Television Reception Bulletin

COMPILED FOR RADIO ENGINEERS, SERVICE MEN AND RADIO EXPERIMENTERS BY THE ENGINEERING STAFF OF THE

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TELEVISION as we have it today, is far from perfect. Television is, however, in a sufficiently advanced state to provide a very interesting and fruitful field for the amateur experimenter. Signals are actually "on the air" and can be received with relatively simple and not necessarily expensive equipment.

As the reception of a bit of badly distorted phonograph music from a well worn record was considered quite an event only seven or eight years ago, now equally thrilling to the constructor of a home television receiver is the reception of a recognizable profile of one of the technicians of a television broadcast station, or even a page from some magazine held up before the transmitter. In other words, television as we have it now is something for the amateur, rather than the layman who is interested solely in the image received and not in the fun of experimenting with a new science. One cannot yet press a button and have appear on the screen of his television receiver a view of a ball game, a yacht race, or a political convention. All these things are bound to come in time, but they are not here yet. It is realized that the most certain method of hastening their arrival however, is to have as many experimenters as possible working on the problem. Turn television loose among the amateurs and see the important developments take place, just as with radio broadcasting.

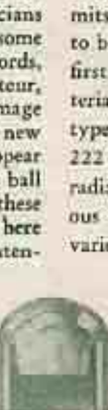
All of the stations now transmitting television have set up receiving equipment of their own for checking the merits of their signals, and the results being obtained are most gratifying. The pictures are small—generally 1½" x 1½", but the detail is usually quite good, and there is little trouble in recognizing the person televised, seeing him turn his head, open his mouth, and roll his eyes. Even the smoke may be seen to rise from his cigarette.

While there are several different television systems being employed at present, they all have many points in common and an outfit designed to receive images from one source may readily be altered to work from other transmitting stations. The system used at WLEX is typical of that being used at present.

For sake of discussion a dotted outline has been used to divide the schematic diagram of the complete receiver into the following components.

The Short Wave Receiver.	The Kino lamp.
The Audio frequency Amplifier.	The Scanning device.

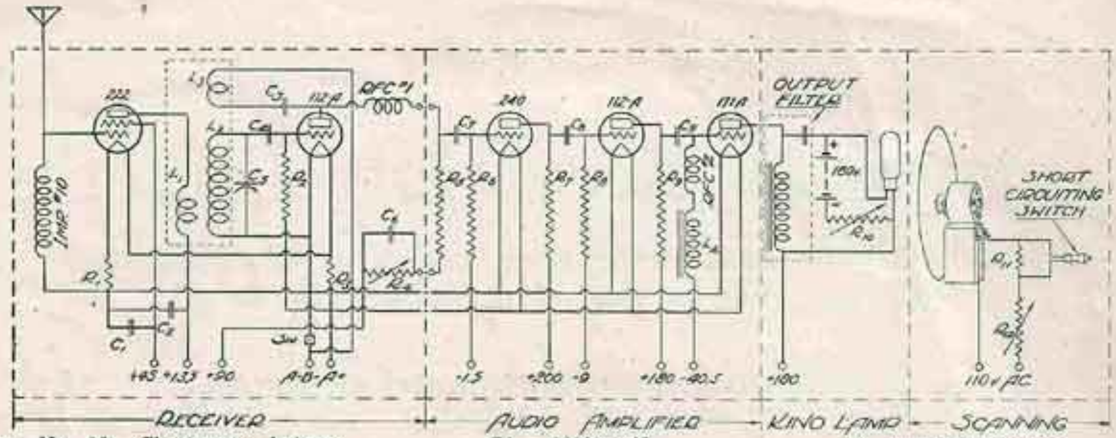
While any good radio frequency receiver capable of being tuned to the wave length of the transmitting station may be used, it has been found that a receiver employing a stage of untuned RF using the 222 is generally preferable. The Receiver illustrated is one we have been using and is a standard Kit set, all of the parts of which are available in the open market. It comprises several rather unique features. One is the single tuning control. Another is the foundation unit design which permits an efficient layout of parts with but few connections to be made by the assembler. As a result of the 222 in the first stage, the sensitivity of the receiver in general is materially better than that of the plain regenerative detector type formerly so much in use. Furthermore, the use of the 222 ahead of the essential regenerative detector prevents radiation—a problem which would soon become quite serious if all the short wave receivers were of the radiating variety. Still another important advantage secured by the use of the 222 tube in this Screen Grid short wave receiver is the elimination of tuning "holes," or dead spots commonly encountered with plain regenerator receivers. Although heretofore rather carefully placed shielding has been considered essential to a receiver using the 222 tube, the use of the untuned antenna circuit makes shielding unnecessary. The elimination of the shielding not only reduces the cost of parts and simplifies the work of construction, but also makes it a simple matter to change coils when going from one band to another.



