
Nov.
BROADCAST
WRNY
STATION
25 Cents
Science and Invention
BUILD YOUR OWN
TELEVISION
RECEIVER
See Page 618
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Popular Television

Built and Described by the Staff

How To Build The S & I TELEVISION RECEIVER

A slight adjustment of the rheostats and the picture comes in clearly. This photo shows a complete television receiver connected to an ordinary radio set. The picture is seen in the cone.

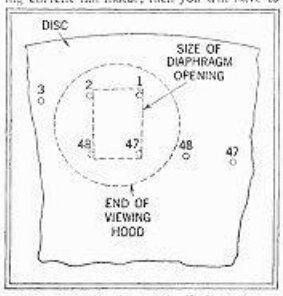
THE front cover illustration shows the simple television receiver designed and built by the editorial staff. The accompanying photographs and drawings show the appearance and the construction details of the television receiver, the apparatus pictured having, of course, to be connected to the output of a suitable radio receiving set. The ideal set for receiving television images from WRNY or other stations, is, for the broadcast wavelength of 326 meters, one comprising two or three stages of tuned radio frequency, a detector and at least three stages of resistance-coupled amplification. When a resistance-coupled amplifier is used, it will be found best to use about 250 volts at least on the last stage from either storage or dry "B" batteries. A good "B" eliminator may be used, but a special filter is usually necessary, to prevent "motor-boating" with a resistance-coupled amplifier.

A Television Receiver of Simple Design, Built Around an Ordinary 16-inch Electric Fan Motor

PROPER MOTOR FIRST ESSENTIAL

THE first requisite for building this television receiver is a good 16-inch fan motor. If the television disc to be used (it should have 48 holes for reception from WRNY and 3XK; also 1XAY and WLEX of Boston; and 24 holes for reception from WGY, 2XAD, and 2XAF, G. E. Co., Schenectady), is quite light, a 12-inch fan motor may do the work. If you have direct current in your laboratory or other location where the apparatus is to be operated, then you will have no trouble in controlling the speed of the motor down to the 450 r.p.m. required for WRNY reception or the 900 r.p.m. required for reception from the other stations broadcasting television.

If you have to select or use an alternating current fan motor, then you will have to find out whether the motor can be slowed down to a steady speed of 450 r.p.m. If the A.C. motor happens to be of the type that has throw-out contact brushes, which open the starting winding after the motor has attained fairly high speed, you will probably find this sort of motor unfit for television purposes. If the motor is of the universal A.C.-D.C. type, with commutator and brushes, the armature being connected in series with the field, then you will find that this motor can be regulated as to speed very nicely by means of the series resistances shown in the accompany diagram. We strongly recommend a universal type motor if you are going to purchase one, as these have been found to regulate well with regard to the speed.



The method of laying out the diaphragm opening is shown clearly by the above drawing.

MOUNTING THE DISC

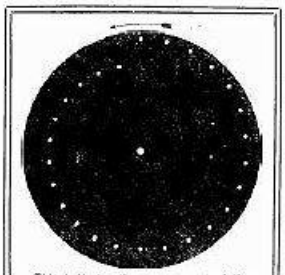
THE disc used in the television receiver here illustrated was a 48-hole 16-inch diameter bakelite disc of standard manufacture. This disc may be mounted and secured on a regular bushing provided with lock nuts supplied by the people who make the disc. In the present case, however, the perforated disc was mounted on the brass spider and hub which had originally carried the fan blades. The blades were removed from the legs of the spider and these were then flattened out in a vise and checked up on a lathe for alignment. A light cut may be taken across the face of the spider legs in the lathe, if one is handy. By drilling holes through the bakelite disc, it is readily secured to the spider by machine

screws and nuts, or the holes in the spider legs may be tapped if the builder so desires. Care must be taken to see that the disc rotates as perfectly as possible in both planes of rotation, that is, flatwise and edgewise; in other words, it must not wobble and care must be taken to see that the spiral is rotated in a true manner. These two requisites are easily checked up by means of a machinist's surface gauge, or else by making up a gauge from a nail driven in a block of wood and holding this near the disc as it is slowly rotated by hand.

