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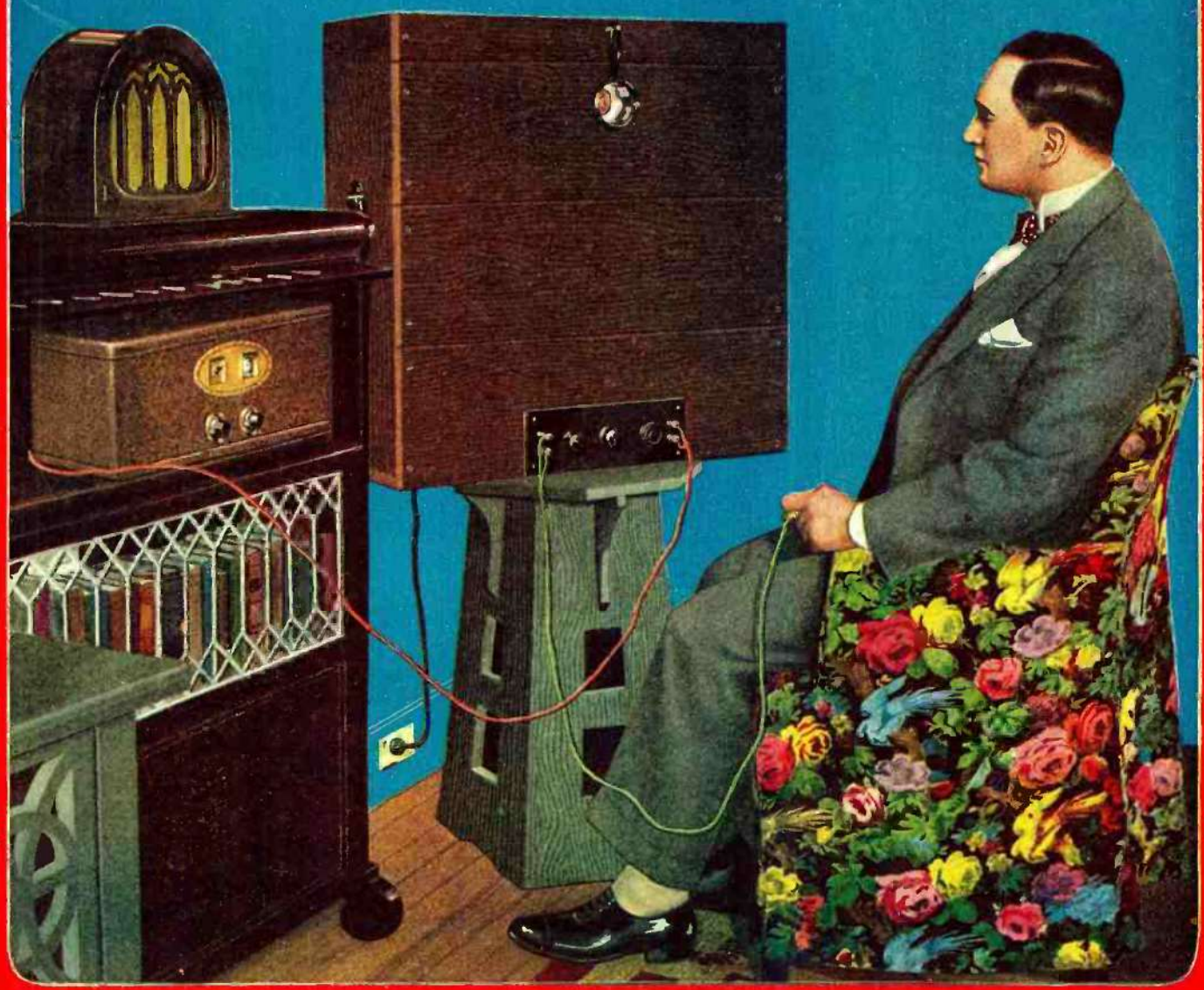
TELEVISION NUMBER

HOW TO BUILD YOUR OWN TELEVISION RECEIVER

SEE PAGE 422



TELEVISION EXPERIMENTER PUBLISHING COMPANY, 230 FIFTH AVENUE, NEW YORK RADIOVISION

How to Make Your Own Television Receiver

H. Gernsback, Editor of Radio News, *receiving the television broadcasts from WRNY at his home in New York City, with the simple apparatus described in this article. For purposes of the test, the neon tube and loud speaker were connected in series temporarily, with successful operation simultaneously.*

IN order to pick up and reproduce the television images now being broadcast by WRNY and W2XAL, you need only a modest assembly of instruments, some of which you probably already have on hand, and some of which you will have to buy.