RAYTHEON KINO-LAMP

In constructing any type receiver, especially for short waves, and particularly one for television work, where a motor and scanning disc are located in the same room, considerable attention must be given to rigidity of construction. This applies to the coils and their mountings as well as the wiring and other parts of the set.

The RF choke coil used in the detector plate lead is of the multi-section slot wound variety having very low distributed capacity over a wide band of frequencies. The other RF Choke, or grid circuit impedance is one especially designed for the purpose and has an inductance of approximately 2 millihenries.



Imp. No. 10 — Short-wave Antenna Impedance
R. F. C. No. 1—90 M.H. R.F. Choke
R. F. C. No. 2—500 M.H. R.F. Choke
L1-L2-L3 Short wave plug-in coils
L4—A.F. Grid Impedance
C1— .5 mfd.
C2— .5 mfd.
C3— .001 mfd.

C4— .00025 mfd.
C5— .000125 mfd.
C6—1.0 mfd.
C7— .5 mfd.
C8— .5 mfd.
C9— .5 mfd.
R1—15 ohms
R2—6 megohms
R3—2 ohms

R4—0 to 500,000 ohms
R5—50,000 ohms
R6—500,000 ohms
R7—300,000 ohms
R8—500,000 ohms
R9—25,000 ohms
R10—0-10,000 ohms
R11—5 to 10 ohms—40 watts
R12—0 to 100 ohms—75 watts

The National short-wave kit was used in this circuit.

THE AUDIO AMPLIFIER. The perfection of the picture received depends upon how good a signal is transmitted in the first place and upon how well it is reproduced at the receiving end. Here the amplifier used following the detector plays the important part. If the signal to be received contains frequencies of from 18 to 20,000 cycles, then it is important that the audio amplifier be able to amplify all frequencies within these limits.

On the other hand, how good must the picture be before you call it satisfactory? Do you remember the first broadcast signal you ever heard? It probably sounded pretty good to you then, but by your present standard of comparison it was pretty poor. We are in the same predicament now as we were eight years ago with broadcasting. Anything at all is "good." We find from experience that the ordinary audio amplifier such as you use at present is good enough to provide picture reproduction clear enough to distinguish forms such as the outline of a hand or head and to follow motion. This may be perfectly O. K. for a starter, and if so, your present audio amplifier can be used, provided it has the gain of a good two stage transformer coupled amplifier.

The diagram of the audio amplifier shown herewith is one that has considerably higher frequency range than the average and gives a picture reproduction that provides ample detail for recognizability of persons. For example, the letters WLEX on a microphone stand become readable when held before the television pick-up.

This amplifier is essentially a resistance coupled amplifier. The first tube is a 240 or 340, high Mu tube. The second is a 112, and the third a 171. The values of the coupling resistors, grid leaks and coupling condensers are marked on the diagram. The grid leak is replaced in the case of the 171 by an audio frequency choke in series with a radio frequency choke. In the output circuit, two 30 henry chokes are connected in series.

Spring suspended sockets should preferably be used in building up the amplifier in order to reduce the possibilities of microphonic tube noises when motor and disc are located close by. Another important point to keep in mind is the necessity for employing high-grade resistors in the grid and plate circuits.

