A New Corner Speaker Design

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A new speaker cabinet designed to accommodate television in addition to providing high-quality sound reproduction.

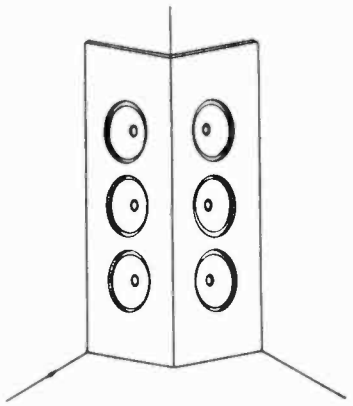

Fig. 1. Mounting a number of ordinary cones on two sides of an obtuse structure for corner use is one solution to the necessity for moving more air.

"Trifles make perfection; but perfection is no trifle."

WITH THIS TRITE SAYING as the guiding maxim in the construction or assembly of a high-quality reproducing system, the experimenter strives constantly to achieve perfection in the whole by working toward perfection in each separate component. In the past few months, the writer has endeavored to delineate the steps taken to arrive at the best possible reproduction from the electrical circuits of a residence radio system. Not that the equipment described is the only solution to the overall problem—far from it—but it is one solution designed to provide the maximum of convenience in operation together with a reproduction quality which leaves little to be desired.

Now that television is firmly established as a home entertainment medium, a *complete* installation must necessarily contain TV facilities, without sacrificing the superb quality desired for radio and phonograph reproduction. And, of course, no mention was made in the previous series of the loudspeaker to be used with the residence system. Therefore, solving two problems at once, the TV installation has been combined with the loudspeaker in a form which results in high-quality reproduction, a reasonable compactness, and a piece of furniture which is an eye-appealing addition to a modern living room.

Basic Design

It has been fairly well established that the most efficient location for a loudspeaker is in the corner of a room. The most outstanding example of this arrangement is represented by the Klipschorn, which consists of a two-way speaker system with both high- and low-frequency units being horn loaded. The cabinet work for the Klipschorn is extremely complicated, and certainly not one which the amateur woodworker should attempt. Some constructors have mounted a multiplicity of medium-quality cone speakers on the two sides of an obtuse enclosure, such as that shown in *Fig.* 1, and used this arrangement in a corner with excellent results. The corner location is optimum from the standpoint of loading on the speaker, since the radiation is over only half the angle of that from a speaker mounted on a flat wall. With a number of ordinary cones, the result is a means for moving rather a large volume of air without the necessity of having a large cone excursion of a single unit. Thus, better low-frequency response is obtained with speakers which individually would not perform so satisfactorily.

The writer has long used a standard two-way speaker of conventional design, and while the reproduction quality has been considered excellent, the low-frequency output did not compare with that of a good theatre system. Thinking from this point, the next step appeared to be in the direc-

tion of a corner speaker, yet utilizing the reflex action of a vented cabinet. Basically, therefore, the new design occupies the corner of a room, and is arranged so that the vents are loaded by a horn comprised of the walls and the sides of the cabinet enclosure. The plan view of the cabinet is shown in *Fig.* 2, with the vent openings *A-A'* along the sides. Thus the vents are loaded by the straight-sided horn between the wall and the cabinet.

Experience has shown that loading of the vents should be accompanied by a similar loading on the direct radiating side of the low-frequency speaker, so the front of the cone is provided with another horn section, *B*, thus equalizing front and back loading and increasing the radiation efficiency. A top for the cabinet provides an air seal by means of gaskets between it and the wall, and the floor provides the other horn wall for the vented ports. The entire cabinet is open to the back, and utilizes the room corner, although if desirable for use in other locations, a false corner could be constructed to provide the necessary back.

After determining the basic design, any necessary variations can be made to accommodate TV, as has been done in this case. The picture tube is simply enclosed in a wood housing, and doors in the cabinet front cover the screen when it is not being used. The superstructure, shown in *Fig.* 3, houses the multicellular high-frequency horn and unit, and the space behind is large enough to accommodate the TV receiver chassis. With such a construction, the picture tube is between the two speaker sections, and the illusion of sound coming from the picture is considerably better than if the speaker is either above or below, or at the side of the screen.