First, since the television images are transmitted simultaneously on 326 and 30.91 meters, by WRNY and W2XAL, respectively, you need either a regular broadcast tuner or a short-wave tuner. If you live in or near New York, and obtain satisfactory loud-speaker results from the regular WRNY transmissions, all you require is a separate audio-amplifier of the resistance-coupled type, and the scanning mechanism, to be described later. If you are already using a resistance-coupled amplifier, as many radio fans are, you will need only the scanning apparatus.

If you cannot hear WRNY's 326-meter wave very well, the best thing to do is to install a short-wave set, in order to pick up the 30.91-meter wave of W2XAL. You will require the audio amplifier also, however. Happily, short-wave receivers are very inexpensive and can be built very easily, so you should assemble one without delay. It will enable you to pick up, not only W2XAL's television signals, but also the "radio-movies" of station 3XK (using the Jenkins system), and musical programs from short-wave broadcast stations in many parts of the world. We can particularly recommend the set described in the Radio News Free Blueprint No. 62. This uses an R.F. amplifying stage, has only one tuning control, and costs very little to assemble. If you do not already own a short-wave receiver, just drop us a card and we will send you Blueprint No. 62 free of charge.

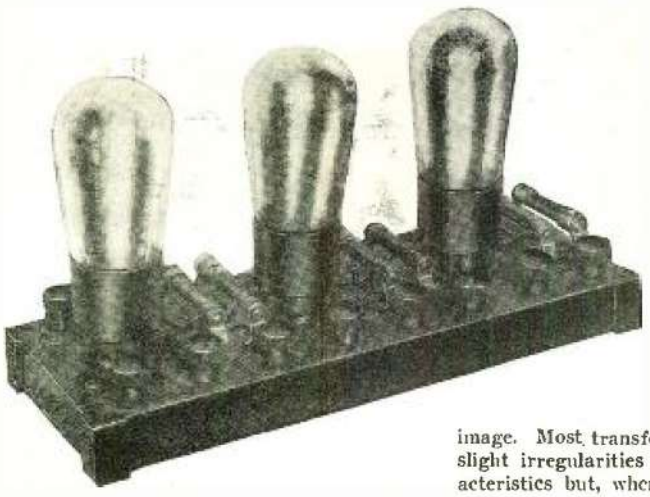
In making this receiver, do not install the single stage of audio amplification. Leave out the audio transformer and the third tube, and simply provide two binding posts for the wires that are shown connected to the primary posts of this transformer. The detector is then easily connected to an external resistance-coupled audio amplifier.

If you are able to use your regular broadcast receiver for WRNY, you will not use for television reception the present audio amplifier if it is of the transformer type. Simply run a wire from the plate (P) post of the detector tube to the top input post of the resistance-coupled amplifier shown in Figs. 1 and 3, unhook the "B+Det" wire running to the power unit or "B" batteries, and bring this same wire to the other input post of the audio amplifier instead. With this arrangement, the detector will be feeding directly into the resistance-coupled amplifier.

RANGE OF FREQUENCIES

"Why can't a regular transformer amplifier be used? Why is a resistance amplifier necessary?" you may ask.

The answer is that resistance-coupled amplifiers amplify audio-frequency impulses ranging from 50 to 5,000 cycles *more uniformly* than do most transformer-coupled amplifiers. The television impulses broadcast by WRNY-W2XAL and others cover this frequency range, and they must be reproduced faithfully at the receiving end, without emphasis on any particular register, in order to create a recognizable image. Most transformer amplifiers possess slight irregularities in their response characteristics but, when voice or music is being reproduced, these are not very noticeable to the ear. When television images are being reproduced, even the slightest irregularity will cause the already crude images to break up and assume peculiar shapes. The general experience of television experimenters has been that resistance-coupled amplifiers are more satisfactory for both television transmitters and receivers, at least in this stage of the art.



A commercial three-stage amplifier which may be purchased already assembled is convenient and compact. The 171-type tube in the output is best suited to the characteristics of the neon tube.

The above statements should not be interpreted as a condemnation of the transformer amplifier. There has long been raging in technical circles a controversy over the respective merits of the transformer and resistance systems for the amplification of voice and musical signals, with the radio experts evenly divided between the two camps. At the present time, however, it is easier to get good pictures from the latter system, so we recommend resistance coupling. However, it is entirely possible to obtain satisfactory results from a *high-quality* transformer arrangement; witness the work being done by James Millen, of Malden, Mass., whose experiments are described briefly on page 421 of this issue.

A good three-stage resistance-coupled amplifier can easily be assembled on a wooden board, about five inches wide and twelve inches long. A completely-assembled one can be bought for about ten dollars, but a home-made one will not cost so much. After you finish it, you will have a fine amplifier, not only for television impulses, but for regular broadcast programs as well.