Noise does not present the same limitations in a television receiver that it does in a broadcast receiver. Any noise is bothersome if you must listen to it, but in a picture it is represented by black spots and streaks that appear in a continually shifting position unless it is a periodic noise.

THE SHORT WAVE TELEVISION RECEIVER

Poor coupling resistors and vibration are the two most common sources of noise in the receiving amplifier. If in an early stage of an amplifier a plate coupling resistor is defective it will introduce noise that is amplified. A pair of head phones connected to the output terminal will reveal this noise. Of course, some noise is to be expected from a high gain amplifier, but one can easily judge the amount of noise that is permissible by tapping the tubes and comparing the microphonic noise with the amplifier noise.

As a rule, in only three stages of amplification, the amplifier noise will not be appreciable and unless there is a poor quality or defective resistor in one of the plate circuits, the amplifier will be quiet.

Vibration from the receiving disc or its motor transmitted to the amplifier or especially the detector tube, will introduce a periodic noise that will put a black streak across the field of the picture. Any periodic interference such as a sixty cycle hum that may get into the signal will also cause streaks across the picture, but these will not remain stationary, but will move upward or downward across the field of the picture.

THE OUTPUT CIRCUIT is so arranged that the Kino-Lamp is always illuminated, and when a signal is received, the brilliancy of illumination merely varies in accordance with the signal.

The construction of the tube is quite simple. There are two flat metal plates placed parallel and very close together. They are one and one-half inches square, presenting an area of two and a quarter square inches. They are mounted so that both plates present a clear surface. In this way either plate can be used as the anode. These plates are in a space containing neon gas.

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

A good background will be obtained if the current is limited to 10 or 20 milliamperes. More current will cause the lamp to glow brighter and brighter but there is no advantage in this so far as the picture is concerned and it only serves to shorten the life of the lamp. Accordingly, care should be taken to adjust the current to the minimum satisfactory value. In fact, quite satisfactory results can be obtained by adjusting the D. C. voltage just below the starting value for the lamp. In this case, a black back-ground is obtained and the image stands out in quite striking contrast. Under such conditions, the tube life will be quite long.

There are two ways of adjusting the current through the neon lamp once it has started. They are by varying either the D. C. voltage or the series resistance. The latter method is the more practical. A fixed resistance of ten thousand ohms in series with the lamp can be used very satisfactorily, however. If this is done, the D. C. voltage on the lamp should vary until it will light with a soft, medium glow. The lamp may flicker a bit when it first starts but this will soon stop when the tube warms a little.

KINO-LAMP AND SCANNING DISC MOUNTING

If a variable resistance is used, we suggest that a ten thousand ohm variable resistor in series with a one thousand ohm fixed resistance be used. Set the resistance to the maximum position and adjust the voltage until the lamp barely glows. Then decrease the resistance until the plate is covered with a soft glow. The reason for the fixed resistor in series with the variable one is to prevent the accidental or careless omission of any resistance in the circuit which would cause damage to the lamp.

The Scanning Device

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

While successful results have been obtained with a number of different types of small motors for driving the scanning disc, the one being used at present is the Baldor 1/8 horsepower type Y1V variable speed condenser type for operation on 110 volts single phase 60 cycles AC. This is a ball bearing motor that operates very smoothly and quietly. The swish of the disc through the air constitutes the major portion of the noise and this is quite insignificant.

The diagram shows the method for speed control.

For the variable resistor "R12," a 75-watt, 4 to 100 ohm special size Clarostat is used. The fixed resistor may be a seven ohm 10 watt resistance. This is labeled "R11" in the diagram and is shunted by the push button speed control leads.

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

Actual power measurements show that when the above motor is turning the two foot aluminum disc over at a rate of 1080 revolutions per minute, the total power input to the motor is approximately 100 watts. The current consumption is 1.1 amperes and the voltage across the motor terminals is 62 volts. This means that roughly 50 watts is dissipated in the two resistors so that the total power consumption is 150 watts.

