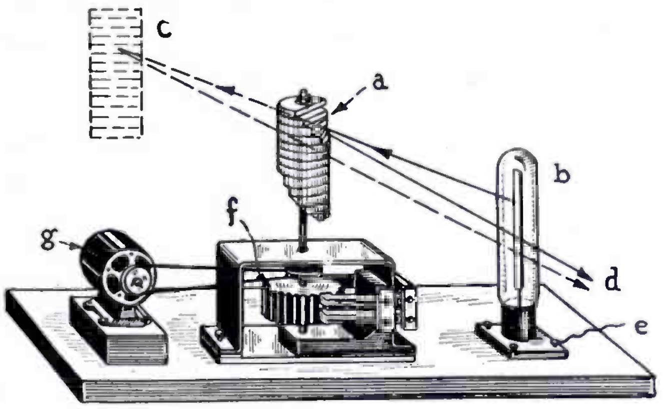

Fig. 5—Diagram of the entire televisor. a, mirror pack; b, thread glow lamp; d, position of the observer; e, connections of the glow lamp to the receiving set; f, synchronizer with electro-magnets; g, operating motor; c, plane in which the image appears in the mirrors.

Advantages Over the Nipkow Disc

The advantage of the new process will at once become clear. For each line of light there is used 1/30 of the total brightness of the glow lamp. In processes utilizing the Nipkow disc, on the other hand, only a dot-shaped surface of the glow lamp is transmitted each time. If we assume that the total surface brightness of our filament lamp is exactly as great as that of a plate-type lamp; and if we furthermore assume that each pictorial line contains 40 individual points (which will be a fair approximation to actual practice) then, by the new system we accordingly obtain a 40-fold increase of light over the Nipkow disc process.

To be sure, this statement is moderated somewhat by the absorption of the light on the mirrors. But, if the mirrors are well silvered, then the absorption amounts at most to say 20 per cent; so that the new process still yields an increase in brightness of about 30-fold. Now a filament glow-lamp of the same surface brightness as a low-power plate glow-lamp can be fed current better than the latter. If a plate glow-lamp can be operated by ordinary radio receivers, then this can be done very effectively in the case of the filament glow lamp; and we can beforehand assume the total surface brightness of the filament lamp somewhat greater than that of a plate glow lamp. This gives a further increase in the total brightness.

To be sure, the utilization of the glow-lamp's luminosity (as a whole) is not quite so good in this process as with the Weiller mirror-wheel processes. Yet the new Telehor process has a great advantage over the mirror-wheel, at least so far as *home operation* is concerned; because with the Weiller mirror-wheel only a *projection* is possible, while *direct observation* is excluded.

For home apparatus in sets with the mirror-wheel, there is the question only of a projection on a rather small ground-glass screen; because otherwise the output of a radio receiver is insufficient. The projection on a ground-glass screen has, however, certain disadvantages, which are due to the coarse granulation of the ground glass and its strong absorption. With the new Telehor television system one can observe the image directly in the mirrors, and thus these disadvantages vanish. If we take into account the loss of light on the ground-glass screen, then with equal power one will get about the same image brilliancy in the case of the new Telehor apparatus as in that utilizing the Weiller mirror-wheel.

Why "Looker-in"? Think Real Hard—Coin a New Word. It may be worth $50.00 to you.

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Simplicity of Construction

But, at the same time, the new system devised by the Telehor experts has the great advantage of being extremely simple in construction. The construction and adjusting of the set of mirrors are far simpler than those for the Weiller wheel; and then, too, the slight weight of the set of mirrors is above all of prime importance. By skillful construction it can be so devised that operation is at all times easily possible by means of an ordinary synchronizer (Fig. 5).

The importance of the new invention becomes especially evident, if one foresees the need for more than 30 pictorial lines. One can change to as many pictorial lines as may be desired, without getting abnormally large sets of mirrors; because we can make the individual mirrors suitably thin whereas, with the Weiller mirror-wheel, a reduction in size is not directly possible.

The height of the attainable picture depends only on the thickness of the individual mirrors and therefore on the total height of the whole pack of mirrors. Filament-type glow-lamps can be obtained today up to almost any desired length. There is the added point, that filament glow-lamps are becoming extremely cheap to manufacture.

In spite of the direct observation of the pictures, it is not necessary to have all the observers look at the picture from the same direction and thus disturb one another. Rather, the pictorial angle amounts to about 60 degrees; at this angle, several persons can sit at the apparatus and look at the picture. Therefore one has the same advantage as with projection of a picture on a screen or other surface, where the angle of observation is also about 60 degrees.

The future construction of the Telehor television apparatus will probably be as follows: In the ordinary television set, only the mirror assembly and synchronizer, the amplifier, and the source of the synchronizing frequency are included, while the glow-lamp and televisor are set up at a certain distance. In fact, the glow-lamp must be placed at a certain distance from the mirrors, to observe the latter from a proper distance. This separation of the glow-lamp and actual televisor is, however, no more inconvenient than, for example, the construction of a normal picture-projection set; in which the projector must, of course, always be set up at a certain distance from the screen.

The new process of the Telehor Company undoubtedly represents a great step forward, even if it is perhaps not the ideal solution. To me the ideal solution seems to be a televisor which with sharp tuning works well on a narrow frequency band.

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A DISTORTION-LESS AMPLIFIER for Television

By JOHN WADE*

Low - Frequency Response — Elimination of Hum and Stability Against Motor-Boating Are Primary Considerations in Modern High-Gain Resistance-Coupled Design.

We are pleased to present the accompanying article, prepared especially for the readers of *Television News* by an expert who has pioneered, in the design of resistance-coupled amplifiers.

—*The Editor.*

TELEVISION is today emerging from an extended period of hibernation, resulting from its wintry reception during the past two years. Boomed abortively in the days when its possibilities were circumscribed by the laboratory walls, it quickly subsided to an innocuous desuetude, awaiting the further development and refinement that would definitely establish it as a complement to our sound radio installations—as an entertainment, not a novelty.

The present-day optimism of the National Broadcasting Company and engineers in general seems justified; and the status of the art today would indicate that the required progress is rapidly rounding the last lap of realization. The experimenter who shelved his neon tubes and scanning discs three years ago will find the old system of radio-picture reproduction modified by this progress; and it is the purpose of this article to describe one phase of television in the terms of tubes and principles with which we have become more familiar during the period of television's reincubation.

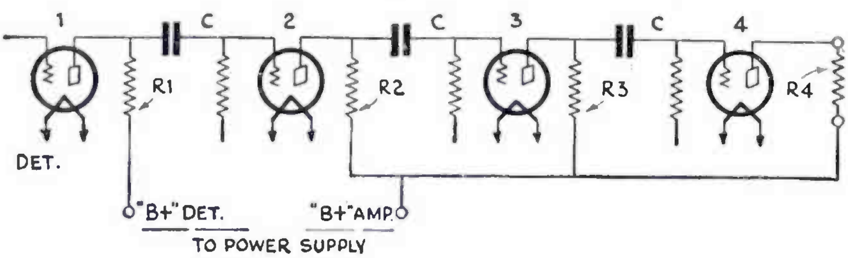

Fig. 1—A fundamental resistance-coupled amplifying circuit—the starting-point for the design of a scientific television amplifier.

The definite details of amplifier construction for a television receiver will necessarily vary with the system of reproduction—the method of integrating the image. However, the principles are consistent; and the amplifiers considered in this article may be superfically modified, in respect to input and output circuits, to meet the requirements of the television ensemble. In recognition of simplicity and general similarity, the amplifiers here diagrammed and discussed are shown outputting to an ionization (glow) tube in a conventional circuit.

Strict Requirements for Uniform Amplification

The primary principles involved in the design of a television amplifier consider the necessity for a degree of fidelity in reproduction exceeding that necessary for good audio reproduction; the amplification of lower frequencies than those essential in sound radio; the reduction of hum; and the stabilization of the circuit.

It has been established that, for high-grade television, the variation of amplification with frequency over the octaves essential for reproduction should not exceed two *decibels*, above or below the average. An excessive variation results in spurious shadows or non-existing highlights.

The lowest frequency to be amplified, when a still subject is being televised and the background shade is supplied at the receiving end is the picture-frequency; which, in many systems, is as low as sixteen per second. An audio amplifier down two decibels at forty cycles per second, dropping off rapidly thereafter, will give excellent sound reproduction. It will, however, be unsatisfactory for

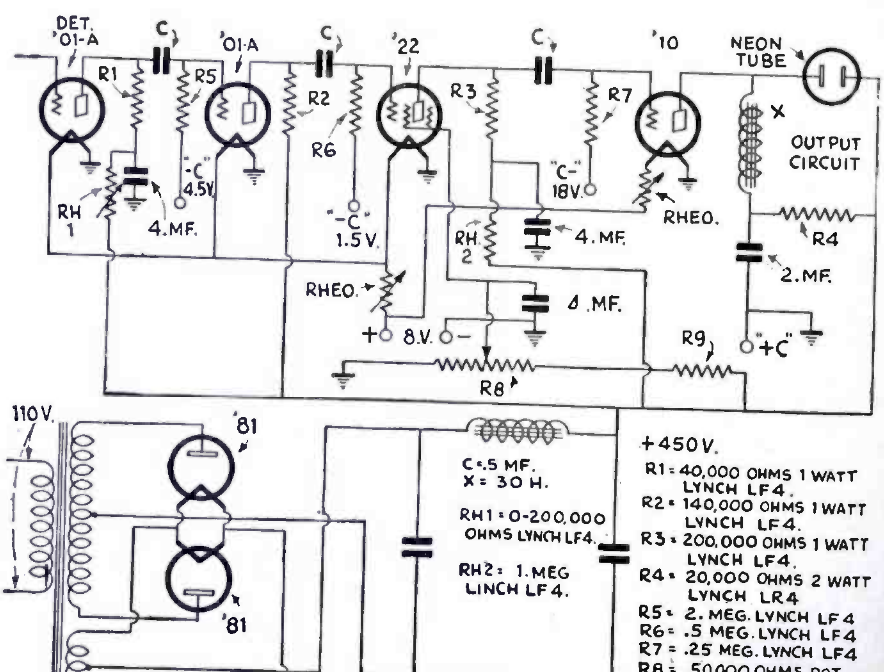

Fig. 2—The modified resistance-coupled amplifier employing battery tubes. The principles demonstrated in this diagram may, of course, be applied to any motor-boating amplifier.

* Engineering Dept., Lynch Manufacturing Co.

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television purposes. When the image has a vector of motion in the tangential direction of the scanning mechanism (that hole) is, moves across the frame in the same direction as the scanning, some frequencies may be lower than the picture-frequency. It is generally conceded that a resistance-coupled amplifier is the only system providing the degree of linearity (fidelity) and low-frequency response essential to good television reproduction. The fundamental circuit, to which we shall refer, is illustrated in Fig. 1.

What Hum Does to Image

The existence of hum in a television output circuit will result in a "hum pattern"; a crazy-quilt design, interesting and pleasing in itself, but having no more place in a televised image, than fog has on a photographic print.

The problem of stability is a fundamental one; for a television amplifier may be described as inherently prone to low-frequency oscillations, known as "motor-boating." This condition results from several causes: the amplifier being of the resistance-coupled type, the resistance-capacity values of the condenser-resistor circuits are often such as to favor a low-frequency periodic disturbance. Such a disturbance could not exist in the average transformer-coupled amplifier, because of its inability to amplify these frequencies effectively. In other words, the excellence of the resistance-coupled amplifier's frequency-characteristic contributes toward its tendency to motor-boat.

The reduction of hum and the stabilization of the amplifier may be considered jointly; because the existence of either or both disturbances postulates the rise and fall of a pulsating voltage in the common coupling circuit—the power supply. The characteristic of the circuit being what it is, the difference between hum and motor-boating frequencies may be neglected; and the design of a humless circuit may be considered as definitely mitigating against the possibility of any low-frequency oscillations.

Calculating the Hum

Assuming that an A.C. hum potential exists across the output of the eliminator, it is necessarily applied to the plate circuits of all amplifying tubes. If the direct effect of this hum potential were the only hum component existing in the output circuit (if all other tubes, for instance, had their plate voltage supplied by batteries), the hum would not be serious; and an ordinary filter would reduce it to a negligible degree. However, the hum current or voltage in any plate circuit is the sum of the direct effect and the amplified effect of the hum existing in the preceding circuit.

Referring to Fig. 1, let us represent the direct hum effects in tubes 1, 2, 3 and 4 by E_{d1}, E_{d2}, E_{d3} and E_{d4} respectively, and the entire hum voltage in each tube plate circuit by E_1, E_2, E_3 and E_4. Obviously $E_{d1} = E_1$.

If μ equals the amplification in each stage (remembering that the phase shift in each stage of a resistance-coupled amplifier is 180 degrees), and all tubes are of the same type, having the identical values of load resistance all supplied from the same plate potential, the following relationships exist:

$$E_1 = E_{d1}$$
$$E_2 = E_{d2} - \mu E_1 = E_{d2} - \mu E_{d1}$$
$$E_3 = E_{d3} - \mu E_2 = E_{d3} + \mu^2 E_{d1} - \mu E_{d2}$$
$$E_4 = E_{d4} - \mu E_3 = E_{d4} - \mu^3 E_{d1} + \mu^2 E_{d2} - \mu E_{d3}$$

If $E_{d4} = \mu^3 E_{d1} - \mu^2 E_{d2} + \mu E_{d3}$, $E_4 = 0$ and no hum will exist in the output circuit.

Solving the equation, $E_{d4} = \mu^3 E_{d1} - \mu^2 E_{d2} + \mu E_{d3}$,

$$E_{d1} = \frac{\mu^2 E_{d2} - \mu E_{d3} + E_{d4}}{\mu^3}$$

Let $E_{d2} = E_{d4} = E_{d3} = E_d$

$$\text{then } E_{d1} = \frac{\mu^2 - \mu + 1}{\mu^3} E_d$$

Condition for "No Hum" in Output

In other words, when the hum voltage in the plate circuit of the first tube, or E_{d1}, equals the fraction $\frac{\mu^2 - \mu + 1}{\mu^3}$ of the hum potential in the last stage, no hum will exist in the output of the amplifier. The hum components have been balanced out. A similar relationship can be established for an amplifier employing different tubes and plate loads. However, it is arithmetically more involved.

It follows from equation (2) that, by reducing the hum variation in R_1, in Fig. 1, to the correct fraction of that in R_4, no hum will exist in the output of the amplifier. If we introduce a second resistor in series with R_1 (such as R_{h1} in Fig. 2) the ratio between the hum potentials in R_1 and R_4 (Fig. 1 again) may be expressed as

$$\frac{E_1}{E_{d4}} = \frac{\dfrac{R_1}{R_p + R_1 + R_{h1}}}{\dfrac{R_4}{R_p + R_4}}$$

where R_p is the A.C. plate resistance of tubes 1 and 4 of the same type.

It is obvious that, by making R_1 small and R_{h1} large, we can make the ratio as small as we wish, or equal to $\frac{\mu^2 - \mu + 1}{\mu^3}$ the desired value for humless amplification.

This value, equation (2), reduces approximately to $\frac{1}{\mu}$. If high-mu or screen-grid tubes are used in the am-

(Continued on page 149)

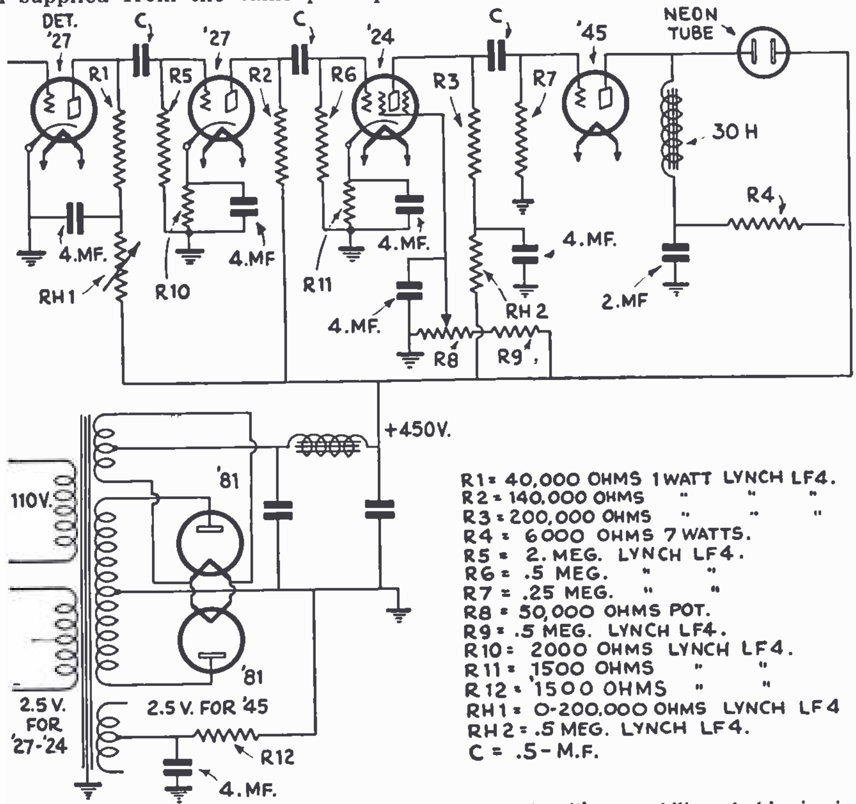

Fig. 3—The amplifier using A.C. tubes. The power-handling capability of this circuit may be considerably enhanced, with additional stability and hum control, by the substitution of a variable mu tube for the '24, and employing a zero to 10,000 ohm variable bias resistor in the cathode circuit.

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TELEVISION DIGEST

Television Broadcasters Preparing For New Year

Anticipating the undeniable inauguration of commercial radiovision during 1931, the leading television workers are preparing for proper broadcasting service to the buyers of radiovision equipment.

According to the announcement of D. E. Replogle of the Jenkins Television Corporation, New York City is the new site of Station W2XCR, heretofore located at Jersey City, N. J., in order to provide better service to the lookers-in of the New York metropolitan area. The station has been transferred to the heart of New York City, thereby securing maximum program material quite as well as proper coverage of the territory.

At Passaic, N. J., the DeForest Radio Company is building an elaborate studio and laboratory for its experimental radio television station, W2XCD. This station, which includes a radio telephone feature and operates on a choice of wave lengths, is to become the testing ground for new television equipment, thereby leaving the regular radiovision program service to W2XCR.

The Jenkins transmitter near Washington, D. C., W3XK, has had its effective transmitting power materially increased by several changes in the equipment. The W3XK programs are now being received practically throughout the United States under favorable conditions. The programs are being carefully selected from available films, suitable direct pick-up means are being developed, and plans are under way for a tie-up with a voice channel. Also, the power of W3XK is to be further increased for a greater service range.

The three television stations, W2XCR, W2XCD and W3XK, are going to operate on the same frequency, sharing time. Collectively, they will be on the air from morning until night. Each station is to have a voice channel, for the essential sound accompaniment to the radio pictures. The assigned frequency is 2000-2100 kilocycles.

Radiovision Equipment Prices Reduced

Radio television is going to make a strong bid for public support during 1931, according to the statement of D. E. Replogle, Assistant to the President of the Jenkins Television Corporation.

"Coincident with the unusual activity of the press with regard to television developments and possibilities, together with greatly increased production facilities at our new plant in Passaic, N. J., we find it possible to reduce the list prices on our home television equipment," states Mr. Replogle. "Dealers can now afford to stock television equipment and to demonstrate radio television possibilities to their clientele, thereby expediting the public acceptance of this form of home entertainment.

"The Jenkins 1931 line will definitely appeal to two classes of buyers: first, kits will readily interest **home-set** builders and tinkers who were the mainstay of the radio industry in its early years; secondly, completely manufactured units are priced right to appeal to the middle class man who desires television in an immediately usable and living room form.

"Meanwhile, television broadcasting stations are consistently reaching out with good picture detail, and most of the television broadcasters are contemplating increases in power, ranging up to five times their present output. Therefore, buyers of home television equipment are assured the proper signals and entertainment.

"We anticipate an immediate reaction on our price reductions. It is our belief that radio television is here. The engineering work has been done to the point where the commercial stage is at hand. The job from now on is one of merchandising as well as engineering," concludes Mr. Replogle.

A Senator Watches Television Perform

Dr. E. F. W. Alexanderson, one of the wizards in "The House of Magic" at Schenectady, recently invited Senator C. C. Dill to foresake the national capital for a day to visit that realm in the Mohawk Valley where television images leap into space for transoceanic and transcontinental trips.

The Western Senator, as a member of the Senate Interstate Commerce Committee, has been one of the leaders in drafting radio legislation. He is now convinced that perfection of the thyratron tube will do much to make television commercially practical because it will eliminate the whirling disk and enable television images and scenes to travel on waves less than one meter in length. This would prevent all interference with sound broadcasts.

> **HOT OFF THE WIRE!**
>
> **New York Gets Powerful Image and Voice Service**
>
> **WGBS (780 K.C. or 384.4 meters) will broadcast voice for W2XCR (Image broadcast on 117.5 meters, 2,035 K.C.). 60-hole scanning will be used with 20 frames (disc revolutions) per second.**
>
> **You can tune in WGBS (voice) on your regular broadcast receiver, and the image signal on a short wave or special television receiver covering from 100 to 200 meters range.**
>
> **New Television studios have been fitted up at 655 Fifth Ave., N. Y. City. The daily programs will be published in the newspapers. W2XCR is licensed at 5,000 watts.**

Senator Dill, who has been co-author of the last two radio bills creating and making permanent the Federal Radio Commission, said he saw no need for any new legislation to control television for some time as the radio law was made sufficiently broad to place such authority in the hands of the commission. When and if the Couzens bill becomes a law this control will be transferred to the Federal Communications Commission.

Television Interests Portugal

The following is a translation from the December 15th issue of the "Diario de Noticias", and is with reference to the Radio Exhibition held at Lisbon, Portugal.

"It is but just to say that one of the great successes of the Exhibition was Casa Serras' booth, and this is amply proved by the interest all visitors had in it.

"The booth is, indeed, marvellously designed and in excellent taste, and, if that in itself were not enough, the sensational presentation of the television instrument of the celebrated inventor, Baird, which appears for the first time in Portugal, would have been sufficient to capture the attention of the public."

The "NBC" Tells You How to See Their "Images"—?X!??

Gentlemen:—

Relative to the NBC television transmitter about which you are making inquiries, I want to emphasize the fact that this station is licensed, and is used for **experimental** transmissions. The mere sending of television images is really experimental work, and it becomes necessary for us to try many different devices, **and to even send distorted pictures** (Hot Dog!) in order to work out some of the problems with which we are confronted. For this reason this station is not endeavoring to serve any particular group of receivers.

We have **many different scanning discs** operating at **different speeds, different number of pictures per second, using 48-60 and other lines per picture.**

Because of the experimental work, and the nature of our activities, I cannot give you any sketch or definite dimensions, as they are frequently changed. However, I might at some future date utilize a portion of the time on which we transmit on some standard number of lines, such as, say 60, but I cannot make any commitments at the present time.

I am afraid you will have to put us down as a station engaged in some experimental work, and not as yet ready to set definite schedules for the amateur or others who are interested in looking at pictures.

The present type of television transmission is so crude, even the very best, that it has very little program value. As an engineer, I am interested in improving the equipment so that some day we may have something worthwhile.

Very truly yours,
C. W. HORN,
General Engineer.

Ned Wayburn, Famous Dancing Teacher, Interested in Television

Ned Wayburn has expanded into the radio field. The Institute bearing his name now boasts a beautiful radio studio complete in every detail, and has employed an expert radio staff including Roscoe A. Grover (Uncle Roscoe), internationally known radio authority, who has just returned from Europe, where he has been observing methods and making actual contacts in radio, "television," opera and the stage. He was formerly chief announcer of station K.S.L., Salt Lake City.

Report Television Gains

New strides in television have been made by the technical staff of His Master's Voice Gramophone Company, which has attained such perfection in transmission that even such small details as a piece of wire netting and the number of a tram-car are plainly visible. The system, the company says, is not associated in any way with the Baird system nor with that demonstrated in the United States by Dr. Alexanderson of the Radio Corporation, with which the Gramophone company is affiliated.

The inventors assert there is practically no limit to the distance over which images can be transmitted, and the general effect, according to those who have seen demonstrations is that of a cinema picture on a small scale.

The experiments thus far have been chiefly concerned with the transmission of motion-picture films.

Continued on page 158)

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A Non-Mechanical Scanner

By GEORGE WALD

SCANNING DISCS, driven by motors, while necessary in present television work, are admittedly crude and unsatisfactory. The cathode tube, which has been used with some success in the laboratory, has some special and peculiar requirements. Lieut. Wald, a U. S. army officer, stationed at Selfridge Field, has just patented another method of scanning by electricity, without the use of moving parts, which depends on the fact that voltage waves are continually moving up and down an A.C. transformer.

The principal features of the method are here described, with reference to the patent drawings.

NO matter how perfect a motor-synchronized scanning disc may be made, in the writer's opinion it will never be a success in the home. The housewife desires an apparatus whereby she can turn on a switch and tune in a station; then "look and listen." Any other manipulation of devices is destined to failure.

The writer, after consideration of the problems, was led to invent a television apparatus for the transmission and reception of images without the use of any mechanical scanning device; and U. S. patent 1,754,491 has been issued for its basic ideas.