DESIGN OF AN AMPLIFIER

You will need the following parts, arranged and connected as shown in Figs. 1 and 3: a wooden baseboard; three UX-type tube sockets, V1, V2, V3; three ¼-ampere filament ballast resistors, R4; two double-resistor mountings; four 0.5-mf. fixed condensers of the by-pass type, C; one 1.0-mf. condenser, C1; a special high-value grid

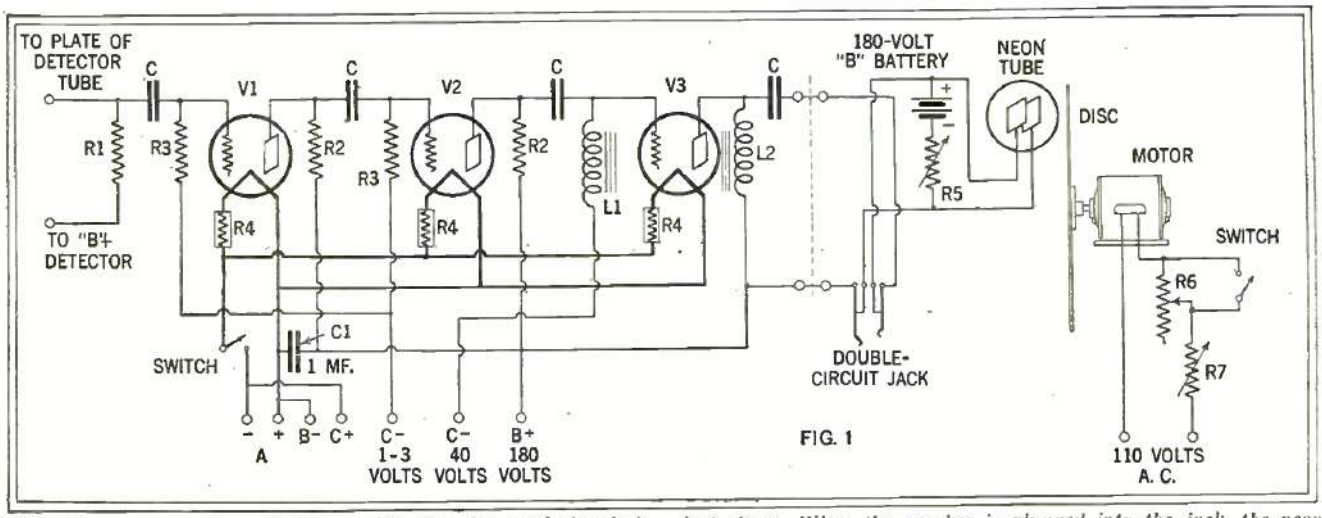
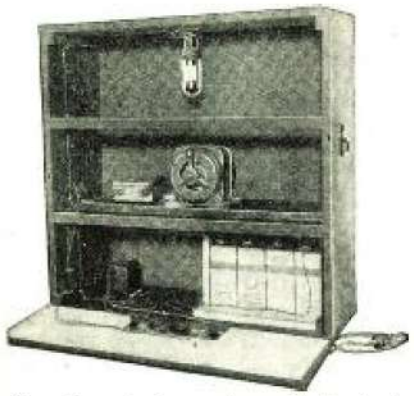


FIG. 1

With this arrangement, sufficient amplification for good signals is obtained by the use of two "high-mu" tubes and a 171-type in the last stage. When the speaker is plugged into the jack, the neon-lamp tube is disconnected automatically from the amplifier.

impedance, L1; an output choke of 30 henries, L2; a filament switch; eleven binding posts; fixed resistors of the following values: one 100,000-ohm, R1; four 250,000-ohm, R2 and R3.

The grid impedance unit L1 is used instead of a grid leak in the last stage, as



The cabinet of the reproducer with the front removed, showing the lamp and the motor with its regulating condenser. The "B" blocks are conveniently located beneath.

shown in Fig. 1. In this position it overcomes the tendency of the amplifier to "motorboat" when used with a "B" socket-power device. The tubes V1 and V2 are of the 240 ("high-mu") type, while V3 is a 171A.

The wiring of the amplifier is simple, and should give no trouble. The hook-up is that of a perfectly straightforward resistance-coupled system, with an output filter consisting of a choke coil (L2) and a fixed condenser (the last of those marked C).

BUILDING THE TELEVISOR

With the amplifier finished, the next step is construction of the scanning mechanism. For this you will need the following parts: a neon-gas glow-lamp, which fits in a standard UX-type socket; a scanning disc 24 inches in diameter, drilled with a spiral of 48 round or square holes; a universal or a condenser-type motor, of not over ⅛-horsepower; a variable resistor, 0-10,000 ohms, R5; a rheostat, 100 ohms, R7; a rheostat, 0-10 ohms, R6, and a pear-shaped hand switch.