Development of the practical aspects of the construction is controlled by the units selected for both high- and low-frequency speakers. In order to get the best possible low-frequency reproduction, manufacturers' catalogs were studied, and the cone selected on the basis of power handling ability and natural resonant frequency.

Good speaker performance depends on a number of factors. Among these is a high gap flux, which should be as great as possible. A high field strength ensures good damping as well as the maximum of efficiency. Another important factor is the relative weights of the cone itself and the voice-coil structure. It is considered good practice —for good low-frequency reproduction—to have these two weights as nearly equal as possible. It is also important to have as low a resonant frequency as can be obtained readily.

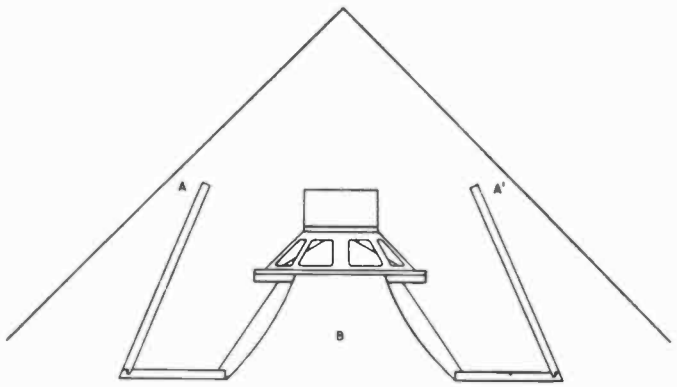

Fig. 2. Plan view of the new corner speaker design, showing vents at either side between the cabinet and the wall, and the horn loading provided by the wall and the cabinet sides.

The low-frequency cone selected for this system is a 15-inch model, rated at 20 watts, and with a resonant frequency of 42 cps. This model is the Stephens P52L*x*—the *x* denoting a special model of the more-common P52L—designed for the woofer of a two-way system, and having straight cone sides and a lower resonant frequency than the standard model. Another important feature is the special treatment of the cone rim to prevent reflections from the frame. Good results may be expected from any of the high-quality 15-inch speakers available, such as the Altec-Lansing 803A or the 515, or the Jensen PLM-15A or P15-NLA models, but the lower resonant frequency of the Stephens model governed the final selection for this particular application.

The selection of suitable high-frequency units is slightly wider. Ready-made are the Stephens P15 unit and the 824 horn, with an 800-cps crossover; the Racon RABAT unit with a two-cell horn designed for a 1200-cps crossover; or the Jensen P8-151 horn with an XP-101 unit. The Atlas HF-1 is also usable, but if this choice is made, the low-frequency cone should have an impedance of 8 ohms to match the dividing network which is supplied. The unit installed in the complete speaker shown is an Altec-Lansing Model 901B, of early vintage, but still quite satisfactory. The horn is a 2x4 multicellular type, built by the writer,

Construction Details

Getting down to a specific design, therefore, the cabinet takes the shape shown in *Fig.* 2 for a cross section at the plane of the low-frequency cone, and at (*A*) of *Fig.* 4 at the plane of the center of the TV picture tube. The top of the low-frequency cabinet has the outline shown in the solid line at (*B*), with the superstructure shown by the dotted lines. The top is 39 inches from the floor, and the corners of the top meet the side wall 36½ inches