NEON TUBE MOUNTING

THE frame for supporting the neon tube behind the revolving television disc is simply constructed from light brass bar, measuring about 1/16-inch by 5/8-inch. Strap iron may be used if the builder happens to have this stock on hand. No dimensions are given for the height of the frame as many builders will want to use a different size disc than the one we used, and so the height of the frame and the dimensions of the metal composing it will depend upon the diameter of the disc, of course.

Examination of the drawings herewith will show that the neon lamp may be rotated, so that the front plate inside the tube may be placed exactly parallel with the perforated television disc. This is easily accomplished by the simple expedient of using a standard vacuum tube socket having a hole in the center, or what is known as the one-hole mount. By passing a machine screw through the center of the socket and putting a nut on top of the bakelite shelf, the socket and neon tube can be rotated as required. Two sub-base brackets or supports, available at any radio supply store, are used in building the top of the superstructure which carries the neon tube. Two well insulated wires lead from the vacuum tube socket down to the base of the machine. The connections to the socket for the average neon tube is to the plate terminal and to the diagonally opposite filament terminal. This can be determined by experiment after the machine is built, or else beforehand by testing the neon tube on your receiving set. The plate that faces the television disc is the one that has to be illuminated. In some neon tubes there is a large and small plate; the large square plate is the one that is to face the television disc.



This indicates the arrangement of the holes and the direction in which the disc should rotate to receive television from station WRNY.

HINTS ON RECEPTION

WITH regard to the style of motor to use this is best of the series type; that is, with the armature and field winding connected in series. Small induction motors can be used, but do not regulate well in speed much below one-half their normal speed of 1750 r.p.m. If the picture image is observed and drifts toward the right, the motor is going too slow; if the picture drifts to the left, it is going too fast. The editor has found it advisable to regulate the motor speed to a point considerably above the desired value, and then to apply a piece of cardboard or a blotter against the surface of the disc to slow down the speed to the desired point. D.C. motors will regulate very well with the electrical rheostat arrangements shown in the circuit accompanying this article, however.

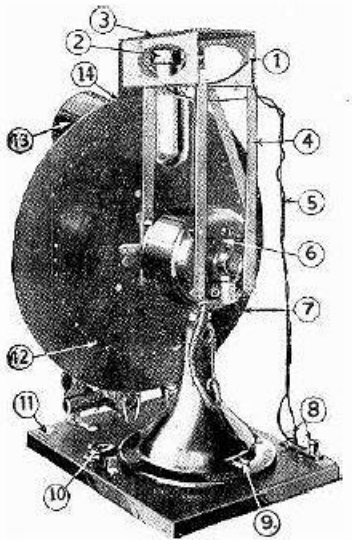
VIEWING HOOD AND LENS

THE viewing hood or visor shown on the machine herewith was built by cutting down a standard megaphone which can be purchased in any sporting goods store. The heavy metal ring at the mouth of the megaphone enabled the designers to secure it by means of three spring brass clips, soldered to the brass front plate shown in the drawings. It can be snapped off whenever desired. One of the accompanying drawings shows how the size of the diaphragm plate is determined, the rule here being that only one disc hole or perforation must be exposed at a time. A thin piece of leaf copper was used in the present case, from which to cut the diaphragm opening, and this was sweated to the brass front plate of the instrument. A fairly strong lens, about 2 inches in diameter, with a focal length of approximately 3½ inches, was procured for the purpose of helping to enlarge the image. This lens was secured inside the megaphone viewing hood by placing three machine screws through the megaphone shell and putting nuts on these, inside the shell. This is probably one of the best ways to build the viewing visor for any size television receiver, as the visor can always be snapped off the machine when it is to be moved to some other location.