The neon-gas glow-lamp is described in detail in another article in this number (see page 427); so nothing more need be said about it here.

The scanning disc is merely a flat disc of aluminum drilled with a spiral of holes about 3/64-inch in diameter, as shown in Fig. 4. Now please accept a word of kind advice: *don't try to make your own scanning disc* unless you have available a lathe and a power drill-press, and have had some years of experience as a mechanic on precision work. We are showing the details of the disc as a matter of interest, and not with the expectation of having our readers make it themselves. Buy a disc—there are a number of inexpensive ones now on the market—and you can then expect to see good images.

For a motor to turn the disc, you can get either a condenser-type machine designed especially for television work, or a universal motor such as are used by the thousands for electric fans, vacuum cleaners, coffee grinders, etc. The speed of the motor must be capable of adjustment by an external rheostat; for it must be slowed down to 450 revolutions per minute for WRNY-W2XAL, or 900 for the Jenkins radio-movies from

The scanning disc, to show the image in correct arrangement, must revolve in the direction opposite to those of the hands of a clock.

3XK. A synchronous motor, revolving at 1,800 r.p.m., can be used only if it is geared to the disc by 1:4 or 1:2 reduction gears, for WRNY and 3XK, respectively. The ⅛-horsepower size of motor is widely available, and is just right. A special condenser-type motor was used in the particular television receiver shown in the accompanying illustrations, and proved exceedingly satisfactory because its speed can be controlled very smoothly by a hand rheostat. This motor has a half-inch shaft, on which the mounting flange of the disc fitted snugly. If you happen to pick up a motor with a shaft smaller than ½-inch, you can buy for a few cents a bushing to adapt the disc to it.

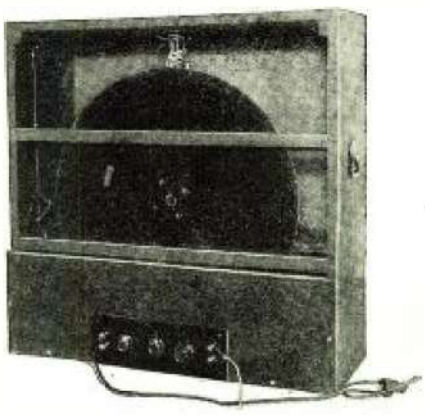
THE TELEVISOR BOX

The idea is now to assemble the scanning apparatus so that the neon tube is mounted directly behind the disc and above the motor, with its flat plates parallel and as close as possible to the back surface of the disc. The tube should be placed along the vertical center line of the disc, at such a height that the outermost hole of the spiral sweeps just under the top edge of the plates, and the innermost hole just above the bottom edge. Any strong, rigid framework that satisfies these conditions will serve the purpose.

The drawings (Figs. 5 and 6) show an arrangement of excellent design. A simple box 31 inches square and 12 inches deep is made up of ¾-inch boards, securely fastened together with wood-screws. The corners are strengthened by additional ¾-inch strips about 1½ inches wide. A shelf to hold the motor is made of another piece of ¾-inch stock about eight inches wide, and supported by two side and one center supports. No dimensions are given for the latter pieces because they naturally will depend on the size of the particular motor on hand. They should be cut so that the center of the scanning disc coincides with the center point of the box.

The neon tube is suspended upside down from the top of the box; its socket can be spaced away from the board with thin strips in order to lower the tube to the proper position with relation to the holes in the disc.

The back of the box may be covered, or left open. A piece of beaver board, or



The lower panel of the cabinet—which was solidly built—in place showing the controls, (R 5, 6, 7), switch, and lead from the amplifier.

similar ¼-inch board used for partitions, will be most suitable for the purpose.

The front of the box should be covered with two pieces of this board, one 21 inches high and the other 10 inches. From the larger piece cut out a hole 1⅝ inches square, directly in front of the square plates of the neon tube. On the small board mount the three variable resistors R5, R6 and R7, and two pairs of binding posts, as shown in Fig. 6. A telephone jack may also be mounted on this panel; this device is optional and its uses will be discussed later.

To facilitate experimentation with the disc, motor and the neon tube, do not permanently screw down these front panels at first; but merely turn one or two screws into each, to hold them in position.

It is well worth while to construct a box like this, as it will afford absolute protection against the rotating disc. The latter is far less dangerous than any ordinary "B" power device but, as a matter of safety, revolving machinery of any kind should be enclosed. If you do not want to make anything as elaborate as this heavy box, use lighter material for the sides, or make upright supports of broomsticks and cover the sides with cloth. At any event, be sure that the motor is securely fastened, and that the neon tube is not shaken by its vibration.