As shown in Fig. 1, the receiving tube, when seen end on, presents a screen of anode and cathode wires, crossing at right angles, and establishing the elemental points of the televised image to be reproduced. Each of these wires is connected to one tap of a secondard (12, 16, Fig. 2); and variable frequencies are applied to these secondary coils. As the currents in the secondaries set up a varying voltage at each tap, there is a maximum difference of potential at the intersection of only one pair of wires at any instant; and at this point the discharge between the anode and the cathode produces one bright point on the image screen.

As each variable-frequency train sweeps over the row of cathodes, the bright point on the screen moves and produces a line; and as each train of frequencies passes over the row of anodes, the entire frame of the image is traced. The time relations of the impulses are so synchronized that a systematic scanning of the image, by the bright, glowing point, is effected. The television impulses, which have

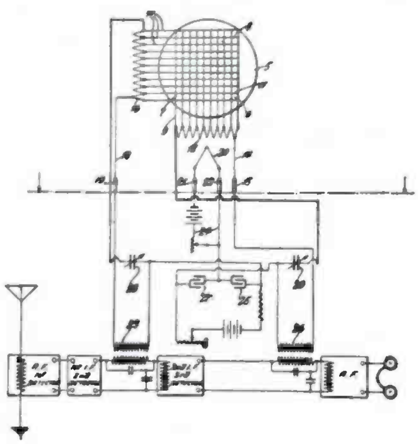

Fig. 3 (above)
The circuit of a television receiver using the Wald tube.

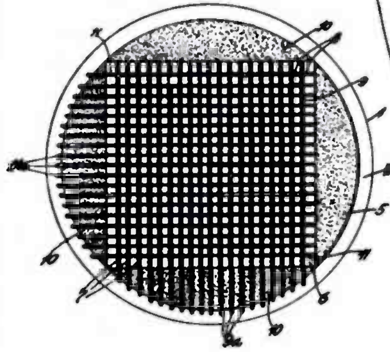

Fig. 1
An end view of the tube, showing the cross wires which tap the secondaries.

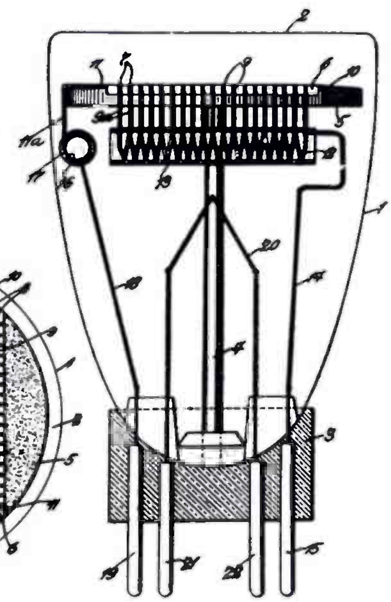

Fig. 2 (right)
A cross-section of the new tube, showing the relative positions of its elements.

been superimposed on the cathode current, modulate the brightness of the scanning point and thus reproduce the shades of light and darkness in the image.

The tube shown in Fig. 2 is of a modified type, such that the portions of the secondaries to which the taps are connected are placed inside the envelope. It has six prongs, the connections of four being shown. There are two more, connected to the anode and cathode tuning condensers which are shown at 28 and 29 in Fig. 3. These condensers serve to adjust and center the image on the frame. A slight change in the tube will permit it to receive the image from any station, even though the latter does not use the variable-frequency system described below.

The Transmitting System

The transmitting apparatus invented by the writer works on a similar principle; it contains the light-sensitive elements, similarly arranged in two systems of lines crossing at right angles. The television impulses, as amplified, are superimposed on two varying-frequency currents, corresponding to the scanning. The image-frequency is separated from these and the television current is broadcast together with an actuating carrier wave.

For telephonovision, the voice is transmitted on the same wave as the image, by using a part of each image-line to record sounds. At the transmitter, the voice is converted into light and applied, at the end of each image line, to the same photo-electric cell that transmits the image. At the receiver, that part of the image line is reconverted into a voice current in the conventional manner.

The writer is at present developing an invention which will reduce the dot-frequency required in television (usually regarded as the square of the number of lines in the image multiplied by the frequency of scanning) to about the square-root of the present frequency value. This, by reducing the high modulating frequency and consequently the width of the transmitting channel, will overcome one of the greatest obstacles to the development of television. The system, however, is still in process of perfection.

In Our Next Issue—

"How to Build a Drilling Jig for Television Discs."

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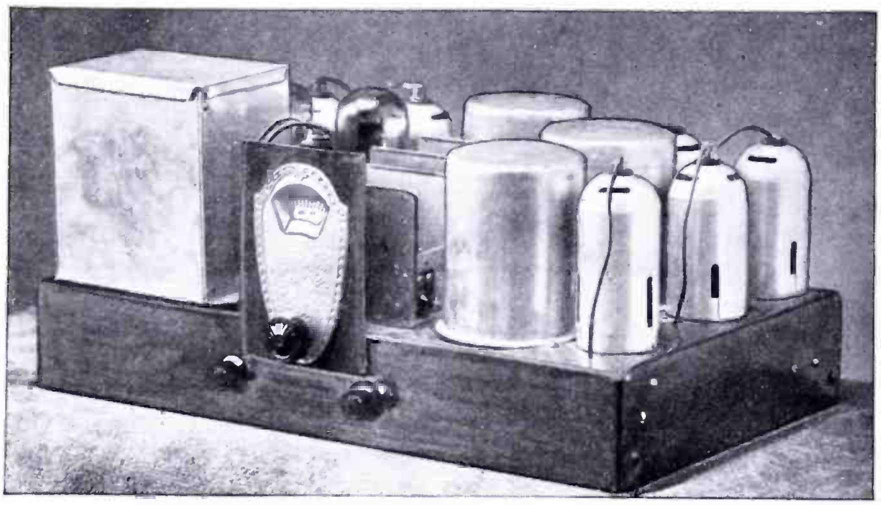
A UNIVERSAL TELEVISION RECEIVER

By JOHN J. FETTIG*

An excellent design of special television receiver, free from oscillation tendencies, and having a high gain R.F. section, a sturdy detector stage, and a carefully designed audio frequency amplifier having an output stage with two '45 tubes in parallel.



The television receiver chassis.

THE apathy of the reception that, until now, television as a home entertainment factor has received, is largely attributable to the public's misconception of the possibility of obtaining any such entertainment. Yet, a comparison of the status of television, as it is today, with that of aural radio in the hectic year of 1921 is illuminating; in that it shows television offering a greater entertainment value to the user.

For example, in 1921 there were but a few broadcast stations regularly operating. At the present time there are twenty-seven stations that regularly transmit television impulses and, by the time this article goes to press, there will probably be a few more. The average transmission time in 1921 was five hours per day. Today, the average television transmission time is six hours per day. Whereas, with the crystal receiver of the vintage of 1921, only one or two persons were able to enjoy the program through the medium of headphones, television images may now be viewed by from two to six people. Besides this, television in its present state offers the ardent experimenter, once again, ample opportunity for the employment of his constructional and creative talents.

Since television impulses are transmitted on wavelengths between 100 and 175 meters, it becomes apparent that a special receiver is necessary for the reception of these signals.

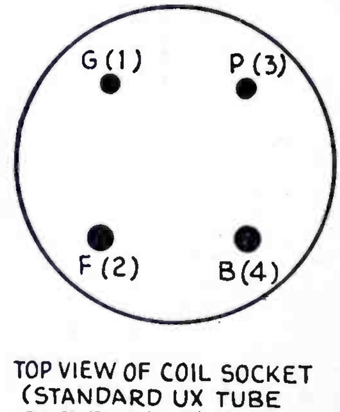
This article will be devoted to the description of a receiver designed primarily for the efficient reception of television signals, but which is also versatile enough to be used as a high-quality broadcast receiver or for the reception of short waves. It may be mentioned, in passing, that the short-wave bands offer the listener a thrill that has no counterpart in the broadcast spectrum. He can hear police being dispatched to the scene of a crime at the moment of its commission. Trans-Oceanic broadcasts are commonplace, and the chatter of radio amateurs fills the air.

High Television Frequencies

In the design of a television receiver there are several important considerations that are not encountered in broadcast receiver design. A high degree of selectivity is *not* desirable; since the channels used for picture frequencies are considerably wider than those necessary for aural reception. The reason for this becomes apparent when we calculate the frequency of light-intensity variations possible, during each second of transmission, from a station scanning sixty lines at twenty frames per second.

A picture of elongated aspect would be composed of 4320 elements. Multiplying this by the number of pictures framed per second, we have a total of 86,400 elements viewed in that time, or 43,200 complete changes per second! This means that the television channel required to pass the "A. F." component essential for good quality reproduction must be over eight times as wide as that used for sound broadcast purposes! The audio-frequency amplifier necessary for a flat response from 15 cycles to 43,200 cycles begins to partake of the nature of a radio-frequency amplifier; in other words the maximum frequency is equivalent to a wavelength of about 7,000 meters. These figures will serve to indicate some of the difficulties involved in the design of a good television receiver.

A successful television receiver must be absolutely free from any tendency to oscillate; otherwise the image will be marred by a *ripple* pattern. This fact, in addition to the necessity for a wide carrier-admittance channel, precludes the utilization of ordinary short-wave receivers or short-wave adapters; since, almost invariably, they employ regenerative



TOP VIEW OF COIL SOCKET (STANDARD UX TUBE SOCKET USED) NUMBERS IN PARENTHESIS CORRESPOND TO NUMBERS IN SCHEMATIC DIAGRAM.

* Of the Radiotechnic Laboratories.

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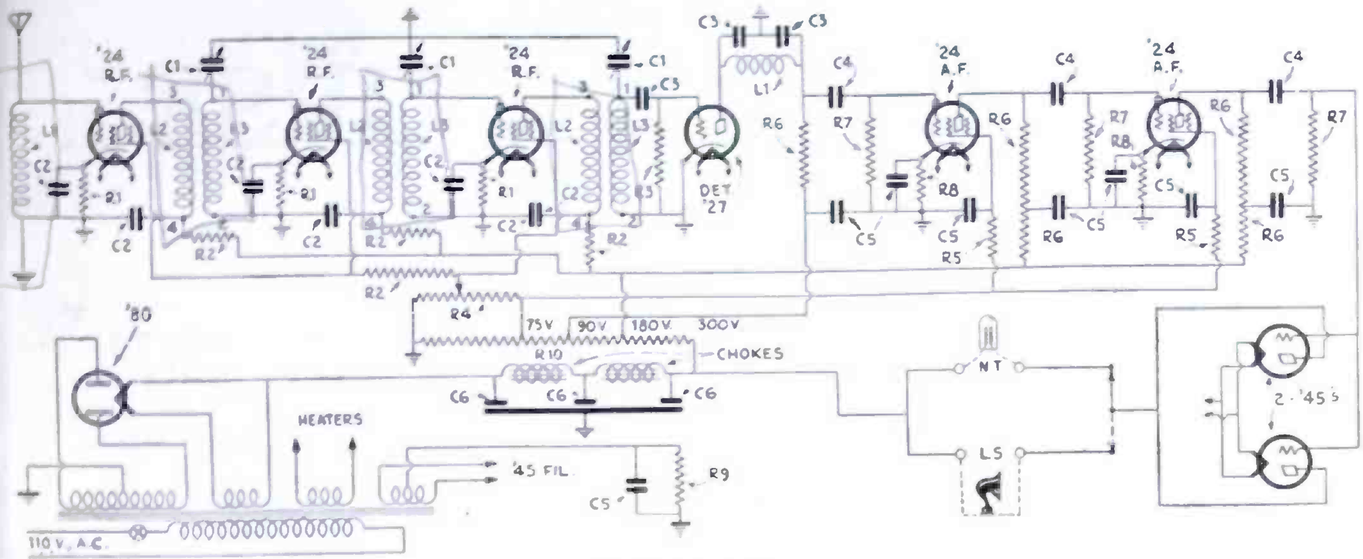

List of Parts

R1	500 ohms	R7	250,000 ohms	C4	.01 mf.
R2	10,000 ohms	R8	1,000 ohms	C5	1. mf.
R3	2 Megohms	R9	750 ohms	C6	8. mf.
R4	50,000 ohm potentiometer	R10	13,500 ohm voltage divider	L1	Shortwave R.F. choke (60 millihenries)
R5	20,000 ohms	C1	.00014 mf.	L2	Primaries of R.F. Trans.
R6	50,000 ohms	C2	.1 mf.	L3	Secondaries of R.F. Trans.
		C3	.00015 mf.		

detectors. Consequently, in order to obtain sufficient sensitivity, we are compelled to use a ***high-gain*** radio-frequency amplifier.

Arrangement of the Tuner

The radio-frequency circuit consists of one untuned or coupling stage, making the outfit equally efficient on any antenna, and two tuned, transformer-coupled stages. Each section of the ganged tuning condenser has a maximum capacity of .00014-mf. Radio-frequency transformers wound on plug-in coil forms are used; the forms are 1½ inches in diameter and, for the television band, are wound with a primary consisting of 28 turns of No. 30 wire and a secondary having 29 turns of No. 26 wire. (These windings should not be separated more than ⅛-inch, or too great a degree of selectivity will be obtained.) The impedance of the primary is sufficient to permit the use of screen-grid tubes. It will be noted that both the plate and screen grid leads are provided with 10,000-ohm resistors, to prevent common coupling between stages; these are absolutely essential.

A 50,000-ohm variable potentiometer, used to regulate the screen-grid voltage on the R.F. tubes, serves as a volume control. The centre arm is connected to the screen-grids; one end goes to the 75-volt tap of the voltage divider, and the other to ground.

A '27 tube, employing grid rectification is used as detector; this type has been found to retain its efficiency as a detector, even at extra high frequencies. A filter in the plate circuit prevents all radio frequencies from passing into the audio system.

With this form of detector, three stages of A.F. are required in order to properly phase the image; *i.e.*, give us a *positive* image.

Screen Grid "A.F." Amplification

Details of the audio amplifier circuit can be derived from the circuit diagram. The first two stages employ screen-grid tubes. It will be noted that all plate, screen-grid, and biasing circuits are by-passed. This precaution must be observed in order to secure a satisfactory picture. Filter resistors are inserted in all plate leads to prevent motorboating. The use of screen-grid tubes in the first two stages enables us to secure the gain necessary for good picture intensity.

The third stage consists of two '45's in parallel; the plate current of the output stage governs the amount of light in the neon glow-tube, and these two power tubes will cause approximately 68 milliamperes to flow through the glow-tube, thereby insuring a brilliant light.

The power supply is quite conventional, comprising an '80 rectifier tube, feeding into a two-section filter circuit, using capacitative input. A three-section dry electrolytic condenser is used in the filter.

If all the specified values are carefully observed, no difficulty should be encountered in the construction of the receiver. Compactness and simplicity of construction has been given considerable thought in its design; the over-all size is 18½ x 11 x 7 inches.

If the chassis is obtained in the finished form, a screwdriver, a pair of pliers, and a soldering iron, will be the only tools necessary. One need not be an engineer in order to assemble the set; for any reasonably handy person can do this easily.

No output device has been incorporated in the receiver, because most dynamics have a built-in output transformer. A single-pole, double-throw switch enables one to switch from speaker to neon glow-tube.

Exhaustive tests, over a long period of time, have proven this set to be a consistent and efficient receiver for television impulses.

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A SHORT COURSE in TELEVISION

The editors feel sure that the reader will greatly appreciate this short course in Television, which has been specially prepared by Mr. Nason, an electrical engineer who has been closely associated with the growth of American television. This second lesson discusses how to lay out scanning discs; punching holes; Sanabria triple spiral scanner.

By C. H. W. NASON

LESSON 2.

Laying-Out Scanning Discs

THERE are but three systems of scanning, existent in America today, which employ the simple scanning disc. They are the 48-line system of Jenkins and Radio Pictures; the 60-line image employed by R.C.A. and N.B.C.; and the 45-line multiple arrangement of Sanabria, employed by Western Television. The scanning apparatus required by the first two is simply described by the picture specifications. For an example, we will take the 60- by 72-element image, as broadcast by the R.C.A., N.B.C. and forthcoming C.B.S. stations. These images are scanned at a rate of twenty pictures per second, corresponding to a shaft speed of 1200 R.P.M.

The reference to the picture dimensions, as 60 by 72 elements, shows that the picture is not square, but oblong; with an *aspect ratio* of 1.2. The physical dimensions are determined, in the case of simple equipment by the dimensions of the neon-tube's plate, which is on the average 1.55 inches square.

Round or Square Apertures?

It might be well to digress for a moment to discuss the relative merits of the *round* and *square* holes. There has been much said on this subject and the writer will not pause to review the arguments. A simple statement of the matter should make things quite clear.

With our present systems, the whole problem of the amateur lies in the small amount of available light. The light available to the eye at any instant is that passing through a single aperture. A physiological effect (too complex to describe here in detail) further reduces the apparent light, because of the rapidity with which the aperture is traversing the field of vision. Inasmuch as the percentage of the light available through the

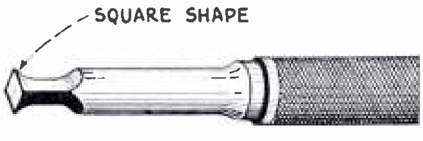

Fig. 1. Shows author's suggested style of square hole punch, which is placed against the disc metal and struck with a hammer; placing a piece of end-grain wood under the disc.

round aperture is 78.54 of that available through the square opening, there remains but little choice in the writer's opinion. On top of this the square aperture is much simpler to cut accurately than the round.

Calculation of Dimensions

We start our design with several factors known. The dimension "W" (width of the image) is determined by the size of the picture desired and the size of the neon-tube's plate. We know "N," the number of apertures, and we know that the circumference of the circle represents an arc of 360 degrees. Assuming a dimension "W" of 1.44 inches we may proceed as follows:

Given:

$N = 60$
$C = 360$ degrees

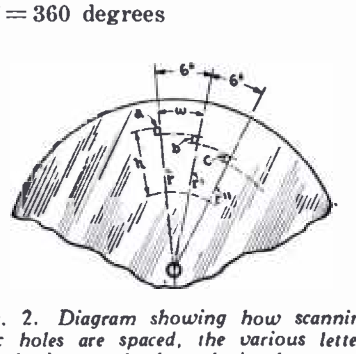

Fig. 2. Diagram showing how scanning disc holes are spaced, the various letters referring to the formula in the text.

$h = 60$ elements; the height of the image
$W = 72$ elements, or 1.44 inches

Then

The angle of displacement = 6 degrees = (360/60)
The aperture size = 1.44/72 = .02-inch square.
$h = .02 \times 60 = 1.20$ inches
c = the circumference of the circle through the first aperture = $1.44 \times 60 = 86.4$ in.
r = the radius through the first aperture = $86.4 \div 6.2832 = 13.75$ in.
r' — the radius through the inner aperture = 13.75—1.2 = 12.51 in.

We can readily see that the diameter of our disc must be greater than 27.5 in. Allowing a bit extra for a light-shield (to keep the light of the neon tube from direct vision) obtain a circular blank of aluminum 30 in. in diameter; about 20 gauge stock will suffice. With a sharp punch or scriber, mark the center carefully; and draw a line from this center mark to the edge with a sharp scriber. These lines should be as thin and light as possible. Using a protractor, draw further radii at intervals of six degrees until sixty in all have been drawn.

These sixty radii locate the relative positions of the apertures, in one sense. Selecting any one radius, lay off the distance 13.75 in. from the center and draw a partial circumference through this point with a pair of dividers. This portion of this circumference need only cut the next radius line. This concludes our work until the first and second apertures have been punched.

A Tool for Punching Apertures

If the reader is handy with tools, he may readily construct a punch for cutting the apertures. If he is unable to do this work himself any machinist

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can do the work at a slight cost. An ordinary drift, nail set or center punch should be ground down to a flat surface, .02-inch square. For best results, the tool should be cut back slightly, and directly behind the cutting edge, as shown in Fig. 1. A block of some soft wood should be cut and carefully levelled on the end grain. The larger this block, the better it will serve as an anvil on which to perform the punching operation. Lay the disc on the block, and carefully align the punch so that its edges coincide with the sides of the angle "a" formed by the first radius line and the partial

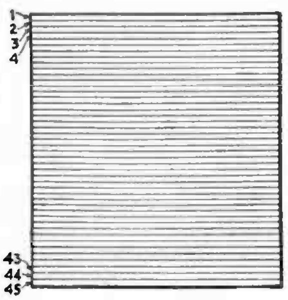

Fig. 3. Scanning diagram used by the author in explaining how the Sanabria triple spiral scanning disc works: the scanning sequence being 1-4-7-10, 2-5-8, 3-6-9, etc.

circumference drawn through it. (See Fig. 2.) Now hit the punch a sharp blow.

Punching into the end grain of the wood should allow the metal to cut cleanly without leaving a burr. If burrs are left, they may be removed by careful work with a small file. The diagram shows clearly the location of the tool for punching the second aperture, at *b*.

With the dividers carefully located in the center mark of the disc, draw another partial circumference, running from the inner edge of the second aperture to the third radius line. Locate the punch in the correct angle and punch the third aperture at *c*.

The remaining apertures are cut by following the same method of locating—namely, by drawing a partial circumference through the lower edge of the preceding aperture.

When the sixty apertures have been cut, we must decide whether to lay out a 48-line spiral on the same disc, or use a separate disc for that type of signal. Once the hub has been fitted to the disc it will be difficult to locate the center in order to lay out another spiral.

The 48- by 60-Element Spiral

It is possible to take as our initial dimension either a given aperture size or one picture dimension. With a .020-inch aperture, a 48- by 60-element image would have a dimension "W" of 1.2 inches. The radius at the outer aperture would be 9.16 inches. The "h" side of the image would be 0.96-inch; the angle between successive radii would be 7.5 degrees (7 degrees, 30 minutes).

The image size is almost as great as the neon tube will stand; but it would be possible to obtain a larger image on a separate disc, or on the same disc were we to come closer to the inner aperture of the 60-line spiral with the outer one of the 48. This would necessitate the use of another punch of a different size.

For the time we will leave the method of mounting to the reader's own ability, and discuss another type of scanning disc in use in this country.

The Sanabria System

In a later lesson we will discuss the theory of this and other scanning systems; but today our main problem is getting "on the air." Those readers who reside in the middle west will be interested in the type of disc required in the reception of signals from W9XAO, Chicago. This system scans the scene three times for each rotation of the disc; this scanning is not complete in each instance, the lines being separated by twice their width in each scanning operation. The field is divided into 45 lines as shown in Fig. 3. The scanning sequence, instead of running from 1 to 45 by units, is as follows: 1—4—7—10—13 16—19—22—25—28—31—34—37—40 43.

The second operation includes the following lines: 2—5—8—11—14—17 20—23—26—29—32—35—38—41—44

The third and completing operation comprises lines: 3—6—9—12—15—18 21—24—27—30—33—36—39—42—45

The manner in which the apertures are laid out is shown in Fig. 4.

The whole thing is really much simpler than it seems if we remember that the apertures scanning adjacent lines are 120 degrees apart. A little care enables one to lay out the disc with no more trouble than in the first instance. N is of course 45. Assuming a square image and an aperture of .034-inch we find that the *"h"* and *"w"* dimensions will be 1.53 inches. The angle of displacement is 8 degrees. The circumference through the outer aperture is 69.1 inches, and the radius at the outer aperture is 11 inches. Notice that the radii at the inner and outer apertures lie between the 48- and 60-line spirals already laid out and we may therefore—with proper care—construct a disc containing all three modes of scanning. Of course it will be necessary to provide for a shift of the neon tube to the required points and a method of changing the speed of rotation.

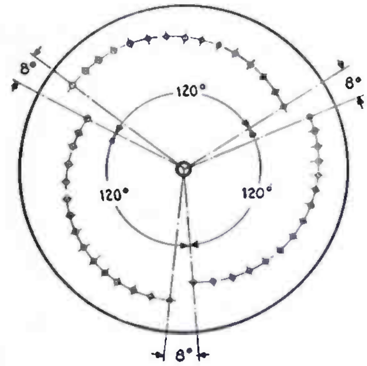

Fig. 4. Above shows how the Sanabria triple spiral scanning disc is laid out. Various advantages are claimed for the Sanabria system of scanning, such as better illumination and detail, with greater freedom from lines in the image. The Sanabria scanning disc system is the one used at Chicago.

Laying Out the Sanabria Disc

In order to avoid conflict with lines previously drawn, it would be well to reverse the blank if a combination disc is being made. If not, a 24-inch disc should be obtained and 45 radii, separated by 8 degrees, drawn. Mark off the 11-inch radius and draw a segment of a circumference with the dividers so as to cut the 16th radius (120 degrees). With an .034-inch punch, stamp out the first and the 16th aperture—one above and the other below the line—just as in the first disc punched. Draw another circumference through the lower edge of the 16th aperture to the 31st radius, and punch that aperture. Continue in this manner until all apertures are punched; make sure in each instance, that the arc you have drawn traverses 120 degrees, by checking with the protractor before punching.

If you intend to make a combination disc it might be well to cut the apertures for the Sanabria system first, to avoid any possibility of losing the previous labor by slipping up on the last step.

