

# TELEVISION News

HUGO GERNSBACK Editor

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## FEATURES

LATEST IDEAS IN CATHODE RAY  
TELEVISION

By HAHNS GUNTHER

THE STUDIO ASPECT OF  
TELEVISION

By H. J. BARTON CHAPPEL

PHASING THE TELEVISION IMAGE  
By C. H. W. NASON

SYNCHRONIZING D. C. MOTORS  
By M. RAPPAPORT

SINGLE SIDE-BAND TRANSMISSION  
By R. D. LE MERT

HOW TO MAKE ACCURATE  
SCANNING DISCS

TELEVISION IN COLORS



Television With a Short Wave Converter

Aug.

# Televisor

Most efficient televisor produced for home use. Equipped with Duraluminum lens disc 16" diameter. Each of its 60 lenses accurately adjusted focally to produce clear, definite images on screen. Disc driven by heavy duty synchronous motor, with switch and framing device operated from front panel.

# Short Wave

The Rawls Short Wave Unit in connection with the broadcast receiver has been especially designed for long distance short wave reception from 15 to 200 meters, Super Heterodyne Circuit incorporating 9 tubes in the combination. The use of the new multi mu and pentode tubes give exceptional tone and power. To switch from one short wave band to another, it is unnecessary to change coils—just the click of the panel switch and the change is made automatically.

# Rawls



# Broadcast

A six-tube receiver, designed to give the ultimate in tone, selectivity and power. Uses the following tubes: two 235 Multi Mu, one 224-A Detector, one 227 and one 247 Pentode output with 280 rectifier. The tone quality of the set is due to the accurate matching of all parts. Its eight-inch Dynamic speaker handles, without distortion, the tremendous output of the pentode tube. Designed especially for reception of the synchronized voice with television image.

# Television

The television receiver is the most important receiver of the combination. Eight tubes T.R.F. circuit, using two 235 Multi Mu in RF circuit, one 224-A Detector, one 224A, one 227 and two 245's in audio circuit, also with the 280 rectifier. Very careful attention has been given the audio amplifier and its frequency response is flat from 15 to 75,000 cycles, which is necessary to give clear, definite television images. Its two 245 tubes are so connected to supply the undistorted output and current necessary for proper operation of the Rawls crater point lamp.

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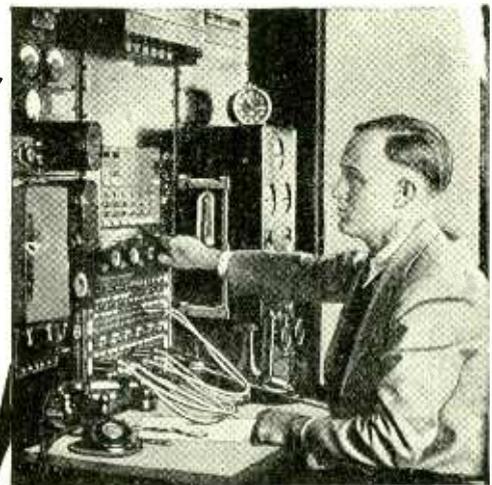
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## CATHODE RAY TUBE OR DISC?

By HUGO GERNSBACK

**T**HERE seems to be a good deal of confusion, not only in the public's mind but partly in manufacturers' minds as well, as to which will prevail in the future—the *cathode ray tube* or the *disc*.

The writer frankly believes that when television is finally accepted on a par with present-day audible radio, most likely neither the cathode ray tube nor the disc will be found in the television set of 1942 or thereabouts. Radio, as well as all other similar mechanical arts, has proven again that new inventions never spring into existence fully perfected. It is a slow process of evolution. Neither the disc nor the cathode ray tube is perfect, both have their faults and shortcomings, and the chances are that in the future an entirely different television system will be used. It probably will be an outgrowth of the cathode ray tube or it may be a combination of both cathode ray and neon tubes, but it surely will not be a mechanical disc.

The disc should not be condemned entirely, as it certainly has shown its worth up to the present time, and has helped to make television what it is. The trouble with the disc is, of course, the mechanics of it. This feature, for some reason or other, seem to be looked upon with more or less suspicion by the average radio engineer.

The idea of the disc does not seem to present as "elegant" a solution for television, as, for instance, the silent and non-mechanical cathode ray tube, which has no moving parts at all. In this respect, the cathode ray tube approaches our present-day radio sets, in which we have no mechanically moving parts, the only "moving" parts being the silent electrons which fly at the speed of light inside the tubes.

As I have stated in a previous editorial—which, by the way, has brought in letters from all over the world—the chances are that in the end we will not "scan" at all, as we know the term today. However, this is probably in the future, and it undoubtedly will be some time before the art catches up with that prediction, possible and plausible as it is.

If it were not for the mechanics and moving parts of the present disc system, we might say that the *lens disc*, which is in use at present, has reached a fairly high state of development. It is certainly a tremendous improvement over the plain hole discs with which we started out. By means of the crater tubes now available, we really get a very satisfactory amount of illumination, and fair size images can

be obtained. As such lens discs are produced now, they are reasonable in price and their results are pretty fair.

A mistaken notion of the advocates of the cathode ray tube is that this tube has cured all the ills of the disc. This is not true at the present time of writing. In the first place, you can now get only small images with a cathode ray tube—about five inches on each side. Making the images larger calls for larger tubes or expensive projection apparatus. These are not practical or economical at this stage of the art, because their cost is commercially prohibitive. Secondly, the color of the obtained image is not any better—if as good—as with the crater tube. With the latter we obtain the familiar orange and black combination, whereas the cathode ray tube gives a green and black effect which, to many, is not as pleasing as the orange and black combination. Other colors can be obtained, but practically all of the tubes now available use green. It is true that the cathode ray tube gives better definition and better detail when working at the ultra-high frequencies, and as the art progresses there is no question but that it will take the lead and in time supersede the disc entirely. That time, however, has not yet arrived. I believe the disc has not as yet seen the end of its ascension, by any means. The chances are that a number of improvements can still be made on the disc to make it vastly more efficient than it is today. In my opinion, the disc will be with us for a number of years to come, even though the cathode ray tube will forge ahead and will eventually come out far in the lead.

A parallel to this might be had in the crystal detector.

At one time we had nothing but crystal receivers. Later, the vacuum tube came along and took the lead, and has held it ever since. Yet, strange to say and believe it or not, the crystal detector is still being sold in good quantities today, and thousands and thousands of crystal sets are still being bought all over the world—including the United States.

At the present time cathode ray tubes are necessarily expensive, but it should be remembered that vacuum tubes which sell today for 35c at one time brought \$12.00—and were difficult to obtain at that. There is little question that as the art progresses tremendous improvements will be made in the cathode ray tubes to give us better and larger images. At the same time the future cathode ray tube probably will not sell for any more than a good radio tube brings today—with the chances that its price will be even lower.

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THE NEXT ISSUE COMES OUT AUGUST 15TH



by H. J. Barton Chapple

*A singer being "televised" in the original Baird studio as it appeared in 1928.*

WITH television transmission establishing themselves gradually all over the world, there are many different aspects of the whole science which are demanding specialization. At the receiving end the amateur can concentrate on his experiments in connection with the vision apparatus itself and also in the design of that type of set best suited to the reception of the vision signals broadcast into the ether.

At the transmitting end, however, not only are concentrated efforts being made from the technical angle, but studio experts are studying a new technique which has arisen so that by the best management what can be seen with existing apparatus will be greatly improved. One writer recently summed up the situation in the following very able manner: "Television, like 'the pictures' and like broadcasting itself, is one of those peculiar mixtures of art and science, of stage management and academic engineering, that demand a true versatility of mind and generous blending of talent if we are to make quick progress."

Direction in the studio, with its call for intimate knowledge as to what form of dress, make up and gesture comes over best on the image screen, is showing its effects. This can be substantiated if the trouble is taken to compare modern images with those of, say, twelve months or so ago.

Speaking broadly, there are three types of views which at the present state of the science represent or embrace the scenes or subjects which can be transmitted best. These have come to be known as the close-up, the semi-

extended and the extended. Taking these in turn we find that the close-up is one in which the detail is very distinct, but only the head and shoulders are visible. In this view therefore it is necessary to include only those artists whose facial expression and head movements are the main features of the work.

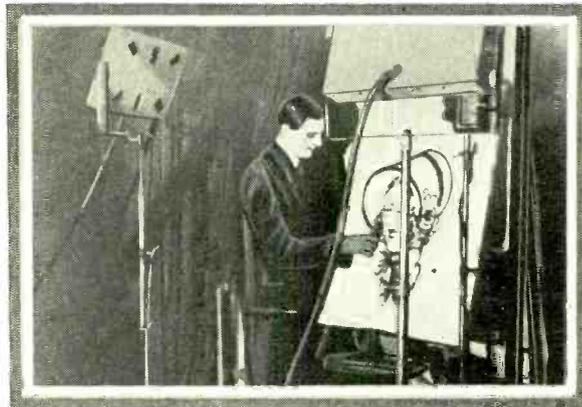
This is covered by those singers who are able skilfully to characterize their songs, comedians with character make-up and lecturers who have models which will illustrate their talk and thus add enormously to its educational value. In the general sense the usual "straight singer" fails to make an interesting subject while even mimics, siffleurs, etc., have not the same television value as those first mentioned. The long periods of facial immobility during their turn is detrimental to

picture interest, a factor which must always loom in the foreground with a television program.

Coming now to the semi-extended or three-quarter length picture, it is found that instrumentalists (violinists, banjoists, etc.) together with novelties like shadowgraphy and cartoons, singers in costume and comedians using props and capable of good action, make the best subjects. Owing to the relatively small space available which artists have at their disposal, very great care and constant supervision are essential to ensure that the area covered by the scanning disc or mirror drum is utilized to the fullest advantage.

Finally we have the extended scene, in which a greater amount of space is available for the artist or artists but unfortunately the resultant detail in the image is less than with the two other scenes, especially the first. In this form of television presentation movement is called for, not just the restricted action of cross talk comedians or the movement of a violinist's bowing arm, but definite body action such as expressed by dancers or in the demonstrations of sport (golf, tennis, etc.) If a small sketch for revue is to be put over then generally they are specially written with the television requirements carefully borne in mind to ensure the best results being obtained.

In some of the accompanying photographic illustrations various stages in this development of studio technique can be traced. The early studio photographs emphasize the restriction imposed by the close-up although since



*The Baird studio arrangement for a semi-extended scene, with a cartoonist for the subject.*

these were taken in the Baird studios as far back as 1928, great progress has been made. We have the individual vocalist, pianist and lecturer complete with model to emphasize his salient points.

A step forward is then indicated by the semi-extended scenes of early 1931 also taken in the Baird studio. Two scenes from a small sketch are shown, only one artist at a time being watched on the image screen.

Among some of the best turns which have been "worked up" in England to fulfil television's demands is the weekly cartoon feature which forms part of the Baird television broadcast in the morning program. The cartoonist, Mr. Rupert Harvey, wields his charcoal while maintaining a constant flow of patter pertaining to the subject being shown. The illustration gives a very clear idea of the size of the drawing best suited for presentation.

The positioning of the photo-electric cells is of extreme importance and one of the photographs shows the "boxes," each with six apertures, which

from one view (i.e. close-up, semi-extended and extended) to another are made to vary the types of subjects.

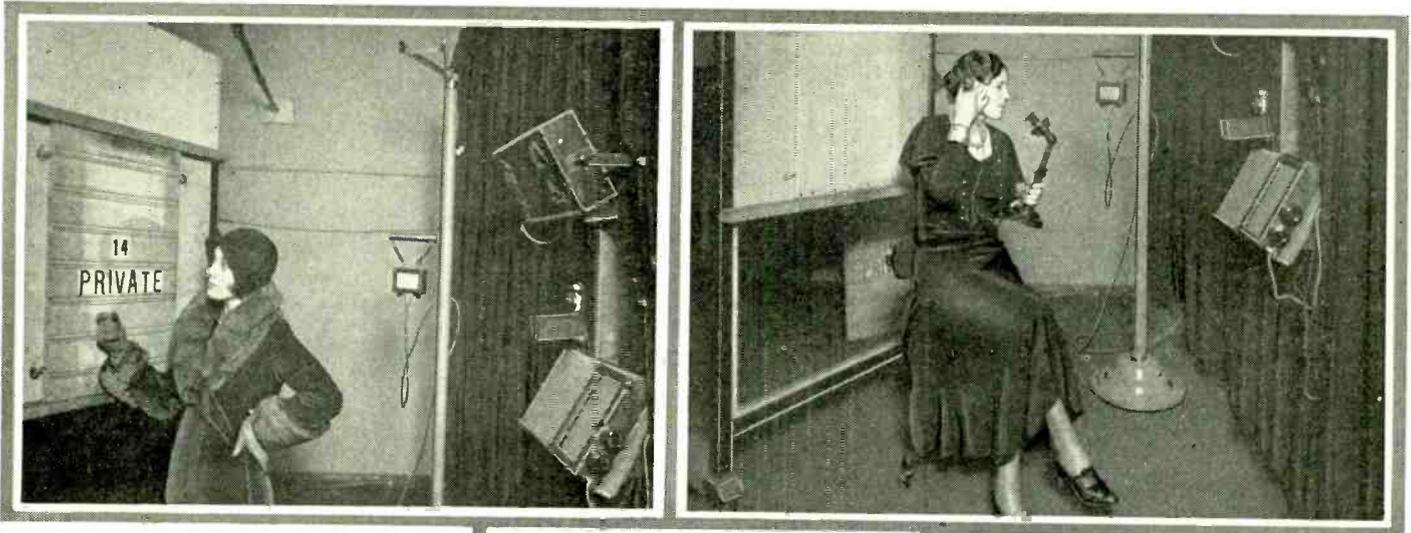
During these transition periods excerpts from phonograph records are played on the "sound" wavelength while a strong synchronizing signal is transmitted on the "vision" wavelength. The former ensures that anyone at the receiving end will not imagine a breakdown has occurred at the transmitter, for the loud speaker still functions, while the predominant synchronizing signal serves the very useful purpose of keeping the vision apparatus in both frame and phase without the necessity for re-adjustment when the performer makes his re-appearance.

Numberless experiments have been carried out and are still going on to ascertain the suitability of artists and scenes for television as exemplified by present day methods. As a case in point it can be said that entertainers at the piano are a type which it is advisable to utilize only at intervals. On the other hand, these entertainers use a form of showmanship which is alien to the solo pianist, whose move-

ment of the hands over the keys, being the only movement, is hardly broad enough to sustain interest unless he or she is an outstanding personality in the musical world.

It cannot be too strongly emphasized that an enormous amount of personal care and attention has to be given to every individual, as the television requirements of separate artists are seldom alike. This is where the studio director can make good use of his intimate knowledge of the science. There are different positions for the photo-electric cell stands and microphone stand, while details of style, color and costume material, together with ornaments and properties, must be gone into in great detail.

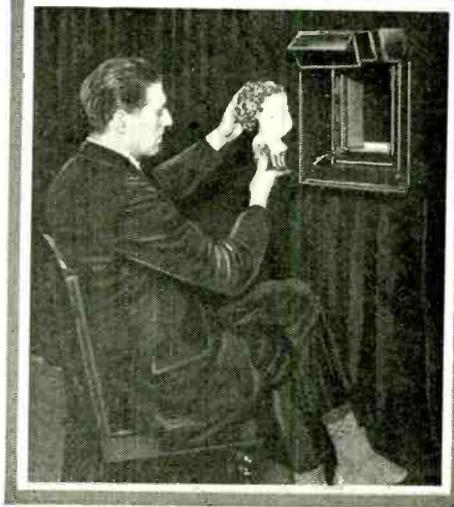
For example, it is necessary to remember that red, when televised, appears white and, therefore, rouge on the lips or cheeks should be avoided. If it is desired specially to emphasize the lips, then a little blue grease paint will ensure this happening. A dark complexion can be much enhanced by a little flesh-colored powder, while if



house these "light microphones," whose function is to translate light shades into equivalent terms of electrical current. In addition, the microphone must be close at hand and this is seen on the right just below the cell case. The rather heavy cable is the cell lead which passes to the initial stages of the amplifier handling the vision signals.

Taking a very general survey of the whole situation it must be appreciated that the individual or individuals looking in are concentrating their attention on a very small area and in consequence, to maintain human interest throughout the broadcast, there should be no suggestion of monotony in the program.

Careful observation and an analysis of written commentators has shown that the best way of avoiding this is to break up the program into as many "groups" or turns as possible. These must not be too short or a disconnected effect is brought about and the procedure adopted in English television transmissions is to allot approximately four minutes to a single act for each group. Furthermore, where such a course is practicable, changes



Upper left: a scene from a 1931 television sketch presented in the Baird studio. Note the photo-electric cells at the extreme right. Upper right: another incident of the same sketch. Here note the background screen. Bottom: Illustrating the educational value of television, whereby a lecturer can show models with his talk.

the hair is curly or waved a pleasing effect is always secured.

Apparently dresses of a bright red, pink or white color should not be worn, nor those of black or any very dark color. Light blue and light green are among the best, although there is not the least objection to a patterned material provided the contrasts are not too pronounced.

Short-sleeved dresses with perhaps a bracelet on the arm are quite effective, while a V or square-cut neck is better for vision. If a necklace is worn it may well be of the "choker" variety.

In the matter of jewelry, discrimination should be exercised, and special care taken to avoid wearing diamonds or other stones which shine or sparkle excessively. Pearls, and beads of a darker shade, seem to be the best.

Small wonder then that the studio aspect of television plays such an important part in the scheme of things and as technical perfection is reached this side of the question will take on even a greater share in the success which we all know is coming to television.

# CATHODE RAY TELEVISION

Its Progress and Development in the U. S. and Abroad

By HANNS GÜNTHER

**T**HIS article describes a new cathode ray televisor perfected in the laboratory of Manfred von Ardenne and tells about the hopes attached to this television process. By way of supplement there follows a report about the physical basis of the process and its previous development. Television, which in the last few years made surprising advances for a while, has doubtless for about a year reached a standstill, at least so far as the usual television systems with mechanical scanning are concerned. It is perfectly possible to transmit living pictures, but the reproductions appearing in the receiver have a relatively coarse grain; if one seeks the causes, one sees that further progress in the methods hitherto used is possibly only at very great expense, and that the results even then will leave much to be desired.

### Cathode Ray Has No Inertia

Under these conditions it is natural to seek other means for realizing television in which the fundamental difficulties connected with rotating perforated discs, mirror wheels and similar devices are not encountered. An excellent means is provided by the cathode rays, the use of which for this purpose is so natural that it is idle to quarrel about who was the first to attempt television by means of them. Since the cathode rays consist of moving electrons, (i.e., of almost massless particles) they operate without the least inertia.

In the well-known Braun tube, the cathode rays strike on a screen inside the tube, and it lights up brightly where the rays reach it, so that by the

motion of the luminous spot one can follow the influences acting from without. For deflecting the rays one can first use electromagnetism, by placing near the side of the tube a coil with an electric current flowing through it. The magnetic field of the coil deflects the luminous spot perpendicularly to the axis of the coil. If the magnetizing current is changed, the luminous spot follows it without inertia. The second method of deflecting the cathode rays consists in influencing them electrostatically. For this purpose the tube is put between two plates, (it is best to have the plates fused into the glass) to which an electric potential is applied. The negatively charged electrons of the cathode rays are then deflected toward the positive plate in the electric field existing between the two plates.

While in the case of the electromagnetic process a fairly powerful magnetizing current is needed to produce a deflection, for the electrostatic method only potential is required but no appreciable electric power, at least no more than is necessary for charging the very low capacity condenser formed by the two deflection plates.

In its original form the Braun tube was provided with a cold cathode. A very high potential, at least 30,000—50,000 volts, was needed to produce the cathode rays. To produce a sharp spot on the light screen, a screen with a fine opening was put in the path of the cathode rays. In manufacture the tubes were pumped out to a pressure of about 1/1000 mm of mercury. However, in use the vacuum changed. Consequently after some time the tubes were no longer serviceable and had to be pumped out again.

### Latest Improvements

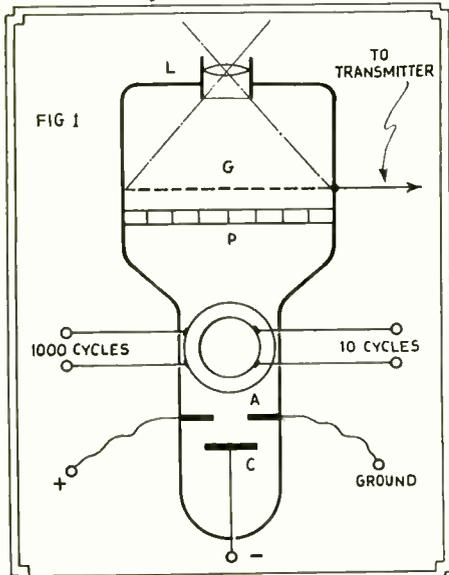
The improvements made recently in the United States and Germany in the old Braun tube consist first in the use of a glowing-cathode. With this are combined the advantages that one has disposal over a very much greater number of electrons than with a cold cathode and that considerably lower anode potentials may be used. There already are tubes which give a very bright light spot with an anode potential of only 200 volts. However, to attain the great brightness required for television, where, of course, the luminous spot necessarily has to be distributed over a fairly large surface, much higher voltages are needed. In the case of such tubes anode potentials of 2000 or even 3000 volts are customary. However, these are comparatively simple to produce by means of a transformer and a rectifier, since the tubes have only an extremely small anode current consumption, namely less than 1 milliamper. Here we do not at present need to go into the other technical details of these modern cathode ray tubes, which in Germany have been produced in especially

good form by several workers, including Von Ardenne and the research staff of the Allgemeine Elektrische Gesellschaft (Gen. Elec. Co.).

If one wishes to develop a television system operating with cathode rays, one will first try to produce a cathode ray receiver, i.e., make the luminous spot run through a certain surface on the screen of the tube and at the same time so control its brightness that a complete picture is seen. But it soon appears that such a receiver can give forth its full efficiency only if the transmitter is equally without inertia. Accordingly, the very first television system using cathode rays, which was devised by the English physicist Campbell-Swinton, had not only a cathode ray receiver but also a cathode ray transmitter. Since the transmitting tube developed by Swinton was taken over with only slight changes in the cases of all later cathode ray television systems thus far made public, a short description may be given on the basis of Fig. 1.

### Construction of Tube

The tube represented in Fig. 1 consists of a cylindrical part of large diameter with a likewise cylindrical but considerably narrower neck attached to it. At the end of this neck is the cathode C and at a short distance from it the anode A, which is pierced in the middle and is grounded to prevent disturbances. If one applies to the cathode a high negative potential, cathode rays originate and fall through the opening in anode A upon plate P. This plate consists of numerous photoelectric elements, which are arranged mutually insulated in the form of a network. On the other side of the plate is put the grid G, through which a picture of the object to be reproduced is cast upon P by means of the



Diagrammatic representation of the Campbell-Swinton transmitting tube, which is the basis of practically all modern cathode-ray tubes.

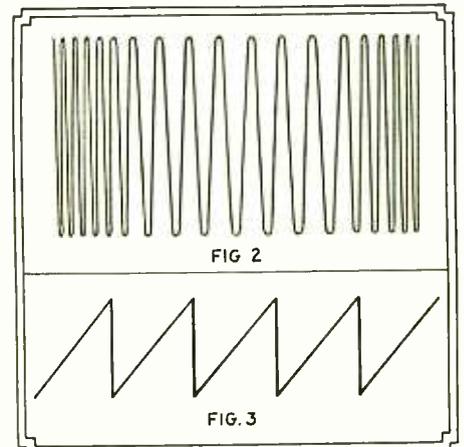


Fig. 2 shows the shape of the lines produced on the luminous end of a cathode-ray tube by the low- and high-frequency deflecting currents. Fig. 3 shows the wave form of the current actually used for deflecting purposes.

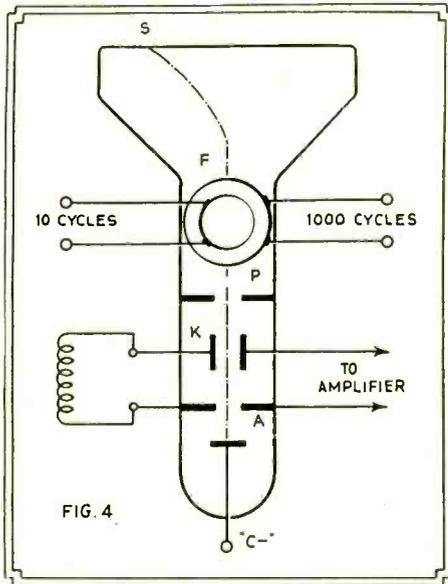


FIG. 4  
The Campbell-Swinton cathode-ray tube for receiving purposes. The broken line through the center indicates the path of the electrons.

lens L set in the tube. The grid G is connected with the grid of the first amplifier tube.

If the image is deposited on plate P, at first no electrons pass over to grid G, because as yet there is no potential applied to the elements of P. This is first imparted to the cells of P by their being charged by the cathode ray coming from cathode C. The moment an element of plate P is struck and charged by the cathode rays, current passes from this element over to grid G, the amount of current depending on the brightness of the image at the point in question.

Now we only need to imagine that the cathode rays coming from C scan the entire plate P, and we already have the picture transmitter in principle. To guide the cathode rays over the entire surface P, two deflection coils are supplied, as indicated in Fig. 1; to one is applied alternating current of 10 cycles, to the other alternating current of 1000 cycles. The two coils are arranged cross-wise, so that the deflections produced by them are at right angles to each other. Thereby the luminous point carries out a motion like that represented in Fig. 2, and since the luminous spot has a certain width, the entire surface is scanned by it, 10 times a second.

**Saw-Toothed Currents Used**

Strictly speaking the scanning in the example given would actually take place 20 times a second, namely once from top to bottom and again from bottom to top, etc. However, the arrangement is so made that one uses for deflection not ordinary sinusoidal alternating current, but alternating current of saw-tooth form (see Fig. 3). Such alternating currents cannot be produced directly by vacuum tube oscillators, but for a long time other methods have been known; e.g., a glow lamp oscillator, consisting of a glow lamp, a condenser and a resistance, which produces alternating current of the form of Fig. 3.

By using a deflection coil of 10 cycles and one of 1000 cycles we can accordingly scan the image 10 times

a second and each image consists of 100 lines. Thereby a very fine texture can be obtained, always presupposing that enough photo-sensitive cells are on hand in the transmitter. If their number is too small, the analyzing of the picture would be determined by the size of the individual cells.

Fig. 4 shows the receiver tube used by Swinton, which again contains the cathode C and the anode A, but also a couple of deflection plates K, to which the transmitted potential is conducted. On the way to the screen the cathode rays here too pass through two crossed coils, which are also shown in Fig. 4. By means of these the cathode rays, exactly as in the manner indicated, are conducted 10 times a second over the entire surface of the screen. The brightness of the luminous spot on the screen is controlled in a somewhat primitive way, by keeping a greater or larger part of the electrons from passing through the field between the coils by means of the changing potential on condenser K and by means of screen P.

The Swinton tubes, which were presented as early as 1911, had the disadvantage of possessing cold cathodes and therefore required a potential of some 50,000 volts to run the apparatus. The photo-sensitive screen P was composed of little cubes of rubidium. It fitted the wall gas-tight, so that a somewhat higher gas pressure could be used on the grid side, to increase the flow to the grid.

**Improvements of Zworykin**

A considerable improvement in the Swinton apparatus was suggested and worked out technically by Zworykin, an American engineer. Above all, Zworykin used glowing-cathode tubes. Also, he made the photo-sensitive screen out of potassium cells. Finally, aside from some technical improvements, he used a three-color luminous screen to attain television in natural colors. As yet, nothing exact has become known about the details of this apparatus, particularly concerning the way the scanning of the three-color screen and the synthesis of the image out of the three-colored rays takes place. It is perfectly conceivable that one gets at least approximately natural pictures, for the colors in which mineral substances light up when struck

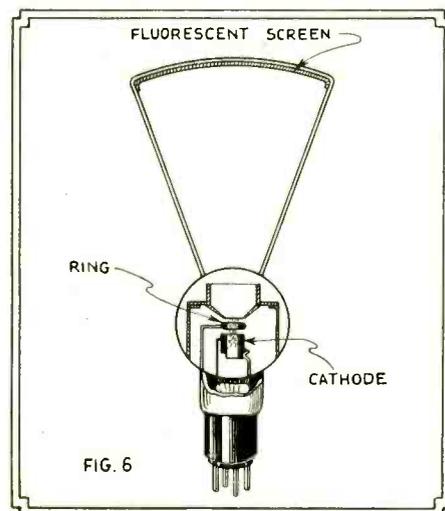


FIG. 5  
A cross-section view of a Farnsworth cathode-ray receiving tube.

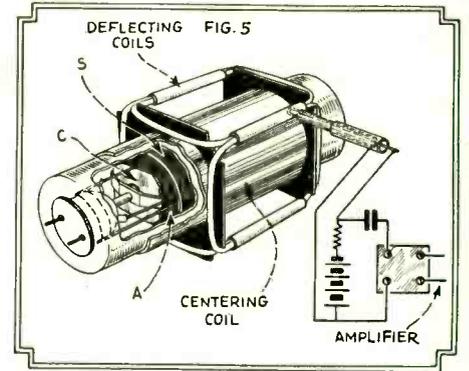


FIG. 5  
This is one form of Farnsworth cathode-ray tube for television transmission.

by cathode rays are very different, according to the kind of substance in question, and it is perfectly possible that Zworykin has found substances which light up red, green, and blue. At any rate, Zworykin has a good name in radio technology, and even if his apparatus is at present still in the laboratory stage, it is conceivable that at not too distant a time he will succeed in producing a serviceable televisor based on this principle.

A third cathode ray televisor has been developed by P. T. Farnsworth of San Francisco. Farnsworth started out with the purpose of making up a television image of 200,000 elements, because he considers such fineness necessary, in view of the character of the human eye. He also uses two crossed coils for scanning, these having a saw-tooth alternating current flowing through them, one coil having a current of 12 cycles, the other one of 4800 cycles. Thus for picture transmission Farnsworth arrives at a frequency of 1.2 million cycles. It is to be understood that such high frequencies offer considerable difficulties in amplification. The Farnsworth system has not yet reached a practical stage.

**The Farnsworth Tube**

As a transmitter Farnsworth uses, it is remarkable to say, a tube with a cold cathode and high vacuum. There is a further difference from the designs previously discussed in that Farnsworth uses in place of the large net-shaped photo-electric plate P in Fig. 1 only a single small tube-shaped photo cell, which is screened against the electron discharge except for a very small opening. Opposite the cathode lies a flat window of plate glass, through which the image to be reproduced is formed on the cathode. The cathode consists of a brilliantly polished material, which, under the influence of the light falling on it, sends out electrons. Close before the cathode lies a lattice-shaped anode, which is given a potential of 500 volts. Hereby Farnsworth means to attain the formation of an "electric image," the nature of which he explains as follows:

If one should put a fluorescent screen in the plane in which the photo cell is located, the electrons leaving the cathode under the influence of the light falling on it would reproduce, faithful to nature, the image cast on the cathode. What physical processes take place we cannot exactly recognize

(Continued on page 151)

# Single Side Band TELEVISION TRANSMISSION

More Image Detail With Lower Frequency Range Possible With This Method

By R. D. LE MERT

**S**TATION W6XAH, Bakersfield, California, is the first station in the West to use single sideband suppressed carrier transmission. This system permits the transmission of more detail and of course a better picture within the limitations of the frequency channel allocated by the Federal Radio Commission, which is 100 kilocycles at this time.

W6XAH is licensed to transmit 96 lines, 20 picture frames per second, (1200 R.P.M.) and scans left to right and top to bottom in continuous sequence. (R.M. A. Standard.)