CONNECTING THE TELEVISOR

With all the mechanical work done, you can now start with the electrical end. As explained by many articles in RADIO NEWS, the neon-gas glow-lamp has the same function in a television receiver that the loud speaker has in a music receiver. It translates back into light-impulses the modulated electrical impulses created at the transmitter by the photoelectric cells. (See the first article in this issue for a fuller explanation.) It is connected in exactly the same place in the audio circuit that the loud speaker ordinarily occupies.

The best arrangement is shown in Fig. 1. The two output posts of the resistance-coupled amplifier are led to a double-circuit telephone jack, which may be mounted on the lower panel of the box holding the scanning apparatus. The inner springs run to the connection posts of the neon tube, across which are connected also the resistor R5 and a *separate* 180-volt "B" battery. Resistors R6 and R7 are in series with each other in the 110-volt A.C. circuit. A six-foot length of flexible cord is run from the pear switch (which is nothing more than a push button in a small wood case which can be held comfortably in the hand) to the resistor R6.

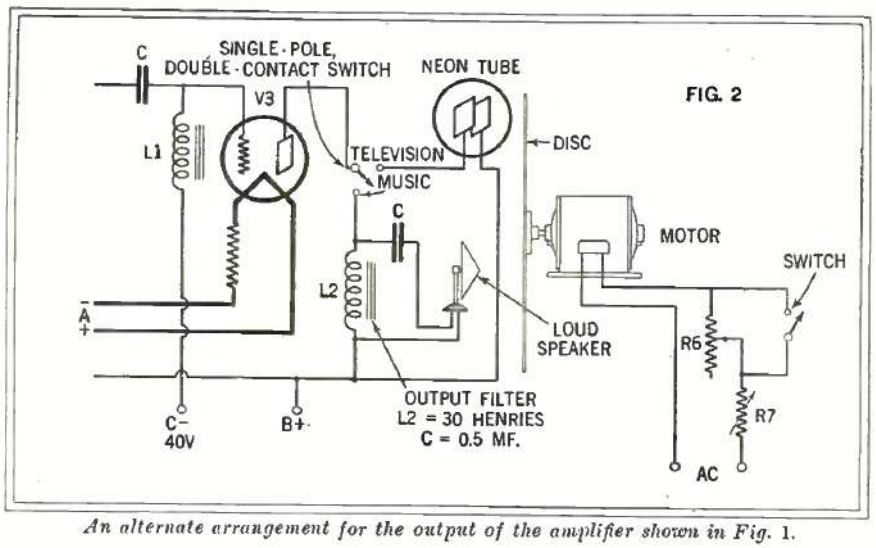


FIG. 2

An alternate arrangement for the output of the amplifier shown in Fig. 1.

No. 67

RADIO NEWS FREE BLUE PRINT ARTICLE

Large blueprints of the diagrams in this article, containing information for the construction of a television amplifier and reproducer as illustrated here, will be sent postpaid on request. Write to the Blueprint Department on a sheet of paper separate from any letter to other departments; print your name and address legibly and ask for No. 67. (See also page 449.) This will avoid possible delay.

Now turn on your receiver, tune in WRNY or W2XAL with the loud speaker plugged into the double-circuit jack, and adjust the set to give a clear, loud signal. Turn up the resistor R5 until the neon tube breaks out into a bright pink glow. The glow should take place on the plate facing the disc. If it appears on the opposite plate, reverse the battery connections to it. Further details on the characteristics and operation of the glow-lamp will be found in an article on page 427 of this issue.

Turn on the alternating current to the motor, and adjust R7 so that the latter turns at about half its normal speed. Turn off all the lights in the room. The instant the buzz-saw note of the television signals comes through the loud speaker, pull out