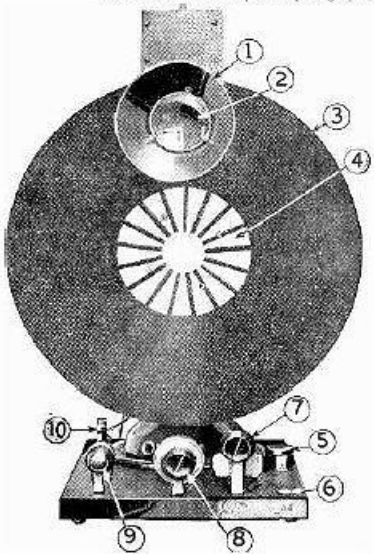
STROBOSCOPE INDICATES CORRECT SPEED

ONE of the greatest problems the beginner in television reception will encounter is that of checking the correct speed. Of course the average machinist or electrician will not mind checking the speed frequently with an ordinary speed counter, or possibly he may be so fortunate as to own a tachometer for the purpose. However, the average tachometer cannot be used with a small motor, as it takes too much power from the motor, and therefore slows the disc down and you do not know where you are at.

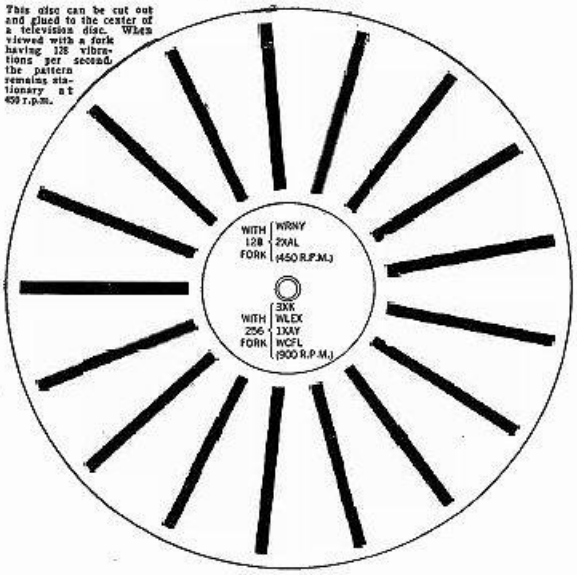
The method of using the *stroboscope* principle, with the black line disc noted on the front cover and in the present photographs,



In the diagram at the left, 1 indicates a separation of the wires leading to the socket 2, affixed to top plate 3, which in turn is mounted on the uprights 4, screwed fast to the motor by the screws which hold the case in place. The wires 5, lead down to binding posts 6, which connect with the ordinary receiving set. 9 is the standard switch on the fan motor which receives its current through plug 10. 11 is a control button, 12 the holes in the television disc, and 13, the cone.



Right: 1 indicates the cone; 2, the lens; 3, the disc; and 4, the stroboscopic pattern; 5, attachment plug; 6, control button; 7, vernier rheostat; 8, main motor control; 9, neon lamp control; and 10, leads to the receiving set.



This disc can be cut out and glued to the center of a television disc. When viewed with a fork having 128 vibrations per second, the pattern remains stationary at 450 r.p.m.

together with a tuning fork of the proper pitch, was suggested by the Editor, Mr. H. Gernsback, and details were worked out by members of the staff.

For the benefit of those who are desirous of using the stroboscope principle for checking other speeds than those here given, the following table and formulae will be found useful.

STROBOSCOPE TABLE

R.P.M. of Shaft	*R. P. Sec.*	*Tuning fork frequency*	*No. of marks on chart*
60	1	128	128
120	2	128	64
180	3	128	42.6
240	4	128	32
450	7.5	128	17
480	8	128	16
900	15	256	17
1080	18	128 (72)	7.1 (4)
1260	21	128	6

These formulae will help to solve your problems: here N = Rev. per second of disc; F= freq. of fork per sec.; and M = number marks on disc. Then N = F ÷ M; M = F ÷ N; and F = M × N.

The following pitch forks are available: 426.6, 256, 128, 288, 320, 341.3, 384, 480, 512.

For the benefit of the constructor we have provided herewith a good size reproduction of the stroboscope discs which can be cut out or else copied on to a piece of Bristol-board or drawing paper, and either glued or attached to the front of the television receiver. A tuning fork of the proper pitch may be obtained from music stores or from college laboratory supply houses, names of which will be furnished upon request from the editor.

For checking the speed of the motor at 450 r.p.m., a tuning fork giving 256 vibrations per second is necessary. This is used with a disc containing 17 black marks for the 450 r.p.m. specified. For other speeds, either a different fork has to be used, or else the number of lines on the stroboscope disc will have to be changed. All this data is contained on the drawings of the discs reproduced herewith.