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HINTS *for the* BEGINNER

Action of Scanning Discs; Framing the Image; Laying Out Holes

By H. W. SECOR

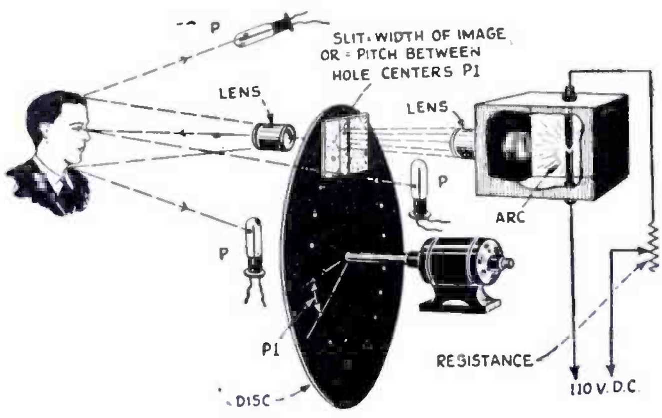
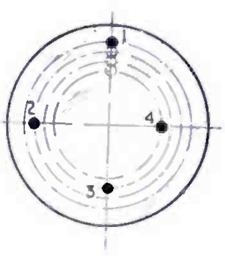


Fig. 1—Typical arrangement of television transmitter, showing lamp which throws a beam of light through scanning disc holes and a lens. The reflected light rays fall on photo - electric cells "P"; the fluctuating currents are amplified and then sent by radio or wire to the receiving station.

THOSE who have had little or no experience with television will probably find the following hints of value and interest. Referring to the first illustration (Fig. 1) we see how the subject before the television transmitter (such as that used in the Bell Telephone Laboratories' demonstrations) is posed for scanning by the "flying-spot" method.

A synchronous motor drives the disc containing the spiral of scanning holes, behind which is a diaphragm, against which the light beam is focused. In some cases a lens is placed in front of the scanning disc; in any event, the small pencil of light scans across the face, one line after the other, until it has described the whole image. The continually - changing light beams reflected from the face or other object, fall on the photoelectric cells "P"; and the continually fluctuating current from these cells, (which are connected in parallel with a compensating or regulating resistance in series with each cell) are passed into a vacuum-tube amplifier of from eight to nine or more stages. In the present Bell Laboratories' television apparatus, the arc lamp at the transmitter has been replaced by an incandescent lamp of special design.

Fig. 3—A scanning disc with only four holes is here shown for the sake of study. Note that the holes slightly overlap.



Amplifier Should Cover 20 to 40,000 Cycles

In the next diagram (Fig. 2) the "direct-vision" method of illuminating and scanning the subject's face at the transmitter is portrayed. Here a number of strong lights are focused on the face of the subject; and the reflected light rays pass through a lens, through the holes of the revolving

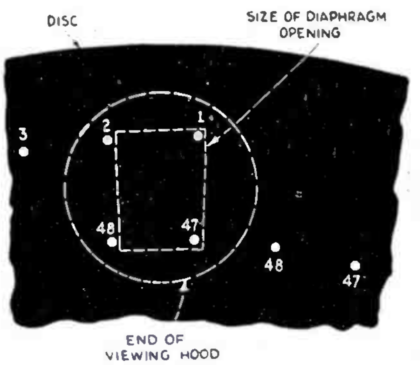


Fig. 4—Above shows how hole number 2 is just ready to enter the picture area as hole number one is leaving. Holes 47 and 48 are repeated for the purpose of study.

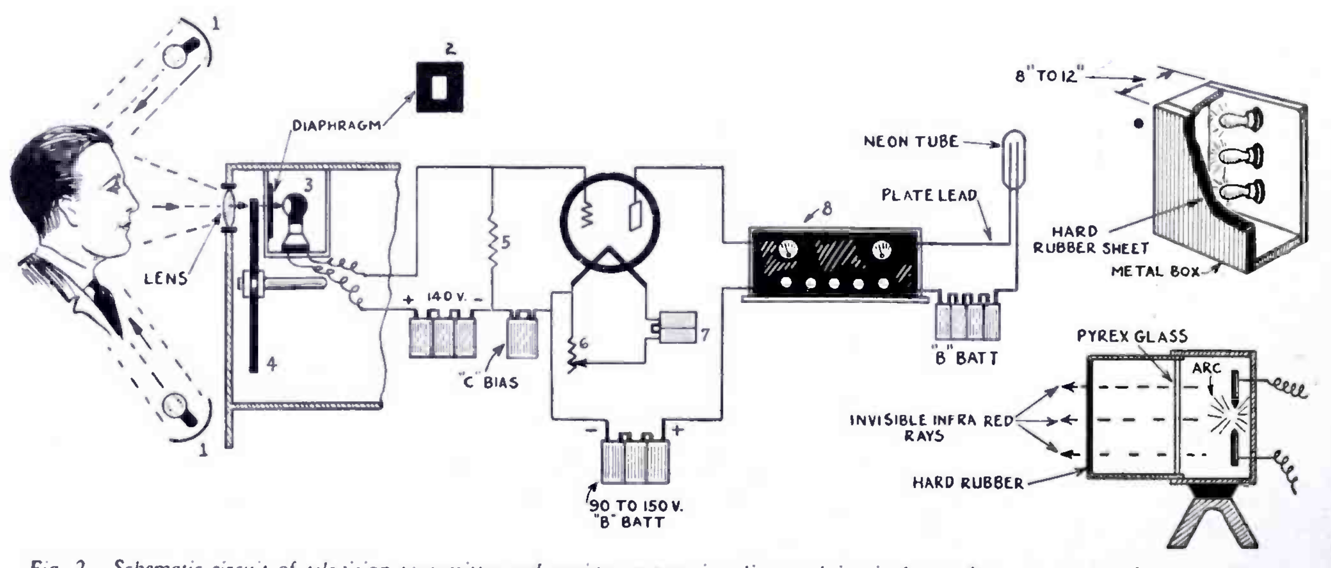


Fig. 2—Schematic circuit of television transmitter and receiver, a scanning disc revolving in front of the neon tube of course. Illustration at right of figure shows "dark lights," formed by placing lamps behind hard rubber window.

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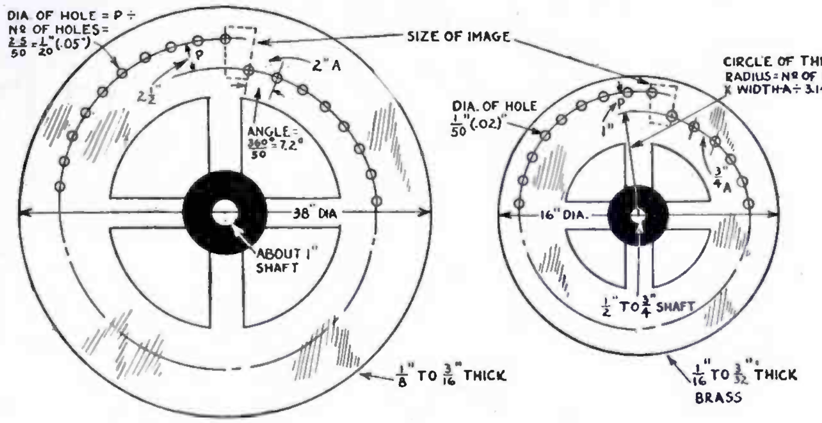


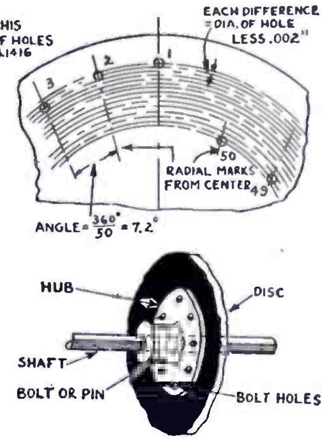


Fig. 5—Various details connected with the laying out of holes on scanning disc are illustrated at right. The center sections of the disc are cut away in some cases to make the disc lighter and thus enable a smaller size motor to rotate it at the required speed.

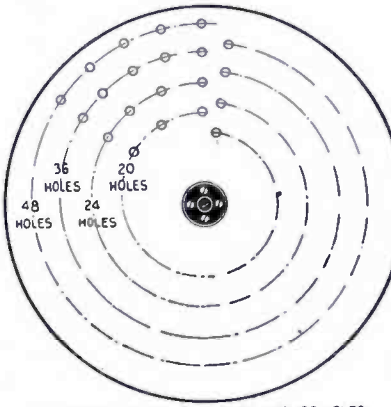
disc (4) then through a diaphragm (2—shown above in front view) and then onto a photoelectric cell (3). The photo-cell's currents are passed through a coupling tube and then into a V. T. amplifier of the resistance-coupled type, employing six to eight stages or more. For the best results the amplifier has to pass a very wide band of frequencies; from, say, twenty cycles up to 40,000 cycles per second. Fair results will be obtained with an amplifier not designed to pass such a wide band of frequencies as this; but the picture will, of course, be not so well balanced and complete in detail. Some experimenters have obtained a passable image with an ordinary audio-frequency amplifier, utilizing transformers; but a resistance-coupled amplifier is the only one to be considered if you are going to experiment with television in earnest. The output of the multi-stage amplifier is connected to the neon glow-tube, which is placed behind a second revolving scanning disc at the receiver.

At the right of Fig. 2, we may see how a subject may be illuminated at the television transmitter by invisible or "*dark*" light. Powerful incandescent lamps are employed behind a hard-rubber sheet in the upper diagram; while that at the lower right utilizes an arc lamp and a hard-rubber window, which passes the invisible infra-red rays. John L. Baird, the well-known British television expert, has demonstrated many times that a subject can sit in total darkness, illuminated by invisible infra-red rays in the manner just made clear, and be televised, by utilizing a special photo-electric cell designed to be particularly sensitive to the infra-red part of the spectrum.

Laying Out the Holes of the Scanning Disc

In the next diagram (Fig. 3) we see how a scanning disc (with only four holes shown for simplicity's sake) is laid out; the holes being arranged to overlap slightly. It will be clear from this diagram how the holes, 1, 2, 3, and 4 each scan along orbits of their own and that, after all four holes have passed by a given point, the whole picture or image will have been completely covered or scanned.

Referring to Fig. 4, we see how the scanning holes are arranged in relation to the size of the diaphragm opening, or image. Note that the 47th hole and the 48th hole have been repeated at the left of the diaphragm opening; merely to show how, as the 47th hole is just about to leave the picture opening, the 48th hole is just ready to enter the frame.



UNIVERSAL DISC 48, 36, 24 AND 20 HOLES

Fig. 6—Above shows one way of laying out "universal" disc, containing various numbers of holes. A proper diaphragm and adjusting mechanism for the neon tube are of course necessary, so that these devices can be slid up or down in order to scan any particular spiral.

Several hints on laying out scanning discs are illustrated in Fig. 5; this diagram corresponds to the method followed in the earlier Bell Laboratory design of scanning discs, which contained 50 holes instead of the present 72. If you will note the size of the image as indicated by the dotted line, it becomes apparent that the diameter of one hole will be the height of the picture (P) divided by the number of holes; and that the radial angle (at the center) is ascertained by dividing 360 degrees by the number of holes. Also, it will be evident that the holes are caused to overlap slightly by making, for example, the distance between two successive layout lines (circles described by the centers of the holes) equal to the diameter of a hole, less .002-inch.

One method of mounting the metal

(*Continued on page* 156)

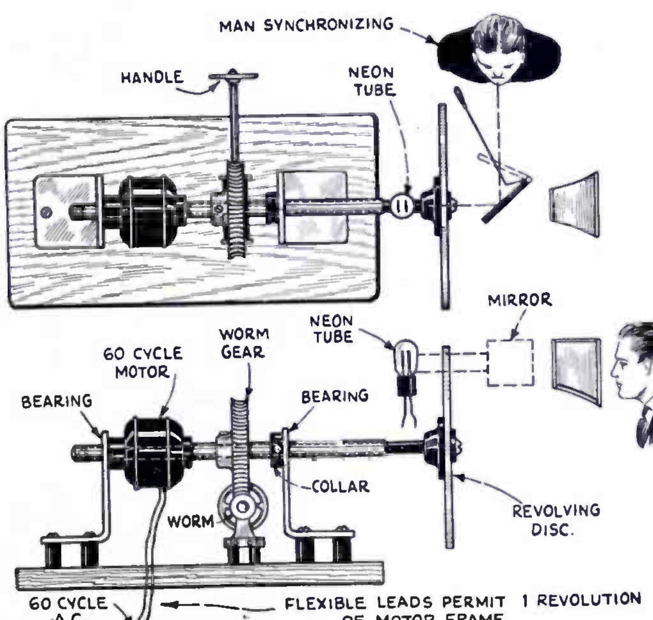


Fig. 9—At right shows method used in a commercial television receiver for the purpose of framing the image. A worm gear is mounted on the shaft carrying the motor and scanning disc, and by turning the worm the motor is rotated through any necessary part of the revolution, until the picture is framed squarely in the diaphragm opening.

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HOW SHALL WE AMPLIFY the TELEVISION SIGNAL?

By C. H. W. Nason

The author, one of the foremost television engineers in America, discusses the principles of design essential in the construction of a television amplifier, capable of amplifying all frequencies from 15 to 30,000 cycles.

ALTHOUGH utilized in widely divergent services, the television signal differs but slightly from that of radio telephony. In broadcasting, the radio-frequency carrier is modulated at an audible rate corresponding to the signal input to the modulator tube. The modulation voltages are composites of frequencies varying from about 50 to slightly beyond 5000 cycles. In television, the signal components cover a band of frequencies, ranging from as low as 15 cycles on through the entire audible range and beyond. The highest frequencies to be encountered, in the present state of the art, are of the order of 30,000 cycles. Obviously, the audio-frequency amplifiers of standard design are unsuitable in such a case; and a special problem in amplifier design confronts the worker entering the television field.

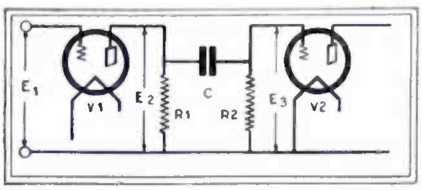

Fig. 1

The problem in designing an amplifier is to keep the ratio of the input voltage E3 to the output voltage E2 as high and constant as possible.

It is a wise, though not universally accepted, practice in the design of apparatus of a multiple character, to consider each unit as an entity and to strive for perfection in the design of that single element of the whole, without regard for the failings of the associated apparatus.

According to our previous statement regarding the frequency-band utilized, we see that our amplifier must present a gain-frequency characteristic essentially flat from 15 cycles to 30 kilocycles (Fig. 4). The inability of the eye to differentiate between small variations in light intensity, without a standard of comparison in direct juxtaposition, makes allowable a deviation from normal gain of plus or minus twenty per cent. over the band.

Resistance Coupling Essential

The high-frequency response of any amplifier is dependent upon the admittances due to shunt or stray capacities remaining negligibly low in comparison with those of the other circuit elements. The inherent stray capacities of transformer windings make it impossible to design a transformer-coupled amplifier capable of reaching both the low and the high frequencies. The same disadvantage is present in impedance-coupled circuits. Hence, we are limited to resistance coupling in one form or another; not because of the effects of stray capacities, but because of the variation in *phase displacement* apparent in transformer-coupled circuits, with variation of the signal frequency. The human ear is incapable of recognizing phase differences; but phase distortion of the television signal is quite apparent in the received image, and quite apart from discrimination against the higher frequencies. The transformer-coupled amplifier is therefore unsuited for television use.

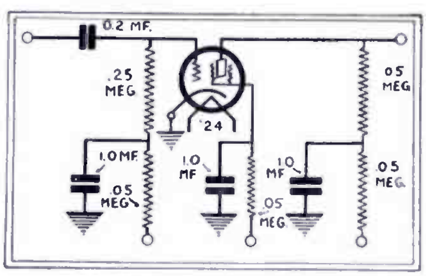

Fig. 2

The fundamental circuit of the improved Jenkins television amplifier. With grid-leak detection, an odd number of stages is used; with power detection, an even number.

In a resistance-capacity-coupled amplifier (shown schematically in Fig. 1) the basic gain per stage is a "function" of the "mu" (μ) of the tube V1, the plate resistance Rp, and the load resistance R3. That is, at a mid-range frequency where the reactance of C is negligible and with the effective load resistance taken as the paralleled grid- and plate-resistance values,

$$\text{or } R3 = \frac{R1\ R2}{R1 + R2}$$

The gain per stage is:

$$\frac{E2}{E1} = \mu \frac{R3}{R3 + Rp}$$

This we may consider as a constant from which all deviations from the normal gain are to be measured; taking it as 100%, the percentage of reproduction attained at other frequencies is

$$E3/E2 \times 100$$

Inspection of the equation shows that the gain is primarily dependent upon the magnitude of R3; and that the condition $E2/E1 = \mu$ obtains when the factor $\frac{R3}{Rp + R3}$ approaches unity, through the plate resistance's becoming negligibly small in comparison with the load resistance.

It is possible that, at some low frequency, the reactance of C will become large in comparison with R2; and an attendant rise in R3 will increase the gain at the low-frequency end. This is usually overcome, through the fact that E3 is taken across R2 in series with the reactance.

In computing the response at the low frequencies we have

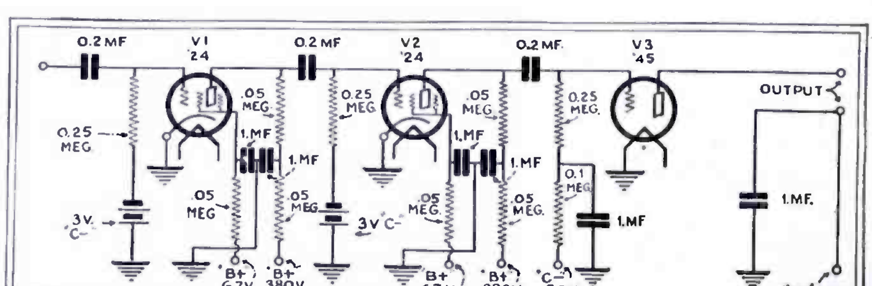

Fig. 3

The complete circuit of the new Jenkins television amplifier, whose characteristic is practically flat up to 30,000 cycles. Constants are given in the diagram; the high degree of filtering and circuit isolation shown is absolutely essential.

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$$\frac{E_3}{E_2} = \frac{R_2}{\sqrt{R_2^2 + XC^2}} = \frac{\omega R_2 C}{\sqrt{\omega^2 C^2 R_2^2 - 1}}$$

The evaluation of the quantity is dependent upon the factor C R2 and, with a predetermined value of R2, the low-frequency response is dependent upon the value of C. Likewise, with a fixed value of C, raising the value of R2 will improve the amplification at the low end.

C R is the "time constant"; numerically equivalent whether C and R are taken in farads and ohms, or in megohms and microfarads. Its values for a reproduction factor of 95%, at various low frequencies, are as follows:

Table 1

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

The reproduction factor must be held high in the individual stage; as the percentage of amplification at a given frequency decreases geometrically with the number of stages. Thus a reproduction factor of 95 in the single stage becomes 85.7%, when cubed by three successive stages.

Effect of Tube Capacities

The high-frequency response is less subject to predetermination. Obviously, as the value of the grid-filament capacity reactance of V2 becomes lower with increasing frequency, R2 (effective) becomes

$$\frac{R2\ Xc}{R2 + Xc}$$

where Xc is the capacitative reactance; and the output capacity of the preceding tube is effective in a like manner across R1.

At the high frequencies there is a still further decrease in the effective gain per stage, due to the feed-back of energy across the grid-plate capacity, and the calculation becomes of increasing complexity. Experimental determination of the high-frequency response becomes our sole means of accurate evaluation; and we can

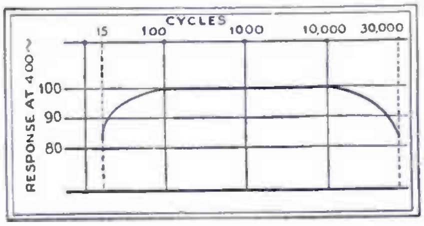


Fig. 4

The standard, 100%, is the reproduction of a 400-cycle note. The characteristic of the amplifier is practically straight between 100 and 10.000 cycles; between 15 and 30.000, it does not fall off enough to destroy the televised image.

merely play safe by holding R1 and R2 low enough to nullify the effects of parasitic capacities.

Filtering by means of resistances and condensers does much toward keeping the elements at their assigned values, by terminating each resistance effectively at ground and keeping the signal voltages out of the battery circuits. The arrangements are shown in a self-explanatory manner in the schematic of the completed amplifier (Fig. 3).

Before attacking the design of the complete amplifier, an explanation of one peculiarity is in order. As the signal passes through each stage, it becomes shifted in phase by 180° and, if an uneven number of phase shifts take place, the resulting image will be *negative*. Assuming the first shift to take place in the detector circuit, we require an audio amplifier of either one or three stages. In power-detector circuits, the detection takes place in the plate circuit of the tube and no reversal occurs; therefore, we employ either two or four stages of amplification.

Table II

	3rd Stage	2nd Stage	1st Stage
	'45	'24	'24
Ep	60	30	1.5
μo	3.5	300	300
μe	2	20	20
Eg	30	1.5	.075
Ec	50	3	3
Eb	250	180	180

Assuming the first case and taking the required output R.M.S. voltage as 60, we decide upon a '45 type tube for the output stage; since this is the most economical tube capable of supplying this voltage under the power output conditions encountered—that is, 60 volts across 10,000 ohms (the approximate impedance of the neon tube).

The design of each stage (as indicated in Fig. 2) is shown in the data of Table II. The values of R2 and C are chosen to give a reproduction factor of 95 at 10 cycles, with a fairly low-resistance leak, to avoid the shunting effects of the grid-filament capacity.

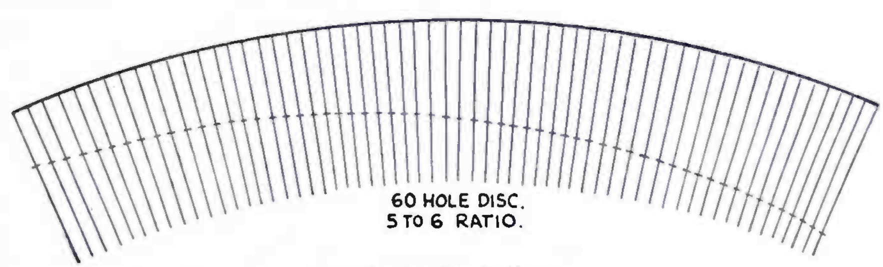
The bias is chosen so that it cannot swing positive at any signal voltage which is probable; *i.e.*, each individual stage is so proportioned that there is but slight danger of overload.

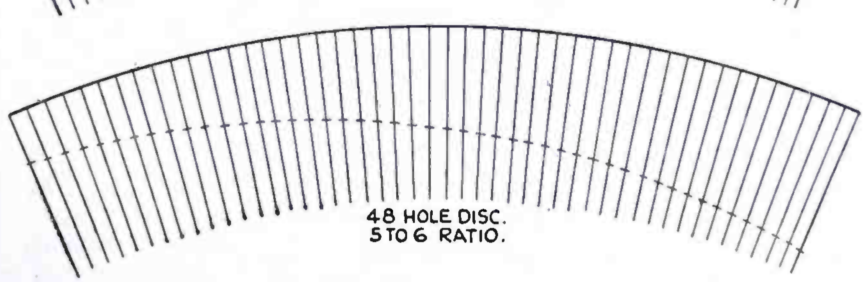
A frequency-characteristic taken with one of these amplifiers is shown in Fig. 4. It can be seen that the curve is superior to that obtained with even the best transformer-coupled amplifiers, and that it holds closely to the limits set in the opening paragraphs.

In the schematic drawing (Fig. 3) the D.C. voltages given are not the effective terminal voltages, but include excess voltage to compensate for the IR drop in the plate circuits.

Read Before Using Charts on Page 108

THE scanning disc templates on pages 108 and 109 are laid out so as to give a square image such as used until recently. N. B. C., Columbia Broadcasting Co., and the new Jenkins Station W2XCR will employ an image ratio of 60x72 elements. This represents a proportion of 5:6, the picture being wider than it is high. By patterns made from the drawings at the right for the 60 and 48 hole layouts respectively, the experimenter can lay out his disc for the 60x72 picture. To do this continue all radial lines on your disc pattern to the center; then use one of the segment patterns shown at right and place against the circumference line on your disc layout, matching the first hole line on the disc, with the first line on the segment and continuing in this manner with the second hole line, etc. Drill sizes: 1/16" dia. for 24 hole; No. 70 drill (.026") for 36 holes; for 60x72 image, 48 holes, dia. = .0113"; for 60 holes, 60x72 image, dia. = .0074. For the drilling of the last two holes use No. 80 drill (.013") and grind or emery down to size.