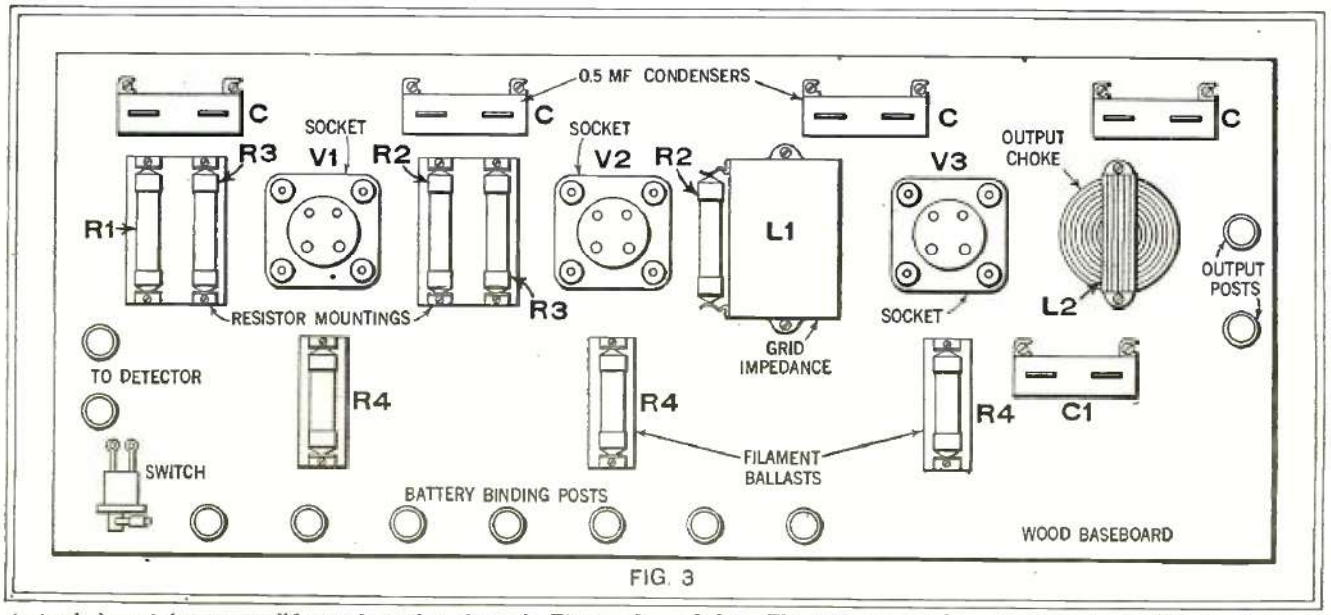


FIG. 3

A simple layout for an amplifier such as that shown in Fig. 1. It uses straight resistance coupling in the first two stages (see preceding pages for values), a grid impedance coil, and an output choke. The output may be connected as in Fig. 2, above, for greater convenience. It is possible, also, to have the tube and speaker in series, with a slight additional "B+" voltage.

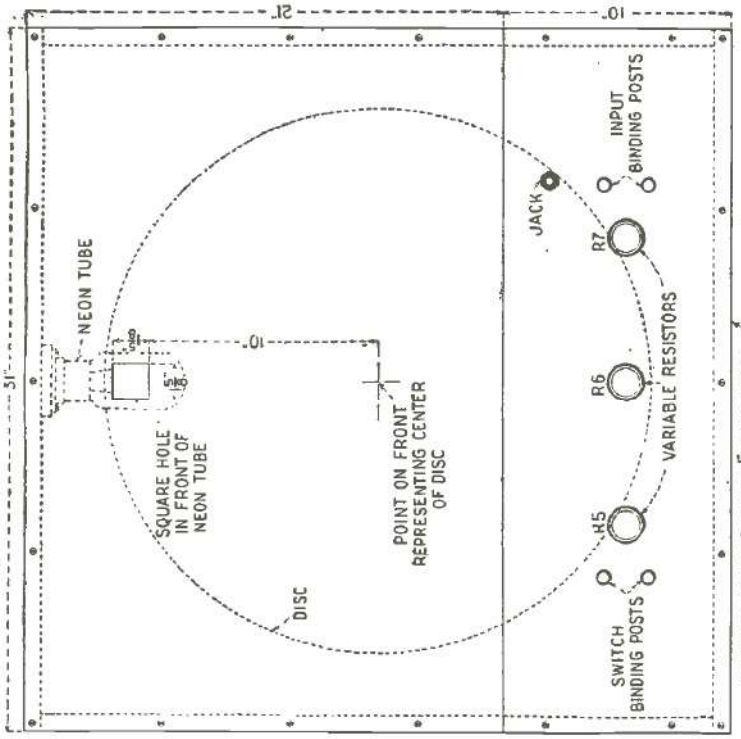


Fig. 6

Here we have the front of the box. While the cabinet illustrated is fitted with heavy wooden panels, beaver board or similar material is quite heavy enough for the purpose. The controls are conveniently mounted, as shown.