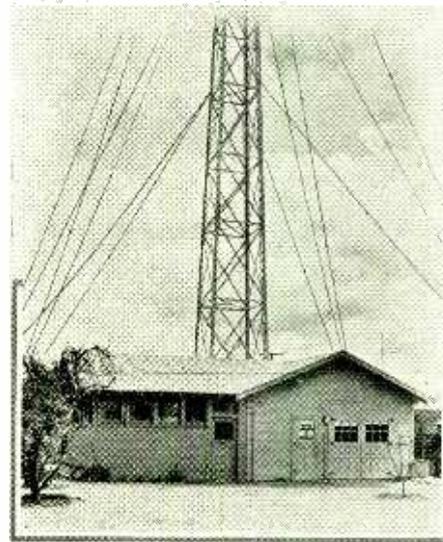
It was quite interesting, during the development work, to note the amount of increased detail which was available between the 60 line picture and the one using 96 lines, both pictures being transmitted at 20 picture frames per second. In the 60 line picture, small objects were not seen at all! In the 96 line picture even the shading under trees was easily seen, as well as the details of the facial features of individuals.

### Halving the Frequency

It is also possible when using the ninety-six line picture, in the transmission of moving picture film, to use practically any kind of film, the darkest type coming through with good fidelity.

If one attempted to transmit 96 lines without the use of single sideband transmission the channel width would be more than 184 kilocycles, which, of course, is out of the question. Its advantages are many compared to other methods of transmission, and will be shown in a latter part of this article.

By the use of the increased detail obtained by 96 lines, it is possible to take



General view of the transmitting station with part of one of the antenna towers in the background.

outdoor scenes of tennis games, boxing matches, etc. In the studio the scenes televised show the artist and the furnishings of the room, windows and other details which go to increase the atmosphere for a stage setting.

The transmitter is housed in a building consisting of two rooms, each 24 feet wide and 48 feet long. One room houses the main transmitter and the power control panels, and also the speech input

panels and monitors. The main transmitter faces the front. Along the left side of the main transmitter is seen the single sideband equipment, which is housed in a separate screened-in panel. On the right side of the room are the generator control panels, consisting of 3 panels.

In the rear of the room on the right side are two banks of power transformers (each 15 kilowatts), supplying the power for the rectifiers. Both generators and rectifiers are used to supply the power in transmission. The filaments are operated by a direct current generator. On the left of the room is shown the speech input panel, the sideband panel being shown at the right.

In the room adjoining are the main television amplifier, the projection machines, and the pre-amplifiers, the picture which is transmitted actually going through 17 stages of amplification.

### Complete Laboratory Equipment

Great care in building these amplifiers was necessary, as the frequencies involved vary over a wide range. The main amplifier, having eight stages of specially designed amplification, has a frequency range from 30 to 95,000 cycles. Its characteristics are practically flat from 50 to 80,000 cycles.

In this room also is the machine shop, which is well equipped for this type of research. It also contains the usual testing equipment, oscillographs, low-frequency oscillators, frequency measuring apparatus, etc.

The studio building is located approximately 50 feet from the first building. It contains the direct pick-up cameras and associated amplifiers, two condenser microphones, piano, studio furniture, etc. An underground line connects the studio with the transmitter rooms.

The two towers are each 150 foot in height, and were made of wood to keep down absorption and re-radiation. They are separated 150 feet. The antenna itself is a large single wire, fed by a transmission line.

### Lower Power Consumption

Even disregarding the previously mentioned advantages possessed by the single sideband system, that there is less interference due to the sharper tuning permissible in the receiver and that the received signal strength is subject to less variation due to changes in the ether conditions, this system has the advantage of lower power consumption for given results. The maximum power required is one-fourth of that for the usual transmitter. It is important to remember that the power output of a single sideband transmitter is zero when no speech or picture is transmitted and that the output varies from zero to full load each time a word is spoken.

This is one of the reasons for the large size of our power supplying apparatus and generators.

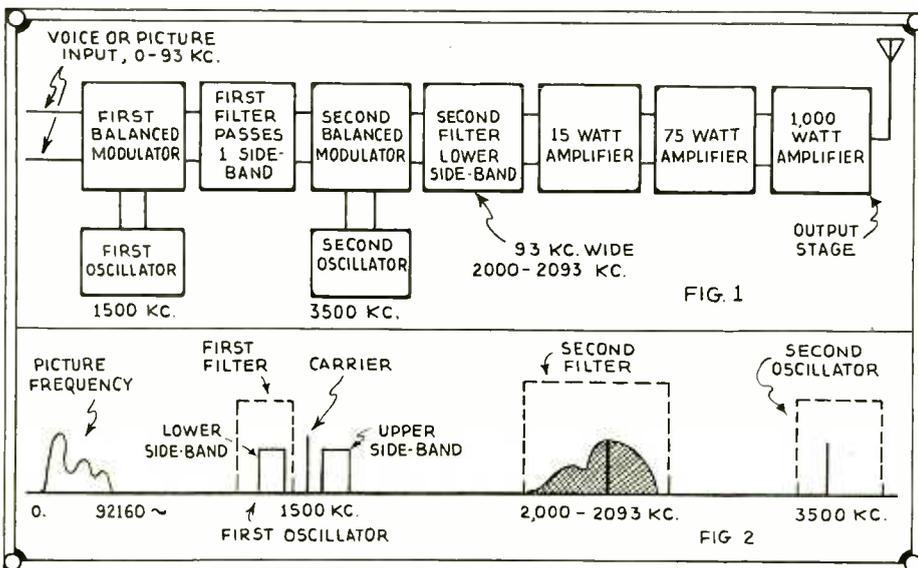
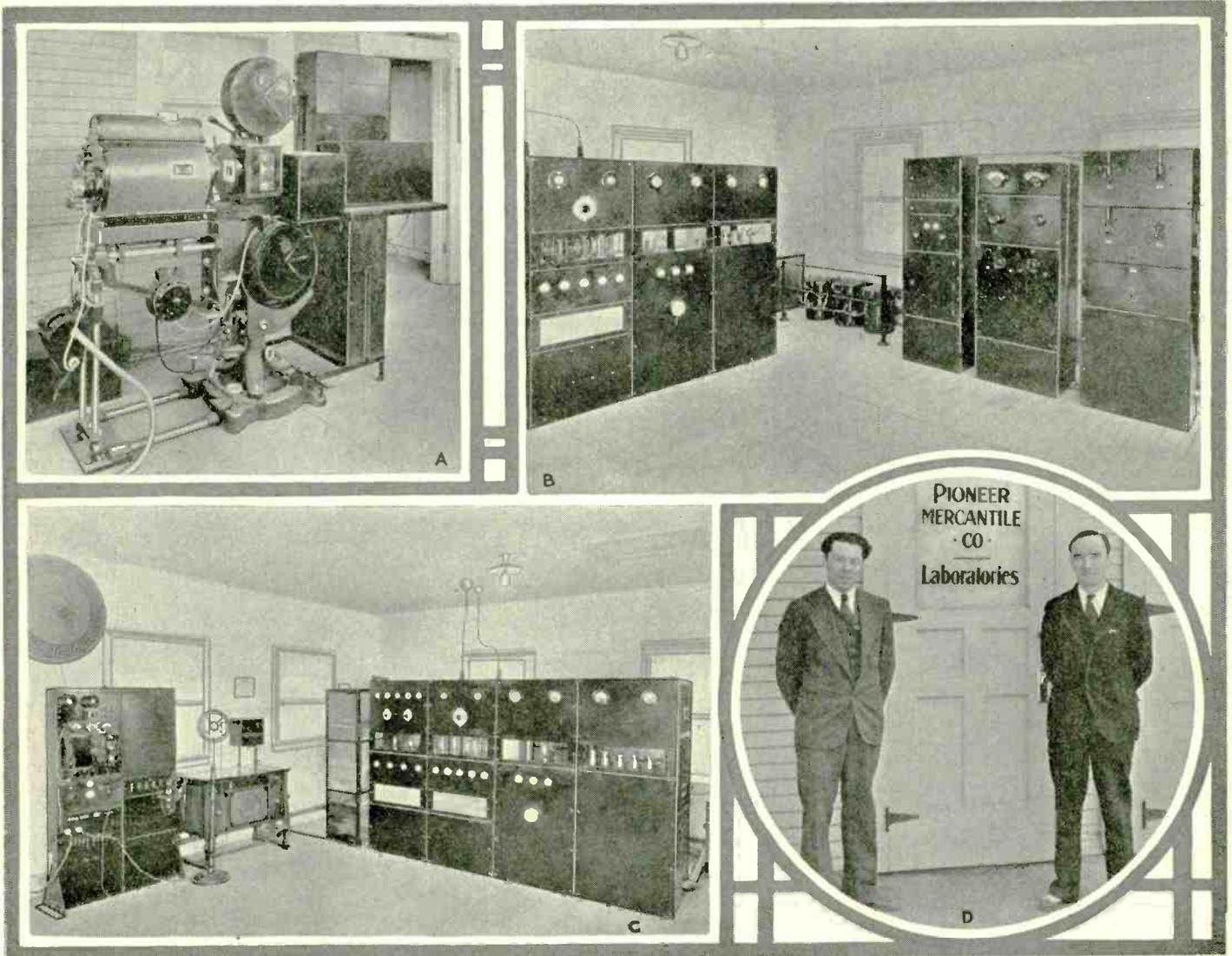


Fig. 1: layout of the transmitter equipment at W6XAH. Fig. 2: position of the side bands in the double modulation process. The transmitted sideband is separated sufficiently to be free of all harmonics of both oscillators.



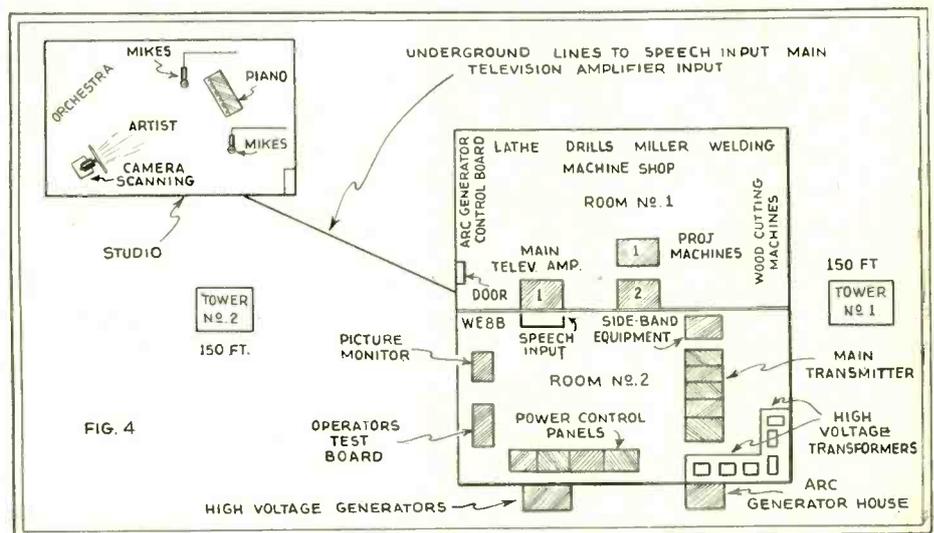
It is quite interesting to note the different methods employed in the production of the single sideband.

It is well known that, when alternating carrier current is modulated by voice or picture currents, the resultant wave is distributed over a frequency range which may be considered in three parts: (1) The carrier frequency itself, (2) a frequency band extending from the carrier upward, and having a width equal to that of the frequencies appearing in the modulation wave, and (3) a band extending from the carrier downward, and having a similar width. The products of modulation are spread over a region comprising the original carrier frequency and the two bands, known as the upper and lower sidebands. These two bands have the same width and each transmits power which contains all the elements necessary to reproduce the original speech or picture transmitted. The ordinary transmitter transmits all of the products of modulation (carrier and two side bands). It also sends out the carrier continuously and adds the two sidebands when they are impressed, as when a word is spoken.

The total transmission or frequency range is from the peak of one side band to the peak of the other or from top to bottom. In the single sideband, elimin-

(Continued on page 152)

A: close-up of the large projection machine used in transmitting images on motion-picture film. B: to the left, part of the radio transmitter; to the right, the power supply panels. Note the big transformers behind the railing in the center. C: left, input control apparatus; right, radio transmitter. D: R. D. Le Mert, left, and Frank Schamblin, right.



Layout of the entire W6XAH station. Note that the studio building is separated from the transmitter house, which is located conveniently between the aerial towers.

# The Dalpayrat System of DYNAMIC SCANNING

**I**T IS the opinion of many television experts that an entirely new principle is needed to free the art from its present limitations. An analysis of the systems designed up to date reveals a great lack of originality and a duplication of objectionable imperfections which tend to re-enforce this conviction. The new system to be described in this article overcomes certain difficulties and appears to offer a satisfactory solution to many serious problems. The invention, which is essentially based upon a new system of scanning, does away with motors, lens discs and mirror drums, no rotary motion being used anywhere. The scanning is serpentine, or zig-zag, first down, then up, going over each line always in the same direction, as it will be explained later.

### Arc Light Eliminated

At the transmitter a special direct pick-up camera is used which does away with the powerful arc light employed in the "flying spot" system. At the receiver, which employs a similar scanning device, the image is projected on a screen in a console cabinet, or on a screen placed at a distance.

The advantages of this system are as follows:

- 1) Eliminates motors.
- 2) Eliminates discs or drums.
- 3) Eliminates powerful arc lights and the flying spot technique at the transmitter.
- 4) Directly picks up the image of the subject to be transmitted outdoors

By Henri F. Dalpayrat

**This proposed new method of television scanning is interesting because it acts directly on the subject, almost like a camera. Its possibilities are worth your study and consideration.**

with daylight, or indoors with ordinary electric lighting.

5) Eliminates or prevents the reproduction of dark horizontal lines due to mechanical imperfections.

6) Transmits larger scenes and films.

7) The number of lines to be transmitted or received can be changed at will without removing any parts. The number of frames per second can also be varied by special tuning controls.

8) Means are provided to obtain exact synchronism and to maintain it with any transmitting stations which utilize a similar system of transmission.

9) The apparatus used both at the receiver and the transmitter is simple, compact and easily adjusted.

10) This system has none of the physical limitation present in rotary mechanical devices. Its initial cost and maintenance have been calculated to be not higher than other devices and possibly much cheaper.

The writer does not condemn all mechanical systems, but believes that it would be beneficial to many readers and experimenters to become acquainted with their weak points and difficulties in order to consider them justly and to anticipate them as inevitable.

The perforated disc and neon tube arrangement, which is elementary in theory, will not be discussed here. Suffice to say that this system is the most economical and gives very good results when well designed and adjusted properly. The main objection is that the image is too small and indistinct and that due to the insufficient illumination it cannot be magnified optically. There is also the disadvantage that only one person at a time can comfortably see the picture.

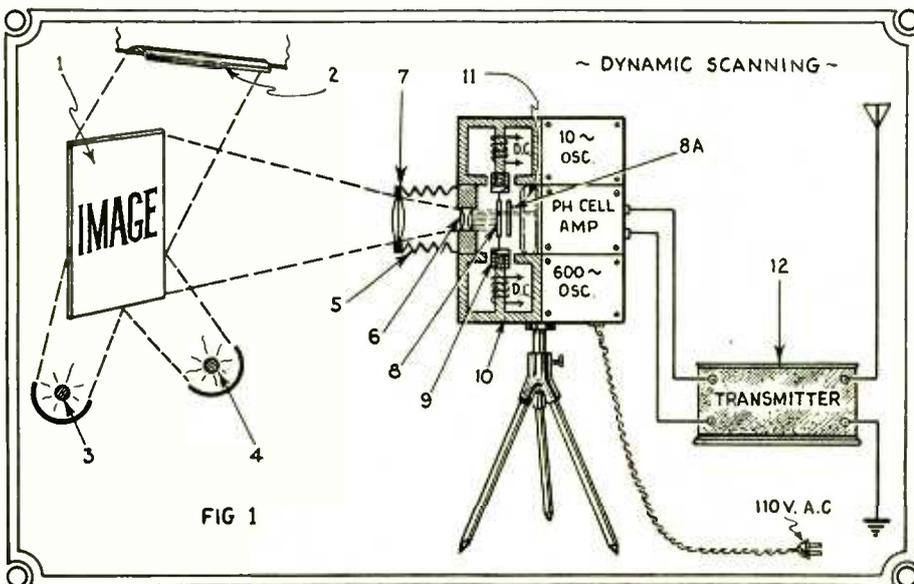
### Mechanical Scanning Systems

The two most popular televisions used at present are evidently the crater tube or crater arc tube and lens disc or mirror drum combinations. The objections often cited against these systems are that they are heavy, cumbersome, noisy, and somewhat dangerous to handle and difficult to keep operating properly. It is also difficult to design efficient lens discs or mirror drums so that no spreading apart of lines takes place. The lenses or mirror must also be so arranged that the overlapping of lines on the screen will be reduced to a minimum, to prevent blurring or distortion of the image. These televisions cannot reproduce more or fewer lines than they have lenses or reflecting surfaces and in order to receive a different number of lines from another station one must remove the scanning device and put on a new one in its place. Mechanical synchronizing devices are plentiful but few are able to accomplish what is claimed for them.

### Details of Dynamic Scanner

The DYNAMIC SCANNING system which will now be described has none of these objections and in fact has many new and interesting advantages.

Fig. 1 shows a typical "direct pick-up" camera transmitter. Part 1 is the image of the subject to be televised which is illuminated by a photographer's violet-ray lamp, 2. Parts 2, 3 and 4 are sources of light, one of which may be yellow-white and the other orange-red. These colors are suggested as an example only, as pure white light would do just as well. However, with colored lights it is possible to alter the quality of the light reflected from the subject and thereby correct or neutralize the inefficiency of certain photo-electric cells for certain colors. The light from the subject is reflected forward and reproduces a small picture within the reducing camera. This camera consists of a folding or collapsible dark box, 5. Part 6 is a pair of



This drawing shows a detailed cross-section view of the Dalpayrat dynamic-scanning television camera. The image to be transmitted is illuminated by lights 2, 3 and 4, which may be of different colors to balance the color deficiencies of the photo-electric cells.

condensing lenses which receive light from a large lens, 7, and transfer the picture under the shape of a bundle of parallel rays. These rays reproduce an image upon the surface of a slotted diaphragm, 8. Another slotted diaphragm, 8a, is placed behind and very close to the first one. One slot is cut vertically in one diaphragm and horizontally in the other. This will be better understood by examining Fig. 2. Part 8 vibrates up and down and has an horizontal slot; 8a vibrates sidewise and has a vertical slot. Returning to the camera in Fig. 1, part 8 is fastened to moving coils 9 of special dynamic units 10. These coils are connected in such a way that when one pushes the other pulls, thus causing diaphragm 8 to vibrate up and down. Part 8a is vibrated sidewise by another pair of dynamic units and at exact right angles to the motion of 8. The cross section of the beam of parallel rays projected from condensing lenses 6 being about 1 1/4 inches square, the slots in 8 and 8a will be about 1/64 of an inch wide, for a 60-line picture, and a little over 1 1/4 inch long.

**Diaphragm Construction**

These diaphragms can be made of very thin, light, rigid material, like fiber, aluminum, etc. For best results it is necessary that the slots be stamped out to leave clean, smooth, straight edges, as burrs or irregularities would distort the picture elements transmitted. The picture element is square and is produced by the superimposition of two slotted lines at right angles to each other.

The moving coils 9 are connected to a sine-wave oscillator which vibrates them at a frequency of 10 cycles, thus displacing the diaphragm 8 down on a half cycle then up on the other, or 10 times up and 10 times down. In this manner 20 pictures or frames will be scanned per second. To obtain a 60-line picture it is necessary that the other diaphragm 8a vibrate 60 times faster than diaphragm 8, or 600 sine wave oscillations (1,200 half cycles) per second. In this system, due to the vibratory motion of the scanning element, and the use of both cycles of the oscillations, only one half of the usual scanning frequency, (as used in cathode ray tubes), will be necessary. This will be exact provided that genuine sine-wave oscillators are employed.

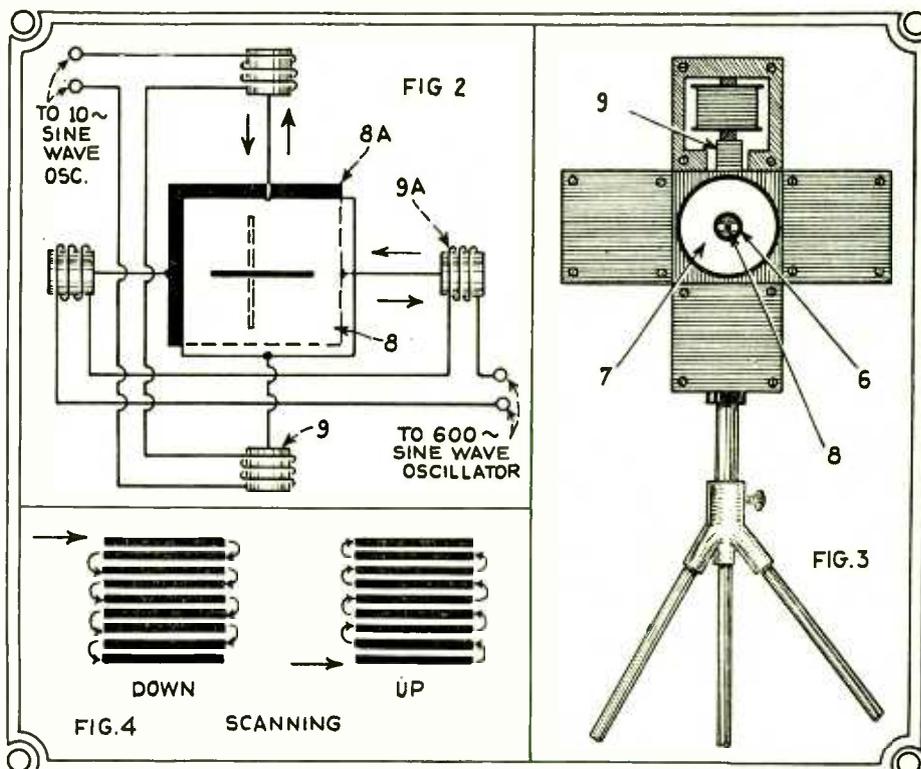


Fig. 2: details of the vibrating diaphragms. Their directions of motion are indicated by the arrows. Fig. 3: head-on view of the proposed Dalpayrat television camera. The numbered parts correspond to those of Fig. 1. Fig. 4: this illustrates the zig-zag scanning effect of the Dalpayrat system.

The dynamic units, although shown large in the drawings, would in practice be actually rather small, somewhat the size of loud speakers now used in midjet sets. The displacement of the coils must of course be greater than those of ordinary speakers. This can be accomplished by units specially designed for the purpose. A few years ago the writer witnessed a demonstration of a new type of speaker, the moving coil of which had a total displacement of over an inch and a half at a frequency of 20 cycles. Taking this case as an example, the writer believes that with careful design, wider motions can even be possible.

Considering the scanning action, one may observe that the intersecting points of the two slotted lines always disclose a small square hole which is of the same size at all times. This hole sweeps over the whole surface of the reduced image in the camera, line by line, thus allowing a beam of light of

variable intensity to reach the photocell, 11. The different values of light liberate corresponding values of electrons within the cell. These different voltage variations are then amplified by a special amplifier and transmitted by the transmitter, 12.

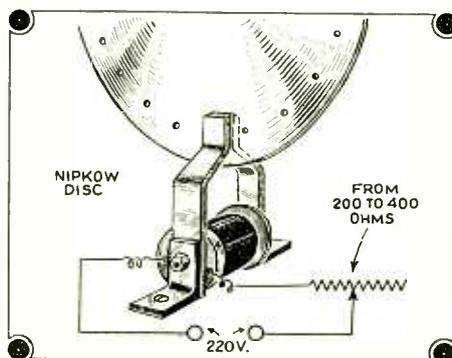
Fig. 3 shows the approximate general appearance of the direct-pick-up camera. The numbers indicated correspond with those shown in Fig. 1. Due to the vibratory motion of the diaphragms, at right angles to each other, a serpentine or zig-zag form of scanning is obtained, first back and forth going down, and then back and forth going up, going over each line always in the same direction. This may be better understood by studying Fig. 4. It is believed by many experts who have approved this system and its form of scanning that its action will be smoother and more uniform on account of the continuous double zig-zag motion involved.

**An Induction Brake For Nipkow Discs**

*By Gerhart Goebel*

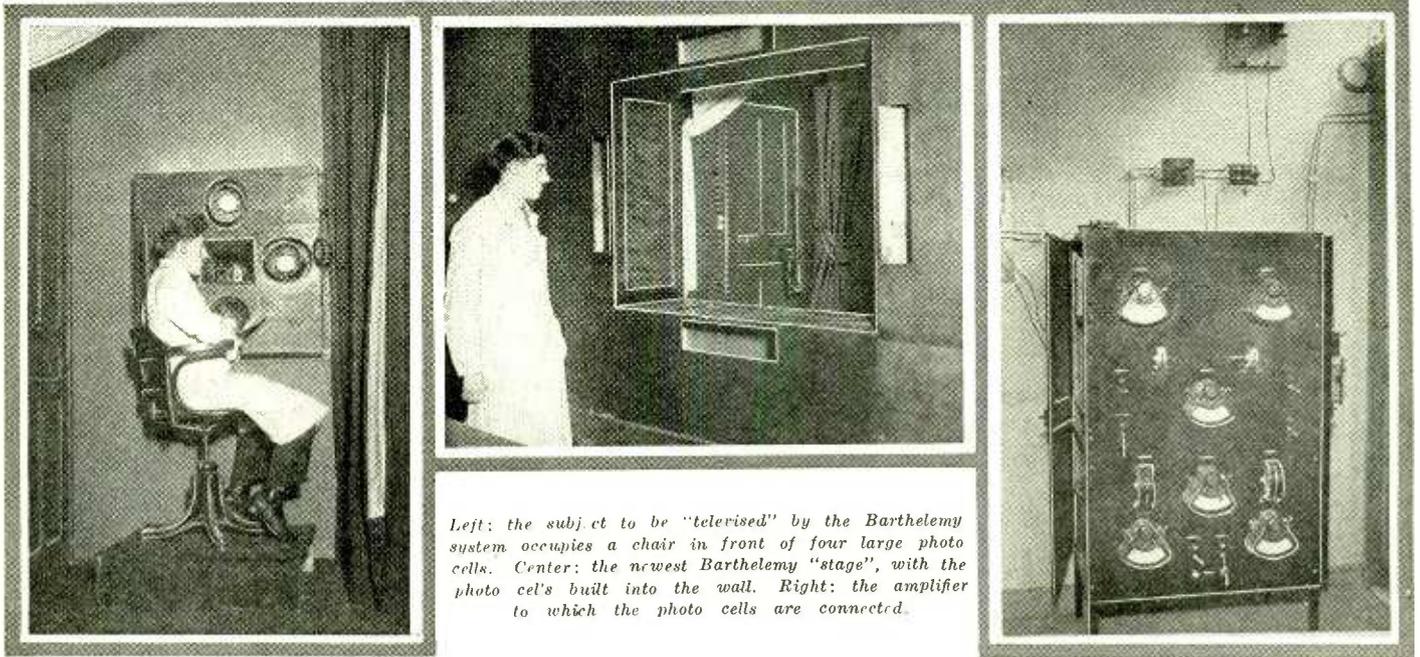
**I**F FOR any reason the number of revolutions of a Nipkow scanning disc is not regulated by a synchronizing (phonic) wheel coupled to it and controlled by the synchronizing frequency, then it must be managed by means of a brake. This is especially the case when there is available for driving the disc not an A. C. synchronous motor, or even, as is still the case in many instances, a D. C. motor. In such cases mechanical brakes are frequently used.

The brake of a Nipkow disc fulfills its purpose only if it can be regulated within wide limits, wears out as little



as possible, and operates gently and without impact. A mechanical brake satisfies these requirements only if it is very carefully built. Much better and more reliable in operation is the induction or eddy current brake. As the braking drum we use the Nipkow (scanning) disc itself. It is embraced at some suitable point on the circumference by the poles of an electro-magnet. Once the disc revolves in the field of this magnet, eddy currents form in the interior of the disc, which check the rotation of the conductor in which they form, i.e., the disc.

The arms of the braking magnet are  
(Continued on page 153)



Left: the subject to be "televised" by the Barthelemy system occupies a chair in front of four large photo cells. Center: the newest Barthelemy "stage", with the photo cells built into the wall. Right: the amplifier to which the photo cells are connected.

# Television Progress in France

## New Barthelemy System Holds Out Much Promise

by MARC CHAUVIERRE

**N**UMEROUS laboratories in France have been for a number of years occupying themselves with the problem of television. In particular it is necessary to cite the work of Edouard Belin in his laboratory at Malmaison, going back more than ten years. On his part, Barthelemy has been at work on this problem since 1928 and gave his first public demonstrations in 1930. But it is only within the last few months that there have been daily television broadcasts in France. These take place every day, either in the morning or in the evening, from the P. T. T. station, which is using the Baird system with vertical analysis of the image and 30 lines. The disc revolves 750 times a minute. The program of the P. T. T. broadcasts generally includes lectures, bits of singing, piano, etc. The sound is transmitted by the Radio-Vitus station, which belongs to the Pathé-Natan establishment. Numerous stations are expected to follow the example of P. T. T., in particular Radio-Toulouse.

### No Wavelengths Available

What considerably checks the spread of television in France is the fact that there is no band of wavelengths reserved for transmitting, and it is necessary to use radio broadcasting stations, which are limited to a band of 9 kilocycles. The situation is the more delicate since no decision can be made in France on this subject until the assent is obtained of the states agreeing to the international radio convention. It is therefore necessary to await an agreement among those chiefly interested: Germany, England and France. At present it is necessary to get along with 30 line images while waiting to be allowed bands 50 or 100 kilocycles wide.

French amateurs have manifested a

lively interest in television, and already a number have had good reception. The French amateurs use principally either the Baird (British) or the Telehor (German) material, but at present several French houses have put on the market discs, motors, phonic wheels, etc. Among the television lamp one finds the Phillips lamps, the Geco lamps, and one single French trademark, "Celsior". As yet there are no commercial examples of the "crater" lamp, which exists only in the laboratory. This is not surprising, because in the actual state of things the French amateurs content themselves with the Nipkow disc (perforated) and the disc with lenses is not yet commercially used.

To make up for that, most amateurs wishing to receive on a screen construct Weiller wheels. It seems that making the Weiller wheel is easier for the amateur than making the disc with lenses. Nearly all amateurs synchronize by the phonic wheel, but there are very varied ideas about how to control it. In general, the direct connection recommended by Baird in England does not give good results, and they prefer connecting with an independent amplifying stage (as in the American Baird method). Some amateurs use a local oscillator adjusted to the frequency of the phonic wheel, i.e. to 375 cycles a second. The hook-up of this oscillator is borrowed from the German Telehor system.

The oscillating circuit is made up of a coreless induction coil of about 7000 turns of wire with a fixed capacity of 3 microfarads and a variable condenser of 3000 mmf. With sensitive sets one can get London television in Paris. There were some French amateurs who used to receive it before the P. T. T. station

commenced its first broadcasts.

The public is awaiting with impatience the first broadcast of Barthelemy.

Barthelemy regularly uses in his laboratory 60-line analysis for true television and for transmitting films. However, these first broadcasts, intended for amateurs, will content themselves with 30-line analysis and 16 $\frac{2}{3}$  images a second (i.e. exactly 1000 revolutions). The television broadcast will take place on 200 meters with 15 kilowatts, and the sound will be transmitted on about 180 meters but with weak power. Barthelemy uses horizontal analysis with an image having the proportions of 3:4. The synchronization can be done by the 50-cycle sector or the phonic wheel with frequency 500.

### System Uses 60 Lines

Actually Barthelemy has attained excellent results with 60-line analysis and is now sending films with several characters, those of auto races, etc. The reception is done on a ground glass screen 12 x 16 inches, the analysis taking place by means of a mirror wheel, and the source of modulated light being a crater neon lamp. The Barthelemy set will not be on the market for some months.

Most of the characteristics of the Barthelemy system are known from a description which already appeared in Issue 4 of TELEVISION NEWS. In the present article we are going to describe the latest invention of this engineer.

It is well known that to increase the fineness of the image, it is necessary to increase the number of lines of scanning. But the more the number of lines is increased, the more the difficulty mechanically; in particular, a Weiller wheel for transmission with 30 mirrors is already very cumbersome. If it is necessary to

(Continued on page 153)

# FREQUENCY REQUIREMENTS for Television

by IVAN BLOCH, E.E.