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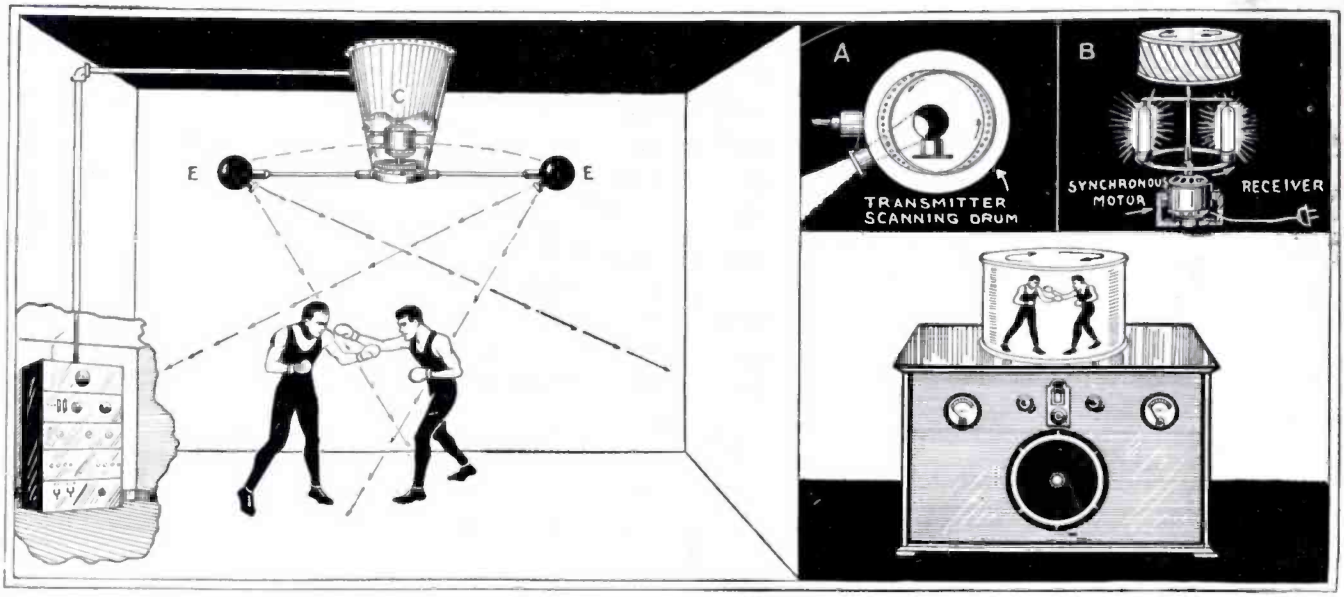

The Gould system of panoramic or "three-dimensional television": the transmitter is shown at the left. The synchronous motor C revolves an arm carrying two "electric eyes" E which pick-up the motions of the boxers from all angles in one revolution. Each "eye" contains a photo-cell and a cylindrical scanning drum, as shown at A; the spiral motion is obtained by the rotation of the system. At the receiver, shown at the lower, right, the image may be viewed from any side. The vertical drum on the receiver is slotted spirally, as shown above at B; and the two neon lamps, revolving in the opposite direction, combine their red and green lights to give natural colors. The advantage of the vertical drum is, for one thing, that more people can observe the image.

Television Projected in Three Dimensions

WHILE all television images hitherto reproduced have been extremely limited in the angle of vision of the scanning apparatus (if only because the detail of the image was limited for electrical reasons) it will ultimately be desirable to present moving scenes of considerable size. An interesting system of viewing localized action from all sides has been worked out by Leslie Gould, the Bridgeport, Conn., inventor, whose system of colored television was described in the July, 1930, issue of RADIO-CRAFT (page 24). The ingenious method proposed is illustrated here as it would be applied to the televising of a boxing match, to which it seems especially suited.

Above the principals is shown a cone C, containing a synchronous motor which rotates a horizontal rod, on each end of which is mounted a scanning device E. This "electric eye," as shown in the detail sketch (A) at the upper right, contains a photo-electric cell, surrounded by a scanning drum, which passes the light rays from the scene below, point by point in a vertical line, to the sensitive surface of the cell. The result, it will be seen, is that the moving figures within the range of the photoelectric cells are scanned spirally, from every direction, in the course of one rotation of the rod. It is possible, of course, to use more than two electric eyes; but a separate channel or waveband is required for each transmission.

At the receiving end, the reproducer used will be composed of a radio receiver and a rotating vertical drum, inside which are mounted two neon tubes, as shown at (B) in the upper right corner. One of the tubes gives out red light, and the other green, corresponding to the two pickups at the transmitter. The combination of the two colors approaches the natural light-values of the scene.

Since the neon tubes revolve in one direction, and the diagonal slots in the other, the reproduced image is also scanned spirally; and the result is that we have, as shown at the lower right, a television image which may be seen from several angles; standing out, as it were, in the round. The effect described by the inventor is that of viewing the ring from any desired angle, just as if it were reduced to the compass of the outer scanning drum of the television reproducer.

BRITISH TELEVISION WORK

Stage effects in television, as shown by the experiments of the General Electric laboratories a couple of years ago, present novel problems; since the photoelectric cell does not see as the eye does. Because of the limited size of the image, when the first television play, "The Queen's Messenger," was produced at Schenectady, faces and hands could not be shown together; and one pair of actors presented the former, and another player the latter features.

The British Broadcasting Co., which is semi-governmental, is now carrying on television work on the regular broadcast band, from Brookmans Park station near London; and on July 14 it staged Pirandello's "The Man With a Flower in His Mouth." For this, an account stated, "scenery" was used. The scenes were painted in bold black on white boards, about three feet by two; and it was not considered practicable to show the actor and the background at once. The looker-in, therefore, had to commit the scene to memory while watching the actor. The British transmissions, it will be noted, are but 30-line images, instead of the 48- to 72-line transmissions available here on the shorter waves only.

Changes of scene were effected, not with a mixing panel of the type used in the American television play, which blended the electrical impulses in a fade-over; but by the simple method of raising and lowering a blackboard which served as a curtain.

Experiments with blue-and-white, green-and-black, and yellow-and-red facial make-ups for the actors finally brought out the fact that white faces, with contrasting lines blackened, give the best results. The work described, of course, represents only a beginning in television technique. The public interest is thus being allowed to grow up with the progress of the art of television in England; contrasting with the policy in the United States, where it has been decided to keep general broadcast listeners "in the dark" until the development of television to a commercial basis shall force its recognition.

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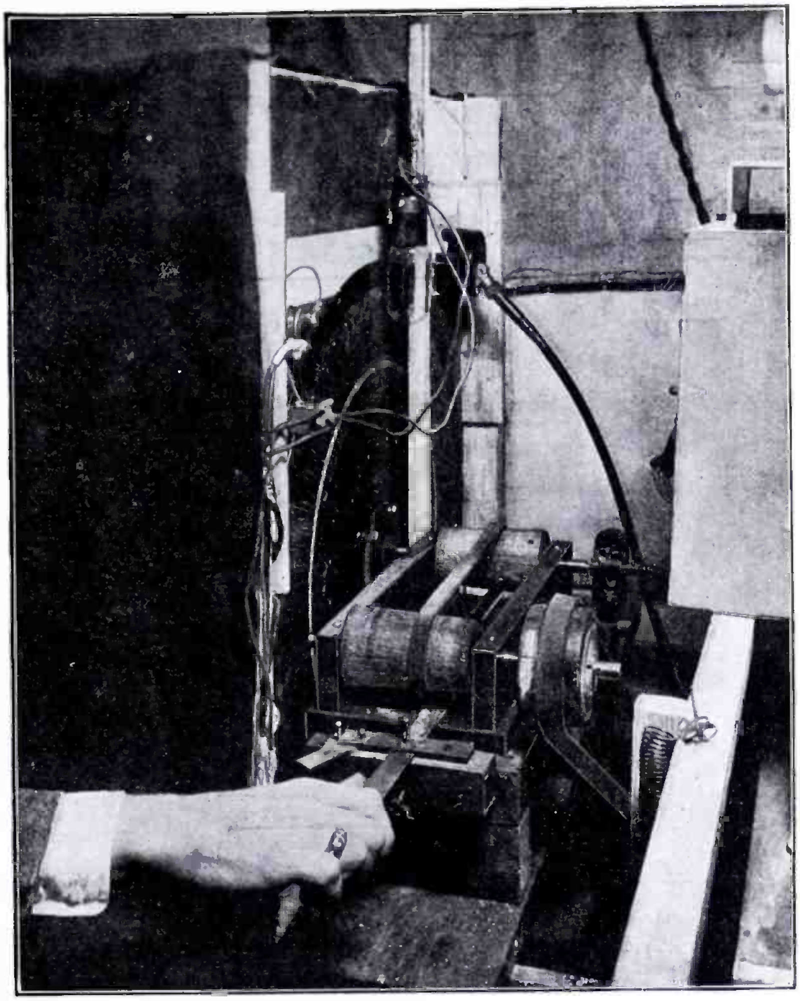
CONE PULLEYS *Provide* Sensitive Speed Adjustment

By C. HERLING GLEASON



Use of the cone pulley in regulating the speed of television scanning disks is advocated by Mr. Gilbert I. Lee, of Los Angeles, California. That such a coupling is sufficiently accurate for television purposes is proved by its use in many industries requiring minute and flexible control. In the paper mills, for example, this type of regulator has been found to meet the very stringent requirements of that industry. The rollers through which paper is passed must run at slightly different speeds because of the stretching of the paper; yet all speeds must be exactly correct and must be maintained constant, since a misadjustment may mean breaking the paper.

THE problem of synchronism in television has been very successfully solved by Gilbert I. Lee, a Los Angeles engineer and experimenter, who has devised a mechanical speed control that overcomes the principal difficulties which heretofore existed.

Mr. Lee's device embodies a steel frame in which are set two conical pulleys, *faced in opposite directions* and connected with a leather belt. A metal guide clasped about the belt can be shifted from side to side by a lever, thus guiding the belt to any desired position on the pulley. It will be seen that when the belt is toward the small end of one pulley, it will encircle the larger circumference of the other; but when it is shifted to the opposite side, the relationship is reversed. When the belt is in the middle, the diameters of the pulleys at that point are equal, providing a 1 : 1 ratio. Thus the speed ratio may be varied at will from 3 : 1 down to 1 : 3. If the driving motor turns 900 r.p.m., the scanning disk may be adjusted to any speed within the range of 300 to 2700 revolutions.

As used by Mr. Lee, the two pulleys, each five inches wide and tapering from three inches in diameter at the base to one inch at the apex, are mounted 12 inches apart (on centers) in a steel frame. The belt is of leather and is one-half inch wide. Special ball-bearing mountings were originally used, but proved too noisy, and phosphor-bronze bushings were substituted.

If
You Are Getting
Good Image Reproduction
from home-made Television apparatus write a description of it, with photos and diagrams, and send to the Editor. All articles accepted and published will be paid for at regular rates.

Practically every known type of speed control was tried before the present method was hit upon. Control through a synchronous motor regulated externally by impulses transmitted simultaneously with the picture frequencies, as employed by the Bell Telephone Laboratories in their famous test of 1927, proved unsatisfactory for transmission over long distances; for, if the synchronizing signal fades, the receiver is thrown out of gear and must be regulated all over again. Friction drives were discarded as too unstable and tricky; gears, as too noisy and not sufficiently flexible. Control by field resistances, Mr. Lee regards as inherently unsatisfactory, as it not only upsets the electrical operating conditions of the motor, but is also slow and inaccurate because sufficient time must be allowed after adjustment for the motor to settle down to a constant speed.

Eventually, he came to the conclusion that mechanical means were the only solution. A control was needed that could be adjusted, preferably continuously, or by very slight steps, over a wide range of speeds, in order to meet the varying requirements of different transmitting stations; one that could be brought up to any desired speed instantly and without hunting; and one independent of external transmission conditions. The result was a drive that is more flexible and stable than any ever tried.

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A Power Supply *for* The Television Receiver

By C. H. W. NASON

In the last issue of this magazine, the author described his idea of the very latest type of television receiver, including the tuner, detector, and audio amplifier. Here he describes a power supply for a receiver of that type.

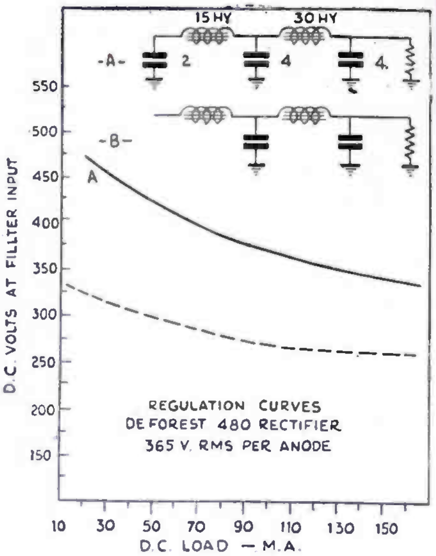

Fig. 1—Above shows "regulation" curves for the two particular filter systems diagrammed at the top of the drawing.

IN ITS essentials, the power supply required for television service differs in no great degree from that used for broadcasting. New developments in the art of rectifier-output filtration cannot be readily adapted to the needs of the amateur; because of the fact that special equipment is required for each individual case. The gods have been good in recent years, and there is no lack of material well suited to the use of the home constructor. The particular design here shown is the result of a brief series of experiments carried out through the courtesy of the De Forest Radio Co.; the problem being the possibility of achieving a sufficiently high output voltage with standard apparatus.

Method of Coupling Filter

Rectifier filter circuits may be connected to the rectifying tube either through a condenser (condenser input) or through a choke (inductance input). The condenser input permits of a higher terminal voltage with a given A.C. transformer voltage; while the inductance input has a more kindly effect upon the operating life of the tube and the filter condensers and gives better regulation. The Amertran "type 245" power block, which we will employ as our power source, has a total secondary high potential of 730 volts (R.M.S.), 365 on each side of center tap. The chokes contained within the power block have ratings of 15 and 40 henries, with D.C. resistances of 120 and 625 ohms respectively. They are, in the order named, the same as the Amertran "709" and "854" chokes obtainable as units.

Two rectifier systems, employing these inductances but differing in the fact that one had a 2-mf. condenser across the input, while the other was fed through the 15-henry choke (with no input condenser), were connected up and output voltage readings were taken over a wide range of current drain. The *regulation curves* for these two filter systems are shown in Fig. 1.

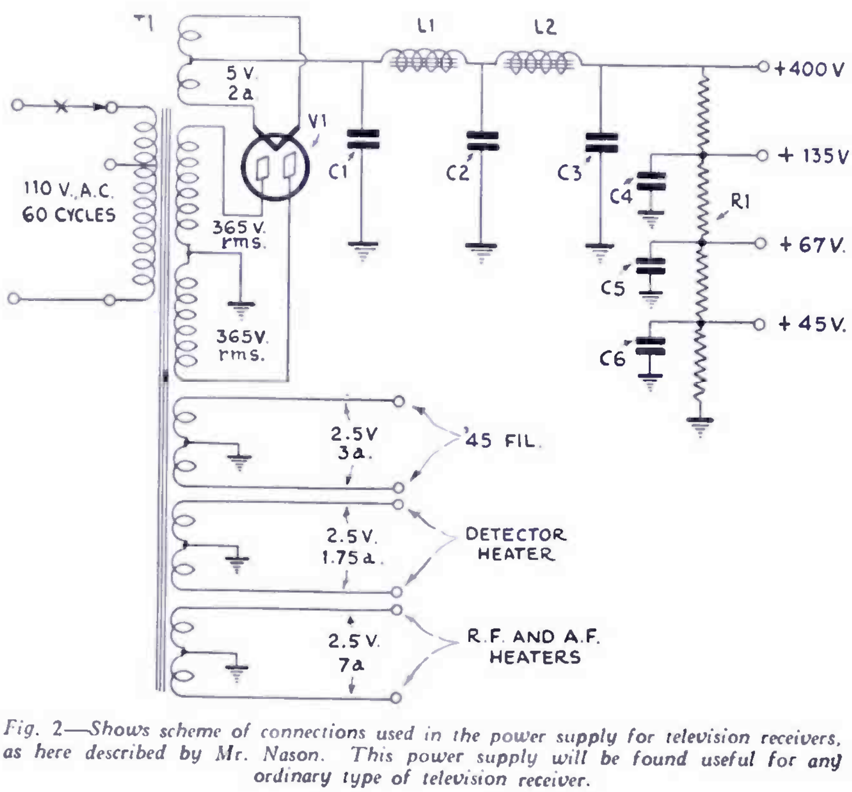

Fig. 2—Shows scheme of connections used in the power supply for television receivers, as here described by Mr. Nason. This power supply will be found useful for any ordinary type of television receiver.

Effect of Load on Voltage

A reference to the article on page 25 of the first issue of TELEVISION NEWS will show that a terminal voltage at the filter output of at least 400 D.C. was required. While it was hoped that the rectifier, with an inductive input to the filter, would be capable of this output voltage, the curves show quite plainly that, in spite of the marked improvement in regulation obtained with this type of filter, the maximum voltage required cannot be secured. Our receiver demands a high voltage of 400, with an *average* current drain of 40 milliamperes. This current drain is not fixed, as we will have to accept a variation in load when varying the brilliancy of the neon tube; an additional drain of ten milliamperes, due to the voltage-divider resistance shunting the rectifier output, gives us a total drain of 50 milliamperes (ma.). Reference to the curves in Fig. 1, yields the information that the D.C. voltage at the rectifier input is about 430, at 50 ma. drain.

We have also taken into account the IR (current times resistance) drop through the filter chokes. At 50 ma.,

(*Continued on page* 151)

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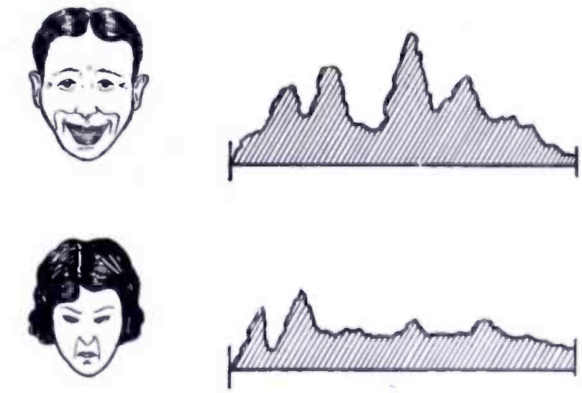
What Does YOUR FACE *Sound Like?*



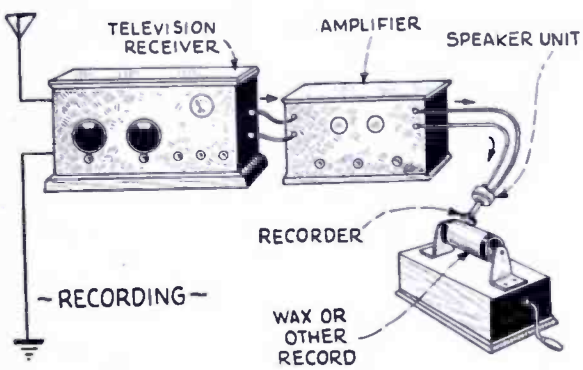
The curves above represent typical pulsations in the television image current for a minute fraction of time and give some idea of the nature of the fluctuating sound waves recorded on a phonograph record for future reproduction purposes.

Perhaps you do not know that the television signals which carry the image of your face through space, may be recorded on a phonograph record and then reproduced at any future time—A novel and interesting idea to experiment with.

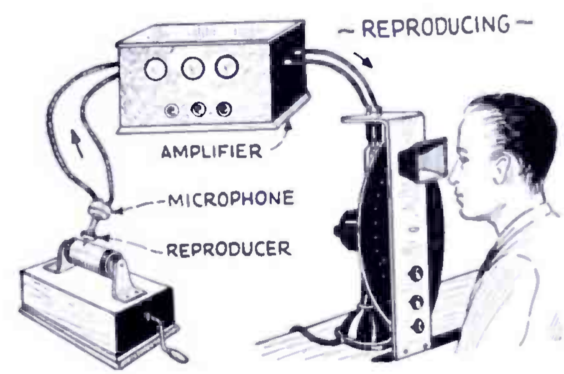
EEE-OOO-U-OWW-EE-UGH — that's about how your face sounds when you record the television signals on a phonograph, and then listen to the reproduction. In other words, some people sound sweet and others may sound quite otherwise, when translated into television language.

These peculiar and yet characteristic sounds, created by a television machine scanning your face, are caused by the fact that as the ribbon of light passes repeatedly across your face, constantly fluctuating or changing electrical currents are set up in the photo-cell and its associate amplifier circuits. These fluctuating "facial" currents pass through the radio transmitter and if you listen in with a pair of phones at a receiving station tuned to the television transmitting signal, you will hear the peculiar whining note.

Perhaps there is not a very broad field at the present time for the application of this trick, which comprises the recording of the hieroglyphics of your face, but there may be tomorrow, many desirable uses for this idea, which has been tried out by John L. Baird, the famous Scotch television expert. At the present time, once your "face" has been televisioned over the air, it is lost forever, but if some recording means (such as a film or wax record) were used as here shown, the image of your face could be reproduced at will for any purpose whatsoever. In the future, if we wish to record the faces of our favorite musical stars, as well as their voices when they are giving an unusually fine performance, we can do so by the same means or similar ones, as above outlined. We can then reproduce the faces and voice to perform exactly as it did in the original reception, whenever we desire to do so.—*H. W. S.*



Picture above shows how received television images may be recorded on a phonograph record and reproduced at any future time, as shown at the right.



At the right we see how the recorded television image of a face or other object is reproduced by connecting the phonograph with a microphone, amplifier and neon tube with scanning disc.

IN OUR NEXT ISSUE

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A Perfect Scanning Disc

By DR. HANS VATTER

The principles described by the author in the accompanying article apply specifically to German 30-hole scanning, but the ideas set forth are, of course, applicable to any scanning disc.

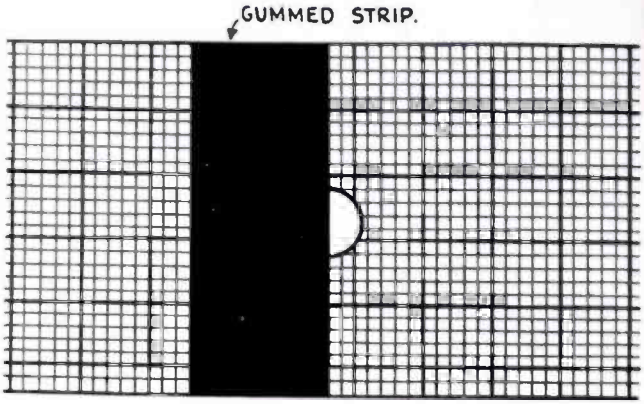

Fig. 1—Shows how square holes can be layed out by the use of graph paper, ruled in divisions of about one millimeter (.039 inch).

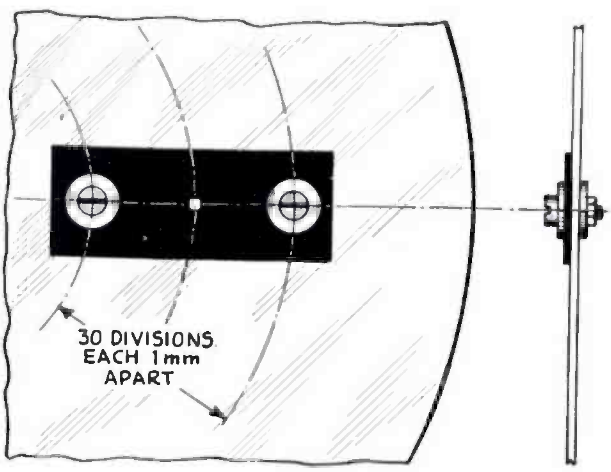

Fig. 2—Above, shows how the metal strips, with the scanning holes in them, are fastened to the disc. The dimensions shown are for 30 holes or lines, each one millimeter apart.

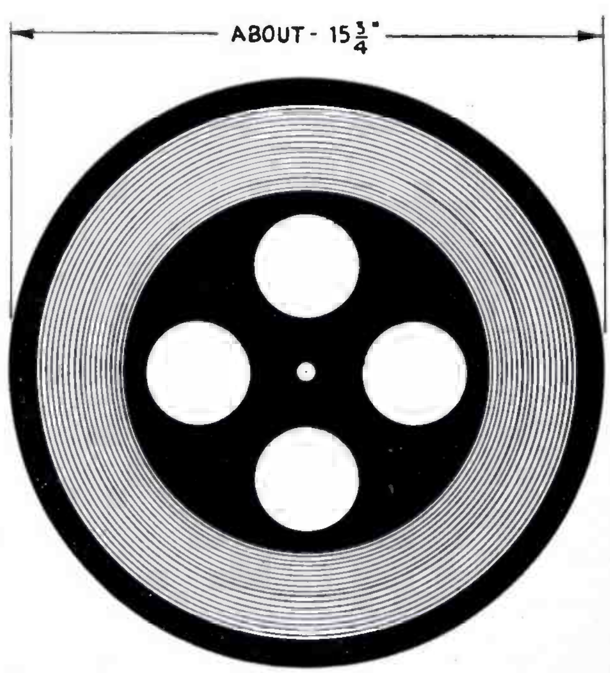

Fig. 3—At right, shows how scanning disc can be made lighter by cutting four large holes in the central portion.

THE experimental television transmissions of the Berlin radio station have already aroused a considerable number of amateurs, who are building their sets themselves, right from the ground up, as in the early days of radio. Since a television receiver corresponding to the specifications of the Reichspostzentralamt (German Central Post Office) cannot yet be had commercially, self-construction is at present the only possibility of participating actively in the evolution of television it seems. It is a favorable circumstance that the simple television apparatus with glow-lamp and scanning disc is exactly suited to amateur construction. There is no part of it that one cannot easily make for oneself. One can even make the television glow-lamp, using for the purpose the ordinary neon glow lamp in commercial use.