All one has to do in using the stroboscope check for the proper speed, is to regulate the rheostats in series with the motor, and then repeatedly take a sight on the revolving black line disc through the legs of the vibrating tuning fork. The tuning fork is struck on the edge of the table or across the knee, and while vibrating, it is held a few inches from the eyes and twisted, so that the revolving disc is observed in a diagonal line passing under the corner of the upper fork leg and over the corner of the lower fork leg. This line of sight is shown in one of the accompanying diagrams.

While in most cases it will probably be found that the number of marks on the disc or else the vibrations of the tuning fork to be used will come out to an even figure, or at least that a suitable combination can be worked out for the speed desired, the calculation may show that an uneven number of marks will be required with any standard fork. Here, instead of using a number of radial black marks on the rotating disc, a spiral may be used and with this sort of design, any uneven number of convolutions such as 7½, 7-1/3, etc., may be employed.

HOOK-UP OF APPARATUS

ONE of the accompanying diagrams shows how the power clarostat (about 150 ohms maximum resistance) and the small 10 to 15 ohm variable resistance is connected in series with the motor. Across the small variable resistance a push-button is connected, and by pushing this button periodically, it becomes possible to keep the motor speed quite constant. In setting the speed of the motor in the first place, the rheostats are adjusted until the speed is a little below the 450 r.p.m. (if you happen to be "looking in" at WRNY's television signal), this factor being indicated when checking the speed with the stroboscope fork, by the fact that the black lines on the disc are seen to rotate slowly backward. If these lines rotate slowly forward or left-handed, then the speed of the motor and disc is above 450.

Rubber-covered wire or lamp cord may be used to connect the rheostats and the motor. The small clarostat at the extreme left of the motor baseboard is connected in series with the wires supplying the energy

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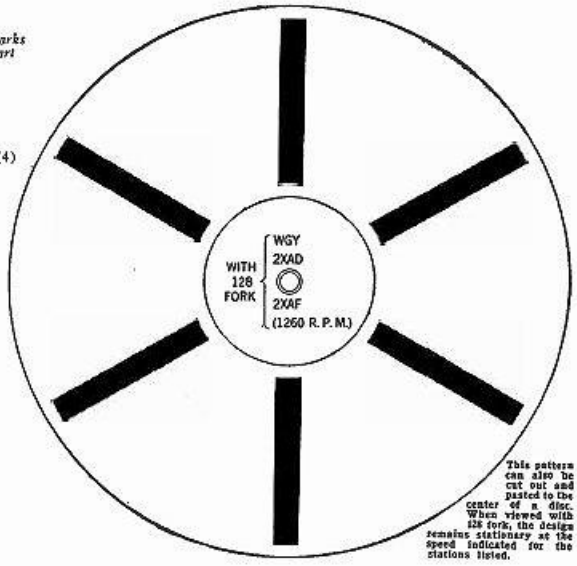

This pattern can also be cut out and pasted to the center of a disc. When viewed with 128 fork, the design remains stationary at the speed indicated for the stations listed.

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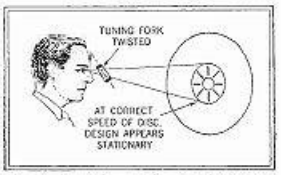
to the neon tube. The terminal posts to the neon tube circuit are mounted on a piece of bakelite, secured to the rear left corner of the baseboard. A rubber foot should be placed under each corner of the baseboard; this will allow the wiring to be simply placed against the wood and held in place with a few staples, if necessary. The clarostats are mounted on small right-angle brackets made from brass or iron. The push-button is placed in a tight-fitting hole, bored through one corner of the baseboard. The 110-volt supply for the motor circuit is brought into the apparatus, through an approved socket or receptacle, mounted on the righthand side of the baseboard, as shown in the picture.