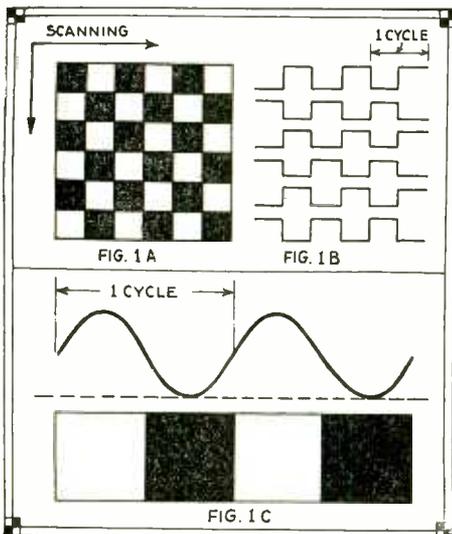
**A**N extremely important factor in the design of television receivers and transmitters is the frequency range over which the amplifying system should respond linearly. This range has not always been clear to certain investigators and hence this article purports to explain clearly how the frequency limits are obtained for any system, any number of "lines" and any number of frame repetitions.

To visualize the problem, let us assume that the object which is being scanned is made up of square picture elements, each of which is tangent on four sides to other elements. For example, let us take a checkerboard pattern, such as shown in Fig. 1A, and let us further assume that the scanning spot of light is of such dimensions that it equals a picture element in area and shape, and that the time required by the spot of light to traverse the pattern from left to right along one line is one second. Thus this scanning spot of light passing over the first line horizontally, would cause the photo-cells to respond to three maximum and three minimum reflections of light.

### Shape of Response Curve

We may assume the response to be of the shape as shown in Fig. 1B, although actually, as is obvious, the response takes a shape more like that shown in Fig. 1C. This response-wave form is due to the fact that as the spot passes from a maximum to a minimum reflecting surface, the photo-cell integrates the total light emitted or reflected, so that for instance on the dividing line between squares, the total light received would be half of the possible maximum.

From Fig. 1B it may be seen that the cyclical changes are equal to one-half of the total picture elements traversed. Or in this case, the time for three cycles being one second, the fre-



Wave patterns resulting from the transmission of a checkerboard pattern.

quency is three cycles per second.

Generalizing,

$$f = \frac{\text{No. of Picture elements per line}}{\text{Time for line Scanning}}$$

For example, if the time for line scanning is 0.1 second and we again have six picture elements per line,

$$f = \frac{6/2}{1/10} = 30 \text{ cycles.}$$

Maximum frequency is obtainable with a checker-board pattern, where each square equals the area of the scanning spot of light. The maximum frequency for a sixty-line picture, six to five image ratio, twenty frames per second, can be found as follows, if we remember that each line contains 6/5 X 56 picture elements, and that each line takes 1/1200 second:

$$f = \frac{72/2}{1/1200} = 43,200 \text{ cycles per second.}$$

From the preceding, the formula for maximum frequency can thus be written down as:

$$f = \frac{1}{2} \text{ Picture ratio} \times \text{No. of Lines} \times \text{No. of Lines} \times \text{Frames per second} = \frac{1}{2} \text{ Picture ratio} \times \text{No. of Lines}^2 \times \text{Frames per Second}$$

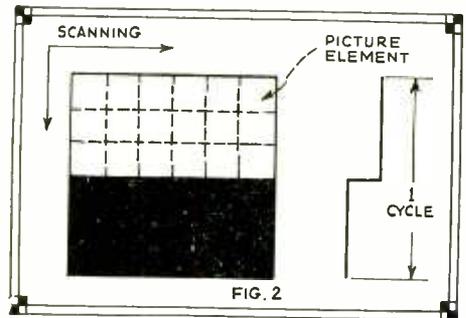
Thus for a 120-line, 24-frame system (supposedly the N.B.C. transmission scheme), we have  $f = 1/2 \times 6/5 \times (120)^2 \times 24 = 207,360$  cycles per second.

### Obtaining Minimum Frequency

To obtain the minimum frequency, we must remember that the lowest cycle of response of the photo-cell is when the received light varies from a maximum value for one-half a frame to a minimum value for the remaining one-half a frame or vice versa, as shown in Fig. 2. Hence, for the minimum frequency, the answer is that it equals the number of frames per second.

It is possible that the photo-cell be called upon to respond to even lower frequency variations. For instance, with an evenly illuminated field, the

photo-cell response is continuous. However, as a rule, if a circuit responds to 20 cycles, the lower frequencies will be taken care of. Other interesting figures can be obtained by analysis. For instance, what frequency is represented by a black square on a white background, the area and shape of the square being the same as that of the scanning spot? The response of the photo-cell will be once per each frame, but the frequency is more than that. Frequency is the reciprocal of the time interval. That is  $f = 1/T$  and since T in this case (sixty lines, twenty frames)



Study this pattern before attempting to figure the minimum frequency of a television transmitter.

is 1/43,200 seconds, the frequency is 43,200 cycles.

From this discussion, which does not consider harmonics, an amplifier should respond linearly from about 20 to 43,200 cycles per second in sixty-line, twenty-frame scanning. If the response is far from linear at the lower frequencies, then all contrast will disappear, blurring and blending the image into the background. Failure of linear response in the higher frequency range will diminish the detail.

Although the explanations given were taken from the point of view of the flying-spot transmitter, they apply as well to direct-pick-up transmitters and, of course, also to receivers.

### Ultra-Short-Wave Hints

Since high-frequency or ultra-short wave reception requires coils of few turns and "midget" condensers space-saving immediately becomes evident.

This is highly important, as it means short interconnecting wires, a factor in eliminating stray effects that might tend to increase the capacity and inductance, and thus lower the over-all efficiency of the receiver.

Careful shielding is absolutely essential, and even with its elaborate use some of the signal may be lost, due to the fact that the tremendously high frequency,

on the order of from 40,000 to 60,000 kilocycles compared with 550 to 1,500 for sound broadcasting, doesn't seem to stick to the electrical laws obeyed by lower frequencies.

For instance, two comparatively short wires, if run parallel for an inch or so, may give a condenser effect that will rob the signal of much of its strength.

Tuning coils, with the turns spaced too close together, will produce the same effect and may raise the wave length range above the point desired. The remedy, of course, is wide spacing of turns, even up to a quarter of an inch.

# TELEVISION *in* NATURAL COLORS

By  
MANUEL DE DIOS

**T**O transmit or receive a ray of white light from an image, analyzed into all its colors, there will be necessary an apparatus seven times as large, as complicated, and as expensive as normal television sets, which will put it beyond the pocketbooks of the great majority.

I think it impossible—given the case that you receive the seven colors coming from a ray of white light, at one time, and transform them into seven electric impulses—to transmit them one after the other, since they all come to the transmitter at the same time and while one is being transmitted the others are lost. I do not see how we can hope to do it. To transmit them all together would occupy seven wavelengths, complicating both transmission and reception.

We know from physics that when a pencil of white light is passed through a prism, it breaks up into seven elementary different colors, each with a specific wavelength.

According to the learned Helmholtz, there exists in the retina of the human eye three different classes of nerves whose sensitive fibres, stimulated by light of different colors, give the illusion of color to the brain.

If a cardboard disc is divided up by various radii and if each division is colored alternately yellow and blue, and if it is put on a phonograph disc and made to revolve rapidly, the eye will receive the sensation of *green*, though neither of the two colors contains it and though the wavelengths of the three are all different. If we paint the disc red, yellow and blue in certain proportions, it will appear *white*! If we paint it with the seven colors, it will appear white all the same. If with yellow and red, *orange*. If with red and blue, *violet*. And if with yellow and blue, *green*.

With only three of the seven colors, red, yellow, and blue, we can, by mixing them, produce in the eye the sensation of every other color, simple or composite.

We have a practical example in trichromatic printing plates, which are composed of dots of yellow, red, and blue, mixed according to the tone of the color whose sensation is to be given.

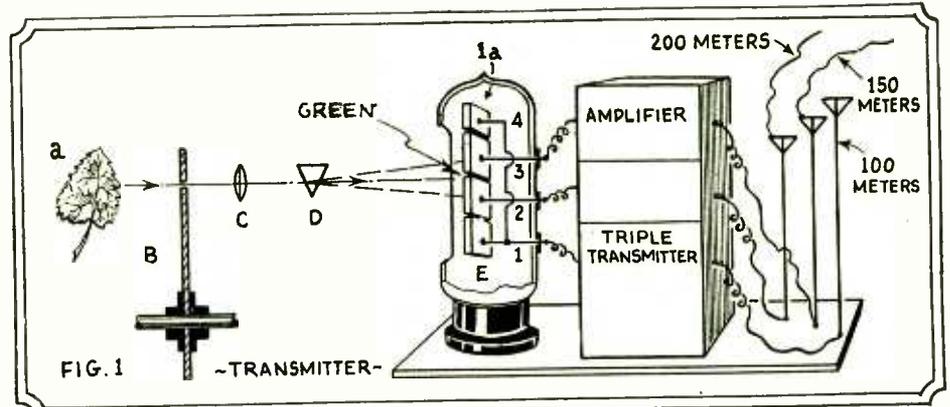
If we manage to convert the seven colors, into which the white light is broken up on passing through a prism, into merely three electric impulses of the photo electric cell, and light with them three television glow lamps colored red, yellow, and blue, there will be the appearance of white, though we have dispensed with the other four colors. Then we only have to convert these electric impulses of the photo electric cells into radio waves of different frequencies or wavelengths and to separate them in the receiver, to have the problem solved in the most practical and economical manner possible.

half of the color below in the spectrum.

Example: cell 2 contains the yellow and half of the green which is above it. The electric impulse obtained lights (in the receiver) the lamp painted yellow. (Fig. 2).

Cell 3 contains the blue, half of the green from below and half of the violet from above. In the receiver the lamp painted blue will respond to this cell.

Cell 1 will receive all the red and half the orange above, and since the half corresponding to the violet cannot be obtained as it is the top of the whole spectrum, it is necessary to pick it up with



Layout of the author's proposed television transmitter, which is intended to televise objects in natural colors. The object to be transmitted is a leaf, "a"; B is the scanning disc, C a collecting lens, D a prism, E is the special color sensitive photoelectric cell. Three wavelengths are required for the actual radio transmission.

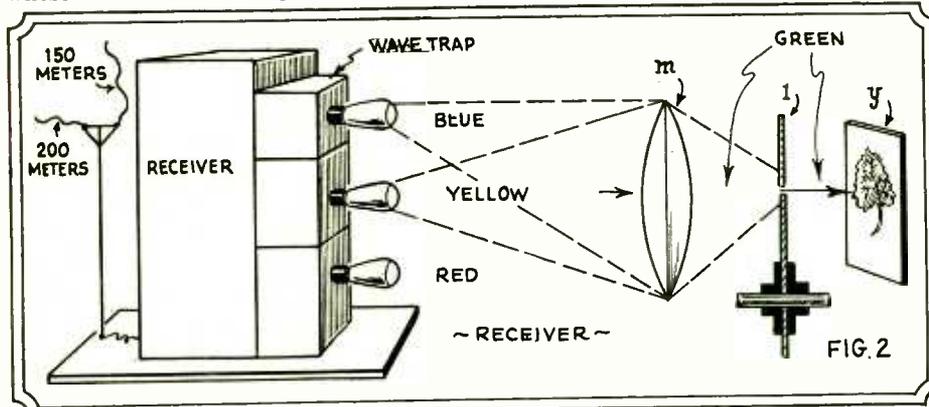
Dispensing with indigo, which has no great practical application, and which moreover does not affect the results which we obtain, we cause the six colors into which the white light is decomposed on passing through a prism to distribute themselves in the three cellules of the photo electric cell E (Fig. 1) in such a way that each one contains a fundamental color, either yellow, red, or blue, and half of the color above and

cell 1a, and to unite the current here obtained with that of cell 1, which picks up the red. With the current of the two cells 1 and 1a, there will light in the receiver the lamp painted red.

### Three Wavelengths Used

When a ray of red light reflected by an object is directed by the disc through the dispersing prism, then according to its natural position in the spectrum, it is going to impress the lower part of cell 1 of the photoelectric cell, permitting the passage of an electric impulse, which then on being amplified and transmitted on a definite wavelength is caught by the receiver. There it is amplified and directed through three "wave-traps," or "filters," each adjusted to a certain wavelength corresponding to those lengths on which the impulses corresponding to the colors have been transmitted. The trap adjusted to the wavelength on which the electric impulse of the red ray has been transmitted diverts it toward the lamp which has been painted red. On lighting it emits a pencil of light, which a lens focuses on the disc which directs it toward the screen where the eye sees it.

If the pencil is yellow, it affects the central part of the photo-electric cell 2, whose impulse, on transmission and re-



General appearance of the natural color television receiver. This shows how the light rays from the blue and yellow lamps combine to form green, which is the color of the leaf.

ception, is then directed toward the yellow lamp by means of another wavetramp. If it is blue, the central part of cell 3 will convert it into radio waves which the other trap or filter of the receiver will direct toward lamp painted blue, whose light the observer will receive on the screen. (See Figs. 1 and 2.)

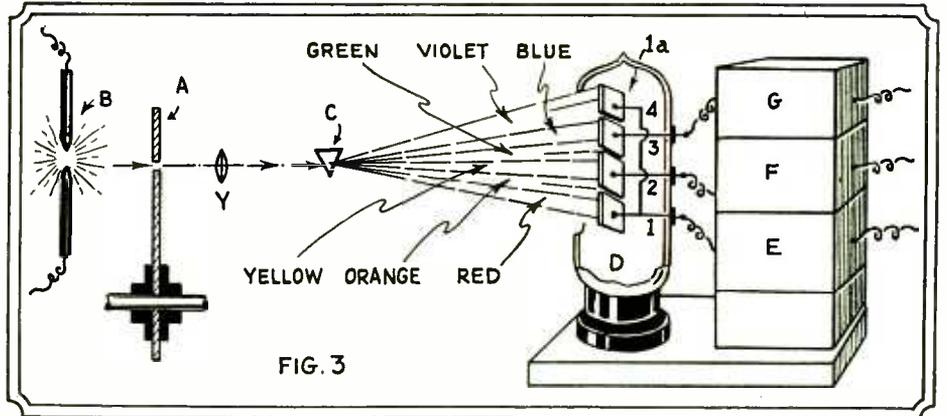
To transmit orange, the prism locates it between the red and the yellow, stimulating photo-electric cell 1 in the upper part of cell 2 in the lower part, causing two currents at the same time, which will light up the red and yellow lamps in the receiver, which on blending will produce in the observer's eye the sensation of orange. Equally, in the case of green, being located between the blue and the yellow by the prism, it will stimulate cell 2 in its upper part, and cell 3 in its lower, their currents lighting up at the same time the blue lamp and the yellow lamp in the receiver which on blending, will produce the illusion of green. (Fig. 2.)

**Blending the Light**

As the violet is dispersed by the prism toward the upper part of the spectrum, it will stimulate only that part of cell 3 which corresponds in the receiver to blue, and since for giving the sensation of violet to the eye it is necessary to mix red with the blue, and since the red is originated in cell 1, which is at the lower end of the spectrum, we could not pick up the other half of the violet dispersed by the prism only for the fact that we place another small photo-electric cell 1a on 3. Picking up this half, it adds it to the current produced by 1, which gives red light in the receiver. This is blended with the blue which cell 3 has brought, and on the screen the observer gets the sensation of the color violet.

Let us study the operation of the transmitter and receiver working together. See Fig. 1.

Suppose green leaf "a" be the object



White light, generated by the arc B and transmitted through the scanning disc A and the collecting lens Y, is broken up into the six colors shown. The seventh color, indigo, is disregarded from the television standpoint. Each section of the special photo-electric cell responds to two of the colors.

whose image we are going to transmit. On being illuminated by a stream of white light, it will absorb all the colors except the green, which it will reflect on the scanning disc "B," through one of whose holes a pencil of light is allowed to pass. Lens "C" will focus it on a point, determined for all the colors, on dispersing prism "D," which will spread or bend them according to the angle of dispersion corresponding to each color in the spectrum. On entering photo-electric cell "E," it will illuminate cell 2 and 3, which are suited to permit the passage of an electric current, only to be stimulated by a light, notwithstanding the color, giving us two currents, which are then amplified and transmitted to the ether in the form of Hertzian waves, both at the same time, on different wavelengths.

Example: 200 meters wavelength for the current coming from cell 2, and 150 for that from 3. On transmission, cell 1 will operate on 100 meters. The

receiver (Fig. 2) by its antenna will receive the waves transmitted, and once amplified, the currents are directed through the three wave-traps adjusted to 100, 150 and 200 meters wavelength, in such a way that when the electric signals of 200 and 150 meters length cross the traps adjusted to these values, they are diverted toward the lamps. That of 200 meters will light up the lamp yellow and that of 150, the blue lamp. As the white light, on traversing the colored glasses, will get the color from them, the yellow and blue light of the lamps, after being blended, are focussed by lens "m" on the scanning disc "1," exactly synchronized with that of the transmitter "B," and will cause a ray to pass which, on being reflected on to the screen, will appear to the observer to be "green," identical with the color of the leaf "A" which is being transmitted.

—Ciencia Popular.

## How to Use a Lathe in Laying Out Discs

EXPERIMENTERS wishing to lay out a television disc and not having access to precision machinery, but who can obtain the use of a machinist's lathe, with thread-cutting attachments, will find the following of interest, as an accurate job can be done.

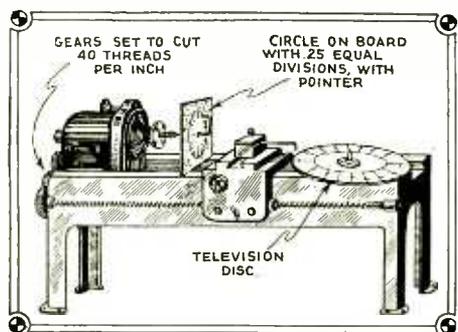
The diameter through the outside hole may be drawn; also this circle can be divided into the proper number of degrees, using a good pair of dividers sharpened to a needle point. This is best done after the hub and shaft have been mounted, using the shaft as the center to work from.

**Phonograph Needle for Marking**

Next fasten the lathe chuck, face up, to the lathe bed to the right of the carriage. Next put the disc shaft through the chuck and tighten all four chuck screws until the disc can just be turned with ease. For a hole layout "marking tool," solder a phonograph needle to a six-inch piece of square brass rod and clamp in tool holder, adjusting the same so that needle clears the disc by the smallest fraction of an inch. Adjust the lathe carriage and disc so the needle will follow one of the degree marks toward

the center when started at the intersection of this mark and the outside diameter circle.

For a scale as a revolution guide on the lathe-head, use a six-inch square piece of white pine divide a circle drawn on one side into twenty-five equal divisions. Bore a quarter-inch



By employing this set-up, the owner of any standard screw-cutting lathe can lay out the holes of a scanning disc with great accuracy. The lathe acts as a micrometer and does the job quickly and neatly.

hole in the center of this circle and mount the board edgewise on the lathe bed, so that the hole lines up with the center hole in the chuck holder. For a pointer on this scale bend a heavy piece of wire and mount as illustrated, by putting through a hole in the board and into the small drill chuck, with tapered shaft, which goes into center hole in head.

Next set thread-cutting gears to cut forty threads per inch. This will make a micrometer of your lathe, for when the head is turned one revolution the carriage will move one fortieth or twenty five-thousandths of an inch.

**Beware of "Backlash"**

For example, if a .015 inch spacing is wanted, move the marking tool to the first hole position and set the pointer on number one mark on the revolution guide, and fasten securely in its holder. Now move the pointer 15 divisions and the marking tool will move .015 of an inch. Care should be taken not to overrun on your guide, as the "backlash" in trying to back up will cause an inaccurate marking of your disc.—Contributed by R. A. Mes-sick.

# Television Reception with a SHORT WAVE CONVERTER

It seems to be a common belief that a converter cannot be used for television. Numerous articles on the design of short-wave receivers for television stress the fact that pictures require a maximum frequency of 43,000, while the standard type of audio amplifier cuts off around 6000 cycles. The result is described as an undecipherable or very poor image which is of no amusement value at all. The above statements must not be taken to mean that a con-

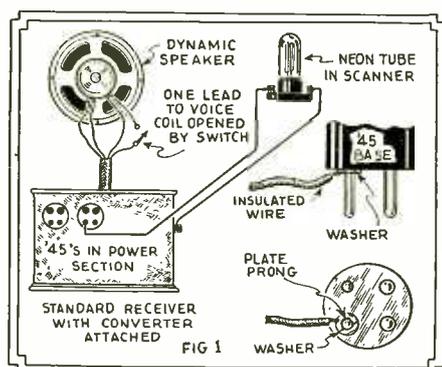
By  
**FLOYD FELLOWS, E.E.**

**Everyone says it can't be done, but Mr. Fellows has done it. Using a converter with a regular broadcast receiver, he obtains satisfactory images from several stations.**

left half of the adjacent picture is seen in the frame opening. This can be corrected by moving the frame opening either to the left or right or possibly by momentarily cutting off the scanning motor power, which will cause the image to drop back several frames.

When the television station is off the air the neon glow lamp should give a bright red uniform glow over the whole surface of the frame opening. When any station is being received this red glow will resolve itself into the image, which may be cleared up by operating the receiver controls.

This complete layout was used by the writer on several makes of super-hetero-



Schematic arrangement of the connections which must be made to the broadcast receiver for the reproduction of television images.

verter is to be preferred to a properly designed television receiver, for it is not; however, some pretty fair results can be obtained with a converter.

A Baird short-wave converter was used in these experiments and proved very satisfactory. There is no reason why any good converter of merit will not perform properly. This converter is used in connection with a good make of super-heterodyne broadcast receiver, which should be of the usual type employing 245's in push pull.

The scanning device can be of any make using a neon glow tube. A 60-line disc was used, as there are several 60 line stations near the writer.

## Making the Connections

The broadcast receiver used by the writer is of the type in which all connections are contained within the metal chassis, including connections to the push-pull transformer. The only wires terminating outside are the dynamic speaker field and voice coil wires. This means that any connection to the primary of the push-pull transformer is impossible without destruction to the original chassis layout.

The converter is hooked up in the usual manner so that the proper setting of the dials will bring in the television signal on the speaker.

The scanning device neon tube is connected to a plate prong of one of the 245 amplifier and to the chassis. The schematic arrangement is shown in Fig. 1.

This connection to the plate prong can be simplified by obtaining a copper washer having such an inside diameter that it will fit snugly over the prong. A wire is then soldered to the washer. A make

shift connection can be made by wrapping the wire around the prong and replacing the tube in the socket. Care should be used, however, to make sure the uninsulated portion of the wire does not touch the set chassis.

Now that the receiver and converter are tuned in to the television station and the neon tube connected, the image is ready to be received. The scanning disc motor is started and when it comes up to speed a picture pattern will start to run across the frame opening. As the disc comes into synchronous speed with the transmitter the picture will slow down and become stationary.

An arrangement should be made on the dynamic speaker to cut off the voice coil as the constant singing of the television signal becomes unpleasant.

## Clearing the Image

To clear up the image the volume and tuning control knobs should be adjusted on the broadcast receiver and also the tuning controls on the converter. If the broadcast receiver has a tone or "static" modifier it should be left in such a position as to give the sharper audible sound when the signal is heard on the speaker.

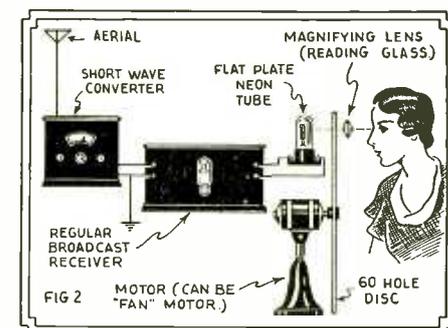
By chance it may be that the image when first viewed, is negative; that is, white objects are black and vice versa. This can be corrected by moving the plate prong connection on the 245 tube to the plate prong on the other 245 tube.

The image may be out of frame, that is the right half of one image and the

## R.C.A. Shows Television

Experimental work in television reception was demonstrated in New York on May 16th, 1932, to its licensees by the Radio Corporation of America. About one hundred executives and engineers, representing approximately fifty radio set and radio tube manufacturers, attended the demonstration, which was not open to the press. The greatest secrecy was maintained.

Although continuous progress has been made with television, this development is still in the laboratory stage. The demonstration was held for the purpose of showing RCA licensees the present status of research and development being carried on by the RCA and its subsidiary companies in this field.



Complete layout, showing the short-wave converter, the broadcast receiver, and the scanning apparatus.

dyne broadcast receivers. Programs were received from W2XAB, W2XR and W2XCR. Sometimes the station's images will oscillate slightly back and forth in the frame opening. This is caused by the scanning disc motor not being in exact synchronism with the motor at the transmitter end. The reason for this is that the motor speed varies or that the power supply at the transmitting end swings in and out with the supply at the receiving end.

The advantage of this set up is that it provides for the reception of images without the added expense of purchasing a short-wave television receiver and permits the use of a present broadcast receiver and converter.

Radio engineers stated that television can best be brought into practical application on its own band of ultra short waves, thereby providing ultimately a service additional to the established service of sound broadcasting. Much work remains to be done toward the improvement of receiving equipment and the creation of transmission facilities for practical television broadcasting.

## Lemmon Resigns

Walter S. Lemmon, formerly vice-president and director of the Short-wave and Television Corporation of Boston, Mass., is no longer connected with that organization, according to a statement issued by A. M. Morgan, general manager.

# How to Make Accurate Scanning Discs

AS a reader of TELEVISION NEWS I wish to let my television friends know how I make my own scanners. The hint I wish to give amateur visionists has been in use in my workshop for sometime, and has proved successful.

I first tried to make my discs by simply dividing a circle with a compass, and then placing the holes on the spokes thus drawn on the metal. I tried that way several times, but have been unsuccessful and all I could get was a disc giving heavy black lines in the picture.

On the other hand I did not wish to go to the expense of buying a vernier and other necessary tools so I designed a machine, which is very handy and cost me only a few hours work and a few dollars for parts.

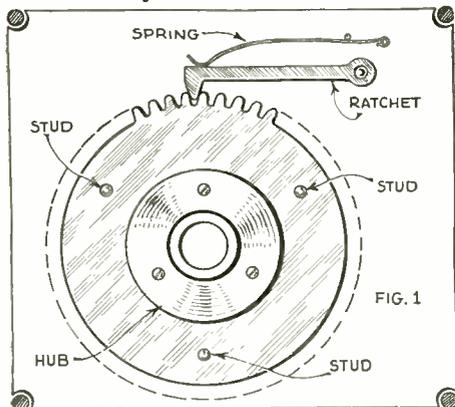
The machine is made of two distinct parts, i.e., the *divider*, and the *perforator*.

## The Divider

The *divider* has been designed in the most simple manner. I bought a gear wheel, of the type used in clocks, having 120 teeth. (I paid no attention to the pitch), and made a small ratchet that is held engaged in the teeth by means of a spring. The wheel itself has been mounted on a brass hub that runs on a small vertical shaft, which has been turned out of a piece of steel. The diameter of the hub is the same as the hub of the driving motor that rotates the disc. In my case it was 1/2 inch in diameter. On the gear wheel there are three studs which hold the blank disc in place when threaded on the hub. It threads at the same time on the studs, on which screw three brass terminal units. Fig. 1 shows the assembly of this part of the machine.

I have chosen a 120 teeth gear wheel because it enables me to divide in 30, 40 or 60 holes at will, by simply jumping the number of teeth necessary for the division.

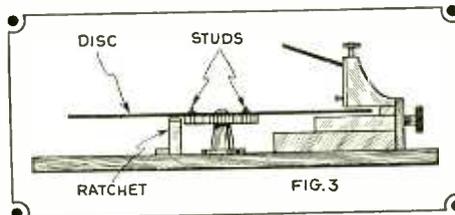
On this side, (France), no experiments have yet been carried out with



The divider unit of the disc punching machine.

## By MARCEL MARRET

**Making an accurate scanning disc is a test of your mechanical skill and patience. If you make this machine first, you will be able to punch out usable discs at a much faster rate than if you attempted to mark them out by hand.**



Perspective view of the punching machine, showing the sliding base 3 and the micrometer adjustment 5 and 6.

48, 72 or 84 holes, but should this case arise, there would be no difficulty in changing the 120 teeth gear wheel for another having the appropriate number required.

The other part of the machine is the *perforator*, which I made out of cast iron. It is built fairly heavy, on account of the precision required. This was considered as an essential condition if we want to make a good job of it.

The first part is a slide base, made in the same way as those used on ordinary lathes. (Fig. 2, part 1) It can be made of one part if it is machined by a specialist, but in my case, it has been made in three parts. One is a flat cast iron base 1/2 inch thick, on which are screwed the two guide plates No 2. The perforator base No. 3 is a piece of cast iron, 1/2 inch thick, and adjusted so as to slide gently in the guide plate, but without play. The perforator base has a hole bored right through in the middle, and threaded at a diameter of .2 inch, so that a complete turn of the screw will cause an advance of the perforator of .04".

## The Graduated Scale

On the knob fixed to this screw a small dial divided in ten equal parts has been fixed, and a pointer permits the reading of this scale, each degree being equal to one tenth of a millimeter (.004") advance of the perforator. This enables the disposition of the holes in the spiral with the necessary overlap, that should not exceed 2 percent, otherwise clear lines would appear in the picture. In Fig. 2, knob 5 and graduated scale 6 are clearly shown.

The punch head 8 is fixed on the sliding base 3 by means of two large screws, which hold it firmly. This is separated from base 3 by a thin layer

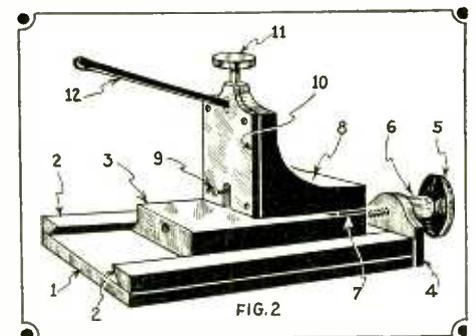
(7) .032" thick, which is equal in thickness to the metal used for the disc. In our case it is aluminum, which has proven to be sufficiently rigid for this use.

The punch head 8 bears in its front part a square groove 1/2" x 1/2" square, in which slides a punch holder of the corresponding size. This cannot be seen in Fig. 2, because it is covered by the front plate 10, but the protruding screw 9 can be seen easily. This screw holds the punch tight (that is inserted in the sliding bar). This bar is terminated at the top by a knob, on which the fist strikes, to push the punch through the metal; 11 is the knob, and 12 is a lever that catches the sliding bar when depressed downwards, and pulls the punch out of the counterhole, where it fits exactly. This latter condition is essential if clean holes are to be obtained in one operation.

## How It Works

The working of the machine will be readily understood, now that we know how it is made. The first thing to do is to bring the perforator backwards by turning the knob 5 from left to right in a screwing motion; then place the blank disc on the 120-tooth gear, and fasten it by means of the three brass nuts (terminal nuts). Then advance the perforator on the disc until the first hole will be driven through by knocking on the knob 11, and punch withdrawn by pressing lever 12 downwards. After this first operation, turn the disc the number of teeth required for the division in either 30, 40 or 60 holes, advance the punch head the necessary tenths of a millimeter (or inch equivalent) and drive the second hole through, and so on, until finished.

The holes are cleanly cut and are sure to be in the correct position, which can be readily checked by placing the disc on the motor shaft and running it at the usual speed. With a little practice, these operations will be done quickly, and only a few minutes will be required to make a really useful disc.



Side view of the disc perforator, showing the relative positions of the divider and its ratchet, the blank disc, and the punching machine.

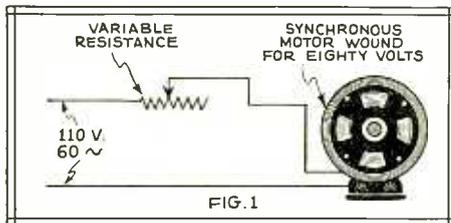
# PHASING THE TELEVISION IMAGE

## An Explanation of Why Television Images Sometimes "Pass Out of the Picture," and Some Suggestions On Curing This Annoying Trouble

By C. H. W. NASON

**T**HE fact that a perfectly-framed image may suddenly slip out of frame (in the horizontal "sense") has caused much argument and discussion. Those who recognize the true cause of the effect are few and far between. This behavior on the part of an otherwise well-educated synchronous motor is rather puzzling, we will admit, but the explanation is quite simple.