Also, the construction of a precision scanning disc offers only slight difficulties. At first, thick discs of sheet metal or other materials (wood, cardboard, fibre, etc.), which were provided with circular holes 1/25th-inch in diameter on a spiral line constructed from the dimensions of the picture as a basis, were used. These discs have the fault of being hard to synchronize, owing to their great weight,; and moreover, they too easily run eccentrically (off center) and show a pictorial field with streaks in it. The first two disadvantages can be eliminated by using for the disc material something very thin, such as sheet aluminum or sheet copper about 1/100th inch thick, which in rapid rotation stretches out perfectly flat. This, because of the mirror-like surface and the small mass, offers only a slight air resistance, and is easily synchronized. At the same time, the constructor proceeded perhaps to use, instead of circular holes, slits with four corners; so made that the outer edge of one spiral hole exactly coincides with the inner edge of the next one. This is absolutely necessary for the attaining of an even surface brightness. Indeed, as soon as the two holes partly overlap, there form on the picture surface bright streaks; because the same spot on the glow-lamp's surface is then exposed twice. On the other hand, if there is a space between the inner and outer edges, then dark streaks appear, which are also disturbing when the picture is looked at.

The Best Disc Design

The simplest method for the amateur, to build an excellent scanning disc, is to make the hole cut-outs separately, in order to fasten them later on the disk over larger holes, in such a way that they can be moved a fraction of an inch in all directions. This adjustment easily makes it possible to

(*Continued on page* 153)

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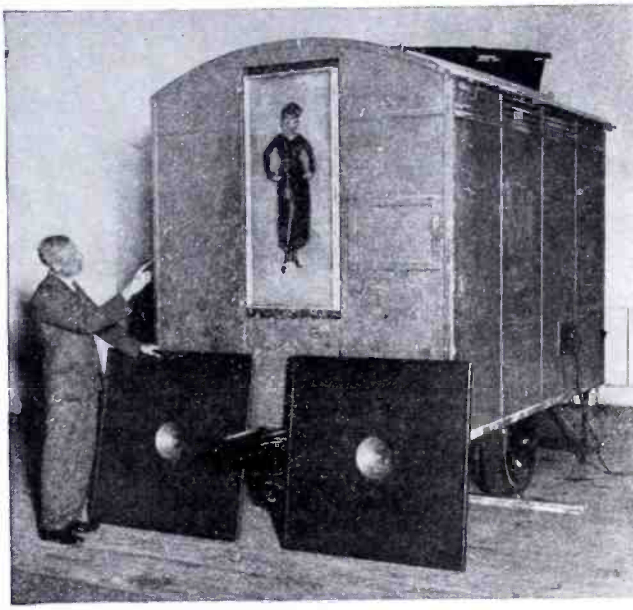
LATEST GIANT *TELEVISION* SCREEN

Large television image is built up of spots of light from 2,100 small lamps, each lamp's brilliancy varying with the image signal strength.



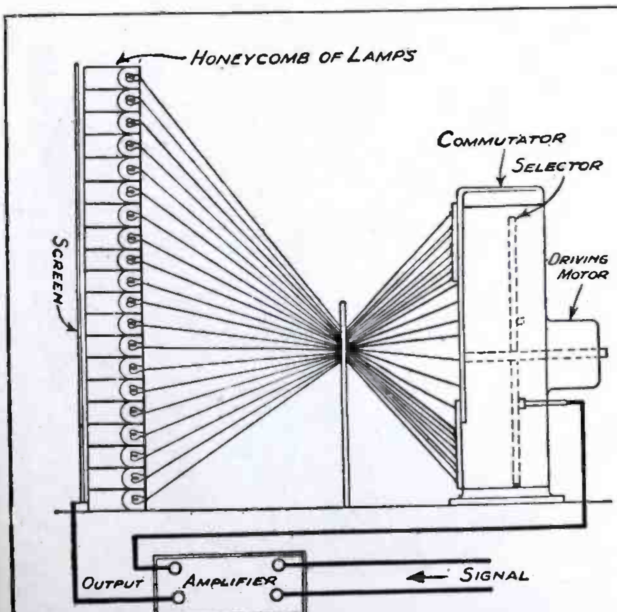
Appearance of the large public television screen, comprising 2,100 small, metal-filament lamps behind a translucent screen. Two dynamic speakers mounted on baffle boards are shown resting against truck.

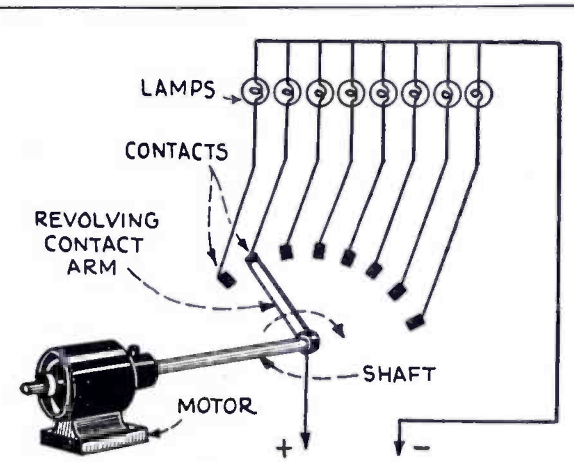
THE accompanying photograph shows a new, large-size television screen which consists of a ground-glass sheet, behind which there are 2,100 small tungsten filament lamps. The size of this public television screen is 2 by 5 feet, and the images produced on it are declared to be of extraordinary brilliance and definition. One writer in *Television*, (London) states that the brightness of the screen was quite comparable to that of the usual theatre motion picture, and that the various parts of the image varied from intense white, through various shades of sepia, to dead black.

At the demonstration in London of this newest form of public television screen, an entertaining program which lasted for about thirty minutes was staged. Mr. Sydney A. Moseley, introduced the demonstration with a short speech; and the audience present were then treated to a *visual* as well as *aural* entertainment. Several well-known television artists presented songs as well as dialogue. Mr. John L. Baird, well-known British television expert, discussed the point that what the spectators were seeing was simply the nucleus of a very much larger television screen, one which would have at least ten times the scope of the present 2 by 5 ft. one.

At the close of the demonstration, the members of the audience were allowed to inspect the apparatus, which was described in detail by Mr. Baird. The screen on which the image appeared, comprises a sheet of ground glass; and behind this there is placed a closely nested series of 2,100 small compartments, in each of which there is placed a small tungsten-filament lamp. Each one of these lamps is connected by means of a wire to one segment of a rotary switch, or commutator, containing 2,100 insulated segments.

As the selector brush of the commutator revolves, each lamp is lit up in turn; so that the whole of the screen (*Continued on page* 144)





Simplified diagram to show how the various lamps in a row, for example, are progressively lighted to build up a television image on the large receiving screen.

Schematic circuit showing the general arrangement of the large television screen, the honeycomb of lamps, the commutator and its driving motor, as well as the amplifier.

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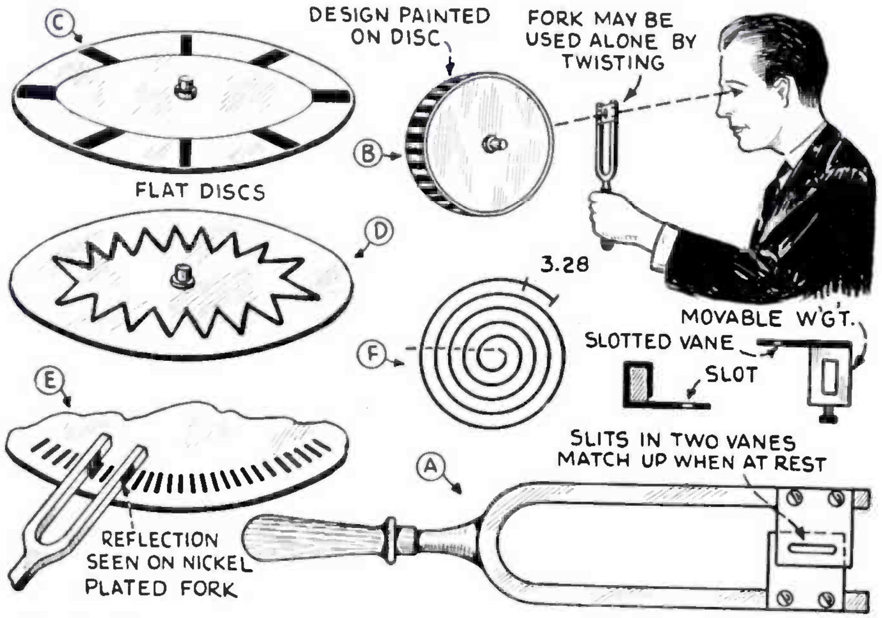

Fig. 2—Above illustrates various designs of "speed checking" discs, which, when observed through a vibrating tuning fork, appear to stand still.

Synchronizing With a Tuning Fork

Did you know that the speed at which any revolving object is rotating, can be quickly and easily checked with an ordinary tuning fork and prearranged pattern of black lines?

By looking through the prongs of a vibrating tuning fork at a revolving pattern of pre-determined design (such as a series of white or black marks), which is arranged to revolve on a television scanning disc, we can determine quickly whether the disc is rotating at the proper speed or not. In one of the accompanying illustrations, several different designs of stroboscope discs are shown. In Fig. 2-A, we see one of the usual type of tuning forks used for the purpose of viewing the revolving design, the sighting being done through the slits in a pair of vanes secured to the legs of the fork. The fork is set in vibration simply by striking one of the prongs against a piece of wood or a table top.

The method of viewing the revolving stroboscope pattern is shown at B and in this case straight black and white lines are painted or otherwise marked upon the edge of a drum. As becomes apparent, there is a mathematical relation between the speed in revolutions per minute of the revolving pattern, (and the disc or shaft to which it is attached), as well as the number of vibrations of the fork, and the number of lines forming the pattern. The formulas expressing these mathematical relations are given below; as well as a table showing the

(*Continued on page* 154)

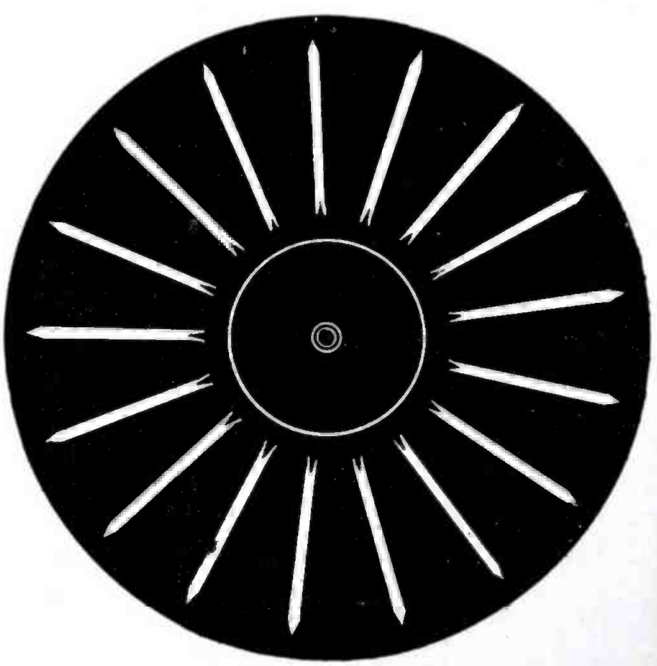

Fig. 3—Above, and Fig. 4 at right, represent two typical charts which can be redrawn larger and mounted on television discs. These designs are to be viewed through a vibrating tuning fork.

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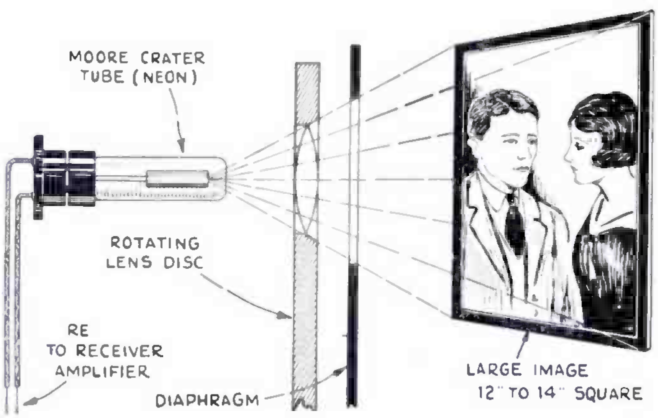
The TELEVISION QUESTION BOX

How to Get Large Television Images

Frank Minturn, Buffalo, New York, would like to know:

Q1. Describe two methods whereby large television images can and have been produced.

A1. Accompanying diagrams show two ways in which large television images have been successfully produced. The first involves the use of the Moore *neon crater* tube which was invented by Dr. D. MacFarlan Moore, one of the research engineers of the General Electric Company. This neon crater tube supplies a high-powered neon light beam from a small crater in one of the electrodes mounted within the tube; and this brilliant neon beam may be passed through lenses arranged in a spiral on the revolving scanning disc on the receiver (or else it may pass through ordinary holes in the disc and then through a lens), and so on to a screen as shown. This was the method followed in the large television demonstrations presented at the New York and other Radio Shows of the last few years. The power supplied to the neon crater tube is not as great as might be imagined; a couple of 250-type amplifier tubes, with about 300 volts on the plates, suffice to excite the crater tube sufficiently to project a bright image, about 12 x 14 inches, on the screen.

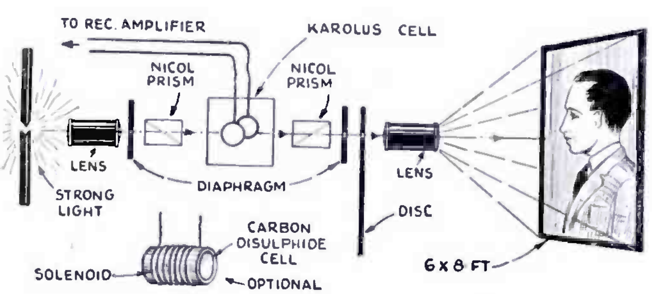


Here is one method used for projecting large television images on a screen. The neon crater tube yields a small, high intensity target of light which is magnified by lenses mounted in the scanning disc.

A second method, which was used about twelve months ago, by Dr. E. F. W. Alexanderson of the General Electric Company in demonstrating 6 x 8-foot television images in a theatre, involved the use of the Karolus cell. One of the diagrams shows the arrangement of the lenses, Nicol prisms and the Karolus cell. The amplified television signal at the receiving station is impressed across the two metal plates immersed in a solution of nitrobenzol in the Karolus cell. The prisms are adjusted until the powerful light beam from an arc (or high-power incandescent lamp) just fails to pass through the optical system on to the screen. Now, when the television signal currents come into the Karolus cell, they cause a polarizing or twisting of the light beam and, with proper adjustment, we obtain a large television image on the screen as shown.

A variation of this cell comprises a tube containing a solution of carbon disulphide, and around this tube there is wound a coil of fine wire. In the experiment mentioned above, the electrostatic reaction between the two metal plates is utilized to twist the light beam; while in the second scheme the changing magnetic field within the coil winding is utilized to twist or rotate the light beam. In any case the Nicol prisms are essential, and also a couple of lenses.

It may interest our readers to know that at least one company has found it possible to operate the Karolus cell with voltages as low as 600 to 1500 volts; this cell usually requiring very high potentials such as 10,000 to 20,000 volts. The Karolus cell holds the secret for at least one form of "large-image" home television receiver, when used in conjunction with a high-candlepower incandescent lamp (say 250 to 400 cp.) with concentrated filament.



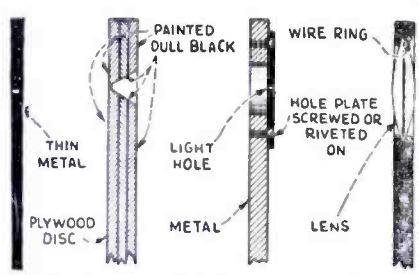
Alexanderson's arrangement for producing 6 by 8 ft. size television images on a theatre screen. This was demonstrated about a year ago to theatre audiences.

What Shape Hole?

Frank Galsworthy, Batavia, New York, inquires:

Q1. What is the best form of hole and the best disc material to use for television reception?

A1. The drawing herewith shows a variety of television scanning disc holes. First we have the thin metal disc, which may be made from aluminum, duralumin, or even brass. Some of the commercial discs being sold are made of metal .020 inch thick. The holes, after they are laid out, may be drilled or punched through the metal. Where a piece of metal is not handy, a plywood disc may be employed, counter-sinking each hole in the manner shown. Where a very accurate job is desired, another trick which has been commercially employed, is to drill the holes around the spiral of considerably larger size than desired; then, over each of these holes, a small plate is screwed. The sight hole has previously been drilled through the center of the patch plate. This permits trying out a number of different shapes of holes on the same disc.



What shape hole? Take your pick—the ideas shown above are explained in the text.

Still another form of television scanning disc is that having a series of lenses, one for each hole, arranged as shown. This method has been used by Jenkins, Alexanderson and other experimenters in some of their television apparatus.

Synchronization

John M. Wiley, Camden, New Jersey, asks:

Q1. Please describe briefly a few simple methods for synchronizing a television motor and scanning disc.

A1. In the accompanying illustration three schemes for establishing synchronism between the television transmitter and receiving discs are shown. The first arrangement, which has been used to a

(*Continued on page* 142)

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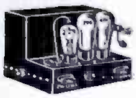

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As used in Victor Sets For use with six 26's, two 45's and one 80: can also be used for any power amplifier using 245 tubes. Price **$2.75** 25 cycle, $3.25

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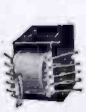
Improved in every respect. Housed in beautiful gold stipple finished metal cabinet, 14x12x5. Reproduction is excellent. Price...... **$2.95**

A.C. STRATFORD Screen Grid 6-Tube Super Dynamic Radio with Big Volume

Uses four 224 screen grids, one 245 power amplifier and one 280 rectifier. Perfect Rola Dynamic Speaker included. Cabinet of walnut veneer, stands 18" high, 12½" wide at base. Less tubes **$26.25**

Kit of Arcturus matched tubes $9.23 or RCA Licensed tubes $3.94.

PEERLESS ABC Power Transformer



Used in Courier Model 65 chassis; plate, control grid, screen grid, filament voltages for three 24's, two 45's and one '80 rectifier; 80 watts, 110-120 volts, 50 or 60 cycles. Price **$3.25**

RCA BRUNSWICK RESISTANCES

K-2673090 Resistor, 2450 ohms, used in RPA 4 and 4A; Part R90	60c
K-2673091 Resistor, 3400 ohms, tapped at 1400 ohms; used in RPA 4 and 4A; Part R91	60c
K-2670325 Resistor, 4000 ohms, untapped; used in RPA 1A and 4; Part R25	60c
K2673067 Resistor, 407 ohms, tapped at 270 and 310; used in RPA5; Part R67	60c
K-2673092 Resistor, 840 ohms, tapped at 300; used in RPA 4A; Part R92	60c
Bremer-Tully 510 Resistor, 4500 ohms	60c
K-2673031 Resistor, 1100 ohms, tapped at 300 and 400; used in RPA 3, 3A and 3B; Part R31	60c
K-2673044 Resistor, 1100 ohms, tapped at 200; used in RPA 7 and 7A; Part R44	60c
K-2673047 Resistor, 6000 ohms; used in 7 and 7A; Part R47	60c

RCA 104 RPA (Power Loudspeaker) Transformer

An excellent transformer for direct coupled audio amplifiers; uses one 10, two 16B's (or '81's), one 874 and one 876. Price............ **$4.85**

POLYMET Filter and By-pass Condenser

1 mfd. 600 volts. Replacement in Brunswick and Bremer - Tully sets. Price..... **45c** $4.80 doz.

BAL-RAD High Voltage Surge-Proof Condensers

For general repair and power pack work. Furnished in fibre container with long, flexible leads, ready for immediate installation. Impregnated in a high quality compound.

GUARANTEED 100% REPLACEMENTS

Size	Mfd.	Work. Volts	Each	Dozen
5¼x2½x1	1 mfd.	800	35c	$3.60
5¼x2½x1	2 mfd.	800	50c	5.50
5¼x2½x1	4 mfd.	800	75c	8.00

Brunswick, Bremer-Tully Condenser Block

For replacement in Models S81 and S82 B-T: may also be used in receivers operating on 60 cycles. Seven fixed condensers are contained in this bank. Red or green spot top... **$1.25**

STRATFORD 1,000-Volt Condensers

Highest grade voltage condenser made. 100% replacement. Individual cartons. Each has flexible leads.

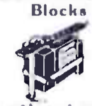
Small, Compact

1 mfd... 60c
2 mfd...$1.05
4 mfd... 1.50

BREMER-TULLY Power Transformer

Used in Models S-81 and S-82 of B. T. and in Brunswick Models S-31 and 32. Delivers current for four 24's, one 27 and push-pull 45's. Must be used with type D-126 regulator tube or equivalent ballast tube....... **$4.50** 25 cycle, $4.75

STROMBERG-CARLSON BRUNSWICK RCA Filter Condenser Blocks



33 mfd. and used as an "A" filter on all sets. Price..... **$3.50**

RCA BRUNSWICK Catacombs

6 and 8 tube panels. For amplifying units. **$5.40**

RCA Pushpull Input and Output

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

A.K. Replacement Transformer

For all battery sets and early electric sets. **$1.50**

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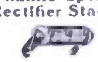

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CX-345	$2.00	0.64
CX-350	11.00	1.25
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Crosley By-pass Condenser, ½ mfd., type 1107	.25
Carter Volume Control, 25,000 ohms	.20
Victor Voltage Divider, 4,325 ohms, tapped at 2,000, 1,350, 775 and 200 ohms	.95
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4	600	60c	6.75

Each container packed in individual carton.

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1 mfd. .35c ea. 3.60 doz. 4 mfd. .85c ea. 9.00 doz.

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BALTIMORE RADIO CORP.

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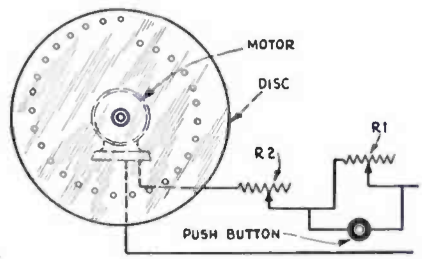
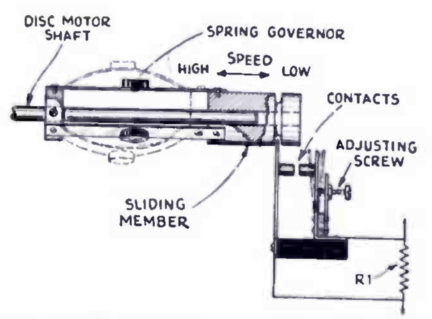
(*Continued from page* 140)

considerable extent, involves the use of a coarsely-adjustable resistance R2, and also a finely adjustable resistance of low ohmic value at R1; a push-button is connected across the lower resistance R1. A rheostat R1, of the wire-wound type provided with a slider or switch arm (or one of the graphite-disc type) having a maximum value of about 12 to 15



A coarsely adjustable resistance is used at R2, and a finely adjustable one at R1, in this speed regulation scheme.

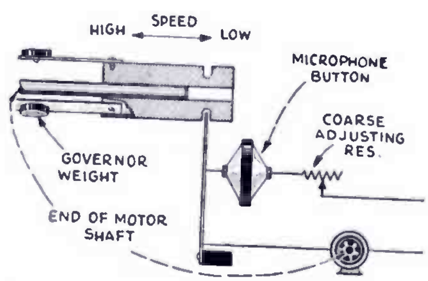
ohms, permits fine graduation of the motor speed. Coarser variations of the motor speed are established by the high resistance R2 of the wire-and-slider type or this may be also of the graphite disc variety. The two rheostats are adjusted until the disc is rotating just under the desired speed, and the operator periodically pushes the button, short-circuiting



One form of "ball-governor" speed regulator for television motors. As the speed rises the resistance R1 is "cut in".

the resistance R1 and speeding up the motor.

Another speed-regulating scheme of the automatic type is shown at Fig. 2; here a three-ball governor causes the short-circuiting switch, connected across the low-value resistance R1, to be opened and closed as the motor speed rises and falls. A variation of this idea is shown in Fig. 3, where a governor causes the grooved sleeve to exert less pressure on the microphone button (or a pile of graphite discs) causing an increase in the resistance of the button, with a consequent reduction of the current passing through the motor and a decrease in its speed. As the speed of the disc's motor falls, the governor sleeve moves toward the right, exerting more pressure on the microphone button, which lowers its resistance, and the motor speeds up; this action repeating itself *ad infinitum.*



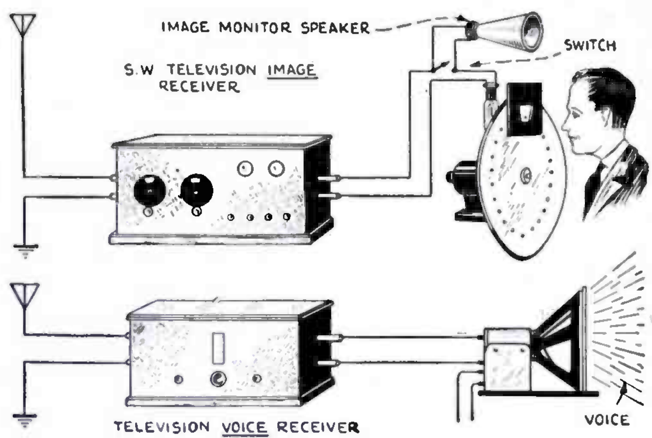
Here a rise in speed releases the pressure on "Mike" button, increasing its resistance, thus reducing the motor speed by lowering the current supplied it.

single-pole, single-throw switch, connected across the loud speaker's terminals. The loud-speaker monitor proves very useful in tuning in the station, the television signal being heard as a buzz-saw note. When this is loudest, the signal is being received with maximum intensity; and a bright television image should appear, if the disc is rotating in synchronism with that of the transmitter.