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

The experimenter will find that the following convention has been adopted by the Raytheon Company in regard to neon tube mountings. The tube is fitted with a standard UX base. The plates inside the tube are placed in a plane at right angles to the axis of the "Pin" of the base. If the pin, therefore, is pointed toward the disc when inserted in the socket, the plates inside the tube will then be parallel to the disc. After setting the tube at the proper height to cover the inch and a half square scanned by the revolving disc, the following connections are made.

The plates are brought out to the "plate" and "filament" prongs. The plate terminal of the tube socket into which the neon lamp is fitted should be connected to the plate of the 171. The filament terminal should connect to the current limiting resistor.

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

The television signal has a very distinctive sound but unfortunately the short waves contain several signals that may easily be mistaken for television. For instance, the high speed code and picture transmission of such stations as WIZ and WQO are very like a television signal because of the flutter or what may be called a group frequency.

In addition to a low group frequency which is the rate at which complete pictures are transmitted and which is around 18 or 20 cycles per second, the television signal contains high frequency notes whose character depends upon the nature and position of the subject before the transmitter.

You will hear a signal that sounds at first like a flutter and will then note that this flutter is really the rapid repetition of a high frequency note. The nature of this note and its loudness constantly changes as the subject before the transmitter moves or is changed. For instance, a newspaper rolled up and held in a vertical position produces a distinct note that is very clear cut. A hand does not produce so clear a note but the signal is of the same general nature.

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

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

Whether or not the received image is reversed horizontally is impossible to tell unless one happens to know the scene being transmitted or something like print is held before the transmitter. For example, one of the objects often placed before the transmitter is a microphone stand with the microphone and the station letters such as WLEX mounted on it. If you receive this object erect, but reversed, so that the letters read "XELW," then your disc is so rotated that the holes pass the neon plate in the wrong direction.

The correction of this fault is not so obvious. It is plain that whether you scan the plate from top to bottom, or from bottom to top makes the difference between the picture being right side up and upside down. Similarly, whether you scan the plate from left to right or from right to left makes the difference between seeing the image correctly or reversed.

How can we make the holes pass the plate in the opposite direction and still progress from top to bottom? Reversing the rotation of the disc alone will turn the image upside down. You must also turn the disc around on the shaft of the motor. Thus, if your image is right side up but reversed, you must reverse the direction of rotation of the disc and also remove the disc from the shaft and turn it around with the other side out.

In spite of the fact that these two factors make three wrong combinations and only one correct one, the wrong combinations provide perfectly recognizable images whose worst fault is to be upside down.

Should the image obtained be a negative instead of a positive, the difficulty is due to reversed AC connections to the Kino lamp. Interchanging these connections will correct the trouble.

In our experimentation at WLEX we have found that the television signal may be almost submerged in noise and yet provide a picture. We find that this information is of interest to those who are already trying to receive the signals from WGY and who, because of the noise caused by day-time electrical disturbances and the static of spring weather, think that reception is hopeless.

It is true that when we are interested in listening to a signal, the noise level is an important determining factor but in the case of television, the noise level may be high, and, in fact, so high as to make speech transmission hopeless and still a fair picture can be received. Of course, noise does not help matters. It produces a mottled background and tends to speckle the picture itself. Extreme noise will produce dark lines of varying width across the field of the picture. But in spite of this, the picture is there and since noise is aperiodic unless introduced by vibration from a disc driving motor, the speckle and dark lines are continually shifting position while the picture remains generally stationary or moves in an orderly fashion.

Accordingly, if in your attempts to receive a television picture, you find the signal more or less accompanied by noise, do not judge the noise by sound broadcasting standards but go right ahead and try the signal on the disc. Of course, be sure that the minimum amount of noise is being introduced by your own receiver.

If you are getting a good television signal, it will sound very much like a slowly revolving circular saw which is slightly off centre. In other words, you hear a high pitched note which might correspond to the tooth frequency and this is broken up into groups whose frequency corresponds to the rate at which the saw (the disc) rotates. The latter we have referred to as the group frequency, while the high pitched note is the modulation introduced by the scanning spot. If the disc speed is high and the signal is weak, it may easily happen that the only sound audible in a pair of phones will be the group frequency. Even so, this is no indication that a fair picture cannot be received.