In a synchronous motor the impressed and the back electromotive forces are out of phase by a certain number of (electrical) degrees. For a six-pole motor, such as employed in systems of the present standard, the electrical phase angle is about 20 degrees and, since there are three pairs of poles, this corresponds to about 6° 40" angular measure, as applied to the actual scanning disc. Any



A rheostat in the motor line provides one of the simplest means of framing television images.

change in the power factor of the load, or any variation in the line-potential, will result in a marked disturbance of this relation, because of the resulting shift in the phase relationship between input and back e.m.f. The fact exists that a great amount of the distortion in present-day images results from a failure of the synchronizing action, due to minute changes in the line-voltage and, consequently, in this phase relationship.

Unless we are to employ motors having an exceedingly large number of poles, we can never hope for a perfect synchronizing action; since the demands are for a system in which the angular variation of the rotating member should never exceed the angle subtended by a single picture element—this is equal to 6°/72 or about 5" of angular measure. A little thought will show that even a slight fluctuation in line-voltage, at either end

of the synchronizing network, will exceed this limit where a six-pole motor is employed. Exhaustive study of this situation will show that a motor having 150 or more poles would be required for acceptable synchronization; but a motor of this character would require an exceedingly high excitation or driving frequency, and thus can only be achieved where a separate synchronizing component is transmitted, together with the image signal.

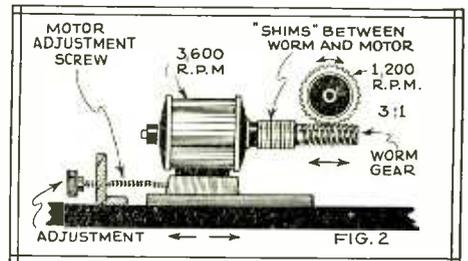
The fact that this pessimistic attitude is based upon thoughts concerning the ideal system only is evidenced by the excellent images to be obtained under present circumstances. We can deduce from the foregoing remarks, however, the fact that a change in the power factor of the load, or in the line-voltage, can effect a de-framing of the received image, such as to require adjustment from time to time during reception. The re-framing can be accomplished by either mechanical or electrical means.

### Electrical System for Lateral Framing

Since a variation in the applied voltage will cause a change in the angular relation between input and back e.m.f., we can see that a certain amount of framing can be accomplished by means of a rheostat connected in series with the motor's supply. Fig. 1 shows a method of accomplishing this end which has been employed in several commercial television sets. The motor in this particular case has been designed to operate at eighty volts, rather than at 110. The rheostat can be used to frame the image quite readily, since a change in the series resistance will result in a change in the applied voltage, and a consequent shift in the angular relationship between the input and back e.m.f. Where the specially-wound motor is not used, a simple series resistor may be employed, either as a continuously variable device, or as a fixed element shunted by a push switch. A mere touch on the switch would be enough to shift the position of the image through a small angle.

Many methods have been shown by which the image can be framed mechani-

cally. The greatest number of those which can be applied, practically, involve the rotation of the motor's stator winding by means of a special cradle. This is an expensive proposition and the writer has been led to devise the following scheme to simplify the mechanical structure. A 3,600-r.p.m. motor is required—this demand being rather easy of fulfillment since 3,600 r.p.m. motors are of a standard character, whereas 1,200-r.p.m. motors have only come into demand since the advent of television. Where proper gears are available, an 1,800-r.p.m. motor may also be used. The gear reduction for shifting to a disc speed of 1,200 r.p.m. has a 3:1 ratio and employs a worm-and-gear arrangement as shown in Fig. 2. The motor is so mounted as to be movable through a small distance by means



A more complicated but also more effective method of making television images "stay put" in the receiver.

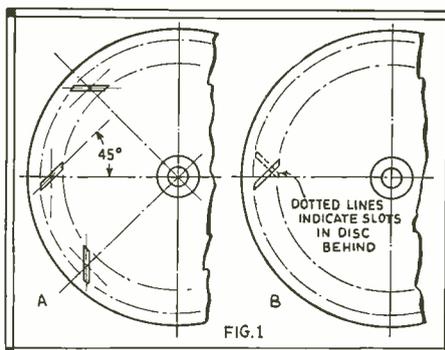
of a knob and screw—also shown in the illustration. It can readily be seen that, if the motor's shaft is at rest, any motion of the motor, and consequently of the shaft and worm, will result in a slight angular motion of the disc. It is this motion which, when applied with the disc in rotation and in the direction of the arrows, will result in a slight shift of the angular position of the disc and a consequent correction of the lateral framing of the image.

It is essential that the motor "end-play" be taken up by means of shims placed between the bearing and the worm, as shown; since otherwise the shaft's play will result in "hunting" (swinging of the image). Gears, such as those here shown, may be readily purchased from manufacturers in types and sizes which permit of accurate assembly and of noiseless operation.

## A Double Disc Scanner By Jess M. Reed

**H**ERE is a scanner which "picks the picture to pieces" by means of slots instead of the customary holes. Impossible? Not at all! Let me tell you how it is done, and I am sure you will agree that this system has certain inherent advantages not found in other systems.

We all know that a square hole will pass more light than a round hole of the same cross section. Therefore, if we are going to use holes at all, we want to get all the light possible through them, and square holes should be used. Now it is possible to obtain a square hole without actually cutting



the hole in the disc. Suppose, for instance, that we cut a narrow strip in two discs and place one slot over the other at right angles to it. The result is a square hole! That is exactly the principle used in the double disc scanner being described. It is much easier to cut a good, clean slot than to punch square holes in a disc. The slots do not have to be arranged in a spiral; therefore if one of the slots happens to be a little off, there will be no streaks to mar the picture. It is possible to go over the same strip of picture twice before the slot moves

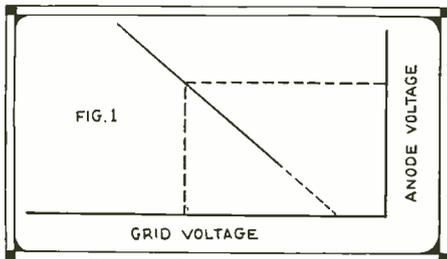
(Continued on page 154)

# SYNCHRONIZING D.C. MOTORS WITH THE *Thyratron* TUBE

By M. Rappaport, E.E.

THE extremely important question on how to keep motors of the direct current variety at constant as well as synchronous speed for television purposes is very perplexing indeed to the present day experimenter. When a television receiver is located in a district supplied with alternating current a synchronous motor may be very well employed. But alternating current is not supplied everywhere and as a result this article is intended especially for those who are not fortunate enough to be in an alternating-current district.

There are many types of speed regulators on the market, consisting generally of a mechanical device operated by centrifugal force, which in turn operates relays to keep the speed constant. Although these regulators function well for power work, they become useless when applied to television scan-



Graph showing the characteristic curve of a Thyratron tube.

ning. There are several reasons for this fact, and the first and most important is that the tension of the springs on the relays change with time. Another very important reason is that the springs are usually so small that the tension cannot be accurately adjusted. Lastly, the device, being mechanical, possesses inertia, so that there exists a time lag between the time that the machine starts to slow down and the instant that the compensating action starts.

### Continuous Action Necessary

The answer to these disadvantages is to devise an apparatus which is purely electrical and which has little or no mechanical inertia. Another characteristic which this apparatus must possess is that the regulating action should be continuous, and therefore relays cannot be used. One of the means of doing this would, of course, be to employ a vacuum tube. However, the ordinary size tube handles only small currents and therefore relays would have to be used. Since we wish to avoid the use of relays, the ordinary vacuum tube is decidedly unpractical. What is desired then is some device which will have good control characteristics and at the same time have sufficient current carrying capacity to be able to change the field current of the motor. The thyratron tube embodies all of these advantages.

The thyratron tube is essentially a three-element rectifier tube into which, after exhaust, mercury vapor is inserted. The presence of the vapor performs the function of changing the pure electronic discharge into an arc, thereby making the thyratron an electrostatically controlled mercury arc rectifier. Due to its controllable rectifier characteristics, the thyratron naturally falls into the category of the pure electrical relays. It is instantaneous in operation and may be kept under absolute control. The electrical relay characteristics of the thyratron depends largely upon its inherent nature, as represented in Fig. 1. In this diagram the abscissa is given as the grid potential, and the ordinate as the plate potential at which the electrical breakdown of the tube occurs. When the plate voltage is raised to a critical value which depends upon the grid potential, an arc will appear. In other words, the grid performs as a trigger which sets off the arc.

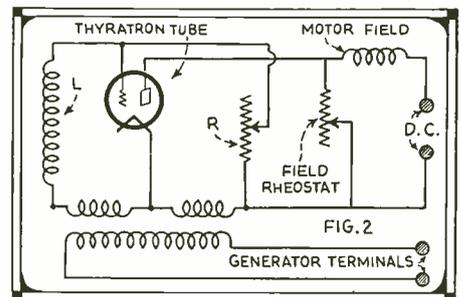
The grid control ratio of the thyratron tube, which is its only characteristic constant, is defined as the ratio of positive anode voltage to negative grid voltage that will just allow current to start. This ratio assumes a constant value for thyratrons whose glass walls do not exert a grid effect, and may be expressed by the equation

$$e = - \left[ \frac{\Delta E_p}{\Delta E_g} \right] i_F = 0$$

Where  $E_g$  is measured with respect to the most negative emitting point of the cathode and must be corrected for contact potential differences between the grid and the cathode and for initial velocities of the electrons. The contact potential may assume as much as two volts and the initial of about one-half volt.

The maximum amount of current a thyratron tube may carry has two limitations. That is, the current must not exceed the pure electronic emission of the cathode. This limit is accomplished by means of an impedance in the plate circuit, because the thyratron has no appreciable internal resistance. If the load resistance does not limit the current then the thyratron develops a pseudo-internal resistance taking the form of a high cathode drop which disintegrates the cathode. The other limitation is that the current must be sufficiently low so that its passage will not heat the grid to an electron emitting temperature. If this condition should occur, the grid circuit will have current flowing through it and the tube will have no control characteristics.

Now that we have an idea of the operation of a thyratron tube, we may

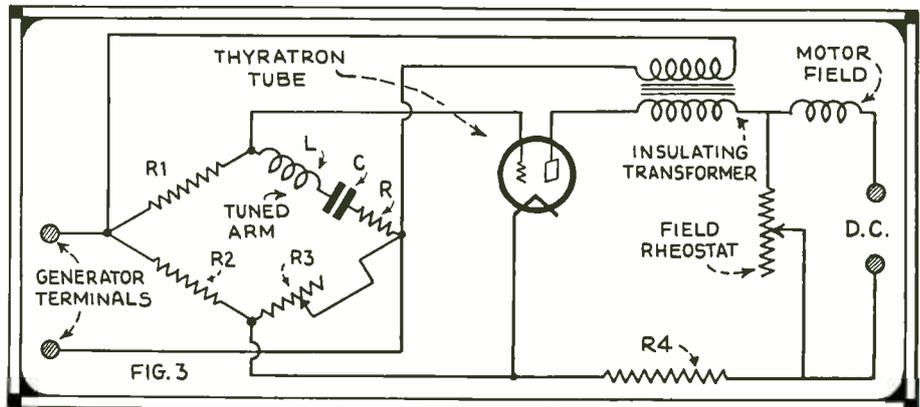


A fundamental circuit for regulating the speed of a dynamotor by means of a Thyratron.

apply it to the operation of a synchronous propelling force for a television scanning disc. What we use in this system is a dynamotor, that is, a motor-generator wound on the same armature. The motor winding is operated off direct current, while the generator produces alternating current. This dynamotor may be purchased at a price not much in excess of a good synchronous motor.

When the dynamotor is rotating at a certain speed, say 1200 revolutions per

(Continued on page 158)



Tuned alternating current bridge method for running dynamotor at synchronous speed for propelling disc in television reception.

# An A.C. Operated TELEVISION TRANSMITTER

PART TWO

By L. R. CONRATH

Engineer, Trav-ler Radio & Television Corp.

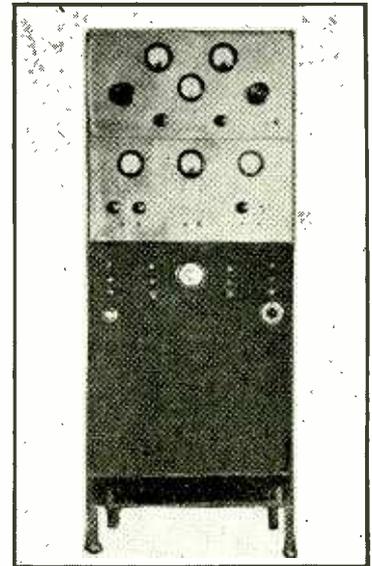
IN THE previous article mention was made of the fact that all "A" and "B" batteries had been eliminated in the design of the amplifiers used in the Trav-Ler experimental television transmitter. There are three amplifiers used, two of which are mounted on the rack shown in the photograph. They are the main amplifier, which consists of five stages, and the power stage, which employs parallel fifty-watt tubes to modulate the oscillator. The other is the P.E.C. input amplifier, of two stages, which is contained in its own shield can, and mounted on the shelf behind the photo-cell rack.

### Separate "B" Supplies

For the P.E.C. (photo-electric cell) amplifier and the main amplifier, two individual "B" supply circuits are used, each employing a type '80 rectifier tube. The power stage is supplied by a rectifier circuit utilizing two type 872 half-wave mercury rectifiers. The filaments of the power stage and of the last two stages of the main amplifier are heated with A.C., while all the other filaments are supplied with D.C. from two special "A" power-packs. These "A" supply units, which are a recent development of the B-L Electric Mfg. Co., consist of a dry metallic rectifier supplied by a stepdown transformer, connected as shown in the diagrams. The condensers used in the filter circuits are of the dry electrolytic type, and are exceptionally compact. Each "A" pack occupies less space than a storage battery and provides an un-

failing supply of D.C. so well filtered that the ripple component of the output, under full load, has been shown to be less than one-half of one-thousandth of one per cent.

To insure a good frequency response, it was deemed advisable to use a large number of comparatively low gain stages rather than a few high gain screen-grid stages. The P.E.C. amplifier consists of two type 227 tubes, resistance-coupled, and mounted in a sheet metal shield can, which is supported by four sponge rubber biscuits. The tubes are mounted on an aluminum panel which is suspended within the metal box by eight coil springs to insure against mechanical vibration of the elements of the tubes, which would result in microphonic noises. The input and output terminals are bakelite binding posts mounted on opposite ends of the box, while the "A" and "B" power is supplied through a shielded cable from the packs which are contained in the main amplifier rack. The



The audio amplifier rack of the A. C. operated television transmitter.

cable terminates in a multi-prong plug at each end, to permit of easy dismantling of the equipment, to facilitate transporting it from one location to another.

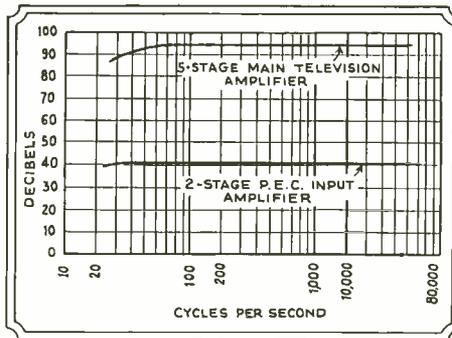
Each tube has its own aluminum shield can surrounding it, in addition to the protection afforded by the steel box which encloses the amplifier. It will be noted from the diagram that each stage has its own "C" battery, and that a 90-volt battery is used to "polarize" the photo-cells. The use of individual "C" batteries avoids common coupling between stages and provides a better frequency response than can be obtained with automatic biasing arrangements. The variable condenser shown in the P.E.C. amplifier diagram is used to provide a certain amount of audio-frequency regeneration, which has a remarkable effect in increasing the pictorial detail of the image at the receiver. Excessive regeneration, however, will result in persistent oscillation which will completely obliterate the image.

### Five Audio Stages

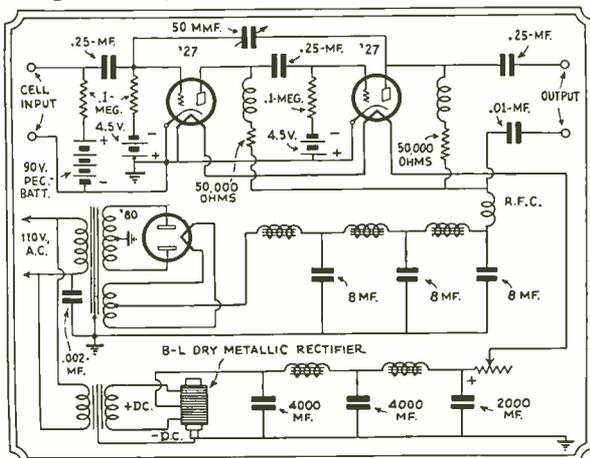
The main amplifier consists of four 227 stages and one pentode stage in which two 247 tubes are operated in parallel. This amplifier is located behind the middle panel in the rack shown in the photograph. Above it is the modulator stage and below it are the several "A" and "B" power supplies. The meters on this panel, from left to right, show A.C. line voltage, plate voltage and pentode plate current respectively. The knobs control the filaments, volume level and "B" supply. A pilot light indicates that the amplifier has been switched on.

The meters on the top panel indicate plate current, filament voltage, and plate voltage of the fifty-watt tubes. The small knobs are used to switch on the filament transformer and plate supply, while the two large knobs are for the power rheostats which control filament and plate voltages. The diagram and description of the modulator and oscillator circuits will be given in the next article.

The lower panel contains a meter to



Above: audio frequency response curves of the amplifiers employed in the A.C. operated television transmitter. Left: complete hook-up of the photo-cell amplifier. Note that the filaments of the '27's are operated on direct current from a dry metallic rectifier.



show the P.E.C. amplifier plate voltage, and switches and pilot lights to control the "A" and "B" power packs. The socket at the left is the outlet to the P.E.C. amplifier and supplies "A" and "B" voltages as well as the photo-electric cell voltage. The socket on the right provides a convenient supply of 110 volts A.C. and is useful for operating a scanning motor, lamp or other device requiring this voltage.

The rack is built up of angle-iron sections and is mounted on four rubber-tired ball-bearing rollers. The four decks behind the front panels support the amplifiers and power supplies and a steel conduit running from top to bottom of the rack carries all connecting wires between decks.

**Shielding Is Thorough**

The main amplifier is divided into five sections, each containing one stage, and each of these stages is completely enclosed in an aluminum shield can, which contains the individual "C" batteries, resistors, condensers, etc. Connections are made through the walls of adjacent shield compartments.

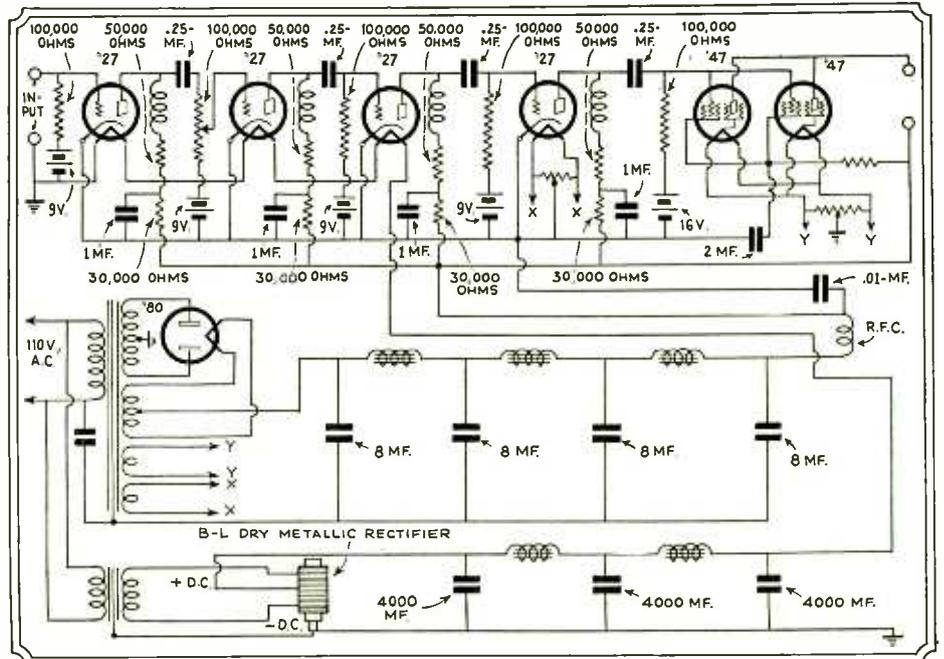
For convenience, jacks are provided on the front panel for input and for plugging in a pair of phones on any stage for monitoring and testing. Connection between the main amplifier and the power stage is effected with a short cable equipped with plugs at both ends to fit the output and input jacks, respectively.

It is somewhat of a task to build a multi-stage resistance-coupled amplifier, to operate it from A.C., and to prevent motor-boating and oscillation, but the use of the proper isolating circuits, consisting of resistors in the plate circuits, by-passed to ground, permits its accomplishment. In some cases quite large by-pass condensers may be required to prevent low frequency "motor-boating." A certain amount of patient experimenting is usually required to stabilize a resistance-coupled

amplifier with a gain in the neighborhood of 135 decibels.

There is nothing very complicated about the circuit diagram. Upon examination, it will be seen that the stages are alike, each consisting of a

Reference to the curves will show that from 50 to 70,000 cycles there is a variation of only two decibels. The total gain of the two amplifiers (excluding the power stage) is about 135 decibels. It is never necessary, how-



The main audio amplifier of the television transmitter, which follows the photo-cell amplifier shown at the bottom of the preceding page. The filaments of the first three '27's are heated by direct current, while the fourth '27 and the two '47's work on raw alternating current from a secondary winding on the power transformer.

coupling condenser, a grid-leak, two plate resistors, a by-pass condenser, and a special air core choke. This choke has a broad resonance peak at the higher super-audible frequencies encountered in television, and serves to bolster up the high end of the fidelity curve.

ever, to use the maximum gain available for the transmission of television images.

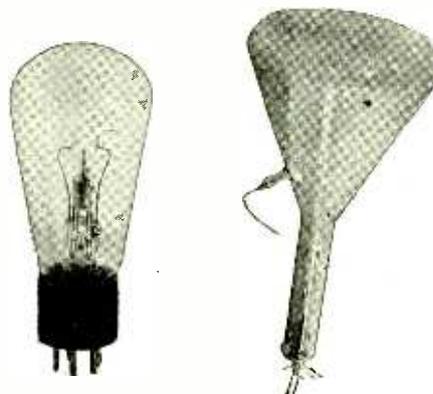
The next and concluding article of this series of three will describe the modulator and oscillator and a complete lens disc scanner and receiver in a modern console cabinet.

## Cathode Ray Tubes Now Available to Experimenters

CATHODE ray tubes are now available to the experimenter. This is welcome news, for these fascinating electronic devices, which have many potential applications other than the electrical scanning of television images, have heretofore been limited to professional workers and the largest laboratories because of their elaborate construction and high cost.

Developed by Allen B. DuMont, chief engineer of the Globe Television & Phone Corporation of New York City, the new cathode ray tubes are characterized by simplicity and moderate cost. The first type of the series is designed to demonstrate the principle of the cathode ray tube, thereby introducing experimenters and students to the new art at a very small investment. In outward appearance, this smallest cathode ray tube is similar to the usual '45 power tube, with a glass bulb of the same shape and size, fitted to a standard five-prong base. A glance inside the bulb, however, discloses the cathode "gun" which sprays a stream of electrons against the fluorescent screen on the inside of the bulb's rounded top, as well as the single set of deflection plates which control the electronic stream in accordance with the voltage impressed upon them. The sen-

sitivity of this device is such that for every volt impressed on the deflection plates, the electronic stream or beam is shifted one tenth of a millimeter, as measured on the fluorescent screen. The tube filament operates on 0.5 to 1 volt, with a drain of 5.0 amperes. From 250 to 500 volts is impressed on the accelerating electrode for the creation of the electronic stream.



Left: the small size cathode ray tube. Right: the 3-inch model.

A step ahead is represented in the 3-inch cathode ray tube with two sets of deflecting plates, so as to obtain an additional control of the stream or beam at right angles to the first. The glass bulb in this case is funnel shaped, with a six-prong base at the end of the long neck, and a flattened window at the front, carrying the fluorescent screen. Because of the distance from the cathode to the screen, as well as the positioning of the two sets of deflecting plates, a far more sensitive device is obtained than in the case of the smaller type. The various voltages and current characteristics remain the same, but the sensitivity is increased to 0.5 millimeter per volt impressed on each set of plates.

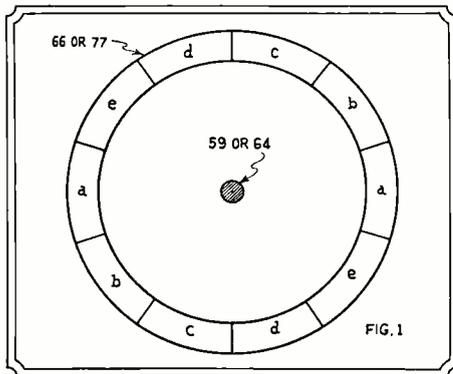
Although the main interest in cathode ray tubes might seem to center about electrical scanning for the reception of television images, there are more immediate and practical uses. Such electronic devices may be employed as voltmeters, ammeters and resonance indicators, utilizing the swing of the spot of light. Again, the gyrations of the light spot may serve to study the wave form of the most intricate electrical variations, such as speech or musical modulation.

# Television Transmission on a Narrow Wave Band

by Lieut. George Wald  
Q.M.C., U. S. Army

THE object of my invention is to permit television transmission within a narrow wave-band. It is a well-known fact that if the grid of an oscillator is made highly negative in relation to the filament, the tube will cease oscillating. Likewise, if the grid potential is made highly positive, the oscillations will cease, since the flow of current from the filament to the plate will stop at the grid.

The image to be televised is scanned by a special light-quantitative scanning device that selects from the image areas of equal light strength. If, for instance, we choose to divide the image into six classes of light strengths, a scanning device is used like the one shown in Fig. 1, with five partially transparent sectors. Each sector, "a,"



Design of the special disc proposed by the author for his narrow band television system.

"b," "c," "d" or "e," is less transparent than the other. The speed of the disc (66 or 77) is such that each sector, "a," "b," "c," "d" or "e," intercepts the image beam during the time the regular scanning device scans the image one complete sub-frame. Thus, as the regular scanning device scans that area of the image which is of a certain class of light, a current of a certain magnitude results. This current is passed through a rectifying tube, the characteristics of which are such that a certain critical voltage is required before rectification will take place. Thus, any voltages existing below this critical voltage will not affect the transmitting oscillator.

### How Current Varies

When the scanning devices pass the area of a class of light corresponding to the light-quantitative scanning sector, or brighter than that, a voltage is produced which is either equal or higher than the critical voltage, thus making the grid of the oscillator tube (19, Fig. 2) either highly negative in relation to the plate or highly negative in relation to the filament (according to what we choose), which stops the oscillator, the critical voltage as passed

by the tube (19) being of such magnitude as to accomplish the latter. In Fig. 3 a light curve of a part of an image line is shown. The vertical lines show what part of light each light-quantitative sector will permit to pass through it. The oscillator will be stopped during each sub-frame for the length of time the scanner is passing that part of the image falling below the light curve (78), while it will operate at the normal frequency when above the curve (78). Thus, in the sub-frame "e" there will be only two brief interruptions, while in sub-frame "a" the station will remain silent during the entire that the line is scanned, except for a brief duration marked "o." At the receiver the reverse takes place. There a commutator (39, Fig. 4) may take the place of the scanning disc (77). Class six light (the darkest areas) is not scanned at all at the transmitter and the corresponding areas remain dark on the receiving image screen.

### Eliminates "Key Clicks"

Interruptions of the oscillator which are not caused by any change in the impedance of the circuit will not produce a broad band. In fact, this method provides excellent means for the transmission and reception of wireless telegraphy without "key-clicks." If a photo-electric cell be placed in a light-proof compartment in which there is an aperture covered by a shutter, the operation of this shutter in the same manner as a telegraph key will produce signals which may be transmitted on a narrow wave-band without causing interference to neighboring stations.

When the grid of the oscillator is held highly negative in relation to the filament, the antenna reaction will be free to swing the antenna current and produce a broader band per interruption than if the grid were held highly positive in relation to the plate of the oscillator. It can further be noticed that the sum of the interruptions for all five sub-frames is less than the number of dots per frame as now

scanned. Furthermore, a 1" x 1" image with sixty (60) elements per inch, and ten (10) frames per second, now produces a wave-band of thirty-six thousand (36,000) cycles. If the same image is transmitted as a 10" x 10" image there will be ten times ten times thirty-six thousand (10 x 10 x 36,000), or a wave band of three million six hundred thousand (3,600,000) cycles.

In my method of transmission, each line will have nearly the same number of interruptions per line (for the same image) whether the line is one inch long or ten inches long; thus, to transmit an image ten times the size will require but the square root of ten times ten (10 x 10), or the square root of one hundred, which is ten times as many interruptions as the 1" x 1" image could have. In other words, the

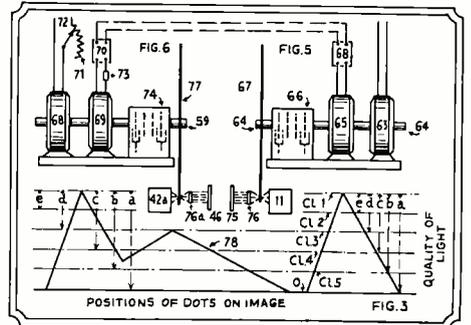
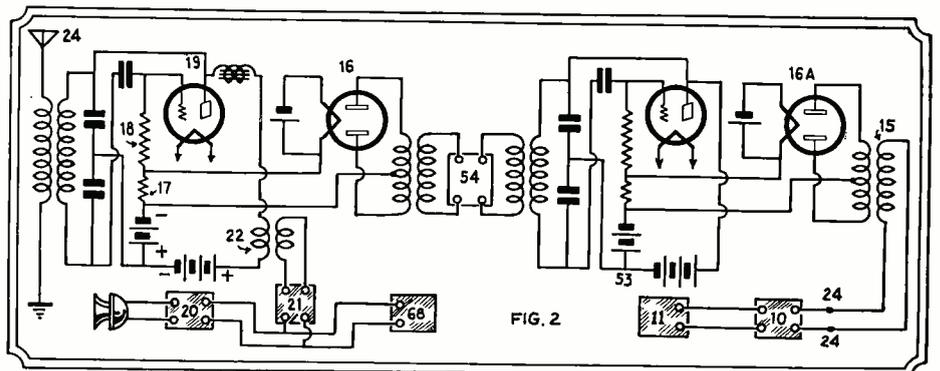


Fig. 3: Current variations corresponding to light fluctuations. Fig. 5 and 6: arrangement of the Wald transmitter and receiver apparatus.

wave-band will be proportional to the square root of the area of the image, as I stated in RADIO-CRAFT, November, 1930 issue.

This can easily be verified by taking a photograph 4" x 4" and enlarging it to a 12" x 12" photograph. In your mind, divide the shading of this photograph into six (6) classes, then lay off on both photographs red lines encircling each class of shading in the



Schematic diagram of the narrow band television transmitter devised by Lieut. Wald.

same manner that elevation lines are laid off in topography, and then mark each line with the class of light it encircles. By mounting the interruptions per line on each photograph, it will be found that the above statement is correct. It must be remembered, however, that when, for instance, class 3 interruptions are counted, the transmitter stopped when line 3 was passed going into that area, and did not start again until the same line was passed going

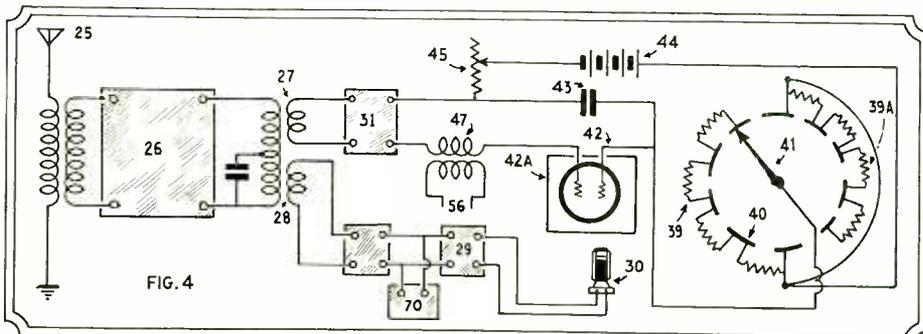
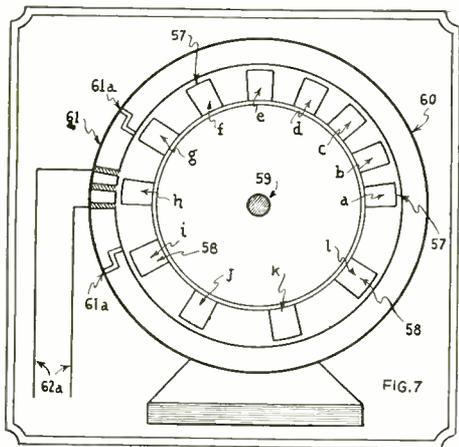


Fig. 4, above: circuit layout of the Wald narrow band television receiver, in which a revolving commutator, 39, replaces the usual scanning disc. Fig. 7, left: sketch of the special synchronizing generator which furnishes the impulses that keep the transmitter and the receiver in exact step.

out of this area. Interruptions of class 6 lines are not to be counted as they are not scanned.