Q2. How is the voice picked up simultaneously when "looking in" on the Jenkins television images, now being transmitted daily?

A2. The diagram shows how the "voice" is picked up on a second short-

You need two receivers (tuners and detectors) to pick up the television image and voice: each being transmitted on a different wave length. A small loud speaker is here used as monitor for image signals.



Loud Speaker as Monitor

Helen Pried, Savannah, Ga., asks:

Q1. What sort of monitor is recommended for use with the Jenkins Home Television Receiver?

A1. The usual practice, with this particular home "Radiovisor," is to use a loud speaker of any type which may be available; and this is cut into or out of the neon tube's circuit by means of a

wave receiver (or even a broadcast receiver which tunes down to about 175 meters); this receiver being connected to either a separate aerial, or (as in some instances) to the same antenna on which the television image signals are being picked up. If the two receivers are to be connected to the same antenna, the primary coils should be of fairly high impedance, or have about 50 turns in the primary winding.

An Open Letter from a Radio Pioneer

March 24, 1931.

Mr. Hugo Gernsback, Editor.
"Television News,"
96 Park Place,
New York, N. Y.

Dear Mr. Gernsback:

Permit me to congratulate you on the manner in which you have handled the Editorial content of your new publication, "Television News." As I have expressed, both personally to you and publicly in the Editorial columns of your magazine, it is my frank belief that any medium, effort or enterprise which sets for its purpose the aim of interesting the amateur experimenter in television, will be doing more toward furthering the development of that art and will bring nearer to realization the day when television will be part of our scheme of home entertainment, than any single organization can possibly hope to accomplish.

"Television News" has disclosed through its Editorial content that it is published with the purpose of interesting the amateur experimenter, and through the admirable treatment you have given the subject at hand, both in Editorial content and in the selection of authors with an outstanding background in the radio and electrical fields, you have demonstrated your knowledge of the problem confronting those desiring to further the development of electrical transmission of sight.

It would be superfluous for me to add to the opinion I have already expressed in the columns of this publication since they are now, as they were then, a true indication of my attitude in television. Yet I feel that one slight change in what I have previously stated is necessary. With such concentrated activity as that now being waged through the medium of your publication, I see the day considerably advanced when television will form a very common part of home entertainment apparatus.

May I express once more my appreciation for your efforts in publishing this magazine since I believe it is not only of great benefit to those interested directly in television, but also is of considerable import to the radio industry in general.

Cordially yours,
PACENT ELECTRIC CO., Inc.,
L. G. Pacent, President.

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All tubes are date stamped and any tube that fails to make good for **ANY** reason will be replaced free of charge within 6 months.

Radio tube users have become wary of so-called cheap tubes. Such tubes are nearly always "**seconds**"; that is, tubes that have failed to pass the manufacturer's tests. These tubes do not give good service and therefore are never guaranteed for any length of time.

NEONTRON tubes are manufactured by one of the oldest, reliable Eastern tube manufacturers and we have made special arrangements for this unparalleled sale. You will find here tubes that you cannot buy elsewhere, yet the price is low when you figure the long service that these tubes will give you. There are no better tubes made than **NEONTRON**, regardless of price.

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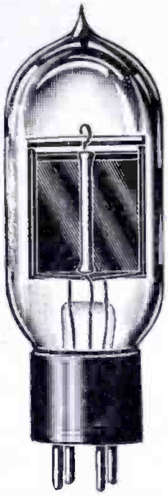

Telion Television Tube $3.90

Switch Tube $.85
Switch is used when one filament burns out, tube therefore has twice normal life. With switch on acts as 171 or 112 Power Tube — with switch off it is 201A Tube.

5-Prong 201A $.85

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High Grade (Hi Mu) 201A Type—better vacuum — works and fits in any set. $.85

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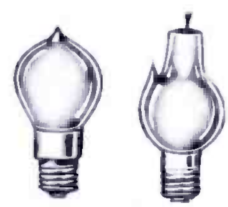
A.C. Adapter Tubes to convert battery sets into A.C. Electric sets—furnished for 226, 227, 171A. $.85



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TYPE	PRICE
UX-201A—Amplifier or Detector—Standard for all purposes	$ .50
UX-226 —Used as amplifier tube for A.C. operation	.60
UY-227 —Used as detector amplifier for A.C. operation	.65
UX-171A—Power output amplifier for A.C. or D.C. operation. ¼ amp	.65
UX-171 —Same characteristics as the 171A on tungsten filament, ½ amp	.70
UX-240 —Designed for impedance and resistance coupling	.70
UX-120 —Power amplifier used in last stage of audio frequency of battery set using dry cells	.70
UX-199 —Detector and amplifier tube, long prongs	.70
UV-199 —Same characteristics as UX-199 only short prongs	.70
UX-112 —Power amplifier tube, ½ amp	.70
UX-112A—Power amplifier tube for low current consumption. ¼ amp	.79
UX-200A—Detector tube recommended for weak signals and good reception	.70
UY-224 —Screen grid, four-element, used as frequency amplifier and linear power detector in special circuits	.70
UX-245 —Power amplifier tube used in last audio stage—for low plate voltage	.85
201A—Quadrode 5-prong, for special circuits	.85
200A—Special detector tube, a supersensitive detector	.85
201A—Special radio frequency, a supersensitive detector	.85
201A—Special audio frequency, a supersensitive detector	.85
171 —Special A.C. ½ amp, extra coated filament—good for electric sets	.85
T-14 (201A High Mu), high emission	.85
Switch tube, 201A or 112 or 171, double life	.85
226, 227, 171A—Adapter tubes, to convert battery sets into A.C., each	.85
UX-210—For power amplifier, high voltage	1.60
UX-250—Power amplifier used in last stage of audio frequency	1.60
201A—All bakelite shield tube	1.60
UX-222—Screen grid tube for D.C. operation. Radio frequency amplifier	1.60
Tellon television tube	3.90
Photo-electric cell—2 inches	3.90

RECTIFIER AND CHARGER BULBS

125 mil. rectifying tube (B. H. type)	2.15
2 amp. old and new type charger bulbs (list $4.00), our price	2.95
5 and 6 amp. old type charger bulbs (list $8.00), our price	4.85
UX-280—Used as a fullwave rectifier tube for high emission	.75
UX-281—Characteristics similar to the 280, but used as half-wave rectifier of high emission	1.60
Freshman rectifying tube, especially designed for use with Freshman Master "B" Eliminators. UV brass base, limited quantity	.60

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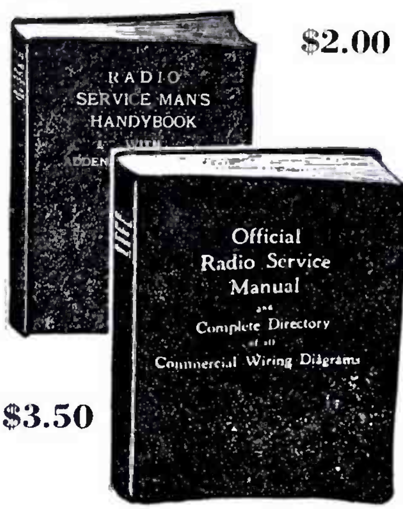

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How the Germans Televise

By DR. FRITZ NOACK

(*Continued from page* 93)

The Mihaly Methods

The Telehor Company also uses a scanning disc with a glow-lamp, a driving motor and synchronizing wheel; the motor is connected by a belt to the axle of the synchronizing motor and, consequently, to that of the scanning disc also. Phasing is effected by turning the frame of the synchronizing motor around its axis while it is in operation. To produce the necessary voltage for the glow lamp, a special battery or power unit will be required.

In a larger type, to be used as a universal television receiver, there is also a small vacuum tube oscillator generating a local synchronizing frequency of 375 cycles to which it is tuned by a small rotary condenser; an ordinary receiving tube will serve. This current is amplified and conducted to the synchronizing motor, which operates on 375 cycles; unlike that in the simpler model, which is designed for 50 cycles. The synchronizing motor and scanning disc are so delicately balanced that the output of the oscillator and its amplifier are sufficient to keep the apparatus operating at the proper speed. To maintain perfect synchronism between the transmitted image frequency and the locally-generated 375-cycle current, the Telehor circuit conducts the A.C. plate potential of the receiver's tube to the osciliator. The oscillator-frequency is thus restored to the normal value if it should vary; a very slight amplitude of the image-frequency will suffice. Only when the received image-frequency is completely lost, through fading, can the receiver get out of synchronism; and this cannot last.

If the image is improperly framed in the "window" of the receiver—say, with the bottom half at the top—this can be corrected by turning the mounting of the synchronizing motor, as already explained.

The possibility of using a tuning-fork, instead of the tube oscillator to obtain the local synchronizing frequency, has been considered; but the tuning fork, although it has been successfully employed in transmitting photographs by radio, must be carefully protected against changes of temperature, or its note will vary. So the use of the tube is simpler and cheaper; however, its construction entails some practical difficulties if exact frequency-regulation is to be required. As the frequency decreases, resistance will cause a lessened peak of the curve of frequency-response.

With the Telehor, the television receiver is connected to the loud-speaker terminals of the radio receiver, and the speaker across the terminals provided on the television apparatus; a switch permits immediate change over from sound to images, and vice-versa. To provide the necessary voltages, a power unit will probably be built into the receivers; the televisor will then have only two cords, one to the receiver output and one to the house socket, with terminals for the speaker, as stated.

The designs so far made are only for alternating-current operation; direct-current house supply does not give a voltage sufficiently high. It is not impossible that a battery-operated model may be provided for those who have D.C. receivers.

The German Reichspost (post office department, with control of wire and radio communications) is making test broadcasts for the benefit of experimenters in Germany, from which others will also benefit. The Berlin transmitters are used, and perhaps others, such as Stuttgart, will be used later. This will permit of determining the practical value of the television apparatus, and the suitability of different radio receivers for operating them, before official programs are regularly undertaken.

Latest Giant Television Screen

(*Continued from page* 137)

is "scanned" in one revolution of the selector. As the selector revolves at 750 R.P.M., it will be seen that over 25,000 contacts are made every second!

The standard television signal is amplified, and the output from a nine stage amplifier is fed to each lamp in turn; since each lamp will light up to a brilliance determined by the amount of current flowing at that moment, a picture is built up on the screen when the selector brush is in synchronism with the disc at the transmitting end. Synchronism is obtained with a synchronizing gear differing from the standard Baird toothed-wheel synchronizer in size only.

This new system of screen television has two great advantages over any previous efforts—that by choice of lamps any brilliancy can be obtained; and that flicker is greatly reduced because the lamps are *not* instantaneous in their action, but continue to glow for a short time after the selector brush has passed the respective segments.

This prospect opens out a new field for the movie. In the movie theatre of the future we shall see events of the day at the instant they are occurring. In addition, it will be possible to feed a number of theatres from one master studio.

www.americanradiohistory.com

How to Build the New Jenkins Television Receiver

By H. G. CISIN and CHAS. E. HUFFMAN

(*Continued from page* 105)

The Jenkins television receiver gives excellent fidelity over a wide band of modulated frequencies. A splendid picture signal is attainable, even when the received wave has a field strength as low as 20 microvolts per meter, and is due to the amplification provided by the two R.F. screen-grid tubes. Additional sensitivity is inadvisable, since signals weaker than 20 microvolts per meter, are subject to static distortion and will also show numerous traces of other electrical disturbances.

The R.F. amplifier is selective enough to separate all stations readily, but it nevertheless amplifies the side-bands as well as the carrier frequency, thus assuring superfine picture detail. The detector rectifies the R.F. signal, producing the picture frequency; which is further amplified to the necessary value by the three-stage audio amplifier.

Construction and Wiring of Receiver

The assembly of the kit is simplicity itself. First, the schematic wiring diagram, photographs, etc., should be studied and the instructions should be read over and understood. Then the components should be checked up with the complete list of parts. In starting the actual work, turn the chassis upside down and mount the two condenser blocks (8A, B, C) and (16A, B, C). Also mount the fixed condensers (35), (43) and (50). The R.F. choke (20) may be mounted during the process of wiring.

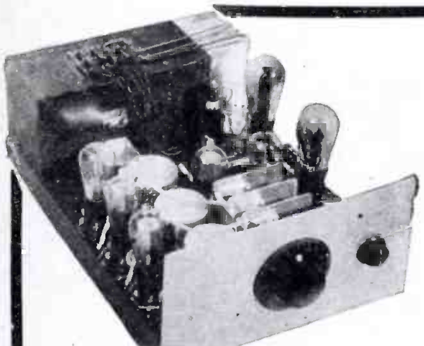
Next, turn the chassis right-side up and fasten the three-gang variable condenser at the front center. Then mount the eight sockets, the three R.F. coils, and the four binding posts. Then mount the three condensers (32), (38) and (45) on the underside of the raised bakelite strip, as illustrated. This strip also serves as the support for six metallized resistors. The condenser (31A) is mounted next; then the voltage divider (57), the power pack (53) and, finally, the large condenser block (56A, 56B).

All the other small parts, such as metallized resistors, R.F. chokes, mica condensers, center-tapped resistors, etc., can best be mounted by soldering them in place during the process of wiring.

The last step in the assembly is to mount the combination volume control and switch at the left side of the panel; fasten the panel to the chassis; and mount the dial and the volume control knob.

No difficulty should be experienced with the wiring. It is suggested that the filament circuits be wired in first. The various pairs of filament wires should be twisted. The power switch (54) should be wired in at this time. Then wire in the grid circuits. Note that the connections from the stators of condensers (4) and (12) go to the *caps* of the screen grid tubes (6) and (14) respectively, and also that the connection from the fixed condenser (32) is to the *cap* of the screen-grid tube (36). The screen-grid connections are made at the sockets. The volume control is wired in next.

The plate circuits should then be completed, next the cathode circuits, and then the necessary negative returns. The "Ground" binding post should be grounded directly to the chassis, while the "Antenna" post should be carefully insulated from it. The antenna post should be connected to the antenna coupler (2). The various by-pass condensers should be wired in and also the filter condensers. The rectifier filament and plates are con-



Television Kits

You can enjoy the excellent radiovision programs now on the air—without discouraging failures, waste of time, big expense. Start right—with Jenkins kits, if you wish to build your own set, or with complete Jenkins equipment. You don't have to cover the ground which Jenkins engineers have covered for you during the past six years!

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Here's a perfected television receiver kit as the result of two years of intensive engineering effort. Non-regenerative for distortionless images yet employing ample tuned r.f. for weak signals. Single-dial tuning. Covers 100-150 meter band. A.C. operated with self-contained power pack. All components supplied, including metal platform and front panel. Assembled in few hours by any handy man or boy. Provides good half-tone detail, where usual receiver would give only silhouettes. JK-20 Kit, without tubes, $69.50. Tubes, $16.90 extra. Self-synchronizer amplifier accessory, SK-30, $35.00 extra.

JENKINS RADIOVISOR KIT

Complete kit of parts, fully machined, ready to assemble and wire. Mounting brackets, field coils, wedges, ball-bearing shaft, rotor, scanning disc assembly, speed control, condenser, lamp socket and housing, wires, screws, nuts, bolts, packed in neat box with instructions. Assembled in few hours. RK Kit, $42.50. Lamp, $6.00 extra.

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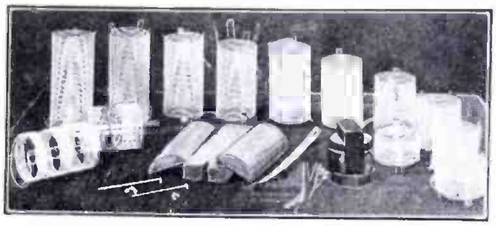
WE GUARANTEE these Kits to build as LOW LOSS a receiver as any similar Kits on the market selling as high as twice the price!! If you want RESULTS use AT LEAST two tubes. Good coils give the effect of an extra tube. These Kits are COMPLETE to the last nut (panel, baseboard, all hardware, etc.). On top of all that we give FREE with each Kit one of our fine coil winders. Make neat, sensitive, long-range short-wave sets as shown in photo. Can be used to receive ordinary broadcast wavelengths also. Receive stations DIRECT from THOUSANDS of miles. Foreign countries easy. SOME THRILL!! Add more tubes later for loudspeaker use. Each Kit has FULL instructions (6 pages), also pictorial diagrams showing where to put each wire—easy to build. Kits listed below are similar: 2-Tube Kit, $10.95, Postpaid. 3-Tube Kit (2 audio stages), $12.95. Short-wave-tested tubes, $1.25 ea. You can use the new 2-volt tubes with above sets with same results (require only 2 dry cells and last long). 2-volt tubes, $1.80 ea. All Kits on market are priced without headphones and tubes. Fine head phones, $1.75 pr.!! KITS FOR OPERATION FROM LIGHT SOCKET: Two-Tube Kit, $12.95, postpaid. 3-tube Kit, $14.95. Filament transformer, $3. Lights as high as 6 type '27 or screen-grid tubes. If interested, ask of our 4-tube Kit with tuned screen-grid stage. 3 tubes, though, works a speaker. Tested AC tubes, $1.75 ea. Instead of a coil winder you can get a set of plug-in coils if desired. Why pay as much just for the PARTS you need? Get the whole Kit and be sure of correct values.



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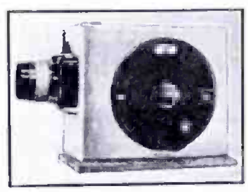

This fine shielded wavemeter has numerous uses. It finds foreign broadcasting stations on short-wave receiver dials, saving you time. Long distance is easy with this meter. First look up the station's wavelength in magazine, then set wavemeter to this wavelength (marked on dial). Then tune receiver to wavemeter. Not connected to your set in any way, just brought near it. Tunes 15 to 125 meters. Shielded from hand capacity. Comes complete with extra plug-in coils, individual calibration chart and full, simplified instructions for operating it with any short-wave set. Works with any good set (AC or DC) like DELFT, Pilot, National, Silver Marshall, etc., etc. Complete Wavemeter, $6.95, Postpaid. Why pay $12 or more? Easy to operate and ACCURATE!! Can be used to check transmitters if desired.

Special Amateur Band Wavemeter

Looks like above meter. Covers amateur bands with wide dial spread. Accuracy ¼ of 1%. $5.95, Postpaid, with calibrated coil for any one band. Calibrate for other bands yourself, or, add $1.60 for each extra band desired.

PLUG-IN-COILS!!—There is SOME difference between different makes of PLUG-IN-COILS! We test ours in a short-wave set. (They look like the coil shown on the wavemeter in this ad, but have finger handles so the windings are protected.) Tube-base coils (fit a UX (4 prong) socket) for R.F. amplifier use, 15 to 125 meters, using either a .0001, .00014 or .00015 condenser. Set of 3 (with finger handles), $1.30. Same kind of coils but with tickler windings also (for detector) $1.85.

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(These Parts, without tubes, are available in Kit Form)

1—Three-gang Variable Condenser, .00025-mf. each section, sections shielded (4, 12, 23);
3—.00002-mf. Trimmer Condensers (5, 13, 24);
1—Special Shielded Jenkins Television Antenna Coupler (2);
2—Special Shielded Jenkins Television R.F. Coils (11, 19);
4—Special 300-Turn R.F. Chokes (9, 17, 20, 30);
2—By-Pass Condenser Blocks, each containing 3 -0.1-mf., 400-volt units (8A, B, C), (16A, B, C);
4—.0001-mf. Fixed Mica Condensers (10, 18, 25, 29);
1—1-mf. 600-volt By-Pass Condenser (31A);
3—¼-mf., 600-volt Blocking Condensers (32, 38, 45);
3—2-mf., 200-volt, By-Pass Condensers (35, 43, 50);
1—Filter Condenser Block containing one-4-mf., 600-volt unit (56A) and one- 2-mf., 600-volt unit (56B);
1—Power Compact (also containing two-30 henry chokes) for supplying all plate and filament voltages (53);
3—500-ohm, 1-watt Metallized Resistors (7, 15, 34);
3—100,000-ohm, 2-watt Metallized Resistors (22, 26, 31);
2—50-ohm, Center-Tapped Wire-Wound Resistors (28, 48);
3—¼-megohm, 1-watt Metallized Resistors (33, 40, 46);
1—25,000-ohm Potentiometer Volume Control (21) with Power Switch (54);
1—2000-ohm, 1-watt Resistor (42);
1—2000-ohm, 5-watt Resistor (49);
2—50,000-ohm, 2-watt Metallized Resistors (37, 44);
1—25,000-ohm, 2-watt Metallized Resistor (39);
1—41,000-ohm, 10-watt Enameled Resistor Voltage Divider (57);
5—UY-type Five-Prong Sockets (6, 14, 27, 36, 41);
2—UX-type Four-Prong Sockets (47, 55);
4—Binding Posts (1, 3, 51, 52);
3—Screen-Grid Tubes, type 424, (6, 14, 36);
2—427-Type Tubes (27, 41);
1—480-Type Full Wave Rectifier Tube (55);
1—445-Type Power Tube (47);
1—Aluminum Panel, 6¾"x12⅞"x⅛";
1—Chromium-Plated Steel Chassis (mounting holes drilled), 12⅞"x18½"x1⅝" high;
1—Dial;
Wire, etc.

(NOTE: Numbers in parentheses after each part, refer to corresponding numbers used to designate parts on diagrams.)

nected, and the remaining wiring of the power supply is completed. Extreme care should be taken, in performing the wiring, not to cause short circuits through the metal chassis.

After the wiring is completed, it should be checked over carefully, before connecting up the set. It is then merely necessary to plug in to a 110-volt A.C. source, connect aerial and ground, and connect the neon terminals of the televisor to the output binding posts (51, 52). Thereafter the only adjustments needed are at the three trimmer condensers (5), (13) and (24).

The finished television receiver, when used in conjunction with the Jenkins "Home Televisor" or with any good radiovisor, will be a source of much pride and enjoyment to its owner. Television broadcast stations are constantly increasing in number and, just at present, they have been improving their programs enormously.

Columbia Ready to Televise

By A. B. CHAMBERLAIN

(*Continued from page* 89)

Fig. 7 is a picture of the receiver which will be employed for making observations in the field. A flat-plate neon lamp is used. The scanning unit is similar to the one employed in the scanner unit at the station. The television image when viewed through a magnifying lens will appear approximately 3 by 3½ inches in size; it is a 60 x 72-line picture containing 4,320 elements.

Mr. M. A. Trainer, who has been working on television engineering problems for several years, at one time as assistant to Dr. Alexanderson of the General Electric Company, is consulting television engineer for the Columbia Broadcasting System.

The station will operate on a frequency-band from 2,750 to 2,850 kilocycles, inclusive, with 500 watts unmodulated carrier power.

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A Multi-Channel Television Apparatus

By DR. HERBERT E. IVES

(*Continued from page* 100)

yields results strictly in agreement with the theory underlying its construction. The 13,500-element image, in resolving power and amount of detail handled, is a marked advance over the single-channel 4,500-element image. Even so, the experience of running through a collection of motion picture films of all types is disappointing, in that the number of subjects rendered adequately by even this number of image elements is small. "Close-ups" and scenes showing a great deal of action, are reproduced with considerable satisfaction, but scenes containing a number of full length figures, where the nature of the story is such that facial expressions should be watched, are very far from satisfactory. On the whole, the general opinion expressed in an earlier paragraph is borne out, that an enormously greater number of elements is required for a television image for general news or entertainment purposes. This, however, was anticipated, and the real question is whether the results of this experiment indicate that the finer grain image is best attained by resort to multi-channel means.

This leads to a discussion of what has proved to be a serious practical difficulty with the multi-channel apparatus. This is *the problem of keeping the several channels properly related to each other in signal strength.* In the experimental apparatus, the direct current components (introduced at the receiving end) and the alternating current signals, are separately controlled, manually, by potentiometers. These have fine enough steps so that with care, with a non-changing image, a uniform picture may be obtained. If, however, for any reason the signals on one of the channels becomes too strong or too weak, the picture exhibits at once a strongly lined appearance. The eye is quite sensitive to irregularity of this sort, and the transition from a smooth, grainless image to one showing a periodicity of 1/3 the number of constituent lines largely offsets the higher resolving power afforded by the actual number of scanning lines used. A characteristic practical defect of the system as set up is that any marked change in the general character of the signal, such as is produced by a shift from close-up to a wide angle view may throw out the existing signal balance sufficiently to show objectionable grain in the picture.

Differences of this sort in the three signals are of course caused in general by differences in the characteristics of the three circuits. Such differences can arise from overloading of amplifier tubes, whereby one or more may be working on a non-linear portion; by rectifying action of different amounts in the tubes immediately associated with the neon lamps, or in the neon lamp electrodes themselves. A remedy is the careful design and test of all parts of the system to insure the greatest possible uniformity of performance. When this is carefully done, the behavior of the three signals is reasonably satisfactory.

Conclusion

We are, as a consequence of this work, in a position to make a general comparison of the two chief theoretical means for achieving a television image of extreme fineness of grain, which are (1) extension of the frequency band, and (2) the use of several relatively narrow frequency bands. Both, because of the diminished amount of light which finer image structure entials, demand enhanced sensitiveness of the photo-sensitive elements at the sending end, and increased efficiency of the light sources at the receiving end. The multi-channel scheme described has some advantage in compactness over the equivalent single-channel apparatus, but since it is restricted to narrow angles of illumination of the discs the overall efficiency of light utilization is not essentially different. Comparing now the demands made upon the electrical systems the differences between the two methods are clear cut. Method (1) demands an extension of the frequency range of all parts of the apparatus, the attainment of which depends upon physical properties and technical devices whose mastery lies in the indefinite future. Method (2) demands a multiplication of apparatus parts, and careful design and construction of these parts so as to insure accurately similar operation of a considerable number of electrical circuits and terminal elements. The attainment of the necessary uniformity of performance of the several electrical circuits and terminal elements, while involving no fundamental problems, must present increasing difficulty with the number of channels used.