OPERATING THE APPARATUS

WHEN the television signal is being received and the neon tube is connected to the output of the radio receiving set (and providing there is sufficient voltage used in the last stage—not less than 180) pulsations of pinkish light will be seen in the neon tube. If a sufficiently high voltage is used and the radio apparatus is properly adjusted with regard to the "C" bias, etc., then a pulsating pinkish light should be seen covering the whole neon tube plate which



The tuning fork must be so twisted that either the upper or lower leg is closer to the eye. The aperture between the legs should be very small. The entire pattern can be viewed if the fork is held close to the eyes.

faces the rear of the television disc. If the pulsating glow is seen on the rear plate, then the wires leading to the neon tube must be reversed.

If you are "looking in" with the television receiver, and, having checked the time of the television broadcast with the newspaper program, you should first check the motor speed and make certain that it is revolving at the prescribed speed. As you look into the viewing visor, preferably in a darkened corner of the room, you will see successive lines of orange-colored light as the spiral of holes repeatedly scans the illuminated plate in the neon tube. If you see these bands of light, but they only form irregular splotches, then the chances are that your motor speed is either too high or too low, and a slight change in the rheostats should be made. It is well to recheck the speed of the revolving disc with the stroboscope fork after doing this, as you may change the speed too much.

Several things may happen if you are successful in building up a picture image with the machine: the image may be upside down or it may slowly drift across the viewing lens repeatedly. If the picture slowly drifts across the lens, then the motor speed should be momentarily accelerated by pushing the button connected across the smaller resistance. This presupposes that the motor is running slightly below the correct television speed for the station to which you are "looking in." You may have to change the small

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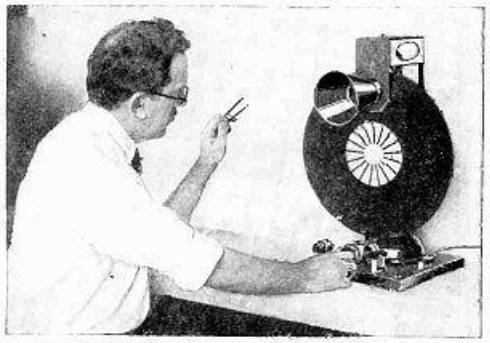

The photograph shows operator checking the speed of the television receiver by means of a tuning fork and a patterned disc. When viewed through the times of a vibrating fork, the pattern remains stationary, exactly as you see it here.

variable resistance or even adjust the larger one slowly in order to make the picture stationary on the lens.

If the picture is upside down, then you are scanning the neon tube plate in reverse order; that is, from bottom to top, instead of top to bottom, and the disc must be taken off and turned around. In some cases it will be necessary to turn the disc around and also reverse the motor, or in still other instances, in order to rectify the picture image, the direction of the motor rotation will have to be reversed.

If the motor happens to be of the universal type, which means that it is usually a series-wound motor, then the direction of rotation can be changed by simply reversing the connections to the field or to the armature brushes. If the motor is an A.C. induction type, with a separate starting winding, then the direction of rotation is reversed by simply transposing the terminals from the starting winding. If the motor happens to be one of those types using copper shading plates, mounted on the tips of the iron stator poles, then the direction of rotation can be effected by remounting the shading plates on the opposite pole tips; or simpler still, the whole stator frame may be removed from the car-case or motor housing, and reversed in its position with respect to the same.

In some cases direction of rotation of the motor may be effected by sliding the shaft out of the rear bearing and then turning the motor around. This is rarely the case, but with some induction motors it is pos-

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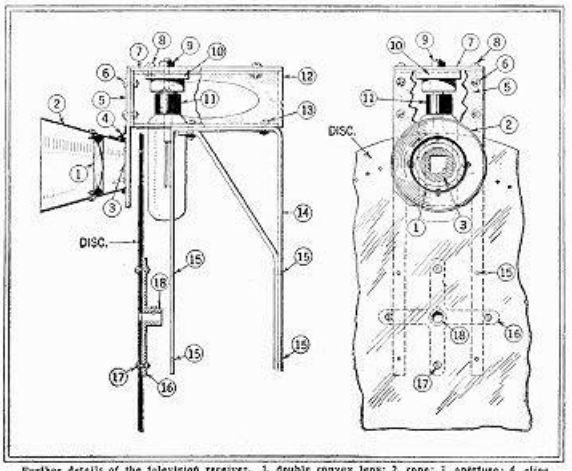

Further details of the television receiver. 1, double convex lens; 2, cone; 3, aperture; 4, clips for holding cone; 5, face plate; 6, screws for holding same; 7, cap; 8, screws for bolting to plates 12; 9, single hole mounting of socket 10; 11, neon lamp; 13, bolts for holding plate 12 to upright 14; 15, holes for mounting uprights to motor; 16, mounting for disk held in place by screws 17; 18, shaft mounting.