Both the regular scanning devices and the light-quantitative scanning devices are driven by a power motor (63) at the transmitter (Fig. 5) and by a power motor (68) at the receiver (Fig. 6). A variable frequency synchronous generator (65) shown in (Fig. 17) with "poles" (57), produces the variable frequency synchronizing signals which drives the synchronizing

variable frequency motor (69). All that is necessary to synchronize the two machines is to move the arm of rheostat (71) Fig. 6. When the latter is moved part of the way, synchronization will occur. Further movement of this arm will bring the motor in exact phase relation to the generator, i.e., adjustment for the angle of lead or lag will take place. The arm need not be touched after once being synchronized as synchronization will be insured automatically.

## Radio Manufacturers Association Issues Statement on Television

**F**OLLOWING its policy to advise the public accurately regarding progress in television, an authoritative statement was issued recently by the Radio Manufacturers Association, the national industry organization. The statement follows:

"From a confused mass of conflicting statements and data regarding television, only by picking out the pertinent facts from the work that has been done in the past and the facts that are presented in the present situation, is it possible to draw any conclusions regarding the future of television. These facts have been many times oversold, at times maligned and altogether misunderstood, not only by the public but by the leaders of the radio industry itself, which must sponsor this new art.

"This statement regarding television is only intended to array the facts of the past and present to point out some of the future possibilities thus made apparent.

"As far back as 1884 there was recognized by Nipkow, a German experimenter, that to transmit visual images it would be necessary to resolve those images into elements, each element to be faithfully transmitted and re-converted into a corresponding light value at the receiving end. To do this Nipkow employed scanning discs, and later in 1894 Amstutz, an Illinois experimenter, carried on the work in this country even further. In 1913 Jenkins of Washington started his work on the development of television which culminated in 1925 in the showing of animated motion pictures by television. In England, John Baird, after several years of work, showed his first pictures

in 1926. In 1928 the Bell Telephone Laboratories transmitted a picture from Washington (D.C.) to New York. Since that time several other experimenters have been carrying forward the development of television. Prominent among these have been the RCA-Victor Company in Camden, N. J., the Jenkins Television Corporation of Passaic, N. J., Philo Farnsworth, now with the Philadelphia Storage Battery Company, the General Electric Laboratories in Schenectady, N. Y., and U. A. Sanabria of Chicago.

"The problems encountered in accomplishing television transmission and reception have in the past been manifold.

*First*—the problem in the method of scanning which started with the ordinary disc was followed later by a disc with lenses which greatly increased the efficiency. Then came the drums and discs with mirrors. Starting with a Russian named Rosing, twenty years ago, several experimenters have been using electrical principles of scanning which are utilized in the cathode-ray oscillograph tube.

*Second*—the problem of transmission has proven to be very difficult. The light values of the elements of the transmitted picture must be converted to electrical values and then transmitted faithfully either by wire or by radio. This is successfully accomplished only by employing a frequency band of several hundred thousand cycles. This becomes of interest when compared with the width of a band for present day

radio voice transmission, which is approximately 5000 cycles. Modulation of the high carrier frequencies for these picture transmissions becomes very difficult.

*Third*—the reception of television signals has presented still more complicated problems. The radio-television signals must be received, amplified, de-modulated and again amplified to operate a light source. Demodulations above 30,000 cycles has presented many engineering difficulties. Much work has been done on the light sources, the most common of which have been the neon discharge glow lamp, the Kerr cell and the cathode-ray tube.

*Fourth*—the great problem has been that of securing finances. Unfortunately, companies have resorted to over-statements, lured prospects with the possibilities of television in order to sell stock, and often in these statements misrepresentations were made, with the result that the public has been very much confused as to the actual state and present possibilities of the television art.

"The present facts of television which are available are as follows:

*First*—for scanning, mechanical features using rotating parts are in wide use and offer a practical means of securing passable television pictures.

*Second*—a direct pick-up system which has come to the front rapidly this year is that of the camera idea. This system can be used for television pick-up in a

(Continued on page 155)

# Steadier Images With The Aid of a Separately Excited Phonic Motor

By DR. FRITZ NOACK

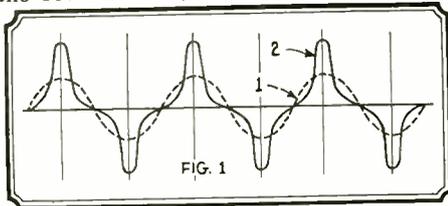
THE USE of the synchronizing wheel or phonic motor in televisions is always represented as something very simple, yet perhaps are the regular thing. Why? Because most amateurs are not clear about the proper construction of a synchronizing motor, the dimensioning of the phonic wheel coils, and the right distance of the magnet poles from the toothed rotor. There are liable to be failures when the amateur, for instance, ventures to construct a local generator of the synchronizing current.

First we shall consider the theoretical basis of synchronizing with the phonic wheel and finally the production of the synchronizing current by a vacuum tube oscillator.

Many televisions today are provided with a synchronizing phonic motor, with the synchronizing current taken from a very steady local generator utilizing either a special tuning fork oscillator or a tube oscillator (European practice). Generally the former is preferred, because it can be kept very constant by heeding special precautionary measures (installing in thermostatically controlled ovens, etc.).

## Methods of Operation

At the receiving end one can operate a phonic wheel by the pictorial line alternating current furnished by the radio receiver, after it has been filtered out of the so-called *picture signal* current and sufficiently amplified, (American system). This method was proposed in Germany by the Telehor Company, but has been abandoned, because with the advent of "fading" there would be no synchronizing current at all, and the motor would act according to "its own sweet will." Moreover, if the number of revolutions of the receiver disc varies altogether too much in the period of fading, it can happen that when fading ceases the receiver disc cannot be brought back to synchronization. This becomes especially troublesome if the synchronous motor or synchronizing phonic wheel is rigidly connected with the receiver disc, as for example in the



The synchronizing motor reacts better if the current through it has the pointed wave form (2), rather than the sinusoidal form (1).

case of the Baird system or the televisions of the Fernseh Company, (which makes Baird receivers for use in Germany). The great momentum of the receiver disc prevents the synchronizing current from being able to get the synchronizing phonic wheel back into the right number of revolutions, after the slightest de-

viation of the number of revolutions from the synchronizing frequency.

The Telehor Company has recognized this failing and has therefore adopted the following course:

## Separate Driving Motor

It uses the phonic wheel for synchronizing in its television receivers, but only for that purpose alone; the scanning disc or "mirror screw" is operated, as Baird also does, by a special motor, which is *not* a synchronous motor. Unlike Baird, however, the Telehor Company does not place the disc or mirror screw rigidly on the axle of the synchronizing wheel, but instead allows this to turn loosely on the shaft. By means of a tension spring laid over the shaft the Nipkow disc or mirror screw is pressed against a disc also placed on the shaft (but rigidly fixed there). The tension of the spring is just sufficient after several revolutions of the shaft so that the Nipkow disc (or mirror screw) is carried along, until in consequence of its friction on the fixed disc and corresponding to its inertia, it comes to the right number of revolutions. The disc (or mirror screw) must have "play," which is absolutely needed for perfect operation. Small deviations of the synchronizing frequency from its supposed value no longer matter now. If such a change sets in, then the picture in the television receiver will swing back and forth a few times, but the disc will not get entirely "out of step," as is easily the case with sets having no "play." If the synchronizing current actually does remain "missing" for a short time, the synchronizing (phonic) wheel is at once again brought back to the right number of revolutions by the newly arrived current, provided the speed of revolution occurring during the time of interruption does not vary too much from the desired speed.

In order to take care of this case as well, the Telehor engineers proceeded as follows:

## Independent Oscillator

A vacuum tube oscillator is installed in its sets which yields approximately the correct synchronizing frequency. This oscillator is impressed on the pictorial line current taken from the television receiver. This pictorial line current thus carries along with it the oscillation frequency, so that it always has the correct frequency and phase value, so long as there is no "fading." If fading sets in, the oscillator keeps on running alone. Now if during the time of fading its frequency is changed a little by the alteration of its plate potential or the like, then in the period of fading the synchronizing wheel and along with it the disc (or mirror screw) will run a little slower or faster. The change will not be great, because the oscillator operates at an almost constant frequency. As soon as the fading stops, the oscillator is again brought back to its desired frequency and again imparts to the synchronizing

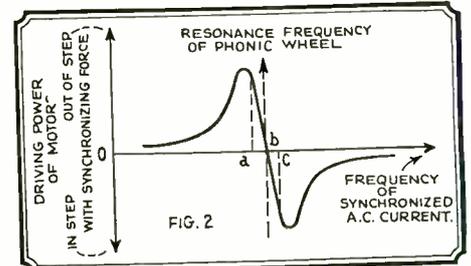
(phonic) wheel the correct number of revolutions.

The synchronizing wheel reacts most exactly on the synchronizing alternating current if the latter does not run in a sinusoidal fashion (Fig. 1, No. 1) but in a somewhat more pointed wave form (Fig. 1, No. 2).

Figure 2 furthermore shows that if the synchronizing frequency is changed, at first there is practically no force at all exerted by the "synchronizing" alternating current. Only shortly before point *b*, where the synchronizing frequency agrees with the resonance frequency to which the synchronizing wheel is "tuned" in accordance with its number of teeth and its speed of revolution, say at point *a* or thereabouts, a great force on the part of the synchronizing alternating current is transmitted to the synchronizing (phonic) wheel. If the synchronizing frequency coincides with the resonance frequency of the wheel, then no more force at all is needed to keep the wheel in correct synchronization. But if we increase the synchronizing frequency, then again a force is exerted on the wheel by the synchronizing alternating current, only it does not act to accelerate but to check, until, on further increase, all power transmission finally stops entirely.

## "The Critical Range"

The range from *a* to *c* is called "the critical range." Within this range, which must not be too great or too narrow (one can adjust its breadth by the breadth of the teeth of the wheel and the shape of the synchronizing alternating current), the synchronizing current may accordingly fluctuate without harm; the phonic wheel will always follow and adjust itself to it. Conversely, one may also say: If the synchronizing current is fixed, the number of revolutions of the running motor may harmlessly fluctuate; still the wheel always remains at the right revolution frequency, which is determined by the synchronizing frequen-



This curve shows that if the synchronizing frequency is changed, at first there is no force exerted by the synchronizing alternating current.

cy, because toward side *a* (Fig. 2) an acceleration of the wheel by the synchronizing alternating current always sets in immediately, and toward side *c* a checking of it.

Now for the construction of the oscillator (Figs. 3 and 4):

As already said, the Telehor Com-



# How STANDARD MOVIE FILM Is Used for Television Broadcasting

## Difficulties Experienced with 24-Frames-Per-Second Pictures Eliminated by New Scanning Method and Use of Duplicate Films

ONE of the greatest difficulties encountered in the adaptation of sight-sound motion-picture film to television projection is caused by the difference in the rate of speed with which the pictures are taken on the movie lot and that with which they are scanned in the television studio. The moving-picture camera exposes 24 sections of the film each second, whereas television laboratories have experimented with scanning system that project a maximum of 20 pictures per second.

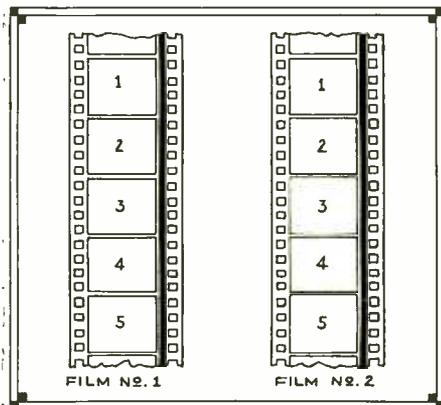
The consequent slowing down of the film results in "slow motion" of the characters in the picture. What is more important, the slower movement of the sound track past the photo-electric cell creates a sound distortion such as that occasioned by rotating the turntable of a phonograph at a speed slower than that at which the recording was made.

About eighteen months ago, Armano Conto, research engineer for Western Television Corporation, of Chicago, set about to perfect apparatus that would not only broadcast pictures with the figures moving at normal speed, but that would also permit the sound to be taken from the film undistorted.

### Three-Spiral Disc Used

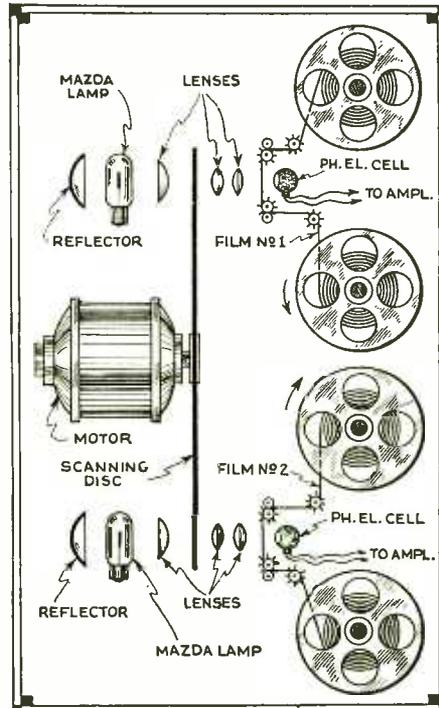
The three spiral scanning system with which Conto worked divides any area to be broadcast into 45 horizontal parts at a speed of 15 times per second. This leaves a considerable gap between the 15 pictures per second as broadcast by the television station and the 24 pictures per second projected in the motion picture houses.

Conto looked with disfavor upon the method by which the film is kept in motion as a part of the scanning operation, a practice used in previous technique. He decided that better results could be obtained if the film remained stationary, as it does in the



Two identical motion picture films are used for television broadcasting purposes. However, only one sound track is necessary.

projection of moving pictures, moving forward at a predetermined time. Consequently, it was necessary to design a disc that would combine the effects produced by an ordinary scanning device and the shutter on a moving-picture projector.



Physical layout of the apparatus used in the Conto system of transmitting sound motion picture film. Note that two duplicate films are used, turning in the directions indicated by the arrows.

The resulting disc is so constructed that the apertures through which the light penetrates are placed on radii that are four degrees apart instead of eight degrees, as in the ordinary three-spiral, 45-aperture disc. Thus, the 45 apertures occupy a 180-degree segment of the disc, leaving the other half blank to act as the shutter.

Conto uses two identical films. Film number 1 is located at the upper diameter of the scanning disc and number 2 at the lower. The movement of both films is toward the center of the disc. The films are placed in the same position in each Geneva movement, (the device which moves the films forward). The two Geneva movements and the scanning disc are interconnected mechanically in such a way that when the first aperture of the first spiral is in a position to scan picture No. 1 in film No. 1, film No. 1 remains motionless for the duration of the entire scanning operation. While picture No.1 in film No. 1 is being scanned, the blank segment of the disc is passing before film No. 2, shutting off the light. This interval is used to move picture No. 2 in

film No. 2 to a stand-still position so that it will be scanned immediately after picture No. 1 of film No. 1 is scanned.

So, of the two identical films, the pictures of film No. 1 which will be scanned are Nos. 1-3-5-7-9, etc.; while pictures No. 2-4-6-8-10, etc., will be scanned in film No. 2.

Conto's real difficulty came in broadcasting standard sound films taken at a standard rate of 24 picture frames per second without sound distortion and without slowing down the movements of the actors. But he made provision for that, too.

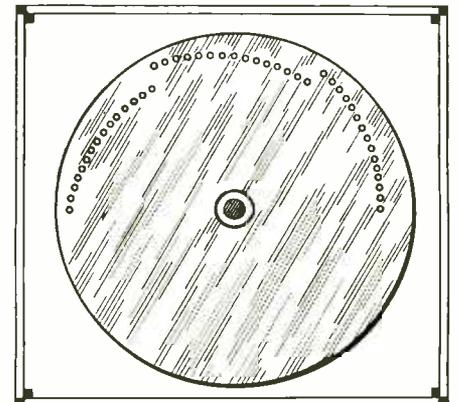
He held the opinion that the continuity of the picture would not be broken if part of the pictures in the film was eliminated, for it must be remembered that the movement registered on the two duplicate films is that which takes place in 1/24 of a second, a shorter period of time than that required to create an impression on the human visual system.

### Some "Frames" Are Eliminated

To maintain such unbroken continuity, the inventor controls the operation of the two Geneva movements by means of a cam which automatically selects certain frames out of each unit of 48 consecutive pictures so that the film runs at its normal speed of 24 frames per second.

For example, with "A" designating film No. 1 and "B" designating film No. 2, the following pictures out of a cycle of 48 are scanned successively in this order: 1A-2B-5A-6B-8A-9B-11A-12B-14A-15B-17A-18B-20A-21B-23A-25B-26A-29B-30A-32B-33A-35B-36A-38B-39A-41B-42A-44B-45A-47B.

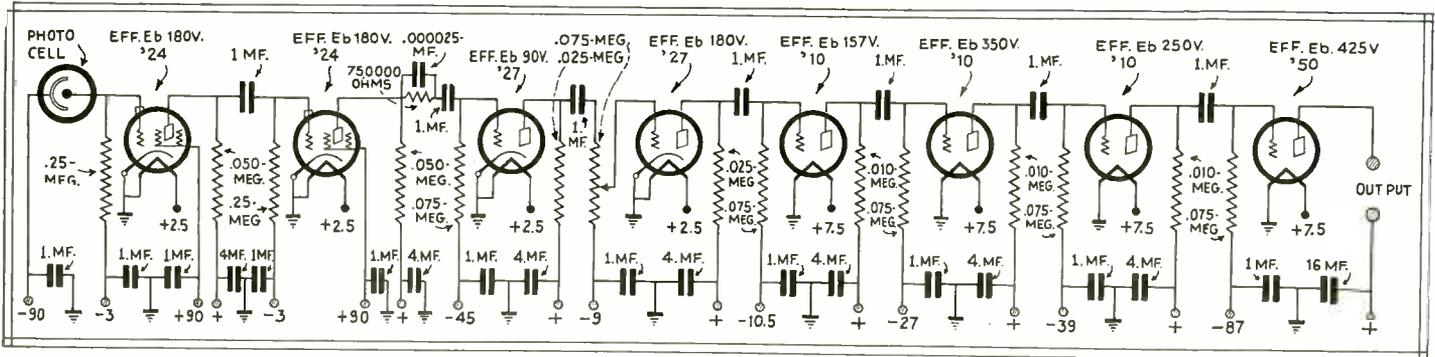
Because the film moves forward at the regular rate of speed, 24 frames per second, the sound recorded on the film is reproduced without distortion by using the ordinary photo-cell system.



This drawing shows the special three-section scanning disc used in the Conto system. It has three spirals of 15 apertures each, the holes being 4 degrees apart and all located in one half of the disc. The blank half of the latter serves as a shutter.

# PHOTO-CELL AMPLIFIER CIRCUIT

By D. E. REPLOGLE\*



Complete schematic diagram of the eight-stage amplifier recommended by the author.

**I**N A television transmitter one of the first and most important problems encountered is that of amplifying the electrical impulses from the converted light impulses to a sufficiently high level to modulate a transmitter.

Since 1908 vacuum tube amplifiers have been known, but the requirements for these amplifiers have been limited to voice and music frequencies, which at most did not exceed 10 kilocycles. In fact, the finest broadcast quality today is only between 7 kc. and 8 kc. When it became necessary to amplify frequencies as high as 100 kc. and more for television, investigators immediately started out along the old line of amplifier design which would result in high quality voice transmission, and there the troubles grew apace.

### Frequency Discrimination

First of all, the photo-cell possessed discrimination against the high frequencies, which are desirable for good television. The available tubes possessed capacities which again discriminated against high frequencies. The accepted methods of mounting and wiring also discriminated against high frequencies. Accepted practices in biasing and in by-pass condensers and in filtering power-supply units discriminated against the necessary low frequencies, with the result that it became a definite problem to build an amplifier for television that would supply the high frequencies that are inherent in the steep electrical wave form inherent in the television signal.

We have found in designing a transmitter amplifier that the passing of signals from the amplifier to the transmitter offers possibilities for losing detail or for conserving it. For this reason the use of a low-impedance output is highly important. This low impedance may be secured by paralleling output tubes, in which case the level is reasonably high but the tube capacities themselves become very objectionable. Another method is to use a small portion of the resistance drop of the plate circuit of the output tube, which greatly reduces the volume but does conserve high frequencies.

We have found that the development

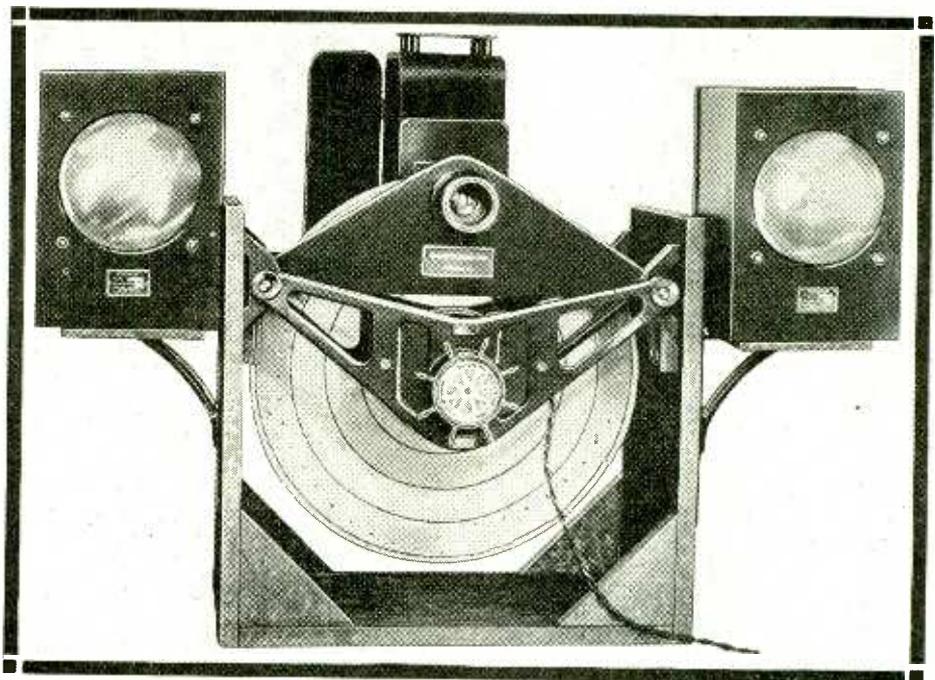
of special tubes with low capacities between elements has been of great assistance. With these tubes, for frequencies up to 100,000, an amplifier can be built with almost no frequency corrections, if real design engineering is put into the construction of each stage. Uncontrolled feed-back between stages is another point which must be carefully controlled in the design of such an amplifier. For this reason shielding in each stage is highly important. It has been found that fre-

quencies present in television signals fed back very readily and hence the shielding must be of a quality equal to that approaching radio frequency.

The circuit shown uses regular tubes. It will be noted that in the second stage a net-work is employed that secures the frequency response.

The use of specially constructed tubes obviates the necessity of the network and permits the use of an amplifier to secure frequencies of an order of 300,000 to 400,000 cycles!

## “Junior” Television Scanner for Amateur Use



**A**DVANCED television experimenters who wish to investigate the transmitting end of the art will be interested to learn that a complete scanning unit is now on the market. This consists of a three-spiral, 45-hole disc, driven by a 900 r.p.m. synchronous motor, a 1000-watt projection lamp with a suitable condensing lens system, and two 6-inch photoelectric cells.

As shown above, the mechanical and optical parts are mounted rigidly in their proper relative positions on a special frame. In view of the fact that the unit may be placed on the same table with other experimental apparatus, the chassis is rubber insulated to prevent the transmission of vibration.

This instrument is made by the Western Television Corporation.

\*Vice president in charge of Engineering, Jenkins Television Corp.

# THE 120

# LINE SCANNING DISC and how it is figured out

By WOLF S. PAJES

**T**HERE is no doubt that when working on a 60-line basis, a mechanically driven disc is in many ways superior to a cathode-ray tube. However, when detail of higher order is required, the difficulties in using a disc system increases so rapidly as to become practically insurmountable in the neighborhood of 120 lines per picture. How this happens will be shown now in detail.

To simplify the reasoning, we will consider first a scanning disc with punched square holes not using any overlapping. The factor of overlapping will be easily introduced into our discussion later.

Let us choose, as a basis, a square aperture with side dimensions of .010" x .010". For a 60-line picture, whose width is  $\frac{6}{5}$  of its height, and for zero

overlapping, the disc diameter at the point of the extreme aperture will be

$$D_{60} = \frac{.010 \cdot .59 \cdot .6/5 \cdot .60}{\pi} = 13.5/ \text{ approx.}$$

Using the same size of aperture for a 120-line picture, the diameter of the disc becomes

$$D_{120} = \frac{.010 \cdot .119 \cdot .6/5 \cdot .120}{\pi} = 54.6''$$

and for a 180-line picture

$$D_{180} = \frac{.010 \cdot .179 \cdot .6/5 \cdot .180}{\pi} = 122''$$

Comparing the diameters of these three discs with their corresponding numbers of apertures we get

$$\frac{122}{54.6} = \frac{180}{120} = \frac{3^2}{2^2} = 2.25$$

$$\frac{122}{13.5} = \frac{180}{60} = \frac{3^2}{2^2} = 2.25$$

$$122 : 54.6 : 13.5 = 3^2 : 2^2 : 1^2$$

We note that the effect of doubling or tripling the number of lines increases the disc diameter four and nine times respectively. In other words, the diameter increases in a square proportion with the number of lines per picture. This looks like a bit of usury on Nature's side, but it is not so. The reason is that when increasing the number of lines in a picture, for example twice only, the detail increases four times; in other words, also with the square of the number of apertures. Therefore, the square function with which the diameter of the disc increases is quite justifiable.

Let us return to the 120-line disc. Using a .010" aperture, which is quite small, we must have a 54.6" scanning disc. The overall diameter will, of course, be larger and about 56". It is obvious that this size of disc is large and out of proportion and cannot be considered for practical purposes.

The only available means of reducing the diameter of the scanning disc is by using a smaller aperture, as the size of

pressed by the factor  $\frac{6}{5}$ , which we will

call hereafter "FORM FACTOR." It is evident that D, the disc diameter, is directly proportional to the form factor. Therefore, by decreasing the value of the form factor, we may also decrease the magnitude of D. Let us consider, for a while, the meaning of this factor.

It indicates the relation between the width and height of the picture frame, and the smaller the form factor, the more oblong the picture frame will be. The existing system uses a frame whose width is 6 units of length and height 5 units. This form is taken from the standard motion picture film, a reason which should not outweigh other more important considerations.

Let us figure out the disc diameters for few different form factors, using the 120-line basis, and a square aperture of .010". Keeping in mind that the disc diameter is directly proportional to the form factor, we get

Table 1

Form Factor	Disc Diameter	
	Aperture .010"	Aperture .005"
6/5	54.6"	27.3"
1 (6/6)	45.5"	22.75"
5/6	37.9"	18.95"
$\frac{3}{4}$ (4.5/6)	34.1"	17.05"
$\frac{1}{2}$ (3/6)	22.75"	11.375"

We notice that by making the picture form oblong, we arrive at disc diameters of reasonable size, and when using this principle in conjunction with small apertures (.005"), as indicated in the third column of our table 1, the proposition becomes very promising. For example, a disc having a form factor

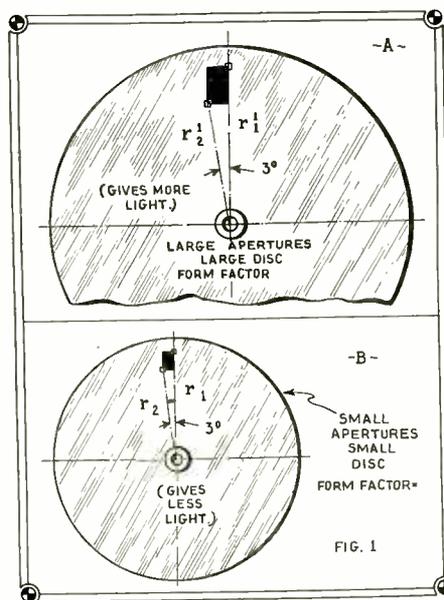
$\frac{1}{2}$  instead of the present form of  $\frac{6}{5}$  and using an aperture .005", has a diameter of 11.375" and in finished form an overall diameter about 13".

It is, of course, understood that the use of such small apertures imperatively commands lamps of high brilliancy, so as to compensate for the effect of small apertures.

### Effect of Small Form Factor

It must also be said that a small form factor, i.e., an oblong picture frame, will have the effect that the transmitting station, which of course, will have to use a disc of identical form factor, will not be able to scan as many persons at a time as before. Also, when transmitting scripture, the type of letters will have to be of slim character, so as to crowd a sufficient amount of letters into the narrow light field.

The small form factor can be effected in two ways, as it is expressed by a ratio of two numbers. One way is to decrease the disc diameter and keep the aperture size small, the other way is to keep the disc diameter large

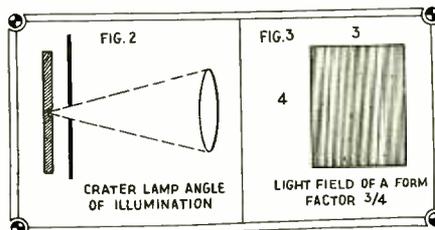


The use of a large disc in preference to a small one results usually in a brighter image, because the size of the apertures may be increased.

aperture is the only variable in the foregoing equations. For example, if we use a .005" square aperture in place of the .010", the diameter of the disc becomes 27.3" instead of 54.6". This, however, brings us to the vital and much discussed light problem in television. This phase of the question will be analyzed later on.

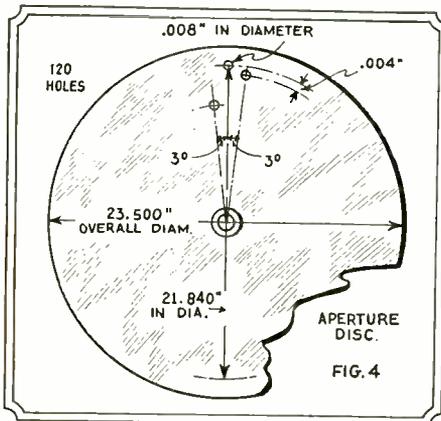
There is another way of diminishing the size of the scanning disc. It requires, however, the co-operation of transmitting stations, which makes matters so much more difficult.

The idea is that the equations given above contain an apparent constant, which is not a constant at all. I am referring to the picture proportions ex-



and increase the step down, i.e., the size of the aperture. The first method will result in a small disc diameter and a weak light field. The second method will effect a large disc diameter, but at the same time, a light-field brilliancy much greater than normal.

For us, the first method is to be commended, as we are concerned more with a small disc diameter than high field brilliancy. In Fig. 1, both methods are presented. It is easily seen from the picture that in A, the fraction  $\frac{r_1 - r_2}{r_1}$  is greater than  $\frac{r_1 - r_2}{r_1}$  in B, which will result in the first case in a



Layout for a 120-line scanning disc using plain round holes

light field much more curved at the bottom, than the light field in the second case.

The high number of lines per picture necessitated us to use small apertures as well as small form factors, in order to keep the size of the scanning disc within reasonable limits.