The Baird Universal Television and S-W Receiver

(*Continued from page* 117)

follow the same instructions of removing the fixed rheostat and putting in a 50,000 ohm resistor and in the No. 8 socket plug in the television *Octocoil* which has only one winding, leaving the regular red *Octocoil* in

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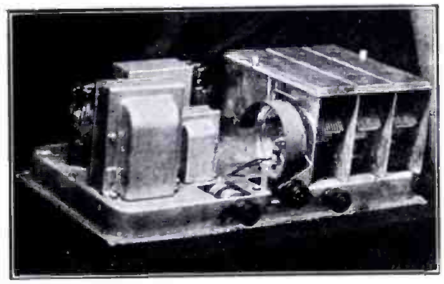

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socket No. 7. This cuts out the J-23 regeneration condenser. Plug your speaker into the speaker jack and tune in a television signal. The television signal sounds like the very rapid whirring of an airplane motor. *For a good clear picture the signal must be very strong and much louder than you ordinarily run the voice signals.* It is possible to get a picture with a weaker signal but the weaker the signal the less detail there will be to the picture.

When you have tuned in your signal to its proper loud point, pull out your loud speaker plug and the neon lamp in your television set will immediately light and flicker very rapidly with a bright orange glow. (As a matter of fact, the neon lamp flickers off and on 40,000 times per second.)

Make sure the rheostat on the front of the television cabinet is turned on full to the right and then plug your motor into the AC line. Now start your television motor by turning on the switch on the left hand side of the television cabinet; then, turn the rheostat on the television cabinet *very slowly* and as you turn it the picture will come into frame. Remember that you must turn the rheostat *very slowly* or you will go by the point where you can see a picture. As soon as the picture comes into frame the synchronizing amplifier will hold the picture in that position as long as the signal is tuned in strong. Moving the magnet holder bar slowly forward or backward will help to bring the picture into the exact center of your lens. If the picture is out of frame horizontally, snap the AC switch on the television motor off and on quickly once or twice. Unless the motor is running very near the proper speed, the picture will appear as a lot of black lines which are leaning either to the right or left, depending on whether your motor is running slowly or rapidly. When these lines straighten up and become vertical they resolve into a picture which is held there by the synchronizing amplifier and the No. 122 tooth wheel.

There are two probable causes for distortion in the picture. One is the position of the lens, which can be slid forward or backward in the chute until the proper focal point is arrived at, and the other is that the picture has not been properly tuned in on the shortwave receiver. A slight adjustment of the shortwave receiver will give you a sufficient variation of the picture so that you will readily learn how to tune the picture, which is exactly the same method employed as when tuning in a radio signal on your loud speaker.

If, due to local conditions, there is any possibility of the line voltage in your home going above or below 110 to 120 volts we recommend the use of a 75-watt Lin-A-Trol. This is a very simple connection and can be placed in your television cabinet.

www.americanradiohistory.com

Television Image and Voice Recorded On and Reproduced From Film

By WILLIAM SIRAWATKA

(*Continued from page* 107)

dark box. After this, it is ready to pass through the camera again.

How the Receiver Works

My television receiver is somewhat similar to the transmitter. The received impulses are impressed on a neon lamp. The light is concentrated, emitted from a point about (1/12th inch) 2 mms. in diameter. The intense light of this tube is passed through the same kind of scanning drum that is used in the transmitter; the varying light is photographed on the film in step with the transmitter. The film is developed and fixed, then run through a motion-picture projector.

The *sound track* (voice record) which is photographed on the film at the same time as the picture, is fed *smoothly* (not intermittently) past a slot, through which a bright light shines. The varying light is impressed on a photo-electric cell, the impulses are amplified and passed through a loud speaker. The film is then passed through a dark box.

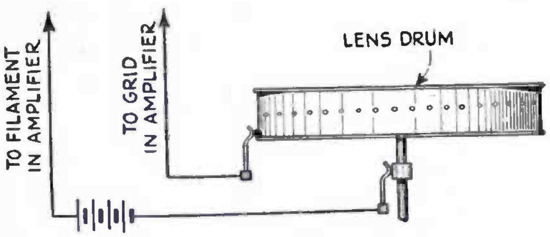
The film (in my proposed apparatus) is one continuous piece, which is re-used until through wear and tear it becomes necessary to install a new one.

Simple Synchronizer

The system I have developed will keep the receiver synchronized with the transmitter automatically. There is a simple contact arranged on the edge of the drum which touches a light metal spring at each revolution.

The contact closes a circuit that acts to impress a small voltage on one of the grids of the tube in the amplifier. Thus, for each revolution, a strong impulse will be transmitted. The light-spot produced by this impulse will not intrude upon the picture, except in the extreme corner, and then but slightly.

Having the synchronizing impulse, we control the receiver by mounting on the receiver drum a trip-magnet, in the same relative point as the contact on the transmitter drum. Equally spaced around the receiver drum are thirteen trip switches. One contact of each switch is connected to a common lead which is connected to one side of the power line; the other side of the line being connected to the motor. The other contacts are each connected to a point on a resistance, which is connected to the other side of the motor No. 1 switch is connected to the terminal of the motor, to which is connected the resistance. No. 7 switch is connected to the center and No. 13 switch to the extreme end of the resistance; the other switches being connected in between.



Detail of Sirawatka scanning drum and synchronizing contacts.

Assuming that the receiver is running in synchronism with the transmitter, switch No. 7 is kept closed by a spring. But, as soon as the drum runs out of step, what happens? We will call each switch a point.

Now the drum is 6 points behind, and the trip magnet is excited by the synchronizing impulse; the trip closes No. 1 switch which cuts out all the resistance, the motor runs up to full speed, thereby catching up with the transmitter. No. 1 switch at the same time excites a magnet in No. 7 switch, which breaks the circuit that runs to the center of the resistance. For each point behind, a point of resistance is *cut out*, speeding up the motor. For each point ahead, a point of resistance is *cut in*, slowing down the motor.

A Distortion-less Amplifier for Television

By JOHN WADE

(*Continued from page* 121)

plifier, it is impractical to reduce R_1 sufficiently to provide humless reproduction. It becomes evident, then, that the requirement of humless amplification will, to some extent, designate the kind of tubes we shall use and how they will be placed.

However, by dividing the amplifier into two sections, making the first humless and reducing the hum considerably in the second section, we can take advantage of high amplification constants and, at the same time, accomplish our end so effectively that the resulting circuit is unfairly described as a compromise.

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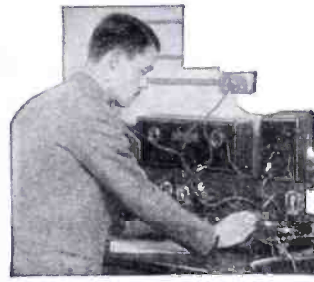

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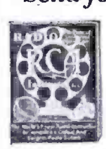

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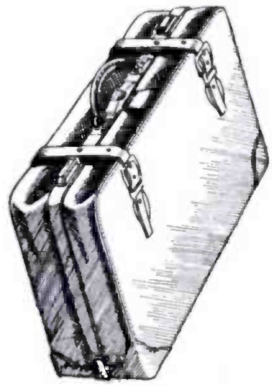

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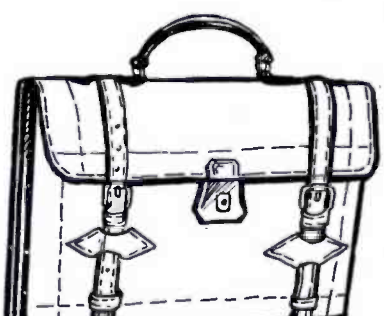

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Such an arrangement is more readily understood by again referring to Fig. 1. Equation (1) states that the hum voltage existing in the plate circuit of the second tube or R_1 equals $E_{d2} - \mu E_{d1}$.

If E_{d1} is reduced to the value $\frac{E_{d2}}{\mu}$, no hum will exist in the plate circuit of the second tube. If a low-mu tube (such as a 201A or a 227) is used in the first stage (or second tube), it will not be difficult to achieve this condition by making R_2 as large as possible (operating directly from 450 volts), reducing R_1 and adding the by-passed R_{h1}. This has been done in Figs. 2 and 3, and the approximate resistor values have been indicated. Resistor R_{h1} is preferably varied for the lowest hum point; but an approximate fixed resistor of 150,000 ohms will be effective.

We now have a humless condition existing at the input to tube 3, and we may start at this point with a clean slate. With only two tubes to consider, a reduction of the hum, rather than its elimination, will be quite satisfactory. The third tube may be a screen-grid tube, because it is the amplification constant of the last or power tube which is the determining factor in the degree to which the ratio of the hum potentials in R_3 and R_4 is lowered. Reference to Figs. 2 and 3 will indicate the consistent application of the principles described in the last two tube circuits.

Two Television Amplifiers

Fig. 2 shows a television amplifier employing battery tubes and Fig. 3 one using A.C. tubes. Note that the resistor values are not identical; as might well be the case were stability and the elimination of hum factors of no importance.

The low mu of the power tube makes this combination particularly easy to handle. This advantage, however, is somewhat counteracted by the load requirements of the screen-grid circuit and the fact that the modulation effect of the screen grid increases the direct effect of the eliminator hum potential in the plate circuit of this tube—*i. e.*, in R_3.

It may be found desirable to experiment with the value of resistor R_4.

It is of course highly essential that only the highest grade of resistors be employed in the amplifier.

It is essential, to the satisfactory amplification of the lower frequencies, that fairly large coupling condensers be employed, and that generous capacities be shunted around all bias resistors in the A.C. circuit.

The power supply system can, of course, be used to provide plate potentials to the radio-frequency circuits, by using the proper resistor values, by-pass condensers, and R.F., chokes.

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A Power Supply for the Television Receiver

By C. H. W. NASON

(*Continued from page 134*)

the drop through a total of 745 ohms is a bit above 37 volts; leaving us a rectifier output voltage of 393 volts. There is bound to be a variable factor arising here, due to the variation in the plate current of the 445 output tube when the brilliancy of the neon tube is changed.

Reference to the curve will indicate that the regulation over the range above 50 ma., is passably fair and that a change in plate current over a range of 10 ma. will shift the plate voltage over a range of but 3 or 4 per cent.

The bleeder resistance, or voltage divider, is an Electrad "D-400" 40,000-ohm, 75-watt unit with three extra adjustable sliding clips; these clips allow one to adjust the voltages at the intermediate taps quite accurately, if a reasonably good high-resistance voltmeter is available. As the receiver was designed to employ a battery and potentiometer in obtaining a variable bias for the neon tube, no biasing means is shown.

Fig. 2, shows the complete power-supply unit, with the output posts labelled to correspond with the voltage designations appearing in the receiver diagram on page 25 of the March-April issue. Note that the heaters are lit, not from a single 2.5-volt secondary, as shown in the receiver diagram, but from three separate secondary windings; these are labelled to indicate their proper connections. The heater center-taps are shown connected to ground in each case. It might be well to note here that, in certain obstinate cases of hum, a cure has been effected by biasing the heaters slightly positive with respect to the cathodes. If hum persists in your completed receiver, try connecting the R.F. or detector heater center-taps to a point on the voltage-divider several volts positive witl respect to ground. An extra sliding clip will be necessary before this can be done.

The materials employed are as follows:

V_1—DeForest 480 rectifier tube;
T_1-L_1-L_2—Amertran "245" power block; or "PF245A" transformer, and "709" and "854" chokes;
C_1-C_2-C_3—Aerovox "B-600" block, 2-4-4-mf., 600 volts;
C_3-C_4-C_5—Aerovox "Type 202" 2-mf. units;
R_1—Electrad "D-400" 75-watt 40,000-ohm resistor, with three extra clips.

This power supply is quite simple and will provide a basis for future television experimentation; for little improvement can be made in it in so far as freedom from hum is concerned. In the field of a 900-R.P.M. scanning disc, the 120-cycle filter-ripple of a full-wave rectifier, working from 60-cycle A.C., will appear as a series of

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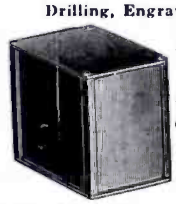

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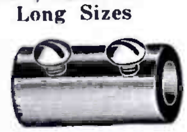

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- Short Wave Question Box

eight dark bands. Sixty-cycle hum, from inductive pick-up, will appear as a similar series of four dark bands. If a synchronous motor is being used at either end of the circuit and the rectifier supply comes from the same A.C. network these bands will be stationary in the field. If the disc rotation is not in synchronous rotation, with respect to the hum, these bands will be seen to rapidly traverse the field of view. In a similar fashion, A.F. oscillation or motor-boating in the amplifier circuits will produce a pattern in the field, the form of which is dependent upon the frequency of the oscillation. To the trained experimenter, this fact provides a handy service guide in the determination of various causes of trouble.

This Disc Indicates Its Speed Automatically

By PAUL L. CLARK

(*Continued from page* 96)

of the receiving set. The chances are 2,303 to 1, that the picture will *not* be framed, but askew, or with portions in inverted order; so that the outer portions of the sent image are apt to appear in the body of the received image. To overcome this irregularity, the disc must be braked by applying a momentary pressure on the motor spindle, or perhaps—for a slight misframe—by blowing the breath against the disc; the feeble mechanical energy so applied being ample to decelerate the speed momentarily without disturbing the normal speed which prevails by virtue of the rheostat's adjustment. After a little practice, the experimenter can successfully hold his picture rock-steady and practically "nailed to the screen."

Trying to tune in a picture or silhouette without a speed indicator is a hit-and-miss proposition, with the chances of success far outweighed by those of uncertainty; since the technician's sole clue is derived from observation of the blending shadows at the picture opening. A brief analysis reveals that even the slightest over-speed or under-speed, at the moment when synchronous speed is being passed over, will cause the picture to pass out of view without being recognized. The speed of the disc should be absolutely determinable. With a 48-hole disc, at 900 r.p.m., 15 complete pictures are coming over each second, and the neon-tube flashes are instantaneously produced; but each flash—occurring in 1/34,560th of a second—must be *located* by a scanning-disc hole and, if this hole is ahead or behind that of the corresponding hole of the distant scanning disc at the transmitter, the picture is going to be distorted.

Suppose that the receiver disc is going *one per cent* too fast; it will have a speed of 909 r.p.m., which means that successive pictures are progressively farther and farther misframed. A single picture which occurs in 1/15th of a second is recognizable; but, if this has superimposed upon it, 1/15th-second later, another picture substantially identical with the first, but overlapping it by *one per cent*, it is apparent that the sharpness of outline is destroyed.

The speed indicator is of the familiar centrifugal type. A spring is opposed to a sliding speed-pointer which, being a dull black, contrasts with the buffed background of the whirling disc; so that, as the disc speeds up, and the pointer moves farther and farther away from the axis of rotation—because of centrifugal force—a black circle of constantly-increasing size appears on the face of the disc. Through the persistence of vision, just as when a spark is twirled around at the end of a string, the circle appears stationary at any fixed speed. On the face of the disc is scribed a circle, which registers with the whirling-pointer circle when the speed is 900 revolutions.

A Perfect Scanning Disc

By DR. HANS VATTER

(*Continued from page* 136)

fulfill the above mentioned requirement, *i.e., that the inner edge and outer edge of two successive holes must be bounded by the same arc of a circle.*

Producing the holes, to which one should give a lateral length of 1 mm., (1/25th inch) is best done as follows: A strip of millimeter coordinate paper is cut, 30 mm. long and 15 mm. wide, (1⅕ inches by ⅗ inch), and, approximately where the diagonals cross, a hole is made with a paper punch. The opening thus made, 6 mm. (0.234 inch) in diameter, is again partially covered with gummed strips of black paper (see illustration, Fig. 1), in fact, four short pieces are arranged perpendicularly to one another, in such a way that in the middle a space (exactly one sq. mm.) remains open. This measure can be very simply kept, if one sticks exactly to the divisions of the paper. The projecting ends and edges of the gummed strips are cut off, so that all cut-outs have the same size and (an extremely important matter for the balance of the disc) the same weight.

The disc itself, of aluminum or copper 0.2-mm. (.08 inch) thick, is built according to the standard of the RPZ (Reichspostzentralamt or German Central Post Office); but with the difference that the holes have a diameter of 5 to 6 mm. (0.2 to 0.24 inch). The above-mentioned paper cut-outs are now fastened over these holes, in such a way that the four-cornered hole comes approximately at the right place. The fastening is done with two small bolts and nuts (Fig. 2). By slight adjustments of the cut-outs under these fasteners, one can find the proper positions for the disc holes. This is done after securing the disc in the usual way on an axle or shaft, and preferably before a ground-glass half-watt lamp with reduced brilliancy.

The paper cut-outs are inserted in turn; care being taken each time to see that, during the quick turning of the disc, the streaks between the lines of light (at first formed between every two holes) disappear, after proper moving about of the newly-inserted pictorial point. After attaining continuous scanning, by repeated moving of the pictorial point just added, then the next pictorial point is put in; proceed in the same way, until finally the whole disc is fitted out and affords a streak-less pictorial field.

Then the disc, after all the parts have been permanently fastened on, can be so balanced by filing or cutting the edge, that the center of gravity coincides with the center of rotation.

The weight may be still further reduced by cutting out four large circular spaces (as in Fig. 3), these being at least 0.8 inch from the pictorial field.—(*Rafa* 1930. *H*11.)

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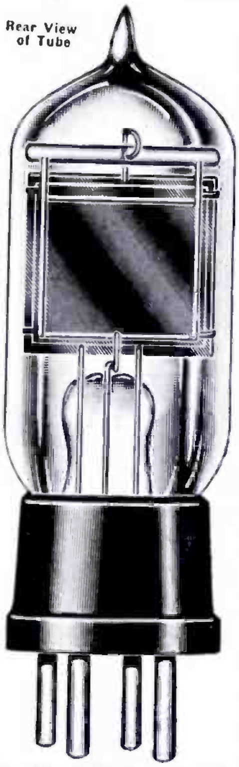

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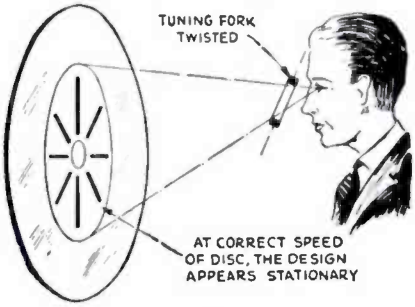
Synchronizing With a Tuning Fork

(*Continued from page* 138)



How Stroboscope chart can be viewed through fork.
Fig. 1.

number of chart marks or divisions to be used for checking a revolving mechanism at a certain speed, when using a tuning fork of a certain frequency.

Referring to the illustrations once more, we note two different designs in Fig. 2 at C and D; while at E is shown how a nickel-plated tuning fork permits the observer to watch the revolving design *by reflection*. In some instances the number of marks in the pattern will figure out to an uneven number; and Fig. F shows a spiral design which permits laying out a pattern of 3.28 units, for example. Alongside of Fig. F, there are shown two designs of movable vanes which can be slid along the legs of a tuning fork. The vane, if provided with a weight and a clamping screw, allows the operator to change the pitch of the fork. The nearer to the ends of the legs the weights, the slower the vibration rate of the fork; and vice versa.

Two of the accompanying illustrations (Figs. 3 and 4), represent designs for use with a 128-pitch fork at speeds of 450 and 1260 R.P.M. (revolutions per minute). The more complicated design can also be used with a 256-pitch fork to check a shaft or disc speed of 900 R.P.M. If the design appears stationary to the observer, then the disc with its attached pattern is rotating at the pre-calculated speed. If the design is seen to rotate slowly backward, then the disc is running lower than the desired speed; if the design appears to rotate clock-wise (for a shaft running in a similar direction), then the disc is rotating faster than the normal speed.

The stroboscope charts can be made on a piece of white paper or cardboard, and they can be attached to the scanning disc with glue or otherwise. The design should be made with India drawing ink or dull black paint.

The formula for calculating the number of marks with a fork of any given pitch is as follows:

(*Continued on page* 155)

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Television—A Challenge to the Inventor

By C. P. MASON

(*Continued from page* 95)

which was demonstrated by E. J. Muybridge of San Francisco on May 5 of that year, and which reproduced the first photographic, life-size moving pictures (of a running horse); as well as the new "electrical railway" which Edison was then testing—and of which the editor observed: "Perhaps it is not entirely visionary to expect that our street and elevated railways may at no very distant day be operated by electricity."

Television, the movies, and the electric railway—all new inventions in 1880. But television has been a long time in getting its growth.

Various other comments soon followed. The editor of *La Lumiere Electrique*, of Paris, laid aside gibing at Edison's "impractical" incandescent light long enough to recall that one of his compatriots, whose name he had forgotten, had addressed him with some such idea. This was Monsieur Senlecq, who complained that he had received more notice abroad than at home.

Actual Television Proposed

In the meantime, however, Mr. Corey's idea had attracted a brief comment from W. E. Sawyer, who stated that as early as 1877 he had described to witnesses an equivalent system; and whose letter, printed on May 12, 1880, outlines the full theory of modern television:

"The transmitting ray and the invisible index in the darkened receiving tube were to start at the periphery and describe their spiral motions in exact unison until the center should be reached; and, the speed being sufficiently great, it is obvious that—as the first spark between the receiving platinum points would not have ceased to affect the retina until the last spark, with the index at center, would have been produced—an exact image of the object at the transmitter would be reproduced before the eye of the receiver."

Here, unlike all the preceding systems, is the idea of reproducing the scene on the eye of the spectator, point by point, in an apparently continuous image, by virtue of the *persistence of vision.* Mr. Sawyer contemplated the use, to *reproduce* the image, of a small, very rapidly-moving electrical arc, whose brilliancy would compensate for its small size and the short time it would occupy any one position.

Then he added, philosophically:

"The recent announcements of this discovery in three different directions, each undoubtedly independent of my own experiments, shows how the same idea often occurs in separate minds. There is no likelihood of any plan of the kind ever being reduced to practice.

"The trouble is to make the selenium sufficiently active, and to get the isochronous motion. Perhaps some of your readers would like to try their hands at rapid synchronization."

Mr. Sawyer spoke quite correctly for his time; selenium is too slow and insensitive for the method described; radio had not been discovered, and wire lines were far from their present state of utility; synchronizing devices were limited; there were no vacuum-tube amplifiers; and no lamps responsive with sufficient quickness to high-frequency current fluctuations. The television worker of 1880 had an abundance of theories, but a great lack of suitable tools.

Other work was done. Kerr in 1880 developed his cell, used today in television. Ayrton and Perry also worked on a multiple-cell unit, in which each sensitive point should control a shutter, like the diaphragm of a camera, to regulate the intensity of light. Middleton worked with thermo-couples at each end of the line; the heat of the couples distorted the light at the receiving end, on the principle of the "Japanese mirrors."

Shelford Bidwell, an English experimenter, gave an account of the successful telephotography of a gas flame—perhaps the first thing to have its picture sent over a wire by its own light—on Jan. 5, 1881. The principle was fundamentally that of the light-recording device, now used with photoelectric cells (Fig. 2). As the transmitting cylinder revolved and vibrated on its spindle, it scanned the image focussed upon it; and the contact registered the action of light or darkness upon sensitized paper stretched on a receiving cylinder. The pictures thus made, however, were not permanent; and few people cared for the picture of a gas flame. Lights and solid shadows could be recorded, but not halftone values.

Synchronizing With a Tuning Fork

(*Continued from page* 154)

$$N = \frac{F}{M}; \quad M = \frac{F}{N}; \quad F = M \times N.$$

N-Rev. per Sec.
M-No. Marks.
F-Fork Freq.

Stroboscope Table

R.P.M. Shaft	R.P. Sec.	Tuning Fork Frequency	No. Marks or divisions on chart
60	1	128	128
120	2	128	64
180	3	128	42.6
240	4	128	32
450	7.5	128	17
480	8.0	128	16
900	15.0	256	17
1080	18.	128	7.1
1080	18.	72	4
1260	21.	128	6.1

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POLYMET 8 Mfd., 500 Volt Electrolytic Condensers $1.05
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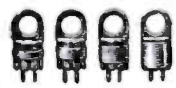
Short wave coils, $1.75



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Hints for the Beginner

By H. W. SECOR

(*Continued from page* 129)

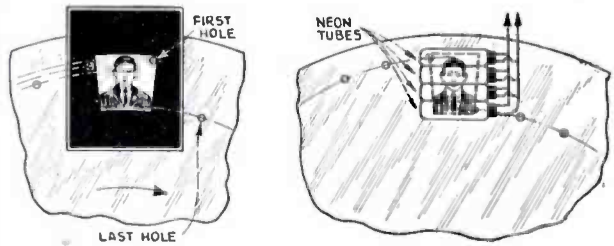

Fig. 7 (left) shows how scanning hole No. 1, clears frame opening just as No. 2 holes is ready to enter. Right hand picture shows use of several small neon tubes to cover frame instead of 1 large tube.

hub supporting the disc on the motor or driving shaft is shown in the lower part of Fig. 5. Some of the experimental televisors which the writer has seen demonstrated have been built with discs cut from very thin metal, and the only thing that held them in perfect line, while they were rotating, was a guide placed in position at the top of the disc, where the image was being scanned. In the latest English television discs, the center sections are frequently cut away (as the drawings herewith show), to make the disc lighter.