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sible to do this, the rotor being secured to the shaft by a set screw.

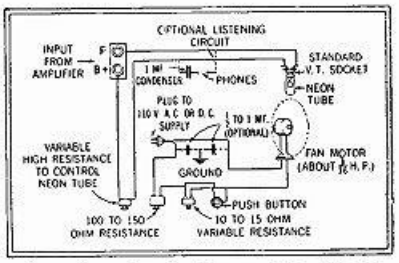
The television set builder who is interested in the connections of the resistance-coupled amplifier, and other details connected with the radio receiving set, should read all about this matter, where complete diagrams are given with explanatory remarks, in the *Television* magazine, Volume I, No. 2. Various methods of connecting the neon television lamp are supplied by some of the manufacturers putting out these tubes. The common connection for the neon lamp, however, is in series with the plate and "B+" supply wire; in other words, it is connected in the same relative position as your loud speaker. Some of the neon lamps, however, are supposed to be checked carefully with a milliammeter, so that no more than a certain current in milliamperes is passed through them, in order to conserve their life. When using one of these more sensitive type neon lamps, it will be found necessary to connect a clarostat, or other fairly high variable resistance, in series with the "B" supply, before it reaches the neon tube. This series variable resistance in the neon tube circuit may have a range of 0 to 10,000 ohms. A fixed resistance of 10,000 ohms, with a variable 2,000-ohm resistance, may be used. In the *Television* magazine, Volume I, No. 2, already referred to, details will be found for making your own rheostats for the speed control of the motor, as well as data for building an adjustable impedance for those using A.C. motors; the variable impedance being preferable to variable resistance control, where alternating current is used.

When all ready to listen in for a television signal, you will soon become accustomed to the peculiar whining note of the television signal proper; and if you follow the published program of WRNY, for example, you will receive the proper introduction by the announcer, and then you will make no mistake when you hear the television signals in your phones.

If you "listen in" to the station at first with a pair of headphones and plug them into the detector jack on your set, this is all right; but if you connect your headphones in the last stage wherein the neon tube is connected, be sure to connect a 1 micro-farad condenser in series with the phones, when connecting them in the place of the neon lamp, or across the neon lamp terminals. The television signal sounds in general like a buzz saw cutting through a plank, and the note continually changes as the person in front of the television transmitter moves about.

NEON TUBE NOTES

IN adjusting the neon tube circuit, it is the usual practice to adjust the "C" bias on the last amplifier stage, so that the tube just glows over the plate facing the rear of the revolving disc. In other cases the neon lamp is adjusted by raising the "C" bias potential on the last amplifier tube, so that



Above is a schematic diagram of the Science and Invention television receiver. A push button cutting a resistance out of the circuit speeds up the motor when necessary.

the neon lamp doesn't quite glow. In this case, when the television signal comes in, the lamp lights up as the television signal pulses are impressed on the circuit. In some cases it may be possible that you see the image in negative form instead of positive, i. e., you may see the image similar to a photographic negative. In this case the connections to one of the amplifier stages should be reversed: at other times it will be found that if the tuning dial of the set, or one of the dials, if it has more than one, may have to be moved from the right side of the peak of the carrier wave, so to speak, to the left side and vice versa. That is, if you had tuned the dial to say 45 degrees for maximum signal strength, and then detuned a little toward the left; you may have to detune toward the right of the peak, 45 degrees, in order to reverse the image.

Another reason for a reversal of the image from positive to negative is that a certain number of stages has to be used with a specified form of detector circuit; this is explained at length in an article covering an interview with Mr. C. F. Jenkins' radio engineer, which appears in *Television* magazine, Volume I, No. 2, page 8.

If you happen to see the television image on the lens right side up reversed, you will have to reverse the direction of rotation of the motor and also remove the disc from the shaft and turn it around with the other side out.