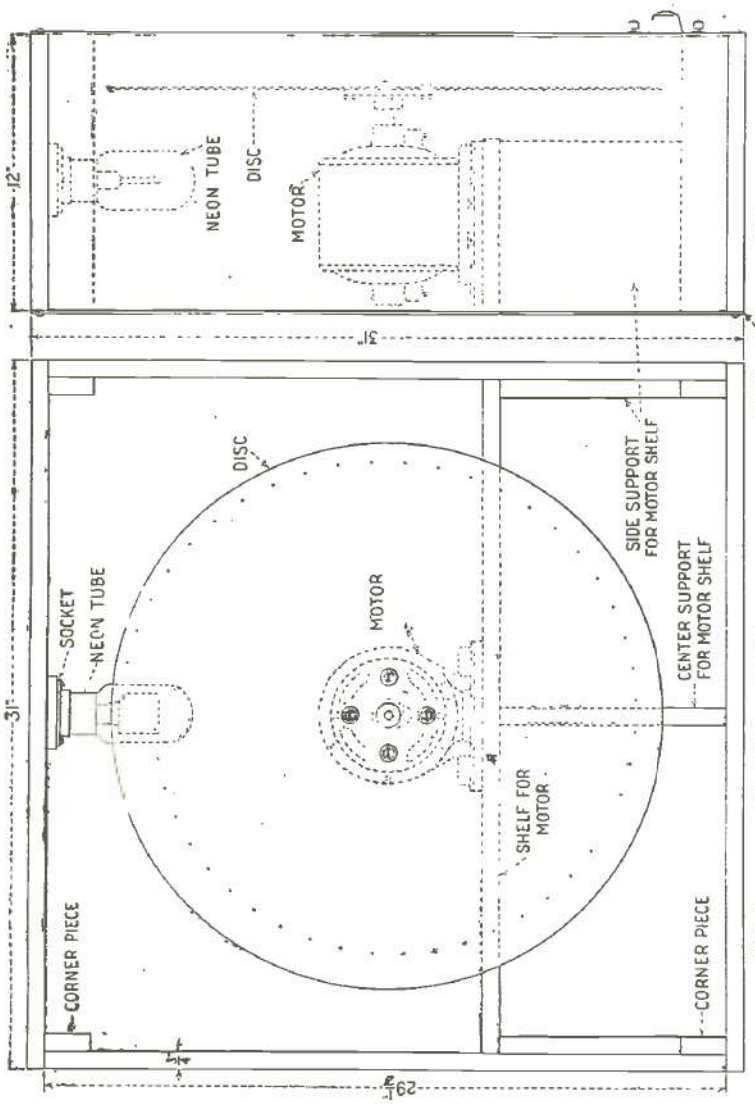


Fig. 5

The height of the shelf is governed by the distance from the center of the motor's shaft to its base. After the latter has been mounted, the neon tube is easily adjusted to the proper place to cover the inner and outer holes of the disc with its plate. Sponge-rubber mounting may be useful to protect it from vibrations through the cabinet.

the speaker plug and start playing with the motor rheostat, R7.

OPERATING IS SIMPLE

If you have no tachometer (speed indicator), the only thing to do is to run the motor up and down the scale. When you hit 450 r.p.m., the crazy criss-cross lines that are shooting back and forth and up and down the surface of the disc in front of the neon tube should melt into a rough image of a man's face, or other distinguishable object. You will notice that, with no signal being fed to the neon tube, the square of pinkish light you observe through the disc is streaked with fine dark lines. The instant the audio signal is turned on, this even glow will be modulated by the fluctuating currents. When you hit 450 r.p.m. and the image of the man's face literally uncurls itself from the hodge-podge you saw before, you will experience a thrill that will make all the effort well worth while. You probably received a big "kick" from your first successful broadcast receiver but, when you see your first television image, you will know what a *real* thrill is.

In the absence of any synchronizing system, the images will tend to wander out of view but, by carefully manipulating the control rheostat R7, you can find the proper setting for 450 r.p.m. The use of the smaller rheostat R6, with its switch, is more or less incidental. Set R6 to about half its value, and just press the switch for an instant when the images start to run off. This will cause the motor to jerk and speed up for a second.

If you are using a universal motor, you can disregard R6 and its switch altogether and depend on R7 for the speed control.

The images you receive may be upside down, or the WRNY televised card may read backward. To correct these conditions, follow the operating hints given in the article on pages 428-9.

OTHER ARRANGEMENTS

An alternate circuit arrangement is shown in Fig. 2. Here the neon tube is connected directly in series with the plate circuit of the last audio tube, with a single-pole, double-contact switch to shift the output of the tube. The rest of the amplifier and motor circuit is exactly like that of Fig. 1. This is a simple hook-up; but its main disadvantage is that the voltage applied to the "B+" post must be at least 300 volts, as there is a drop of about 150 volts across the neon tube itself, and V3 is a 171A, which operates on 180 volts. As no "B" power unit designed for 171 operation will supply more than about 220 or 250 volts, it will be necessary to connect one or two 45-volt "B" battery blocks in series with the highest voltage lead from the unit you have. At least, this will be cheaper than using four 45-volt blocks for the hook-up of Fig. 1.

Several experimenters have used a "B" power unit for the neon-tube illumination with good success, but separate batteries are really the cheapest, easiest and most satisfactory source of supply.