The decrease in the size of the aperture has, however, a very detrimental effect upon the amount of light passed. It is true, as a general proposition, that the amount of light passed through an aperture is proportional to the area of the aperture, and therefore, to the square of its linear dimensions. In other words, if we use a .005" aperture instead of a .010", the amount of light passed will be four times smaller, and not twice. We are, therefore, limited in this respect very sharply, unless we have at our disposal a lamp of intrinsic brilliancy.

**Angular Separation**

There is another factor connected closely with the 120-line basis which tends to decrease the light field intensity. This is the angular separation of the apertures. It is evident that the angular separation for a 120-aperture disc will be  $360^\circ/120=3^\circ$ . Suppose, further, that we continue to use the old picture frequency of 20 per second, then it is quite obvious that the time allotted the field will be of one aperture across the field will be only half of the time required by a 60-line disc. The impression left upon the eye in case of identical apertures and lamp brilliancies will be in the first case only  $\frac{1}{2}$  of that in the second case. If we now combine both light diminishing factors, i.e. that of the smaller aperture and the time ef-

fect, the result will be the product of both effects. So in case of a twice smaller aperture, the brilliancy of the 120-line picture in comparison with the 60-line picture will be  $2^2 \times 2 = 8$  times weaker and in the case of a three times smaller aperture  $3^2 \times 2 = 18$  times weaker. Again our only hope and salvation lies in an intense modulated light source.

Everything said before retains its validity in the case of a lens scanning disc, with the variation that the center of the aperture is substituted by the center of the lens and that the properties of the aperture are transferred into the crater of the neon tube, or any other light source used.

**Mechanical Problems**

The lens scanning disc, of course, brings up the various problems of lens mounting, lens centering, lens diameter and proper focal length. Of no slight importance, also, is the question of how to minimize in the lens the effect of spherical aberration by means of shaping the lens properly and also to determine the optimum relation between  $r_1 - r_2$  (in Fig. 1) and the spherical angle of the cone of light emerging from the crater of the neon lamp (Fig. 2).

The last question I intend to raise is that of overlapping. When using square apertures, no overlapping is required. When, however, round apertures are used, a certain overlapping is necessary in order to create the impression of uniform illumination, although real uniformity with round apertures can never be obtained. When

**Television System Planned for Canada**

THE people of Canada will shortly have the opportunity of seeing television in operation. A new company, known as the Canadian Television Limited, has recently been formed and has secured the exclusive rights for the Dominion of Canada of the well known Jenkins Television Corporation of Passaic, N. J. According to information received from Mr. Douglas L. West, vice-president and chief engineer of Canadian Television Limited, the company intends to develop and exploit every phase of the television field. Extensive research facilities are being organized and completely equipped laboratories installed in Montreal.

Entering the field at this time, Canadian Television Limited will have the benefit of the years of endeavor spent on research and will also receive adequate protection and support from the early pioneer patents of Charles Francis Jenkins.

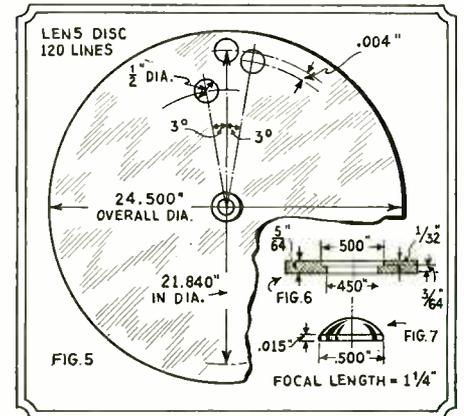
The new film is now making arrangements to demonstrate television in most of the principal cities of Canada. A large screen apparatus will be used and the demonstration can be viewed by an audience of several hundred people. Pictures will be transmitted, either by radio or by wire, and observers will have the opportunity of seeing the complete system in operation, including the broadcasting studio and the method of staging the productions.

It is also planned to install a number of television broadcasting stations throughout the country.

working with round apertures, the way to figure out the disc diameter is to substitute in the above formulas the real step down from aperture to aperture for the size of the aperture itself. For example, if we use a .020" circular aperture and intend to have a 40% overlap, we insert into the formula the quantity

$$.020" \left(1 - \frac{40}{100}\right) = .012"$$

The resulting disc diameter will furnish the desired overlap. In the same way, we compute the overlapping problem for a lens scanning disc, but now



Layout for a 120-line scanning disc using lenses instead of plain holes. Fig. 6 shows how the holes are counterbored for the lenses, the details of which are given in Fig. 7.

the crater size and its form are the objects of our attention.

For the benefit of the experimenter and for practical considerations, two disc layouts are given, one for an aperture disc and the other for a lens disc. Both are intended for 120-line pictures. The form factor is 6/5.

The aperture disc employs round holes with 50% overlap. The reason why we do not use square holes is that they will be too small and too little light will be passed. The diameter of the apertures is .008". The step down from aperture to aperture is .004". Substituting these values in our equation we get 21.84". The overall diameter of the disc will be slightly larger, or about 23.5". Figure 4 is a detailed diagram of this layout. The angular separation is 3 degrees. A 1/6 horsepower motor is sufficient to bring the disc into synchronism. As material for the disc .01" thick duraluminum will be best.

**Details of Holes**

In the lens disc the holes for the lenses are drilled about .45" and counterbored to .5". The stepdown is again .004". The overall diameter is larger than in the case of the aperture disc to make allowance for the lenses, and is 24.5". The lenses are 1/2" in diameter and have a focal length of 1 1/4". The metal used for the disc is duraluminum 5/64" thick. The thickness of the shoulder is 3/64"; the remaining part of the metal is to hold the lenses. The rim of the lenses is .015". The diameter of the crater of the neon lamp to be used is .01". The power of the motor must be not less than 1/2 horsepower and a spring coupling must be provided.

# Single Control SUPER - HETERODYNE For Television Reception

**T**HE single control super-heterodyne has long been the acme of perfection in the broadcast receiver. Unfortunately, this is not true in the case of the television receiver, unfortunately, I say, because of the inherent characteristics with which the "super" is endowed.

The first problem in the design of a television receiver is the attainment of a satisfactory *numeric* or overall selectivity. In the super-heterodyne this is readily accomplished through the use of an intermediate frequency sufficiently low to admit of the use of high values of "Q" in the coils employed. The value "Q" establishes the figure of merit for a coil and is given by the expression  $wL/r$ . With high values of "Q" large gains are also possible.

### Required Features

The demands for satisfactory "adjacent channel" selectivity are met by the fact that the band-selectors employed in the intermediate stages are capable of steep response characteristics together with high resonance peaks because of the relatively low value of their effective resistance. The quality requirement is also taken care of in the intermediate-frequency stages because of the sharply defined band-selector characteristics possible. The double bogies of "beat" and "image-frequency" selectivity common to the super-heterodyne receiver may be conquered by the use of a single band-selector couple prior to the first detector.

It may be readily seen from a glance at the schematic circuit in Fig. 3 that the use of the "super" arrangement tends to simplify rather than to complicate the structure. The sole item likely to cause trouble to the tyro is the single control arrangement. A brief explanation of the manner in which the single control system is evolved may perhaps be of interest to

**Have you ever noticed how few super-hets are used for television? The author explains why they have not been popular for this work, and he suggests a circuit that overcomes past difficulties.**

**By C. H. W. NASON**

the more technical reader. Those not inclined to "theory" may stand aside for the time while we proceed to elucidate.

### Single Control in the Television Super

The choice of 175 kc. as the intermediate frequency for the broadcast super-heterodyne receiver was not one of chance nor of trial-and-error. The demands upon which the choice is based are briefly as follows:

1. It must be low enough that the advantage of the high gain per stage attainable at low frequencies be attained.

2. It must not be so low that "image frequency" interference results; i.e., it must not be of such a value that a station removed from the desired one by twice the intermediate frequency be capable of creating sufficient voltage on the grid of the first detector tube to result in a second and spurious 175 kc. component which no end of selectivity in the intermediate frequency amplifier can remove.

3. It must be low enough that no harmonics of lower order than the third lie within the desired frequency range.

In the case of the short-wave or television receiver the intermediate frequency must be high enough that the tuning of oscillator and signal-frequency stages be divergent to the point that minor deviations from "true ganging" cause little percentage difference in the

frequency of the beat chosen for intermediate amplification.

The three considerations determining the intermediate frequency in the case of the broadcast "super" hold also in the case of the short-wave or television design, but with the added proviso that the signal and oscillator frequencies must be far enough removed, one from the other, to permit of slight irregularities in tuning with but little percentage change in the *beat* or intermediate frequency.

The frequency range required of the television receiver extends from the lower edge of the broadcast band, 1500 kc., to about 3000 kc. This range may be adequately covered by means of a .00025 mf. condenser and a coil having an inductance of 45 microhenries. If we decide upon an intermediate frequency of 500 kc., the oscillator constants must be such as to tune at all positions of the dial to a frequency just 500 kc. above that of the signal frequency circuits.

### Calibration Curve Furnished

In Fig. 1 there appears a curve showing the frequency of the signal tuning elements for various capacities of the tuning condenser. It will be seen that the designations along the right hand edge of the curve correspond to the oscillator settings corresponding to the frequency curve of the signal circuits. Now it is not possible to attain perfect single control in a "super" by the simple process of employing a smaller inductance for the oscillator tuning, despite the fact that with straight line-frequency condensers such a condition might be expected. It is possible, however, to so proportion the inductance and a series condenser acting in conjunction with the tuning condenser, that the oscillator and signal circuits will track in a manner as to produce a constant 500 kc. beat.

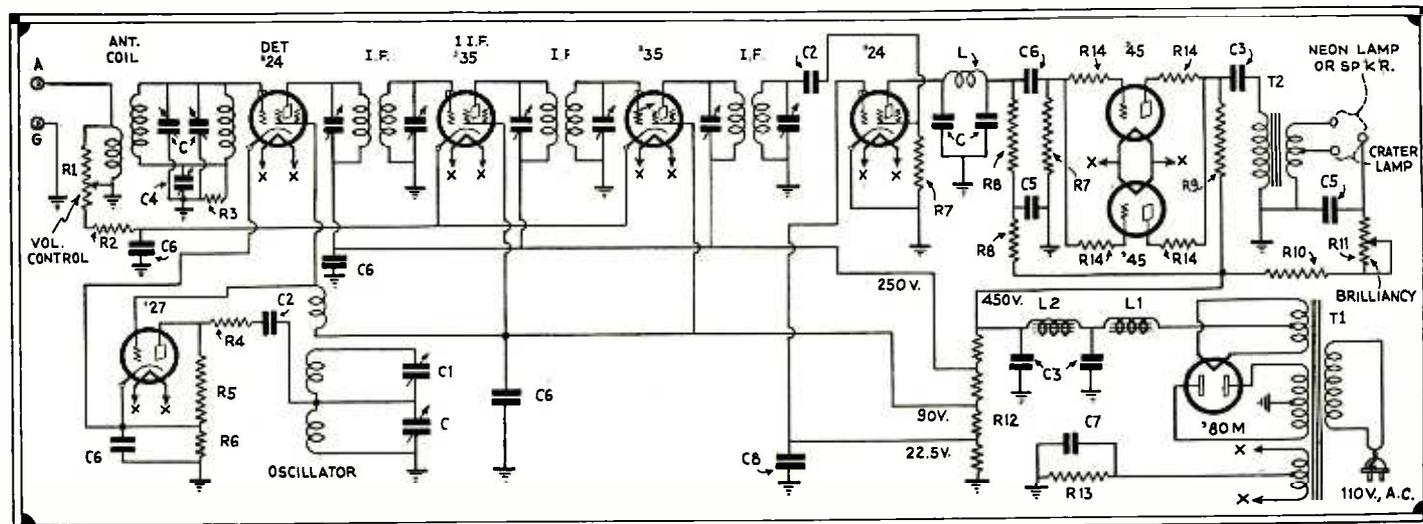
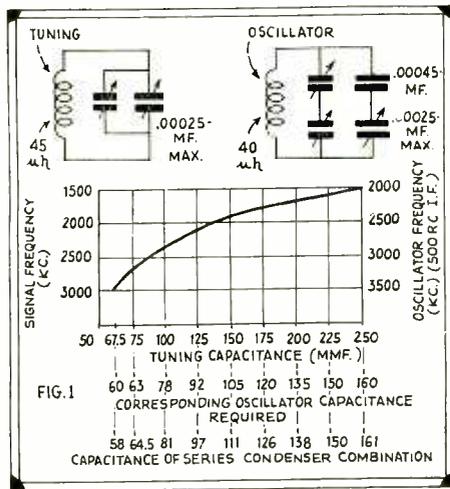


Fig. 3: Complete schematic diagram of the single-control super-heterodyne suggested by Mr. Nason for television reception.

In the lower three groups of figures we have the tuning capacitance giving a desired resonance frequency, the oscillator capacitance giving a frequency 500 kc. higher and the capacitance



Top: coil and condenser arrangements for the tuners and the oscillator. Bottom: calibration curve for the oscillator capacitaries.

to be obtained in the oscillator circuit through the use of a fixed condenser in series with the portion of the gang condenser assigned to the job of oscillator tuning. It may readily be seen that the agreement between the required values and those actually obtained through the use of the values indicated in the figure is quite good, certainly within the limits of accuracy of the slide rule with which the calculations were performed. Minor alignment can be accomplished when putting such a receiver in service by means of the trimmer condensers shown in the sketch at the top of the curve.

**Design of Coils and I. F. Transformers**

The coils and the intermediate transformers may be purchased, or they may be home constructed. The coils for the antenna and for the detector input are as follows—

- Antenna Coil: Primary—10 Turns; Sec. 50 Turns No. 25 Enameled wire.
- Detector Coil: Secondary only, 50 Turns No. 25 Enamelled wire.
- Oscillator Coil: Grid Coil—48 Turns No. 25 Enameled wire. Plate Coil—25 Turns No. 25 Enamelled wire.

All on 1" bakelite tubing. Secondary close to form; other windings directly over low potential end but separated by glassine paper.

The intermediate coupling devices are much more complex in structure and while their constants need not be held to such close limits, they must be a fairly good job of mechanical construction. The inductance of each winding must be held relatively high in order that the greatest possible width of transmission band be achieved. The theory of band-pass coupling is beyond the scope of this paper, but has been covered thoroughly by the writer in articles which have appeared in RADIO CRAFT and other journals. The individual transformers are wound on machined wood formers, slotted to take the random windings which constitute the primary and secondary. These are tuned by means of Hammarlund MICD-140 Double unit condensers to the normal frequency of 500 kc. The calcu-

lated band width for such a system, employing transformers of the type indicated in Fig. 2, is approximately 100 kc. A reduction in the band width can be achieved by employing fewer turns on the inductances with a greater capacitance to achieve the frequency of 500 kc. desired.

While a complex input circuit employing both inductive and capacitive coupling may be employed, it is likely that satisfactory results will be achieved by the use of a simple capacitive coupling in the first detector input circuit. The coupling condenser of .0008 mf. employed in the input circuit gives a band width of the following character as the frequency of the detector tuning is varied:

Frequency	Width
3000	35 kc.
2000	100 kc.
1500	150 kc.

These values may be altered by varying the capacity of the coupling condenser, remembering that the band width decreases as the value of the coupling condenser is increased. For the purposes of variation a Hammarlund MICD-1000 condenser is employed in this circuit.

**Transformer Output**

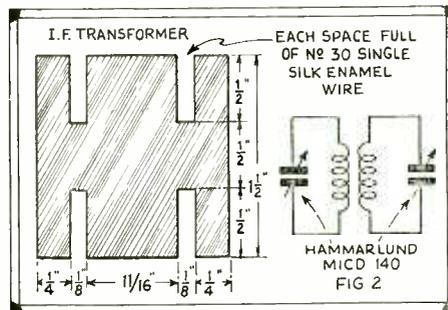
In order to avoid the necessity for a high-voltage transformer, the coupling between the output tube and the neon or crater lamp has been taken through a special transformer so devised as to operate in the plate circuit of a '45 tube with a frequency response characteristic flat from 20 to well beyond 40,000 cycles. It is but recently that the art of transformer design has progressed to the point where such frequency ranges are possible. It is only through the use of an entirely new basic theory of transformer design, in which the transformer is considered as a band-pass filter, that the results are achieved.

In constructing the receiver the chassis assembly of any standard super may be followed. On the front panel the neon tube brilliancy control can be used to replace the tone control knob.

**Parts List**

- C—.00025 mf. Triple Gang Condenser

- C1—(Fixed variable) .0005 mf. "padding" condenser (Hammarlund)



Constructional details of the special I.F. transformers used in the Nason television "super."

- C2—.0001 mf. mica condensers (Polymet)
- C3—4 mf. 600 volt condensers (Polymet)
- C4—.001 mf. padding condenser (Hammarlund)
- C5—1 mf. 600 volts (Polymet)
- C6—.1 mf. 400 volts (Polymet)
- C7—6 mf. 200 volts (Polymet)
- C8—1 mf. 200 volts (Polymet)
- R1—10,000 ohms volume control (Electrad)
- R2—150 ohms, flexible (Polymet)
- R3—½ meg 1 watt (International)
- R4—500 ohms 1 watt (International)
- R5—50,000 ohms 1 watt (International)
- R6—1800 ohms 1 watt (International)
- R7—100,000 ohms 1 watt (International)
- R8—50,000 ohms 2 watt (International)
- R9—4350 ohms 15 watt (Electrad)
- R10—25,000 ohms 10 watt (Electrad)
- R11—25,000 ohms variable (Electrad)
- R12—50,000 ohms variable tap, 10 watt (Electrad)
- R13—650 ohms 5 watt (Electrad)
- R14—100 ohms Flexible (Polymet)
- T1—Special transformer for Mercury '80 rectifier (Polymet)
- T2—Special "Flat-top" output transformer (Polymet)
- L1—15 hy 100 ma (Polymet)
- L2—30 hy 100 ma (Polymet)
- L—250 Millihenry R.F. choke (Hammarlund)

**Television Work Continuing, Says Sarnoff**

FOLLOWING is part of the statement delivered by David Sarnoff, president of the Radio Corporation of America, at the annual meeting of the stockholders of that company held in New York on May 3rd, 1932:

"With regard to television, we have continued the intensive experimental work which has been carried on in order to make television a practical, worthwhile service to the American home. Our experiments up to the present have confirmed the belief that practical television can best be accomplished on its own band of wavelengths, where it will be a service additional to the present system of sound broadcasting. Our engineers have done much research during the past year with television transmission on short waves and with various studio problems incident to television transmission. However, I am going to re-emphasize what I have said before—that while the public was quite willing to experiment with radio in the early stages of broadcast

development, it will expect television apparatus of a more advanced type than the early crystal radios. When broadcasting began the public had had no experience in taking sound and music out of space but the motion picture industry has given it a high standard of excellence in sound pictures, and television images which are obscure and difficult to follow can not be expected to sustain interest over a very long period.

"To attempt to market television equipment prematurely would severely retard a development that has great promise, and which we expect to grow into a great and widely accepted service. Premature marketing could only result in public disappointment, and an immediate loss of sales after the initial impetus. The experimental work we are undertaking will be continued energetically. As stated in the Annual Report, television receiving equipment will be offered to the public when this experimentation has shown that the system of sight transmission having practical value can be assured."

# An Effective Television Synchronizer

By C. H. W. NASON

THESE are many methods which are practicable for the synchronization of remote mechanical systems such as often appear in the communications art (telephotography) or in television. In cases common to the field of communications engineering there is usually no difficulty in accomplishing the synchronization of such rotating members, since a separate signal or low-frequency synchronizing wave may be transmitted as a part of the signal. By means of filters this may be removed from the actual signal at the receiver and thus has no influence upon the actual communications circuit.

Although in television there is nothing to prevent the transmission of such a synchronizing signal, none of the active television bodies has seen fit to do so and no attempt to force the transmission of a standard synchronizing influence has been done. There is, however, one saving possibility which has been employed in many receiving systems with small or greater success.

### Picture Component Exists

There is a component of the television signal which represents the number of scanned lines transmitted per second. The frequency of such a component depends upon the number of scanned lines per image and the number of images per second, and in the case of the present 60 line-20 images-per-second transmissions is 1200 cycles per second. By means of a tuned amplifier it is possible to isolate this component from the balance of the receiver and to obtain a signal of sufficient amplitude at that particular frequency to actuate a small synchronous motor of the correct characteristics. While in systems heretofore employed in television service the synchronizing influence thus obtained has never sufficed to actually drive the scanning mechanism, a fairly positive synchronization has been achieved through the use of a second motive device supplying sufficient power to overcome the frictional and windage losses—leaving to the small 1200-cycle synchronous motor the single function of maintaining speed. Unfortunately, when the station is not transmitting an im-

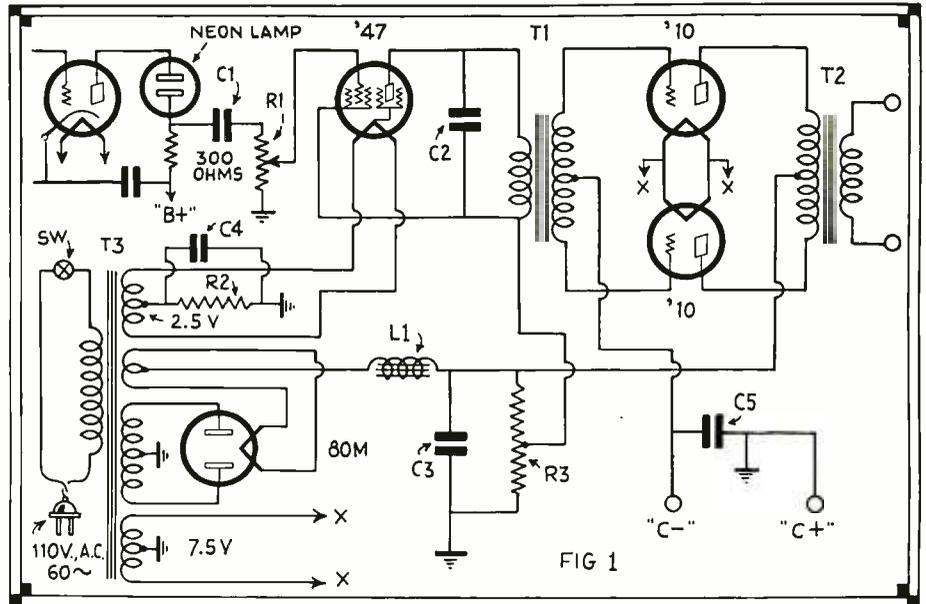
age, as when announcements are being made, the synchronizing influence is removed and some difficulty is experienced in getting the scanning mechanism back into step with that at the transmitter. This is solely a matter of the differential existing between the power required for maintaining the disc in rotation and that available for the maintenance of synchronization.

The writer has recently described in RADIO CRAFT a novel system of amplification permitting the attainment of a high power output from small tubes. This system is known as PUSH-PUSH

the '47 tube, where the transformer primary has been tuned to resonance at 1200 cycles. The constants of the circuit are such that this single circuit will serve to isolate the 1200-cycle scanning component from the image signals of higher and lower frequency. The transformers are designed throughout for this specific purpose and are thus of a specialized character.

### The Driving System

The driving system as outlined in Fig. 2 consists of a simple variable speed motor together with its controll-



Complete schematic diagram of the Nason television synchronizer. While the connections are a bit out of the ordinary, they are very easy to follow.

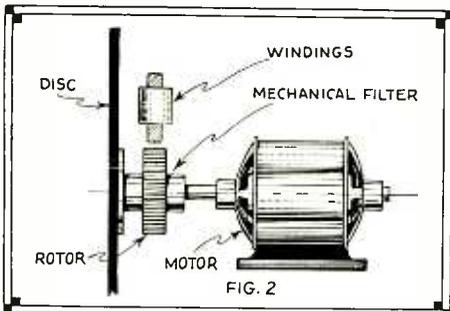
amplification and involves the use of two tubes in a push-pull connection but biased in such a manner that a slight plate current flows when no signal is impressed. The system is described quite thoroughly in the January 1932 issue of that publication and there is no necessity for repetition of the theoretical aspects of the matter at this time.

It is possible by this means to obtain from two type '10 tubes with a plate voltage of 500 and a negative bias of 50 volts an output of about thirty watts. This power output is far in excess of any heretofore employed in a television synchronizing system for receivers and the tubes used and their contributing apparatus are not such as to stagger the experimenter where costs are a large consideration.

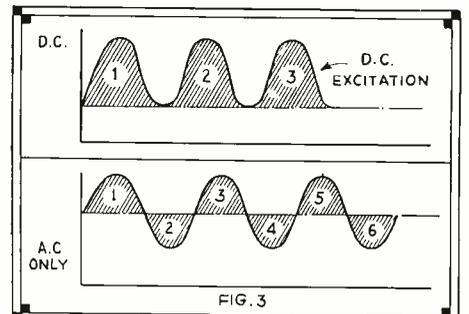
In Fig. 1 there is shown the schematic circuit of the tuned input stage and the Class "B" or "Push-Push" output stage together with the power supply. Inasmuch as the current drawn during the signal peaks is quite high, a mercury vapor '80 rectifier tube has been used. The circuit is not such as to require any great explanation except in the case of the plate circuit of

ing rheostat. It is essential that the motor be controllable in the range about 1200 r.p.m. The synchronous motor designed for operation at 1200 r.p.m. from a 1200-cycle source is connected to the motor shaft through a simple mechanical filter consisting of a clock spring. This increases the synchronizing effect at the moment of coming into step and prevents hunting.

In designing a synchronous motor of  
(Continued on page 155)



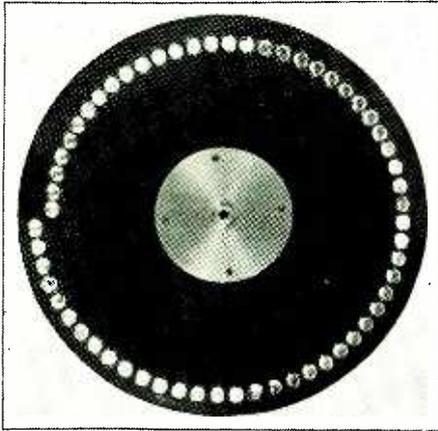
Driving system for the synchronizing system proposed by the author.



These curves illustrate the difference in excitation effects between A.C. and D.C.

# Points in Lens Disc DESIGN

By SAUL SCHILLER  
Television Optical Equipment Co.



The 18-inch, 60 lens scanning disc constructed by the author. The disc itself is made of bakelite, which is thin but strong.

**T**HE accompanying table is a handy guide for lens disc constructor.

Starting with column 1, the factors influencing the choice of the small or large disc should be weighed as follows: When it is necessary to build a compact television unit, it is obvious that the 12" or 16" disc must be used. This is the tendency at the present time. Besides, the small disc decreases the mechanical difficulties, such as vibration and synchronization, and requires only a small motor. However, these mechanical features are sacrificed for the optical efficiency. For an equal size picture, the projected image of the 24" disc is not only closer to the disc by 1/2 the distance of the 12" disc, but it is 4 times as illuminated. This follows because the area of the aperture of the crater tube (see third column) used in conjunction with the 24" disc is greater by the ratio of

$$\frac{\pi \times \left(\frac{.02}{2}\right)^2}{\pi \times \left(\frac{.01}{2}\right)^2} = 4$$

Now the intensity of the arc in the crater tube is measured in candle power per square millimeter of the emitting surface. For example the Speed crater tube has a high intensity of .65 candle power per square mm. Then,

$$\pi \times \left(\frac{.02}{2}\right)^2 \times (25.4)^2 \times .65 = 12 \text{ candle power}$$

represents the intensity of the .02" crater; and 1/4 of this = .03 candle

power—the intensity of the .01" crater. In column 2, only the diameters of the lenses are listed because in each case the focal length may fall within 1 1/4" to 4" from the vertex of the lens. Either a bi-convex or a plano-convex lens may be used, but to facilitate mounting it is preferable to use the latter.

When specifying lenses, bear in mind that for a given image distance, the short focal length lens, e.g. 1 1/2", will project a larger picture. This increased magnification which results

Diameter of Disc	Diameter of Lens	Aperture of Crater Tube
12"	.50"	.01"
16"	.625"	.015"
18"	.750"	.015"
20"	.81"	.015"
24"	1.0"	.02"

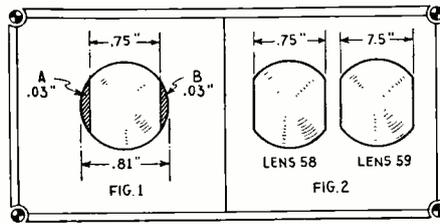


Fig. 1: how the lenses are ground away. Fig. 2: the ground lenses are mounted in this manner.

from a powerful lens (25 dioptries) means that the screen is brought up closer to the disc than the 4" focal length lens (10 dioptries). However, in justice to the 4" focal length lens, it must be stated that these lenses cut down a great deal of distortion (coma) which is caused by severe lateral magnification.

After judging these merits and demerits of the small and large discs, the Television Optical Equipment Company compromised by taking the average; or in other words by "splitting the difference." The next problem was to mount their .81" Sperry Marching Compass lenses, which are ideal for a 18" disc. By referring to the table it appears to be a physical impossibility to accomplish this. Nevertheless, the lenses were altered by the simple expedient of grinding so that they were adapted for the 18" disc. This is illustrated in Fig. 1.

The segments A & B are removed either by filing or by grinding. This operation does not injure the optical properties of the lens in any way. Besides, it is only necessary to alter the last 20 lenses. When mounting these lenses the straight edges are next to each other, as illustrated in Fig. 2.

## New Combination Broadcast-Television-SW Receiver

**A** COMBINATION receiver that may well be called the radio experimenter's ideal has been brought out by the Gold Seal Appliance Corporation,

of East Newark, N. J. In a single handsome console cabinet are contained the following units: a television receiver, tuning from 100 to 200 meters and including a scanning disc, a synchronous motor and a framing device; a regular broadcast receiver tuning from 200 to 550 meters, with volume control and selective tone control; and a short wave converter tuning from 150 to 200 meters in conjunction with the broadcast chassis.



Front view of the combination receiver, with an image showing on the television screen.

The television receiver occupies the lower right corner of the cabinet, the broadcast receiver the lower left section, and the short-wave converter the space just under the television screen, which our artist has embellished with the image of a pretty girl. When the television apparatus is not being used the screen is protected by a pair of hinged doors.

Needless to say, many interesting hours can be spent with this three-purpose instrument. Its owner can certainly never complain about not having something to hear or see at any hour of the day or night.

### Correction Notice

The experimental cathode ray television receiver pictured at the bottom of page 70 of the May-June issue of TELEVISION NEWS was constructed by M. Rappaport in the laboratories of the Television Manufacturing Company of America, Brooklyn, N. Y. Mr. Rappaport is television research engineer for this company, to which the photograph should have been credited.

# TELEVISION COURSE

## LESSON 9

### A Short History of Television Scanning Systems

THE desire to see over some intervening distance is probably as old as time itself, although for our purposes we must discount the earlier claims as based upon necromancy. The present era of television can be well traced forward from the German patent granted to Paul Nipkow in 1884 (German Patent No. 30105) and which is the basis of most of the systems employed today. Nipkow's original specifications involved a system as shown in Fig. 1, where the overall arrangement will be seen not to differ widely from that as em-

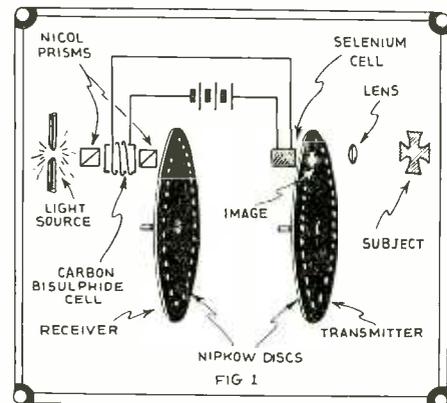
ated, but his device was a single mirror caused to oscillate in two planes at the required frequencies.

As we have noted briefly above, many of the modern investigators have produced little of novelty to add to the systems described. The advances of today are more along the lines of subsidiary apparatus. In recent issues of TELEVISION NEWS there have appeared descriptions of the cathode ray scanners as proposed by Zworykin, Farnsworth, Sabbah, von Ardenne and

similar to that disclosed by Baird in England, in which the Nipkow disc was replaced by two parallel discs operating at different speeds, as shown in Fig. 5.