Fig. 6 shows how a single disc may be laid out, in order to have several spirals of holes, each comprising a different number. In using such a disc, the neon tube will have to be moved up or down (as the case may be) and, likewise, the diaphragm or viewing hood.

The left-hand illustration, in Fig. 7, shows a diaphragm (or it may be a viewing hood) in front of a scanning disc, the first hole having just completed its path across the image. At the right of Fig. 7, we see how several small neon tubes may be banked together to give a fairly even illumination.

Framing the Image

There are several ways of framing the image; but the simplest, often used in the experimental laboratory, is that shown in Fig. 8, where the diaphragm is mounted on a movable arm and moved around the circumference of the spinning disc, until the picture is framed correctly. The objection to this scheme is, of course, that the image will be seen either sidewise, upside-down or at some intermediate and undesirable angle.

The method used by many televisionists today, including the Bell Laboratories and other concerns, comprises a worm gear or circular rack mounted on either the motor or the shaft as shown in Fig. 9. After the picture is picked up, but is seen to be out of frame, the operator then moves a lever, which swings a mirror to an angle of 45 degrees between the disc and the hood; so that he can view the image from the side of the cabinet. He then turns the worm-gear's handle slowly, thus rotating the motor's frame, until the picture is framed squarely and he does not see, for example, two half-faces—one above the other.

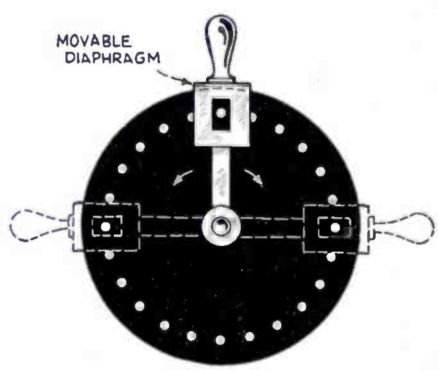

Fig. 8—The simplest framing scheme, the diaphragm being swung around until the image is squarely lined up. Useful only in the laboratory.

How Chicago Puts Over Television

(*Continued from page* 87)

tains three spirals of scanning holes, each spiral occupying 120 degrees or one-third of the circumference. Synchronized motors are employed to revolve the disc at nine hundred revolutions per minute and each disc contains 45 holes.

Television signals are susceptible to skip distances, but reports have been received from numerous distant points that indicate excellent receptions of television signals from the Chicago stations.

Leo Hruska, an amateur operating station W9BBH at Cedar Rapids, Iowa, reports that he is picking up the television programs from W9XAP regularly. He states that he recognizes the cartoons and the half-tone pictures equally well. The world's first musi-comedy, "Their Television Honeymoon," was recently broadcast with both sight and sound signals.

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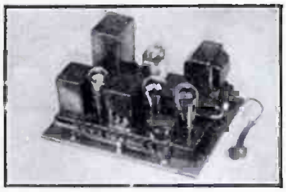

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2 STAGE
245 Push Pull
With "ABC" Supply
POWERFUL

Faithful Reproduction

Here is a truly fine amplifier affording volume galore with astonishing faithfulness and realism. Constructed of the highest quality parts, to give long life and the finest performance.

PHONOGRAPH AND RADIO INPUT

The Concert Power Amplifier supremely efficient for reproduction of phonograph records, radio programs and speeches. Operation requires: Two x 245 Power Tubes, one Y227 AC tube, and one X280 Rectifier tube.

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COMBINATION "A.B.C." POWER PACK

WIRED READY FOR USE

Built with high-grade parts, Supplies "A.B.C." Voltages for 5-226's, 2-227's, 2-171A's, 1-280.

105-120 Volts — 50-60 Cycle

Delivers over 125 Mills and up to 200 volts "B" power. The Power Transformer is designed to take care of a **D.C. DYNAMIC SPEAKER,** two connections being provided on the pack for same.

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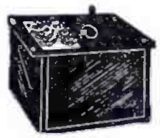
SONORA "A.B.C." Power Transformer

For Models A-31 and B-31



For 5—224 or 227, 2—245 and 1—280 Tubes. For Models A-31 and B-31, 6¾ in. wide, 6¾ in. long, 4 in. tall.

Also Furnished for 25 Cycle Current for $5.50.

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KODEL Step-Down Transformers

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Primary 110-120 Volts, 50-60 Cycles A.C. current. Output 14 Volts A.C. at 2½ Amp Suitable for A Eliminators. Dynamic Speakers, Trickle Chargers, Bell Ringing and Toy Transformers.

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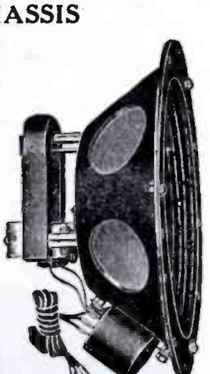
This chassis is the identical one used in the R.C.A. Model 100A and 100B Speakers, which list for as high as $35. Note built-in Output Transformer — this enables the speaker to be used with voltage applied to it as high as 600 volts, without any trace of distortion, rattling or blasting. Equipped with generous over-sized Magnets. The thick armature is accurately centered. The sturdy metal frame is lined with a special fabric, greatly improving the acoustic properties of this sensational speaker! Note the corrugated surface of the cone, an exclusive feature—enhances perfect tonal reproduction qualities considerably. Most compactly made: 9" outside diameter, 4½" deep overall.



Our Net Price **3.25** Net

ISN'T THIS WHAT YOU'VE BEEN WANTING?
At Last A Real Noise and Hum Eliminator

No More Hum-m!

CUT DOWN USELESS SERVICE CALLS: You will find this article to be a money-saver, as well as a money-maker, for you. The majority of your service-calls are due to line-noises. How much time and material has been wasted by your Service-Department making special apparatus to cut down line-noises? Now a simple installation of the "MAXIM FILTERAD" and your troubles are over. Works on all currents—Automatic—Requires no adjustments—Take advantage of this offer now!

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NATHANIEL BALDWIN DYNAMIC D.C. SPEAKER

The ideal speaker for cabinet installation. Baldwin Quality — built to Baldwin high standards, which have been responsible for Baldwin world wide leadership — Superior tone quality. Diameter 9 inches, depth 7 inches. Field resistance of 2,500 ohms. This dynamic speaker can be used with A.C. Receivers that are equipped to supply the "B" current to speaker field.

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X201A	$0.35	X281	$1.05
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Y224	.75	UX199	.60
X245	.50	UV199	.65
X280	.75	UX120	.65
X171A	.50	WD11	.75
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All offers are F.O.B. New York, and subject to prior sale. Terms: A deposit of 20% is required with every order. Balance may be paid on delivery. Or, deduct 2% if full amount is sent with order.

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MANY successes have been made in radio. Still more successes will be made in the future! But the industry is already closed to all except *trained* men. A man must possess the latest scientific knowledge before he can enter or succeed in radio.

Radio is changing constantly. In the 11 years it has been a reality to the general public, many revolutionary things have happened—tomorrow will bring new revelations! A man must keep constantly alert in this profession to make sure that he does not fall behind.

The International Correspondence Schools, through courses prepared by leading radio authorities, have proved they can give men the necessary training to succeed in radio. Many men in the industry today are studying I. C. S. Radio Courses to keep abreast of the times. They recommend these courses to other men anxious to become associated with the radio industry. Complete Radio Course—Radio Servicing Course—Radio Operating Course—in which are you interested? Mark and mail the coupon! Without obligation, it will bring you the important information. Act today!

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If you reside in Canada, send this coupon to the International Correspondence Schools Canadian, Ltd., Montreal, Canada

Be sure to read the announcement on page 152 if you are interested in the Short Wave field.

Television Time Table

Call Letters	Lines per Frame	Power in Watts	Company	Location
			2000-2100 kc.	
W3XK	48	5000	Jenkins Laboratories	Wheaton, Maryland
W2XCR	60	5000	Jenkins Television Corp.	New York, N. Y.
W2XAP	48	250	Jenkins Television Corp.	Portable
W2XCD	48	5000	DeForest Radio Company	Passaic, N. J.
W9XAO	45	500	Western Television Corp.	Chicago, Ill.
W2XBU	48	100	**Harold E. Smith	Nr. Beacon, N. Y.
			2100-2200 kc.	
W3XAK	60	5000	National Broadcasting Co.	Bound Brook, N. J.
W3XAD	60	500	R C A Victor Company	Camden, N. J.
W2XBS	60	5000	National Broadcasting Co.	New York, N. Y.
W2XCW	—	20000	General Electric Co.	South Schenectady, N. Y.
W8XAV	60	20000	Westinghouse Elec. & Manufacturing Co.	East Pittsburgh, Pa.
W9XAP	45	1000	Chicago Daily News	Chicago, Ill.
*W2XR	48	500	Radio Pictures, Inc.	Long Island City, N. Y.
			2750-2850 kc.	
W2XBO	—	500	United Research Corp.	Long Island City, N. Y
W9XAA	48	1000	Chicago Fed. of Labor	Chicago, Ill.
W9XG	—	1500	Purdue University	West Lafayette, Ind.
W2XAB	60	500	Atlantic Broadcasting Co.	New York, N. Y.
			2850-2950 kc.	
W1XAV	48	500	Shortwave & Television Lab., Inc.	Boston, Mass.
W2XR	48	500	Radio Pictures, Inc.	Long Island City, N. Y.
W9XR	24	5000	Great Lakes Broadcasting Company	Downers Grove, Ill.

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

Television Digest

(*Continued from page* 122)

Television's First Play

The simultaneous sight and sound broadcast of a playlet, "The Maker of Dreams," by Oliphant Downs, through the Chicago stations W9XAP and WMAQ quite recently is seen as another step forward in the advancement of the art of television. The presentation represented the first attempt to put on such a program in the mid-West and demonstrated that television drama was not only feasible but practical, according to reports gathered from owners of television receivers in the Chicago area.

The studio arrangement at W9XAP is such that immediate changes can be made from the long shots or full lengths to semi-close-ups or close-ups. The feat is accomplished through the use of a double installation of scanning mechanisms, one of which takes care of the close-ups, the other the long shots and the semi-close-ups. The change from the long shots to the semi-close-ups is made through a system of lenses installed on one of the scanners, by which the size of the lighted area in the studio is changed and the amount of light reflected upon the photo-cells is intensified.

Remote control devices that permitted the changing of the light fields from three different positions were installed in the W9XAP studios last week. At one time during the enacting of the play the switching was controlled by one of the participants seated before the close-up position, while that artist carried on a conversation with another located in a distant portion of the room within the semi-close-up area.

Experiments had been conducted to determine the importance of the materials and colors for costumes, so that the participants in "The Maker of Dreams" were costumed and made up in accordance with the findings during the last few months. Especially prepared makeup developed by Max Factor for television purposes was used.

Not a single report of a catch in the continuity of the first presentation of a television drama was received at the station, which further demonstrates that with the exercising of care a television drama can be synchronized with sound with the same accuracy to which the radio listening public has become accustomed. The program did more than demonstrate, however, for it fully convinced the owners and operators of W9XAP and WMAQ that television is a reality, ready for the public.

Black and White Television

Radio television has been cured of its pink eye, according to statements and demonstrations made by the engineers of the deForest Radio Company. Instead of pink and black pictures, which have been held objectionable from the standpoint of entertainment value, the latest deForest television development is a new type of gas-filled, highly responsive white light source which provides black and white pictures on the screen. According to deForest engineers, not only are the black and white pictures more realistic, but, due to the greater contrast between shadows and high-lights, far better detail is obtained than in the pink pictures. They claim the increased detail is immediately apparent when working with the same signals and apparatus.—Radio Industries.

Send Us PHOTOS OF "Your" Television Receiver

Include a brief description and tell the Editor what stations you receive. We will pay well for good photos of the Television image! Get out your camera and try it. Address:

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HERE'S a NEW plan, which saves you money. *Stop shopping—the lowest prices are right on this page.* Yes, lower than in our own catalog. Why? Because no house can get out a new catalog every month, but by advertising in this magazine we can bring you the latest and lowest prices *up to the time this ad is printed.* We watch our competitors and *do not allow anyone to undersell* us. We meet ANY price on NEW merchandise. *Order direct from this page and save money. 100% satisfaction on every transaction.*

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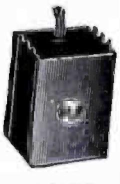
Mount in any position! Guaranteed never to blow out! Remarkably compact and very inexpensive, permitting generous use of filtering systems. The greater the mfd. capacity employed, the less A.C. hum remains. 500 volt peak rating. Ideal for all 171A - 245 power packs—use two of each capacity desired for 250 power packs (1,000 volt peak thereby assured).

No.	Mfd.	Diameter	Length	YOUR PRICE
1801	1	⅝ in.	2⅛ in.	$0.27
1802	2	1 in.	2⅝ in.	.44
1804	4	1½ in.	2⅛ in.	.83
1808	8	1⅜ in.	4½ in.	1.20
1816	16	3 in.	4¾ in.	2.10
1824	24	3 in.	4½ in.	2.70
1832	32	3 in.	4¾ in.	3.30

R.C.A. Double Filter Chokes



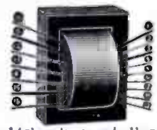
This heavy-duty, extremely strong, double filter choke can be used for all types of filter circuits, experimental work, power amplifiers, receivers, eliminators, power packs, converted sets, etc. Known as R. C. A. replacement part for all Radiola models, particularly Nos. 33, 17 and 18. Each choke D.C. resistance, 500 ohms. Connected in parallel, these double filter chokes have a rating of 15 Henries at 160 Mills; connected in series, 60 Henries at 80 Mills. Fully shielded in heavy metal case with special insulating compound. Size 5⅛ x 3¾ x 2⅞. Shipping weight 6 lbs.

List Price, $10.05.

No. 8336—YOUR SPECIAL PRICE.. 90c

Earl Power Transformer

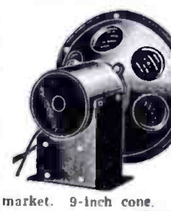
70 WATTS



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen - grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's, and for '71A's are center-tapped. May be used in any number of combinations. Suitable resistors, a couple of 4-mf. filter condensers, two 30-henry chokes and by-pass condensers complete fine power pack. Size 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. List Price $7.50.

No. 1410—YOUR SPECIAL PRICE $1.73

Utah Dynamic A.C. Power Speaker—Model 33A



110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9½ in. wide, 7½ in. deep. Speaker comes packed in wooden crate. Weight 19 lbs. It is one of the most powerful as well as best reproducers in the market. 9-inch cone. List Price $50.00.

No. 1506—YOUR SPECIAL PRICE $7.45

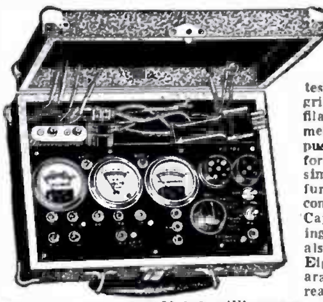
Adjustable Voltage Divider

Designed for extra heavy duty. It can be used in any radio power operated set, "B" eliminators, power packs, amplifiers, etc. Especially useful in all radio set replacement work, used in converting battery sets into power sets. The correct voltage is obtained by loosening screws of sliders and by moving the latter into the correct position. Voltage cannot vary due to the peculiar construction of the resistor and contact sliders. Shipping weight ½ lb. List $1.50.

No. 2275—Divider, 10,000 Ohms, 3 slides........ 75c

No. 2276—Divider, 25,000 Ohms, 4 slides........ 75c

New READRITE Analyzer.



This three-meter analyzer has selector switch for checking all parts of tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid done quickly and accurately. Plate current, filament volts, line and power supply volts are measured. Grid swing test for tubes used. Just push one button for screen-grid and other button for other tubes. Makes testing of all type tubes simple and thorough. 4½-volt grid battery is furnished. Battery is used for grid test and continuity testing of transformers, chokes, etc. Capacity and resistance charts furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. Eight scale readings of meters may be used separately with the jack terminals provided. Scale readings are 0-60-300-600 D.C. volts, 0-10-140-700 A.C. volts and 0-20-120 milliamperes. A.C. and D.C. filament voltages are accurately measured on the one meter. Strong case with leatherette covering. Attractive. Compact. Complete. Fills every need for the expert serviceman or the beginner for radio set analyzing. Size 10¾x3½x8 inches. Shipping weight 15 lbs. List Price $25.00.

No. 700—READRITE ANALYZER. YOUR PRICE........ $14.70

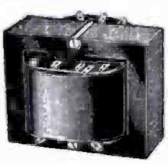
Kolster Power Transformer

85 WATTS

Will supply sufficient current and voltage for push-pull '10's, in conjunction with type '81 half-wave rectifiers. The 2.25-volt secondary output is just below the rated maximum for type '24 and '27 tubes; tubes will last much longer than when heated from a higher-voltage transformer. Four secondaries are rated as follows: Secondary S1, 7.5 V., 1.25 A.; S2, center-tapped, 7.5 V., 1.25 A.; S3, 1.5 V., 4.25 A.; S4, 2.25 V., 1.65 A.; S5, 725 V., 90 Ma. Primary is tapped for low line voltage. For 110-120 volts, 50-60 cycles. 4½ x 4½ x 4½ inches. Shipping weight, 12 lbs. List Price, $19.50

No. 4336—YOUR PRICE........ $5.75

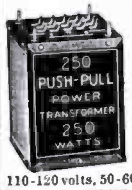
Peerless ABC Power Transformer—80 Watts



As used in "Courier Model 65" chassis. Plate, control-grid, screen-grid, filament voltages for three '24's, two '27's, two '45's, and '80 rectifier (electrostatic reproducer biasing potential rectifier). Has approximately the following output ratings: 2.5 V., 10 A.; 700 V., center-tapped, 350 V. and 120 Ma. on each side; 5 V., 2 A.; 3 V., 60 Ma. Primary tapped for low or high line voltage. The correct replacement for big sets. For 110-120 volts, 50 or 60 cycles. Dimensions 4x4x3½ in. Weight 6 lbs. List $12.00.

No. 1403—YOUR PRICE........ $2.65

"250" A.C. Power Transformer



This power transformer supplies currents for five 15-volt Arcturus tubes drawing 5 Ma. and ½ amp. on filaments; one 2.5 V. tube; two '50's, and two '81's. Two 227 or 224 (if suitable resistance is used) and 750 volts. Full wave "B" and "C." Entirely shielded in metal. 4¾x4¾x6½ inches high. Weight 15 lbs. For 110-120 volts, 50-60 cycles. List $20.

No. 1412—YOUR PRICE........ $3.75

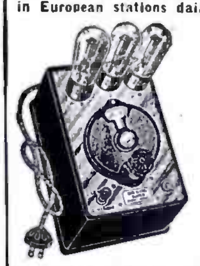
Professional Telegraph Key

Used for telegraphy, radio, home practice, house-to-house communication, as a keying means in test circuits, etc. Mounted on heavy micanite base 3¼x5x½ in. thick. Has 2 switches to telegraph on two circuits, independently or together. A wonderful chance to get a commercial telegraph key with sturdy ¼-in. silver contacts! Handles a lot of power. Shipping weight 2 lbs. List price $3.50.

No. 1625—YOUR PRICE........ 70c

NEW! NEW!! Superheterodyne S-W Converter

Positively greatest converter ever built. It brings in European stations daily, clear as a bell.



At last a short-wave converter that converts any broadcast set into a superheterodyne short-wave receiver. Employs three 227 tubes and covers from 20 to 115 meters. No plug-in coils! Coil switch is used to cover all wave-lengths. Single dial control, no body capacity, no squeals. This converter has built-in filament transformer to heat the three 227's. All you need to obtain from your receiver is a positive B voltage anywhere from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. So simple a child can operate it. Size 7x10x5 inches. Shipping weight 8 lbs.

No. 1614—Super Converter. List Price $25. Your Price (less tubes) $15.95

Kolster Speaker Chassis

May be connected directly in the plate circuit of type '12A tubes; or to higher-power tubes through an output device. In push-pull circuits, speaker may be connected from plate to plate. "9-inch cone" type. Paper-rattle is prevented by a flannel damper; bass notes are well reproduced due to the "free-edge" effect. Its small dimensions make it eligible for use in home-constructed midget sets. Comes with 6 ft. cord. Dimensions: 10 x 5½ x 9½ inches. Shipping weight 6½ lbs. List Price, $18.00.

No. 1500—YOUR PRICE........ $2.80

6 MONTHS GUARANTEED NEONTRON TUBES

Sold on a 6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS! All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

Choice of	Choice of	Choice of	Choice of
226	112A	245	222
227	200-A-199UX	280	210
171A	199UV-120	171	250
201A	224		281
63c each	69c each	79c each	$1.58 each

Genuine Magnavox Microphone

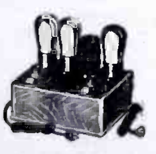
Do Your Own Home Phonograph Recording

Made by the world-famous Magnavox Co. While originally made to strap on the head, it is easy to screw a handle onto one of the side brackets. The side brackets are covered with soft rubber and place the microphone at the best speaking distance from the mouth. Comes with 6 feet of cord. **The biggest mike bargain in America!** Complete with straps and buckle to fit around head. Brand new, in original factory packing. Shipping weight 1 lb.

List Price, $10.75.

No. 1610—YOUR SPECIAL PRICE $1.55

A.C. Short Wave Converter



The thrill of tuning in short waves is yours, because you can connect this short-wave converter to your broadcast receiver, no matter what type receiver you have. Tunes from 10 to 200 meters, using only two plug-in coils. Coils, already wound, are supplied with outfit. Converter has built-in filament transformer to heat three 227's. All you need obtain from your receiver is a positive "B" voltage, anything from 45 to 180 volts. Voltage not critical. No molestation of the receiver. No tricky regeneration control, only a single, smooth-operating dial to manipulate. No squeals, no grunting, no body capacity. All parts for 3-tube short-wave converter, including cabinet, with filament transformer, complete instructions and pictorial diagram. Shipping weight 8 lbs.

List Price $20.00.

No. 1617—YOUR PRICE, less tubes $9.45

F R E E

We have just issued our new "RADIO SERVICE TREATISE." It's red hot all the way through. 52 new hookups and circuit diagrams. 110 illustrations.

Partial contents: Modernizing old radio sets. How to convert battery to power sets. Selection of tubes. The detector tube. The power tube. Changes in grid or "C" bias circuits. Push pull amplifiers. Replacing audio transformers. Phono. attachments. How to choose power transformers. Voltage dividers. Wattage of power transformers. Selecting and installing replacement parts in radio sets. Filter condensers. Repairing "B" eliminators. ALL BRAND NEW DOPE—NOT A REPRINT. Chuck full of REAL radio information all the way through. Even the catalog section has dozens of hookups—never found anywhere before.

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600 VOLTS Cat. No.	Mfd. Capac.	Your Price	800 VOLTS Cat. No.	Mfd. Capac.	Your Price
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1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

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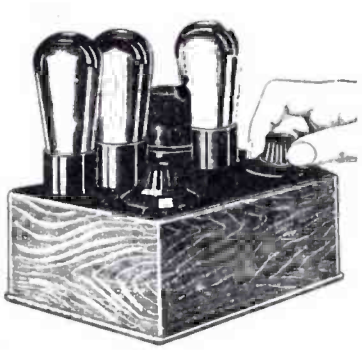
TELEVISION *with a Converter!*



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

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

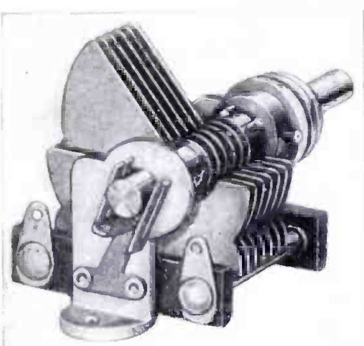
The converter illustrated is model PR-3FS and has a filament transformer built in. There are only four external connections to make, and one of these is to a positive B voltage, 50 to 180 volts, taken from the receiver. If you have a screen grid set you may take this voltage from the screen of a radio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

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

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

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

▽ ▽



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

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

▽ ▽

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

▽ ▽

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Enclosed please find:

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

☐ $6.00 for one year's subscription (52 issues) for RADIO WORLD. Please send the Short-Wave Coil Kit as a premium, your model PR-AK-1, consisting of three plug-in coils and base receptacle.

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

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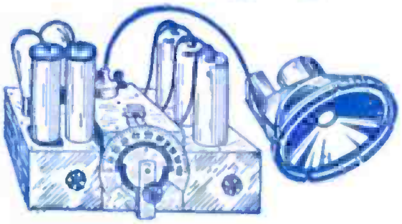
MANTLE SET



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Housed in this gorgeous walnut Gothic Cabinet 16½" high, 14½" wide and 10¼" deep. Only .... **$26.95** | **$24.50**

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First Stage 227. Second Stage 245 in push-pull, with phonograph pick-up and field supply for 2500 ohm D. C. dynamic speaker with or without input transformer (specify which).
Also furnishes filament and plate voltage for 224, 227 tubes.
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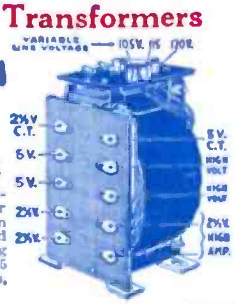

Model illustrated is for A C Dayton Navigator and other sets using 224, 227, 245 and 280 tubes, $3.85.

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This most versatile of all radio receivers is just another evidence of Pilot progressiveness.

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