The audio amplifier need not be limited to a 171A for the output stage. A 210-type power amplifier will work perfectly well, but in this case the shunt-feed scheme of Fig. 1 should be used. The series arrangement of Fig. 2 will strain the power pack and the neon tube is likely to be burned up by the high plate current. With the Fig. 2

(*Continued on page* 466)

How to Make Your Own Television Receiver

(*Continued from page 425*)

hook-up, incidentally, it is a good idea to shunt the glow-lamp by a 0-10,000-ohm variable resistor; this resistor should be so set that the tube lights nicely when there is no incoming signal. The 171A draws about 20 milliamperes, which is the normal load limit of the glow-lamp; so the combination works out very happily.

TRY YOUR LUCK

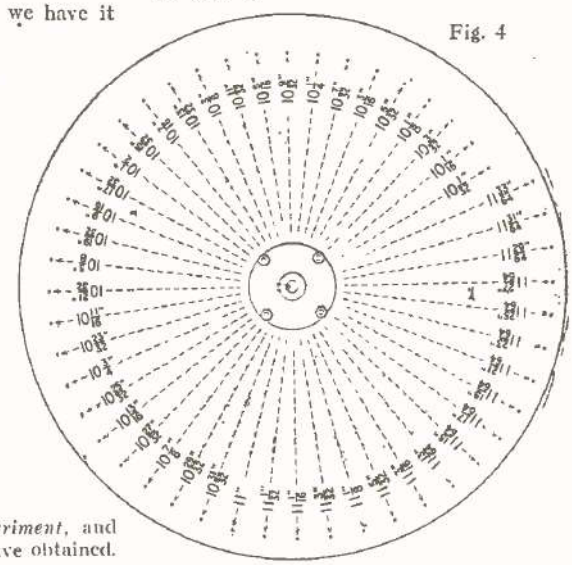
Remember that television as we have it to-day is very crude. Do not expect perfect images, and do not forget that television on 5,000 cycles was, until only very recently, held impossible altogether. Experiment with the neon tube and the motor's speed and try different output arrangements. Try putting an ordinary reading glass in front of the images, as shown in the cover illustration, and see if you can magnify them. *Experiment*, and let us know what results you have obtained.

Drilling layout of the 24-inch disc used. A full-size template accompanies the blueprints—if you wish to try your luck making your own.

To receive the Jenkins radio movies, on 46.7 meters, you can use this same apparatus with the disc speeded up to 900 r.p.m. These "movies" are black and white silhouettes, usually of a little girl bouncing a ball, or playing with a dog.

Next month we will publish more television "dope." Meanwhile, try your luck with this receiver; you will have a lot of fun with it.

Fig. 4



READERS will find interest and probable profit in the article, "How to Build the 'S & I' Television Receiver," in the November issue of SCIENCE AND INVENTION Magazine. This receiver may be readily built upon a fan motor, like the experimental set-up described in RADIO NEWS for September; and employs a very simple, but ingenious, visual ("stroboscopic") method of determining its speed and obtaining synchronism.

Televentures, Telewitticisms and the Televocabulary

(*Continued from page 419*)

within a generation to broadcast to a whole nation such sights as a Reinhardt 'Miracle' or a tennis match. The optimistic American regards the surmounting of obstacles as the very essence of invention, and rightly. One has but to read the Federal Trade Commission's examination of radio patent monopolies to learn of the romance that lies in vaulting over technical obstacles—of fortunes paid to young engineers who made it possible for a farmer in carpet slippers to enjoy the Philharmonic Orchestra better than in a hard-boiled shirt in Carnegie Hall. To an inventor of imagination the difficulties that now beset the commercial realization of television are glittering opportunities, and it is in that spirit that they will be conquered."

WHAT OF THE DICTIONARY?

With the vocabulary of even radio broadcasting quite out of the hands of the engineering profession, what is the puzzled maker of dictionaries to do about the new words which the art of television will require? The "glow lamp" and "scanning disc" may be soon used only in the past tense; but what shall we call the apparatus required for the transmission and reception? Will both be "televisors"? And if not, which?

"Television" is a word on which the language sharps look askance; like "automobile," it is a hybrid—half Latin and half Greek—and the public has even less Latin than the Bard of Avon, and no Greek. The editor of RADIO NEWS, before the days of broadcasting, coined "television," and suggested for the apparatus "telephot," which is a better word from the dictionary standpoint than "televisor." Will we use "phots" or "visors"? An English writer has hinted of "teleopsis" and "teleoppers," to be shortened into "'oppers"; but this seems to lack the necessary seriousness to convince.

What will be the title of the operators? We have "radiotricians" as specialized electricians: we will need a word of the weight of "televisticians," which may do for the present. But a "'visionary engineer" seems impractical.

Television transmissions require modulating frequencies, increasing with the size and detail of the image. While small figures suitable to the experimental receivers of the day are being reproduced from audio frequencies, the larger images of tomorrow will require wider bands and special amplifiers. These will be specially designated: "image-