In the early 1900's Lazare Weiller developed the mirror wheel, as indicated in Fig. 6, in which the horizontal component of the scanning is provided by the axial motion of a series of mirrors and the vertical component by a slight angular offset of the successive mirrors in a manner outlined and used by both such modern investigators as Karolus and Alexander. In 1907 Boris Rosing developed a system such as is shown in Fig. 7, which is a combination of the Leblanc and Weiller ideas. Here the scanning is accomplished by utilizing cylinders of regular polygonal cross section, as indicated. The relative speeds of the drums depend upon the aspect ratio of the image and its structure as to number of scanned lines and frequency of repetition.

In all the foregoing the idea has been to floodlight the individual and to concentrate the reflected light on the photo cell, analysis of the scene being accomplished by the scanners as indicated. In 1910 in Sweden Elkstrom put forward the idea of the "flying spot," the scanner being used to cause a minute spot of light to traverse the scene, reflected light being picked up by photo-sensitive devices. Elkstrom's scanner followed closely the ideas of Leblanc as already indi-



The original Nipkow television idea, which is the basis of practically all disc systems.

played in the present-day "direct pickup" apparatus. Nipkow employed a selenium cell which was connected by wire line to a winding which rotated the plane of polarization of light traversing a gas within its magnetic field. The similarity is obvious to those familiar with modern systems. Nipkow also covered the field quite well as regards the lens disc, both as used in projection apparatus and as used by the Bell Laboratories in their latest equipment, where a crater lamp rather than a flat plate lamp is employed, but where no attempt is made at a projected image.

As early as 1877 Sawyer proposed the use of an oscillating lens in the manner indicated in Fig. 2, where a photo cell of wide area is scanned by the light received from various points on the scanned scene.

Later, in 1880, Maurice Leblanc proposed the use of a pair of oscillating mirrors for the scanning motion (Fig. 3.), one mirror providing the vertical scanning component at a rate 500 cycles per second and the other the horizontal or image frequency component at a rate of about 12 cycles per second. Both these inventors were prior to Nipkow as far as their disclosures were concerned.

Marcel Brillouin in 1890 disclosed a lens disc system almost identical with that in use today, as shown in Fig. 4. He also employed a system

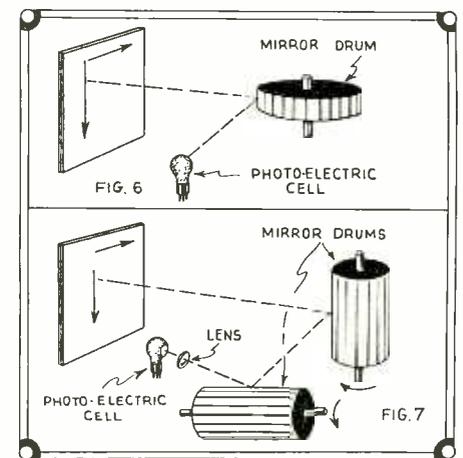


Fig. 6: the Weiller mirror drum. Fig. 7: a combination of the Weiller and Leblanc methods.

others. There is little actually new in this use of the cathode-ray tube, for both Rosing and Campbell-Swinton disclosed systems not unlike those now in process of development in so far as basic details are concerned.

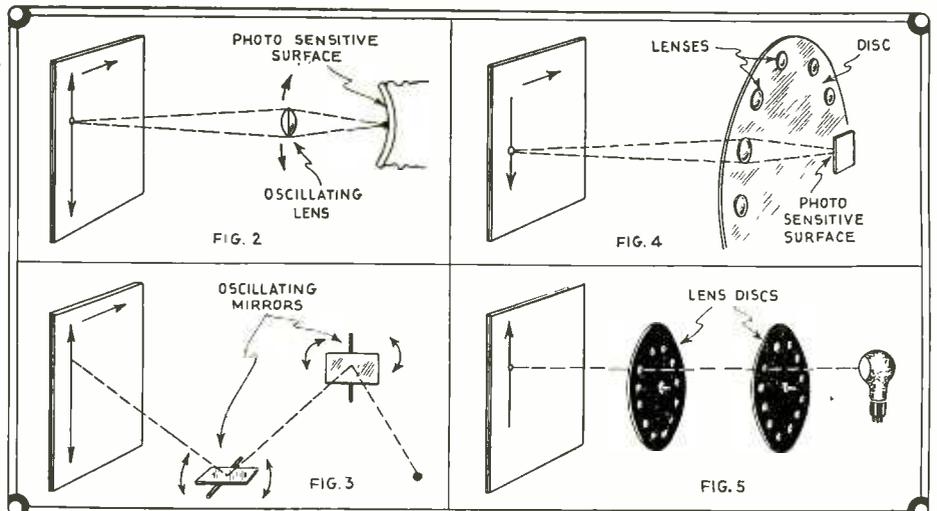
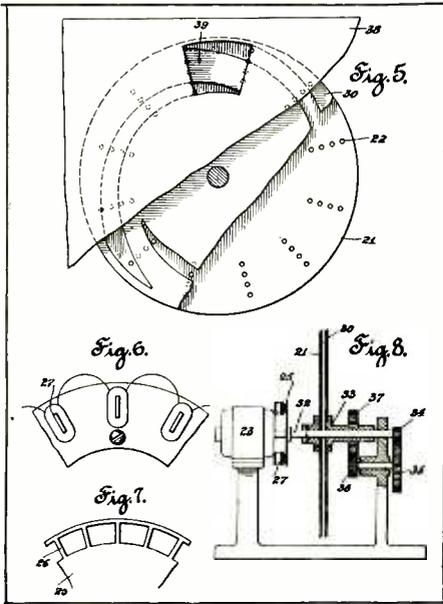


Fig. 2: the oscillating lens system of Sawyer. Fig. 3: Leblanc's oscillating mirror arrangement. Fig. 4: the lens disc of Brillouin, suggested in 1890. Fig. 5: Baird's system of two revolving discs.



No. 1,800,057

**Increased Image Size**

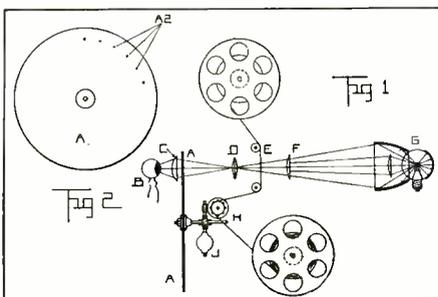
Patent No. 1800057—Issued to H. P. Donle of Meriden, Conn. Issued April 7th, 1931.

In Fig. 5 there is shown a standard Nipkow disc in which the size of the received image (as formed in the plane of the disc) is governed by the circumference passing through the first aperture. In the Nipkow disc a thirty-inch disc is required for the reception of an image 1.5 inch wide. Figs. 6 and 7 give Mr. Donle's idea of a disc combination quite similar in some respects to the Jenkins drum and shutter. By dividing the total of 48 apertures into twelve groups of four each and by employing an eccentric shutter as shown in the latter figures it is possible to obtain an image having any dimension four times that of the original disc and thus having sixteen times the area. The shutter rotates at one-twelfth the speed of the scanning disc.

**Film Scanner**

Patent No. 1828867 — Issued to C. Francis Jenkins. Assignor to The Jenkins Laboratories of Washington, D. C. Issued Oct. 27th, 1931.

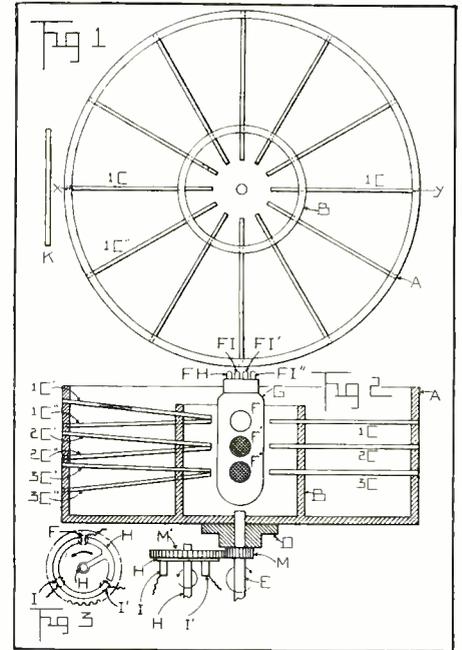
This patent covers a special type of film scanner in which an enlarged image of the film is projected onto a scanning disc having correspondingly enlarged apertures. This permits of a greater distance between film and disc than was hitherto possible and allows a greater degree of image detail, since the aperture effects so pronounced with a tiny scanning aperture are removed. The disc has apertures arranged about



No. 1,828,867

# Digest of Television Patents

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



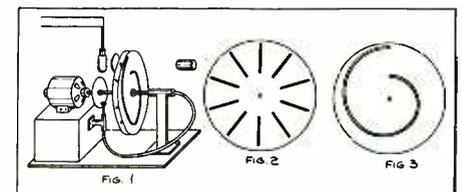
No. 1,683,137

a single circumference rather than in the usual spiral, since the vertical scanning component is provided by the continuous downward motion of the film. A light source and the requisite concentrating devices are shown together with the projection lens "D" which forms an enlarged image of the film in the plane of the scanning disc.

**Improved Drum Scanner**

Patent No. 1683137 — Reissue No. 17784. Issued to C. Francis Jenkins. Assignor to the Jenkins Laboratories of Washington, D. C. Reissued Aug. 26th, 1930.

This is an improvement on the patent wherein a great deal of light was entailed by the small size of the neon tube plates relative to the size of the image obtained. As shown in Figures 1 and 2, small quartz rods are brought to the center of the drum from each aperture on the drum surface. These rods have the property of transmitting undiminished, along their length, light produced at one end. Do not be misled into the idea that light may be concentrated by a cone shaped quartz arrangement as many investigators have claimed; this is a fallacy of the first order. The commutation arrangement as shown in Fig. 3 is such as to short circuit the two unused portions of a triple element neon discharge tube. This system was developed commercially by the Jenkins interests prior to the adoption of the drum-and-shutter which was finally marketed.



No. 1,801,756

**Slotted Disc**

Patent No. 1801756—Issued to Frank Morse Robb of Belleville, Ontario, Canada. Patented April 21, 1931.

This invention relates to a substitute for the usual form of television scanning disc such as to permit the reception of a much larger image for a given diameter disc than is possible with the usual Nipkow disc. In this respect it has much in common with the usual drum-and-shutter arrangements and their ilk. Fig. 8 shows a driving motor, a mechanical transmission or speed reduction such as to permit the two discs shown to rotate at differing speeds, a light source and a viewing lens. Figs. 9 and 10 show the two discs and the manner of their construction.

It will be noted that slots are provided rather than apertures and that the number of slots is fewer than the number of apertures normal to a scanning disc. In the figure ten slots are shown. The angle subtended by each slot is therefore 36° and the distance on the circumference cutting the outer end of each slot subtended between adjacent slots gives the upper dimension of the received image. From this we may determine the height of the image and at the same time the pitch of the spiral slot cut in the disc shown in Fig. 9.

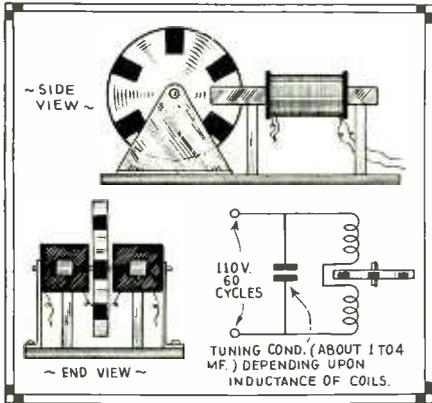
The rotational speed of this disc (Fig. 10) is determined by the picture frequency (assumed as 20 per second) and is 1200 r.p.m. The slotted disc, having but one sixth the slots as compared with the number of desired apertures, must rotate at six times this speed—or 7200

# The TELEVISION QUESTION BOX

## Increasing Motor Power

E. C. Burr,  
376 Springfield Ave.,  
Summit, N. J.

Thanks for your reply to my questions regarding scanning discs. Instead of the motor you suggested I made another type which consists of a 3 1/2" wood wheel 3/4" thick. Six slots 3/4" deep around the circumference are filled with silicon steel laminations and the whole runs in the field of a "U" shaped laminated pole piece. Each field coil is wound with 600 turns of No. 22 enamel wire. When



Home-made motor for driving television scanning disc, and means of increasing power.

brought to speed this motor will run at 1200 r.p.m. but will not carry a 16" disc. Can I modify the design to give more power?

**Answer:**

If you will experiment with various condenser values across your magnet until you find the value giving resonance at 60 cycles, the effective "ampere-turns" of your magnet will increase sharply. This will give the desired power increase.

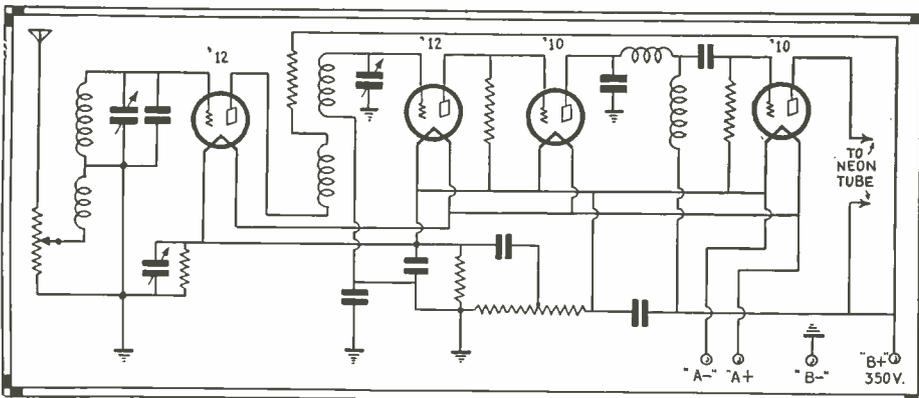
## Loftin-White Amplifier for Television

Mr. Frank Simon,  
Ford du Lac, Wis.

Please inform me if the accompanying Loftin-White modification based on the circuit in the March-April issue of TELEVISION NEWS is O.K.

**Answer:**

NO! The Loftin-White amplifiers have their intermediate filament circuits (your first '10 tube) high with respect to ground by an amount equal to the desired plate voltage of the first tube plus the grid-bias of the second tube. This



Mr. Simon's Loftin-White amplifier, which he built for television work, but which is not suitable for the purpose for the reasons given by Mr. Nason.

Edited by

C. H. W. NASON

cannot be accomplished save where one tube is of the "heater" type. Your circuit is ingenious but not workable unless you wish to substitute some of the new automobile tubes (heater type) in the circuit or float one filament into the circuit on a separate battery.

## Parts Values

John Engstedt,  
Larchmont, N. Y.

Please give me the information regarding the tuning coils in the Traveler Television Receiver as shown in the February issue of TELEVISION NEWS, also the value of the small coil in the detector plate circuit and the value of the resistance between the detector cathode and ground. What are the tuning coils in the Pioneer Television receiver shown in the April issue?

**Answer:**

As I have seen neither of these receivers all I can give you is my own "dope" for similar usage. For the detector biasing resistance use about 25,000 ohms, and for the plate circuit choke a Hammarlund R. F. C. 85 millihenry. The capacity-coupled circuits in the Traveler set would use trick honeycomb coils which you could not duplicate, so forget about them. For the Pioneer job use .00015 condensers wind 32 turns of No. 22 silk enamel wire or 1 1/4" tubing for secondaries. For the primaries use about 15 turns for the antennae coil and 32 turns for the interstage coils wound over the secondary and separated by glassine paper.

## Gas Engine Drive

Ben Benson,  
Inwood, Manitoba, Canada:

I have learned a lot about television through TELEVISION NEWS, but because of my present situation I must ask for special assistance. I intend building a television receiver and scanner but we have no A. C. or D. C. power supply here. I have no current to drive a motor but have a 1/4 h. p. gas engine which could possibly be geared to 1200 r.p.m. Would this be O.K. for driving the disc? If not, how can I possibly receive television images?

**Answer:**

You are not as lost as you might be. I know of one television fan in England who drives his disc from a water wheel. The only possible chance I see for you, however, is to

use your gas engine with a 32 volt generator and storage batteries. That will give you a home lighting plant to start with. Your television motor can then be used to drive the disc through a friction drive of the type shown on page 23 of the March-April 1932 issue. To go further you can use a converter to give 110 volts A.C. from 32 volts D.C. so as to have a power source for an A.C. receiver. I'm sorry, but it all runs into big money.

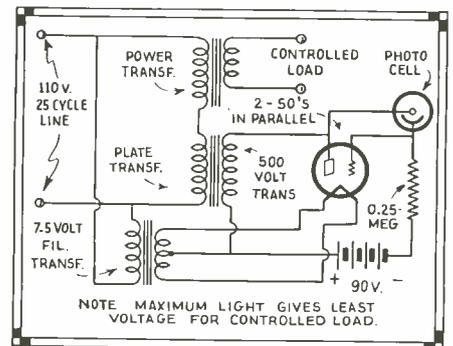
## Photo Cell Control Circuit

R. A. Dickinson,  
West Somerset, N. Y.

I would like a list of material and diagrams to construct experimental apparatus whereby a photo cell will serve to control the output of an induction coil.

**Answer:**

I presume that by an "induction coil" you mean a transformer. This can be done by employing two transformers in series—one feeding the equipment you wish to control and the



This diagram shows how a photoelectric cell can be made to control the output of a transformer.

other a pair of '50 vacuum tubes having a photo cell so arranged as to vary the current drawn by the tubes in proportion to the light incident upon the cell. The plate transformer will then act as a rheostat in series with the transformer you wish to control—that is, within limits. The circuit arrangement is given herewith.

## Screen Material

A. Willman,  
400 Madison Ave.,  
New York, N. Y.

Please tell me what type of screen is best suited to use with a lens disc. A glass supply house informs me that several kinds of ground glass are available. One is the usual form ground on one side only and the other, a better type, ground on both sides. Would a thickness of 3/8" be correct?

**Answer:**

Use glass ground on one side only and as thin as can be obtained. Shoot the ray at the ground side of the glass.

## A Hint to Lens Users

The small lenses used in lens scanning disc unavoidably pick up many finger marks while they are being handled. Many experimenters neglect to clean them off, and as a result are troubled with weak or diffused rays of light. Use only very soft cloth for wiping the glass. The best thing is an eyeglass wiper such as every optician gives away by the dozen.

**Cathode Ray Television**

(Continued from page 121)

from the descriptions thus far given; but it is by no means impossible that such an action takes place. At any rate, the most important novelty of the Farnsworth process seems to lie in this cathode.

In Fig. 5 is depicted a Farnsworth transmitting tube. At the left end we recognize the wires leading to cathode C and anode A, while at the other end is placed a plane closing disk, in front of which is the small photo cell, the wires leading from which are in the little tube put on at the side. The cylindrical part of the tube is surrounded by a sort of cage, which is made of coils through which saw-tooth alternating currents flow. The coils are almost rectangular in shape. Under the influence of these currents the entire electric image moves away through the opening of the small photo cell. In this manner the scanning is obtained.

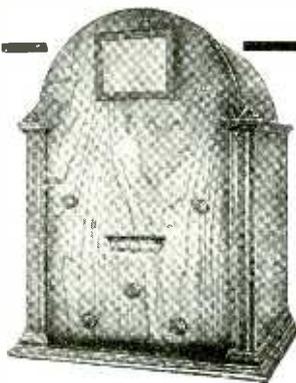
In the receiver Farnsworth uses a similar glowing-cathode tube, of the kind previously described. The most important parts, the cathode and anode, are represented in Fig. 6, much enlarged. The tube is operated with about 1500 to 2000 volts. The tube-shaped anode is closed in front of the cathode, but between the two lies a ring-shaped grid R, which serves for controlling the brightness of the cathode rays and to which accordingly the arriving fluctuations in potential are conducted. In general the electron ray is guided over the luminous screen of the tube in the manner already described.

**Synchronizing Means**

For synchronizing the currents affecting the scanning in the transmitter and receiver Farnsworth uses the impact of potential on the pictorial frequency circuit. The impact sets in through the sudden going back of the current; e.g., in the course of the slow deflection from bottom to top. These impacts of potential are transmitted between two successive pictures; they are supposed to effect the synchronization in a way as simple as it is effective. They also have the result that the light spot in returning from bottom to top is cast completely outside the picture field, so that not the least interference sets in.

For transmitting the pictorial currents Farnsworth has used both telephone connections and also 4-meter radio waves. In the wave experiments distances up to 50 miles are already said to have been bridged. Up to this distance serviceable television is possible with cathode rays, presupposing that all transmitting disturbances are avoided and that the ground wave, which alone comes into question here, is strong enough. Here use of an ultra-short wave is absolutely necessary, as on account of the high number of pictorial elements a very great breadth of frequency band is required, namely, no less than 300,000 cycles. Such a breadth of band is impossible in the field of ordinary radio waves. It is available only in the quasi-optical waves.

Farnsworth in this connection is  
(Continued on next page)



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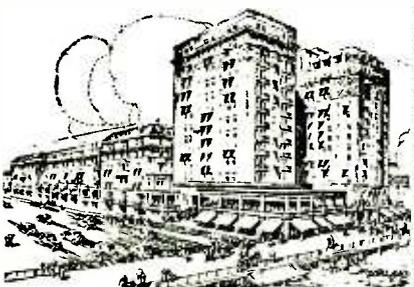
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## First Principles of Television

By A. Dinsdale

This book gives the beginner the first principles of television. Throughout the book technical language has been avoided as far as possible. Only the works of the most distinguished experimenters are taken—in these works all the known principles of television are expounded. In later chapters dealing with contemporaneous work the author describes the apparatus and methods of those workers, who, at the time of writing have gone furthest along their chosen line. This book will enable the reader to understand readily any future system of television which may make use of combinations of variants of the principles herein described.

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### Cathode Ray Television

(Continued from page 151)

said to have made another important invention lately, the purpose of which is evident from the name he chose "picture compressor." How this compressor operates is thus far unknown. Farnsworth has only reported that by this improvement the difficulties connected with the great breadth of frequency band would be considerably lessened. Perhaps it is somewhat similar to the already familiar method of suppressing one side band. The necessary frequency band is supposed to be reduced by the new invention to 7000 cycles. In this case the transmission of television broadcasts would be possible even over ordinary radio broadcasting transmitters.

#### German Inventors Busy

It is important to get an early acquaintance with these American inventions, if only in principle at first and without the possibilities of testing their efficiency. In Germany also numerous inventors are working on television processes with cathode ray tubes. A salable apparatus has not been produced here either, but it is possible that experiments with cathode rays will soon be made publicly. Particular promising among the German television systems in evolution with Braun tubes seems to be the method of Manfred von Ardenne. The cathode ray tube evolved by Von Ardenne and his co-workers is distinguished by special brightness of the luminous spot. Lately he has even succeeded in increasing the brightness so far that the image produced on the fluorescent screen of the receiving tube, about 4x4 inches, could be enlarged to about 16x16 inches. a performance which even a few months ago would have been declared impossible.

### Cathode Ray Television

(Continued from page 151)

This extraordinary brightness of the pictures transmitted, which is produced by the choice of a suitable fluorescent mass and high anode potential at the tube, is of great importance for the development of television, because television will never be entirely satisfying as long as the pictures transmitted have not at least the size of a postcard. The transmitting apparatus also is considerably simplified by the use of tubes so strong in lighting, since now the photo cells stimulated by the light of the fluorescent screen can be arranged outside the transmitting tube.

Von Ardenne's transmitter is at present so built that the transparent image to be transmitted lies before the luminous screen of the transmitting tube. The light of the luminous point running through the screen falls through the film upon the photo cell. In this way the scanning of the image is done. By increasing the scanning frequency, which is produced similarly to the above description by neon lamps with saw-tooth course of current, Von Ardenne has attained such a point that his pictures already now are excellent and also show fine details, while even a few months ago hardly more than silhouettes could be reproduced.

In the case of these experiments it is not a question of real "television," as may be seen, but of "telecinematography" or the sending of motion pictures. However, experience has shown that the two problems are so closely connected that progress in one field at once enriches the other, and perhaps the time is no longer distant when one will be able to buy cathode ray tubes for receiving motion picture broadcasts or for direct television just as one to-day can buy amplifier tubes.

### Single Side Band Television Transmission

(Continued from page 123)

ated carrier method of transmission, no power is radiated except when a word is spoken into the microphone, or a picture applied. A combination of modulators and filters is applied to eliminate the carrier and the upper side band in the case of W6XAH. The width of the sideband transmitted is slightly less than one-half of that which is transmitted in the usual transmitter. In the case of W6XAH this half is made twice its normal size or equal to 92 kilocycles, in the transmission of 96 lines, 20 picture frames per second.

The entire apparatus was designed and built by Mr. Frank Schamblin, president of the Pioneer Mercantile Company, and the writer.

#### New Scanning Methods

A new and revolutionary method of scanning is now being developed in which the scanning disc is entirely eliminated, together with the photo-electric cell and all light.

On its test programs W6XAH has been reported from practically the entire United States. It is the largest visual station west of Chicago.

The reader understands, of course, that special sets must be employed for the reception of television signals transmitted by the single side band system. Data on this subject will be published in forthcoming numbers of TELEVISION NEWS.

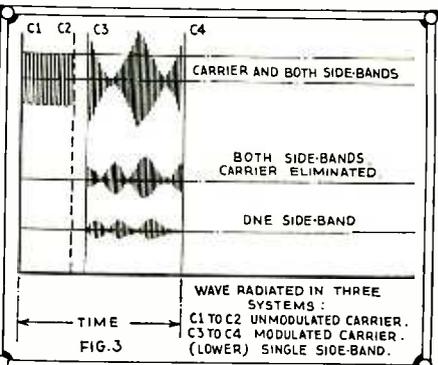


FIG. 3

WAVE RADIATED IN THREE SYSTEMS:  
C1 TO C2 UNMODULATED CARRIER.  
C3 TO C4 MODULATED CARRIER.  
(LOWER) SINGLE SIDE-BAND.

Showing advantage of single side band transmission in saving of channel width for television transmission. The single side band is less than half normal amplitude as when carrier is transmitted.

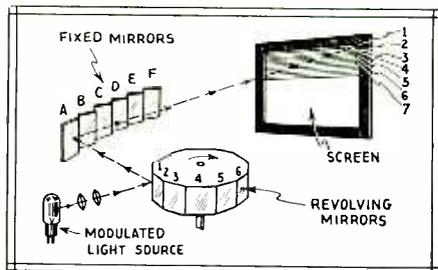
**Television In France**

(Continued from page 126)

have 60 or 100 mirrors, its dimensions become prohibitive. Barthelemy has found an ingenious solution which permits great reduction of the number of mirrors; e.g., in place of 60 mirrors, Barthelemy gets the same result by using 10 revolving mirrors and 6 stationary mirrors. Of course the same system can be used for transmitting or receiving. In transmitting he uses indirect analysis; in receiving, a crater lamp.

Let us see how the optical analyzer works:

The luminous ray first meets a revolving mirror, say mirror No. 1, and next it meets a fixed mirror, A. The arrangement of mirrors 1 and A is such that the luminous point describes on a screen (or on the subject to be televised) a horizontal line 1. Next, the luminous ray, still reflected by revolving mirror 1, meets fixed mirror B, whose inclination and position are such that it traverses on the screen a second line 2, and so it goes down to mirror F.



Arrangement of the parts in the Barthelemy televisor

At this moment the luminous ray is taken up by revolving mirror 2 and fixed mirror A. The point traces then line 7. Still reflected by mirror 2, it traces line 8 thanks to fixed mirror B.

To sum up, revolving mirror 1 traces the first six lines, revolving mirror 2 lines 7 to 12, mirror 3 lines 13 to 18, etc., till mirror 10, which traces lines 55 to 60. At this moment the whole image has been analyzed and the cycle begins again. A turn of the moveable wheel equals a complete analysis of the image.

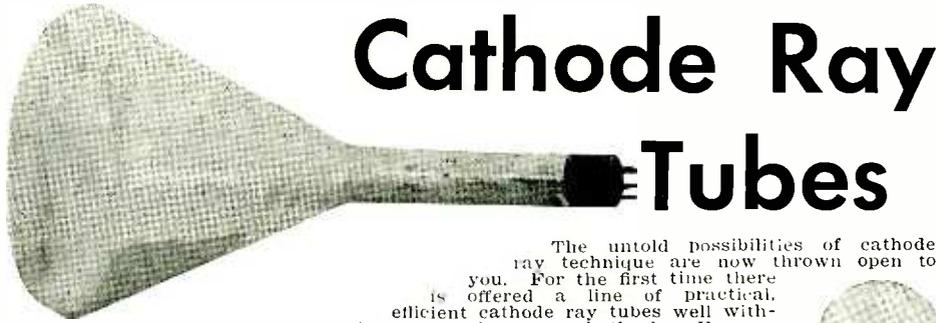
**Induction Brake**

(Continued from page 125)

bent out of carefully heated soft iron about  $\frac{1}{8}$  inch thick and  $\frac{3}{8}$  inch wide according to the illustration. The connection bolt of  $\frac{1}{2}$  inch round iron is turned down on both sides to .36 inch diameter, at the right at .8 inch length, at the left at .24 inch. The right part is given a  $\frac{3}{8}$  inch thread. With the short end the bolt is riveted into the left arm of the magnet while the right arm with a  $\frac{3}{8}$  inch thread is screwed onto the core, putting in between a washer .04 to .08 inch thick. This serves to adjust the distance of the poles to .04 or .08 inch, according to the more or less even course of the disc. The length of the core depends entirely on the winding to be put on it, and the dimensions of the latter depend again on the strength of the braking current available. From 100 to 200 ampere-turns will suffice.

The brake operates perfectly free from impact, elastically, and without any wear. The heating of the Nipkow disc produced by the eddy currents is so slight that in practice it can be neglected.

# Cathode Ray Tubes



The untold possibilities of cathode ray technique are now thrown open to you. For the first time there is offered a line of practical, efficient cathode ray tubes well within reach of any pocketbook. For example:

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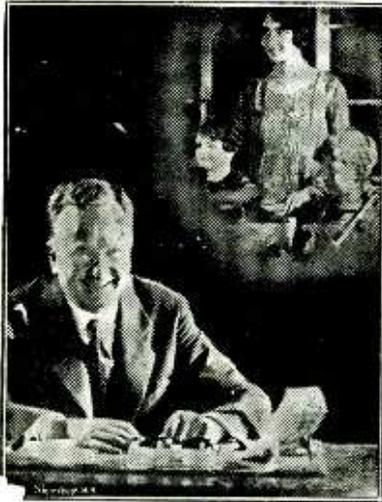
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### Constant Speed Scanner

(Continued from page 139)

employed had 8 teeth. A pair of magnet coils are mounted on an iron core and placed, with respect to the rotor, as shown in the diagram. The magnets are energized by a direct-current source supplied by means of a transformer, rectifier and filter. The filter need not be large; a 10- to 30-henry choke at CH and 1 mr. at C will be more than sufficient, since the ripple in the D.C. is of little importance. The amount of current flowing in the magnets is controlled by a 20,000-ohm resistor R1.

The magnet coils may consist of 6000 turns of No. 32 enamelled wire on each leg. The size of the core will depend upon the diameter of the rotor which, however, should not be too large. The rotor employed had a diameter of 1½" and was ¼" thick. The core should be of a size which allows a very small clearance between the core and rotor teeth; ⅓" in the case of the model.

It should be possible to procure a core from a defunct audio amplifying transformer and cut it with a hacksaw to get the proper size and shape.

The adjustments are simple. First adjust the speed of the motor slightly greater than synchronous speed, then bring the speed down by an adjustment of the magnet resistor R1. If the line-voltage should rise, the speed of the motor will increase. At the same time the current through the magnets will increase, causing a greater breaking action upon the shaft; thereby automatically holding the disc at a constant speed. If the line-voltage should decrease, the motor speed also decreases as well as the energy through the magnet coils, again keeping the disc at constant speed.

A few trials will determine just where to set the controls to obtain constant speed at varying line-voltages between 100 to 130 volts.

—Ralph William Tanner.

### Double Disc Scanner

(Continued from page 132)

down to the next level. Double scanning!

The speed at which the picture is scanned, that is, the width of the "slice" covered by each slot, may be controlled. To give a comparison, we know that with the usual round hole scanner the next hole to go over the picture is set the width of the hole below the preceding one; therefore the width of each slice is definitely fixed. With the slot scanner, the width of the slice may be controlled by varying the speed of one of the discs.

Figure 1 shows the construction of the discs. Both discs are made exactly the same; when they are being used, reverse one so that the slots pass each other at right angles.

The front disc must be turned at a speed sufficient to give persistence of vision, while the rear disc does the scanning. The discs should be mounted as close to each other as possible without touching, otherwise the light will spread between discs, and the diffused light will produce poor delineation.

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R. M. A. Television Statement

(Continued from page 137)

lighted studio, for outdoor pick-up, etc.

*Third*—a great deal of successful development has been made with the cathode-ray tube system for transmission and reception. This system has proven technically sound and shows the greatest possibility. Its chief difficulties are in the production of large quantities of these systems at a reasonable cost.

*Fourth*—the television broadcast transmission spectrum allows only for five channels, namely: 2000-2100 kc., 2100-2200 kc., 2200-2300 kc., 250-2850 kc., and 2860-2950 kc. This frequency spectrum is not adequate for good picture transmission on account of the very wide frequency band necessary for picture detail, so in addition to these bands, on the extreme short waves 5-7 meters, frequencies from 35000-80000 kc. have been requested for television service. Most of the present transmitters are operating in the first mentioned bands, but a few operate in the neighborhood of 46,000 to 48,000 kc.

*Fifth*—the reception of television has been possible by tuning with either a superheterodyne or a tuned radio frequency receiver designed for television reception. Synchronized sound very often accompanies the picture transmission and it is common practice to receive the voice transmission on the standard broadcast receiver. This requires two receivers for receiving synchronized sound and picture transmission. In the television receivers, mechanical scanning and cathode-ray electrical scanning have been employed. The cathode-ray type of scanning has been capable of excellent results and shows great possibilities for further development.

*Sixth*—with the present economics of broadcasting it has been impossible to secure much data on the entertainment value of the subjects that can be broadcast due to the cost in presenting programs. The Federal Radio Commission has up to the present time considered television only experimental and will grant no commercial rights. This means that all broadcasting must be done for the experimental value only and no paid programs can be transmitted by television. This ruling has made impossible the receipt of any money in staging television programs. With commercial rights granted by the Federal Government, the problem will still be complicated as to whether advertisers will continue to assume the increased costs that television must impose for its successful operation, or whether the public can satisfactorily be taxed to bear this burden.

“Many problems appear which must be overcome before television can be a satisfactory means of home entertainment. The most important of these are listed as follows:

1. Greater detail should be obtained in received picture.

2. Television transmission pick-up equipment should be portable and as easily used as present day sound picture pick-up equipment.

3. Transmitting systems must be evolved which will have a satisfactory and reliable service range.

4. Receivers as simple in operation as our present radio receivers must be designed and built at a reasonable cost.

5. Quiet and satisfactorily illuminated picture equipment for the home must be designed and built at a reasonable cost.

“Regardless of the present problems that confront the industry there has been enough work done to justify some predictions which can be conscientiously made. With the development of the new short-wave channels at frequencies higher than 35,000,000 cycles, reliable transmission of television can be predicted. Ample room for an adequate number of transmitting stations can be visualized in this short-wave region. It is perfectly conceivable that a sight and sound service can be worked out to be received on a single receiver with a simplified tuning and control mechanism.”

An Effective Synchronizer

(Continued from page 146)

the “phonic wheel” type, the number of poles depends upon the frequency of the supply and whether or not a direct-current energizing force flows in the motor field windings. In this particular case it seems advisable to supply A.C. alone to the windings, as no particular benefit will accrue from the use of a D.C. energizing force. The number of poles is obtained by dividing the number of current impulses per second by the rotational speed expressed in revolutions per second. There are, where no d.c. flows in the windings, 2400 current impulses per second and the number of poles would be

$$N = \frac{2400}{20} = 60$$

Were D.C. to flow in the windings as is often the case, the number of current impulses would be 1200 per second and only 30 poles would be required. This may seem puzzling to the uninitiated, but may be readily understood from the two sketches in Fig. 3, where the current impulses are as shaded in the two sketches. The field windings must have an impedance matched to the best load impedance for the tubes, by selecting the correct turns ratio for the transformer. This impedance cannot be directly calculated, as it varies considerably with frequency and with the rotational speed of the driving unit. The impedance of the windings must be measured during rotation at 1200 r.p.m. and the value obtained corresponds to the factor known as “motional impedance” in the study of dynamic loud-speakers. The 30 watts of power available for maintaining synchronous speed is sufficient to give quite positive action and



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4 1/2 inches      6 inches  
7 inches      9 inches

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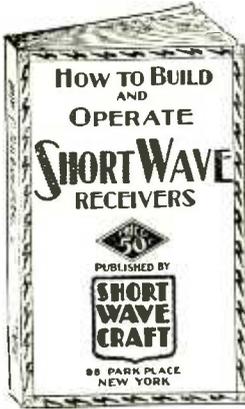
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I enclose herewith fifty (50c) cents for which please send me a copy of your new book, **HOW TO BUILD AND OPERATE SHORT WAVE RECEIVERS**. (Send money order, check, cash, or new U. S. Stamps. Register letter if it contains currency or stamps.)

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**Partial List of Contents**

- The "S. W. C." Two Tube Portable Works "Speaker"—Clyde Fitch
- How to Operate a Short Wave Receiver
- Two-Volt Tube Receiver
- A "Plug-less" S. W. Receiver—John M. Avery
- "My Favorite" Short Wave Receiver—F. H. Schnell
- The HY-7B Super-Het for A.C. Operation—L. W. Hatry
- The "Egert" SWS-9 Super-Het—How to Make It—Joseph I. Heller
- A Super Sensitive Short Wave Receiver—Thomas A. Marshall
- A. S. W. Power Amplifier—H. Winfield Secor
- How to Obtain Smooth Regeneration in S. W. Receivers—"Bob" Hertzberg
- Combination Long and Short Waver—E. T. Somerset, G2DT
- Super Regenerative Receivers
- How to Build the S. W. Superregnode—Clifford E. Denton
- Short Wave Tuning Less Plug-in Coils—Herman Bernard
- How to Use Radio Frequency Chokes—R. William Tanner, W8AD
- The "Ham's Own" Receiver—Norman B. Krim
- How to Use a Separate Regeneration Tube—E. T. Somerset
- Short Wave Converters—How to Build Various Types
- A Short Wave "Fun Box"
- How to Build a Good Television Receiver—R. William Tanner

the device is far superior to the usual models available.

**Parts List**

- L1 Special 250 m.a. choke
- T1 " 1200 cycle input transformer
- T2 Special 1200 cycle output transformer
- T3 Special Mercury '80 Power transformer Polymet
- C1 .1 mf. 1000 volt Condenser Polymet C-971
- C2 Special Resonating Condenser in Transformer case
- C3 1 mf. 1000 volt Condenser Polymet C-974
- C4 1 mf. 200 volt condenser Polymet C-904
- C5 1 mf. 200 volt Condenser Polymet C-904
- R1 500,000 ohm gain control Electrad
- R2 400 ohm Resistor Electrad
- R3 100,000 ohm adjustable tap resistor Electrad

**STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912**

Of Television News published Bi-Monthly at New York, N. Y., for April 1, 1932.  
State of New York } ss.  
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of the Television News and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Popular Book Corp., 98 Park Place, N. Y. C.; Editor, Hugo Gernsback, 98 Park Place, N. Y. C.; Managing Editor, H. Winfield Secor, 98 Park Place, N. Y. C.; Business Manager, None.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Popular Book Corp., 98 Park Place, N. Y. C.; D. Gernsback, 98 Park Place, N. Y. C.; H. Winfield Secor, 98 Park Place, N. Y. C.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated.

H. GERNSBACK,  
Editor and Publisher.

Sworn to and subscribed before me this 1st day of April, 1932.

(Seal.) JOSEPH H. KRAUS  
(My commission expires May 30, 1933.)

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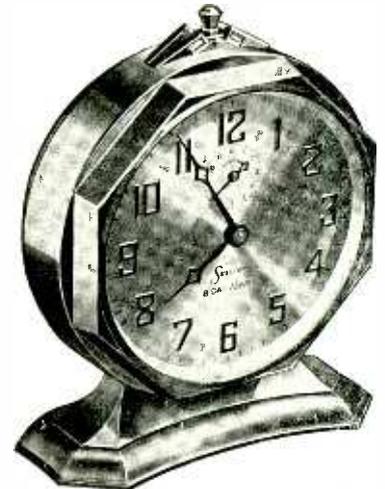
## TELEVISION TIME-TABLE

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

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

**Time on the Air:** The daily newspapers in the larger cities—Chicago, New York and Boston, for example—carry television programs and time schedules.  
 W2XCR—N. Y. City. 3 to 5 and 6 to 8 P.M. daily; 6 to 8 P.M. Sunday. Voice transmitted over WINS, on 384.4 meters or 780 k.c.  
 W3XK—Washington, D. C., 7 to 9 P.M. and 10:30 to 11:30 P.M. daily (E.S.T.). 60 holes.  
 W2XCD—Passaic (De Forest Radio Corp.). 9 to 10 P.M. daily. Sound on 1,604 k.c.  
 Daily image programs are broadcast by the Boston station W1XAV (2-4 P.M. and 8-10 P.M. daily, except Sunday) and also by the Chicago stations W9XAA, W9XAO and W9XAP. (Voice on 447.5 meters; see newspapers for daily programs.)

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A thing of charm and beauty. You or your friends will be proud to own one. A unique refinement is the convenient alarm shut-off—merely tap the button at the top. Even on dark mornings you need never grope for the shut-off. The base is perfectly balanced. The bottom is cushioned to prevent scratching of polished surfaces. Polished nickel case. Metal dial with a glossy satin-silvered finish. Numerals are large, raised on the dial, in gold bordered black. 6½ inches high, 5½ inches wide.

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**SPECIAL PRICE, Parcel Post**  
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- NEW TUBES FOR SHORT WAVE RECEIVERS
- MAKING AND USING 4 INCH WAVES
- DEMONSTRATING SHORT WAVES
- SUPERHETS—HINTS ON THEIR DESIGN AND BUILDING FOR SHORT WAVES



**Synchronizing With the  
Thyratron Tube**

(Continued from page 133)

minute, the output of the generator portion is sixty cycles. If there should be a variation in speed from 1200 R.P.M., there will be a corresponding change in the frequency output of the generator. If we should use a thyratron operating as a rectifier to supply the field current of the D.C. motor portion of the dynamotor, the amount of this current being determined by a bridge circuit which is sensitive to small changes in frequency, we will have a good frequency control. Now let us consider the circuit in Fig. 2.

The grid voltage is supplied from the midpoints of an alternating current bridge, the ends of which are connected across the output of the generator. The lower two arms of the bridge are the coils of the secondary of a transformer, thereby utilizing an arm of the bridge to supply alternating current for rectification in the thyratron. The output of the thyratron is then connected across the field rheostat of the motor so that it supplies a portion of the field current of the motor.

In order for the thyratron regulator to operate, there must be a change in speed from normal. Let us say that the motor slows down, then the frequency of the alternator will decrease. This change in frequency changes the phase of the grid voltage and the output is decreased, thereby decreasing the field current of the motor, which speeds it up immediately. This method, although quite simple, is not so very sensitive.

**Second Method**

Another method which I have found to be extremely sensitive is the one shown in Fig. 3. In this circuit, the grid voltage phase is shifted by means of an alternating current bridge with three resistance arms and an arm containing resistance, capacitance and inductance.

If the tuning arm is tuned to a frequency slightly above sixty cycles, then at sixty cycles the inductive and capacitive reactive drops will nearly annul each other and the voltage across the tuned arm will practically be an IR drop. If the frequency should decrease, there will result a large unbalanced capacitive drop thus changing the phase of the grid voltage considerably. This method of controlling the phase of the grid voltage is extremely sensitive. If the terminals of the bridge are properly arranged, then a decrease in frequency will retard the phase of the grid voltage and as a result decrease the thyratron output. The decrease of the thyratron output results in a diminution of the motor field current, and the dynamotor consequently speeds up until the conditions are balanced. This balance occurs when the speed of the dynamotor is the least bit below normal, since the device operates on a change of speed.

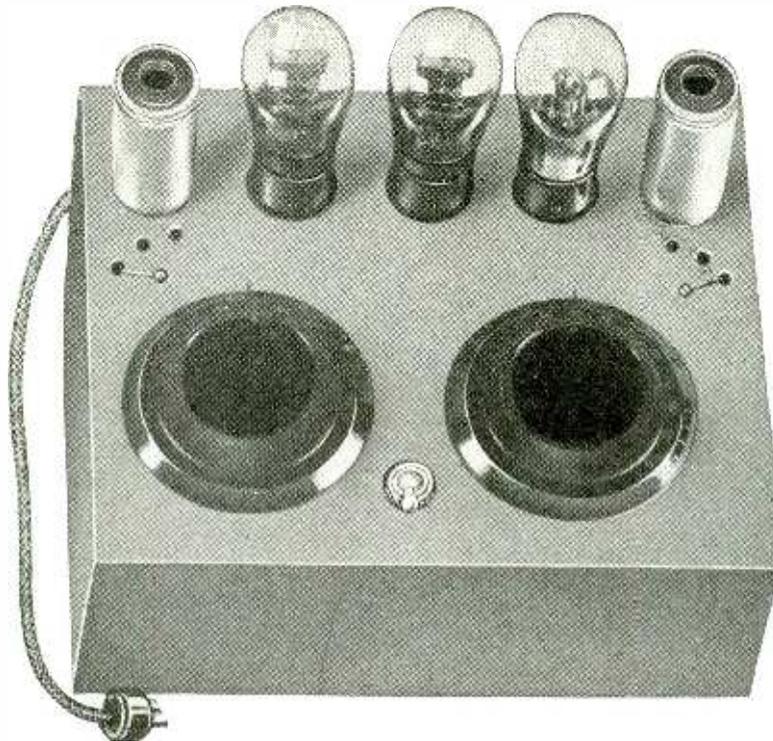
By proper tuning of the bridge circuit and using the incoming signal from the television transmitter, a direct current motor may be run at synchronous speed and in synchronism with the transmitter.

Short Wave Craft 98 Park Place, New York, N. Y. TN-2-3

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 As per your Special Offer, I enclose \$2.50 (Canada and Foreign \$2.75), for which enter my subscription to SHORT WAVE CRAFT for one year.  
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# GET A CONVERTER FREE!



**H**ERE at last you have it—a highly sensitive short-wave converter, 15 to 200 meters, that works on any set and that has its own A, B and C supply built in and that does not use plug-in coils for band shifting.

Two separate tuning condensers and two dials are used, so there *can not be any possibility of sensitivity loss* due to mistuning, as where ganging prevails. Also, any intermediate frequency may be used.

The little extra effort in tuning is well repaid by thousands of miles of extra reception. Stations all over the world have been tuned in, using this converter with a good broadcast set.

There are only three connections to make in teaming up the converter with a receiver.

Two coils are used, one for oscillator, the other for modulator, and two tube sockets are near these coils, underneath the top panel, not for tubes but so that you can move the flexible grid connecting wire of the two condensers to any one of four points for wave shifting. Simple, effective, inexpensive, infallible!

Three 237 tubes are used. These are of the auto-

motive series and are most economical, the total consumption, A and B power being less than 10 watts, hence costing no more than one-tenth of a cent per hour to operate!

This converter works on superheterodynes as well as on tuned radio frequency sets, because **IF ANY CONVERTER IS A GOOD ONE IT IS BOUND TO WORK ON ANY TYPE OF SET.**

There are 16 mfd. of filter capacity and a 15 henry B choke, in the B supply, as well as a husky line transformer.

Do not suppose just because the offer of these parts is generous that this converter does not perform efficiently, for it is a knockout! What sensitivity! What power! What results! Send \$12 today for a 2-year (104 issues) subscription for RADIO WORLD and get the parts for this converter free (less tubes). Order PR-NCV. A clear diagram is furnished with each kit. Note the kit is not wired. Shipments made by express at your expense. Order Cat. R-CNV.

**TUBES USED:** Three 237, supplied extra at \$3.50, if desired. No subscription offer attaches to the tubes.

## PARTS FOR A MIDGET CONVERTER

No matter what type of broadcast receiver you have, you can get short waves by using a midget short-wave converter built of parts we can supply. The panel is only 5 x 6½ inches. There is only one tuning control. No squeals, howls or body capacity. This model is available for battery operation and uses three 227 tubes with heaters in series. Full details supplied with order.

All parts for the battery model (less three 227 tubes), free with a year's subscription for Radio World) @ \$6.00. Order PR-3B.

The three 227 tubes can be supplied @ \$2.00. No subscription goes with tubes. Converter shipping charges must be paid by you.

A set of three shielded coils on 1½ inch diameter to cover the broadcast band, with a tap on secondary that enables going down to 80 meters. For screen grid tubes, including vari-mu tubes. An aluminum cover (not shown) screws over the

base. Send \$3 for a 6 months' subscription, 26 issues, and order PR-TSC-3 for 0.00035 mfd. or PR-TSC-5 for 0.0005 mfd. We pay shipping expense on the coils.

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Absolutely the smallest dynamic speaker that will withstand the strain of modern output power tubes, ever manufactured.

Suitable for use on midset, portable and automobile receivers. Measures but 6 1/2 in. long over-all, having a 1/2 in. diaphragm and weighing but 4 lbs. The "Little Giant" has, under test, actually flooded a ten-room apartment with faithfully reproduced music of virtually original tone quality. Field winding has a resistance of 2500 ohms and may therefore be energized by using it as a filter choke in the power pack, thereby serving a double purpose. This last feature makes the "Little Giant" excellently suited for portable A.C. sets, since it does away with filter chokes and thus with considerable weight. Equipped with built-in output transformer to work from any standard output power tube or tubes used when ordering. Shipping weight 5 lbs. List Price \$6.50. No. 1549. **LITTLE GIANT DYNAMIC SPEAKER...Your Price \$2.50**

**\*UTAH A.C. DYNAMIC SPEAKER—Only a Few Left**

110-volt, 60-cycle A.C. light socket supply for field excitation with Westinghouse dry rectifier. 9 in. high, 9 1/2 in. wide, 7 1/2 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. S.P. 1506—Your Special Price **\$7.45**



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Here is just the condenser for constructing noise filters. In some cases one condenser connected across the line or instrument will be sufficient. However, in most commercial filters there are two condensers connected in series; the center-tap being grounded and the two remaining leads connected across the light line or the interference-producing apparatus. Put up in a neat, black-enamelled case with tinned lugs for soldering connections. 2" high x 3 1/2" wide x 2 1/4" deep. Working potential 600 volts D.C. Ship. wt. 6 lbs. List Price \$7.50. No. S.P. 9062—Faradon 4 Mfd. **\$1.50** Filter Condenser. Your Price



**World-Wide Short-Wave Set NOT A CONVERTER**

**NEW**

A perfect radio short-wave receiver for use between 18 and 200 meters. To put into operation, connect antenna, ground, 45-volt "B" and two No. 6 dry cell "A" batteries, and headphones to the posts provided, plug in a type 30 tube, and tune in! An ingenious circuit makes possible a 4-coil variable-tuning plug-in design. This little instrument has the same sensitivity as many big, shielded short-wave receivers costing ten times as much. A power amplifier may be added for any degree of volume. Complete with 4 plug-in coils. Has fine vernier dial for precision tuning. Never has a first class short-wave set sold for so little money. This short-wave set measures 5 1/2 x 7 x 4 in. high, over all. Ship. weight, 3 lbs. List price, \$12.50. No. 1666—World-Wide S.-W. Set. **\$6.25** Your price.....



**NEW! NEW! SYNCHROMATIC ELECTRIC CLOCK**

Never was such a first class electric clock sold at such a ridiculously low price! An electric clock using the famous synchromatic movement. Naval observatory time right from your light socket! No spring to wind, no batteries. Never out of order. Lubricated for a life-time at the factory. The entire movement with its white-enamelled dial and artistic numbering is enclosed in a dustproof and shockproof genuine molded Bakelite case. The case is of walnut-brown finish with simple but catching design. For 110 volts, 60 cycle A.C. operation only. Complete with cord and attachment plug. Size 3 1/2" x 1 1/2" x 1 1/2". Weight 1 lb. Service men now sell these fine clocks by the hundreds. Be the first in your locality to handle them.

List Price \$3.00. No. 1689—Synchromatic Electric Clock. **Your Price \$1.00**



**FREE 76 Page Radio Treatise No. 24**



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

This book is not just another catalog but a veritable mint of radio information which will be of infinite and everlasting value to you.

**WRITE TODAY.** Enclose 2 cents for postage. Treatise sent by return mail.

**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 VOLTAGE business!

Choice 226	Choice of 200A-199X	Choice 245	Choice 222	Choice 230	Choice 235
227	171A 199UV-120	280	210	232	238
201A	221	171	250	237	236-37
			281		551

60c ea. 69c ea. 70c ea. 1.58 ea. 1.08 ea. 1.08 ea.

**R.C.A. LICENSED TRIAD AND SPEED TUBES**

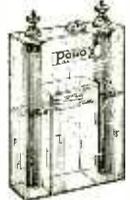
These nationally advertised tubes are guaranteed UNCONDITIONALLY for six months. The prices are slightly higher than our NEONTRONS because these tubes are of much better quality. See listing above for tube numbers.

Choice Price 63c	Choice Price 80c	Choice Price 75c	Choice Price \$1.76	Choice Price \$1.15	Choice Price \$1.15
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**\*"POROX" 2-VOLT STORAGE CELL**

5 Ampere-Hours—For 2-Volt Tubes

One such unit will light a two-volt battery tube for 75 hours continuously. Will handle two 2-volt tubes for 35 hours, etc. Put up in a transparent composition container with two non-corroding terminals clearly marked as to polarity. Easily recharged either directly from a 110 volt D.C. line in series with a 40 watt electric light bulb or from an "A" eliminator in series with a 12 ohm 2 watt resistor. Excellent for use in any circuit requiring a steady source of current. 3" wide x 4" high x 7/8" thick. Instructions included. Ship. wt. 2 lbs. List Price \$4.50. No. S.P. 9060—Porox 2 Volt Storage Cell. **Your Price \$8.00**



**\*6-VOLT BATTERY PHONO-MOTOR**

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

This arrangement was designed to overcome the effects of bumps and jars experienced by moving vehicles. The motor is sold complete with 10 in. turntable, mounting plate and motor switch and speed control. Shipping weight—10 lbs. List Price, \$15.00. No. SP9058—6-Volt Battery Phone Motor. **Your Price \$2.50**



**\*VERSATILE PORTABLE PUBLIC ADDRESS SYSTEM**

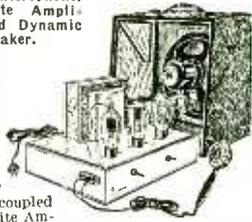
Comprises Microphone, Loftin-White Amplifier and Dynamic Speaker.

A recently completed all-electric A.C. development incorporating all the features and advantages of the direct-coupled Loftin-White Amplifier principle. The amplifier is a high quality two stage job, having some **RADICALLY NEW IDEAS IN AUDIO FREQUENCY AMPLIFICATION** and employing 1-27, 1-45 power tube and 1-80 full-wave rectifier. It is remarkably free from A.C. hum.

The design is adaptable to all purposes, i.e., microphone, radio and phonograph. Has an undistorted power output of approximately 3.5 watts; **SUFFICIENT TO OPERATE FROM 2 TO 3 ADDITIONAL DYNAMIC SPEAKERS.**

The portable address system is sold **COMPLETE WITH THE NEW R.C.A.-VICTOR HAND MICROPHONE**—a sturdily constructed unit which will withstand a lot of rough handling.

Put up in a single compact and perfectly balanced carrying case, the fruit of which is utilized as a handle for the self-contained dynamic speaker. Complete with microphone and accessories the weight is only 30 pounds. For 50-60 cycles, 110-20 volts A.C. operation. Shipping weight 38 pounds. List Price, \$75.00. No. S.P. 9063—Versatile Portable Address System. **Your Price, complete with microphone \$25.50**



**\*R.C.A.-VICTOR HAND MICROPHONE**

The most ruggedly constructed hand microphone ever manufactured. There is quite another of its kind that is quite as sensitive. Designed especially for home recording and personal entertainment. Requires but a 22 1/2 volt battery to operate. Easily connected to any radio or amplifier in a few minutes. This unit is essentially a single button carbon microphone—acoustically centered in a stout metal housing which serves the dual purpose of protection and noise shielding. Responds indiscriminately to all speech and music frequencies. Has a high D.C. resistance and may therefore be shunted directly across the grid and cathode of the detector tube without employing a coupling transformer. Sold complete with 6 ft. connecting cable. Shipping weight, two pounds. List Price, \$10.00. No. S.P. 9064—R.C.A.-Victor Hand Microphone. **Your price \$2.75**



**Screen Grid Cap Connectors**

Newest **SCREEN GRID CAP**. Small, neat in appearance and ruggedly constructed. A stark necessity in service work. Sold only in lots of 12 or more. Shipping weight 4 oz. No. 1672—Screen Grid Cap Connector. **Your price...Dozen \$1.12**



**\*Guaranteed 8-Mfd. Electrolytic Condensers**

Judiciously used in many parts of any R.F. or A.F. circuits, in power packs, in dynamic speakers, they will perform miracles in eliminating any trace of objectionable A.C. hum or other incidental disturbances. These electrolytic condensers are particularly recommended for 250 volt power packs. Where the working voltage of the unfiltered A.C. is 800 volts, two electrolytic condensers in series will stand up indefinitely.

Easily mounted through the use of a bayonet socket base which is equipped with a "positive contact" spring. Totally shielded and protected by a copper cap. Shipping weight—1 lb. List Price, \$2.50. No. SP9054—Guaranteed 8 Mfd. Electrolytic Condenser. **Your Price \$4.99**



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# PROTECTION



In their own secluded laboratory, these engineers, with slide rule, meter and microscope are always making improvements and double checking Certified Triad production.



Hundreds of skilled young ladies find interesting and profitable employment, making "small parts" for Certified Triads.



Many "batteries" of sealing machines controlled by highly skilled co-workers make Triads great production possible.



At the end of every production line, the tubes are given their first check. Ten characteristics are checked here. Even this is more than is done with the average tube, but it is not enough for "Double-Checked," Certified Triads.

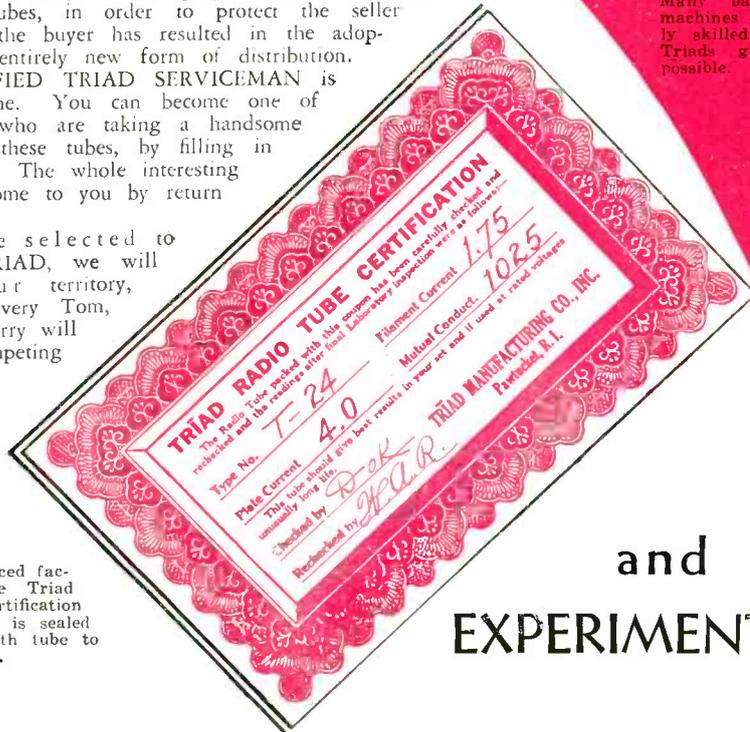
## for SERVICEMEN

CERTIFIED TRIAD TUBES are the result of many years experience. All the guesswork has been eliminated. They are designed, manufactured and tested by the most modern machinery. They are produced by skilled operators. No better tubes can be bought.

A complete study of the proper method of merchandising tubes, in order to protect the seller as well as the buyer has resulted in the adoption of an entirely new form of distribution. The CERTIFIED TRIAD SERVICEMAN is the key stone. You can become one of the agents, who are taking a handsome profit from these tubes, by filling in the coupon. The whole interesting story will come to you by return mail.

If you are selected to represent TRIAD, we will protect your territory, for you. Every Tom, Dick and Harry will not be competing with you.

Write for full information



This is a reduced facsimile of the Triad Radio Tube Certification Coupon, which is sealed in the box with tube to which it refers.

## and EXPERIMENTERS

Even a good radio receiver will sound like "nothing at all" if it is equipped with poor tubes. Most people realize that the radio tube is the heart of their receiver. Ordinary tubes can be bought for a song, but you usually get what you pay for. No one expects to get Cadillac or Lincoln service from an Austin. No one looks for custom-made shoes for three dollars. Those who expect the very best performance from inferior tubes are not logical and they are sure to be disappointed. No form of entertainment is as inexpensive as radio. Isn't it good business to keep it working at its best? You can be sure of doing so, by insisting on CERTIFIED TRIAD TUBES. A line to us will enable us to send you the CERTIFIED TRIAD SERVICEMAN, we have selected to serve your vicinity.

**The TRIAD LINE is complete. It includes all types of standard Tubes as well as Photo-Electric Cells and Television Tubes**

**TRIAD TELEVISION MFG. CO.**  
Pawtucket, R. I.

Gentlemen:  
Please send me full information and prices on the complete line of Certified Triad tubes. Check shows my field of interest in Short Waves and Television.

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9-COIL CIRCUIT  
 NEW TYPE SUPER-HETERODYNE  
 ONE CONTROL - 18 TO 550 METERS  
 FINEST BROADCAST RECEPTION  
 SUPER-SENSITIVE ON SHORT WAVES  
 NEW DESIGN - NEW RESULTS

**\$59<sup>50</sup>**  
 COMPLETE  
 WITH TUBES

# THE NEW PILOT DRAGON 4-BAND SET

Just out — PILOT CATALOG!

Just out — PILOT catalog!

Everything for the service man, set builder, and experimenter is to be found in the new PILOT catalog.

REPLACEMENT PARTS. All PILOT's replacement parts are listed. They include power transformers, all types of resistors, dry electrolytic condensers, loudspeakers, chokes, and other manufacturers' type parts for Service Men.

EXPERIMENTERS' PARTS. New instruments for experimenters have been added, making PILOT's line of parts the most complete offered by any Company.

SHORT WAVE EQUIPMENT. PILOT has always been headquarters for short-wave equipment. The new catalog and a supplement now in preparation include everything for building short-wave receivers.

S.W. TYPE 224-A TUBES. The PILOT 224-A tube is especially designed to reduce noises in S. W. receivers. It will improve your results.

WRITE TODAY. Send 5c in stamps for the PILOT catalog or, better, send 50c for a year's subscription to Radio Design Quarterly and the catalog and supplement will be sent FREE. Don't delay! Do it today!



POLICE ALARMS - AIRPLANES IN FLIGHT } PLUS REGULAR  
 SHIPS AT SEA - FOREIGN STATIONS } BROADCASTING

You'll put your O.K. on this set as the most beautiful piece of radio design you have ever seen. Ask your dealer to show you how the DRAGON wave-band switch changes from three coils for broadcast pre-selection to any independent pair of coils for each of the three short-wave bands. Notice how other sets using tapped coils, loaded with dead end losses, fail at high frequencies. Listen to the DRAGON's freedom from inter-band interference in contrast to results on makeshift tapped-coil circuits. Examine the precision construction of the 9-coil catacomb. Listen to the quality of the new amplifier and the acoustic cabinet. Then you'll say, "That's my idea of a Radio Set!" and you'll tell your B.C.L. friends so, too.

### NO PLUG-IN COILS

This 9-coil catacomb and switch is built into the chassis of the new DRAGON all-wave receiver. This method of construction eliminates all dead-end losses.

Complete information about the DRAGON receiver will be sent to you free if you will include your radio dealer's name and address with your request.



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(Short Wave Headquarters - Established 1908)

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