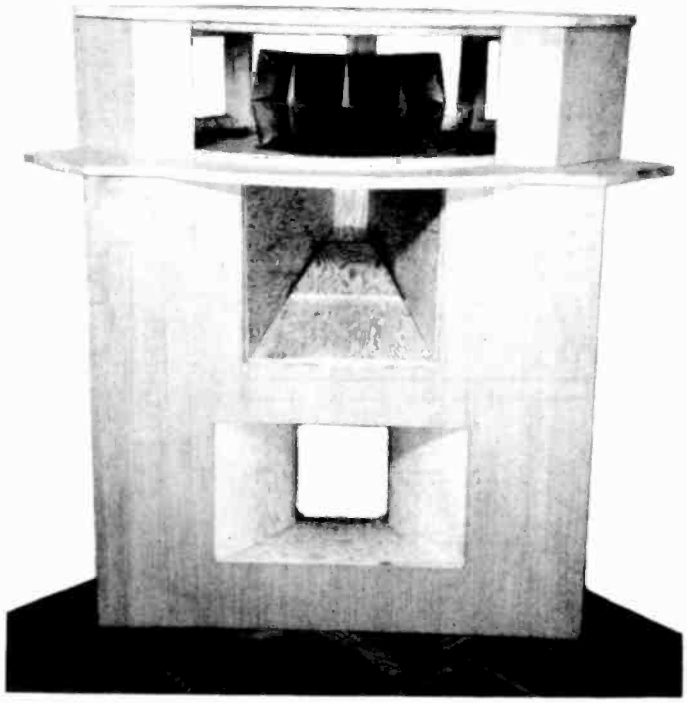

Fig. 3. Front view of the new speaker during construction, showing the LF unit "well" and the TV tube enclosure.

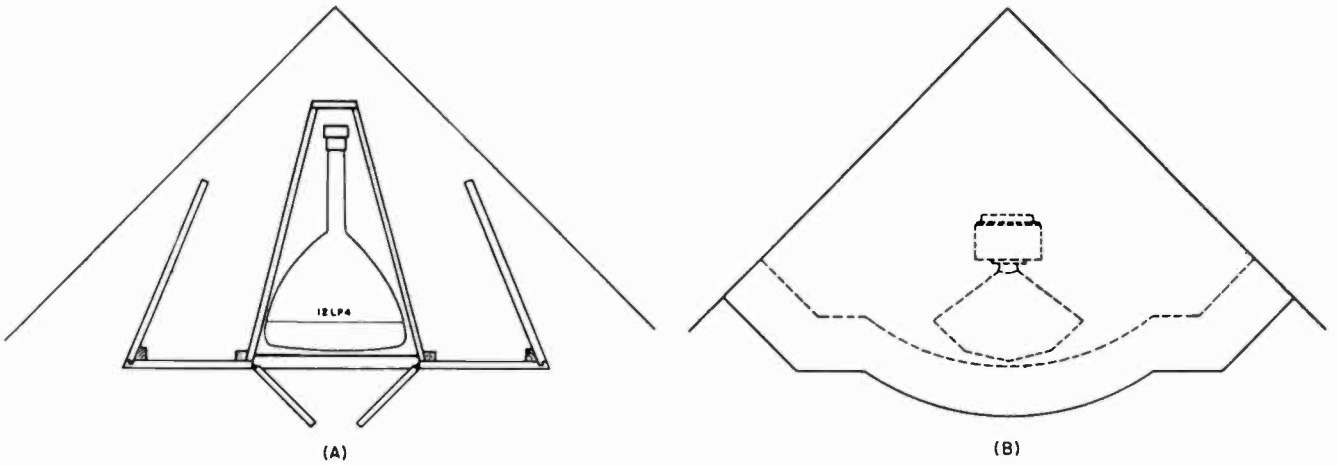

Fig. 4. (A) Cross section of the cabinet at the plane of the center of the picture tube to show location of tube enclosure. (B) Plan of the top (solid lines) and of the superstructure (dotted lines).

from the corner. Allowing for the volume of the speaker well and speaker and of the tube enclosure, the net volume of the cabinet is 8.5 cu. ft. This does not include the vent horns, which are usually included in the volume when vent pipes are used on the reflex ports.

Figure 5 shows the major parts used in the assembly of the low-frequency portion of the speaker, together with the housing for the picture tube. It will be noted that there is a hand hole in the bottom of the tube enclosure, with a removable cover which serves two purposes: it mounts the deflection yoke, and thus permits adjustment of the TV receiver with the tube removed from the cabinet; and it also permits anchoring the cabinet to the corner of the room by means of a pair of steel cables and two turnbuckles. The cabinet is placed close to the corner, and with the turnbuckles open to their maximum, the cable is looped over a hook mounted on the floor right in the corner. Then the turnbuckles are tightened up, thus locking the cabinet into the corner with the top tight against the wall. The quarter-inch semicircular groove along the back edges of the top provide space for a gasket to make an airtight seal. When the hand-hole cover is replaced, the structure is airtight except for the vents.

The wood selected for the top and front of the cabinet should be a suitable match (or contrast) for the furniture used in the room where the speaker

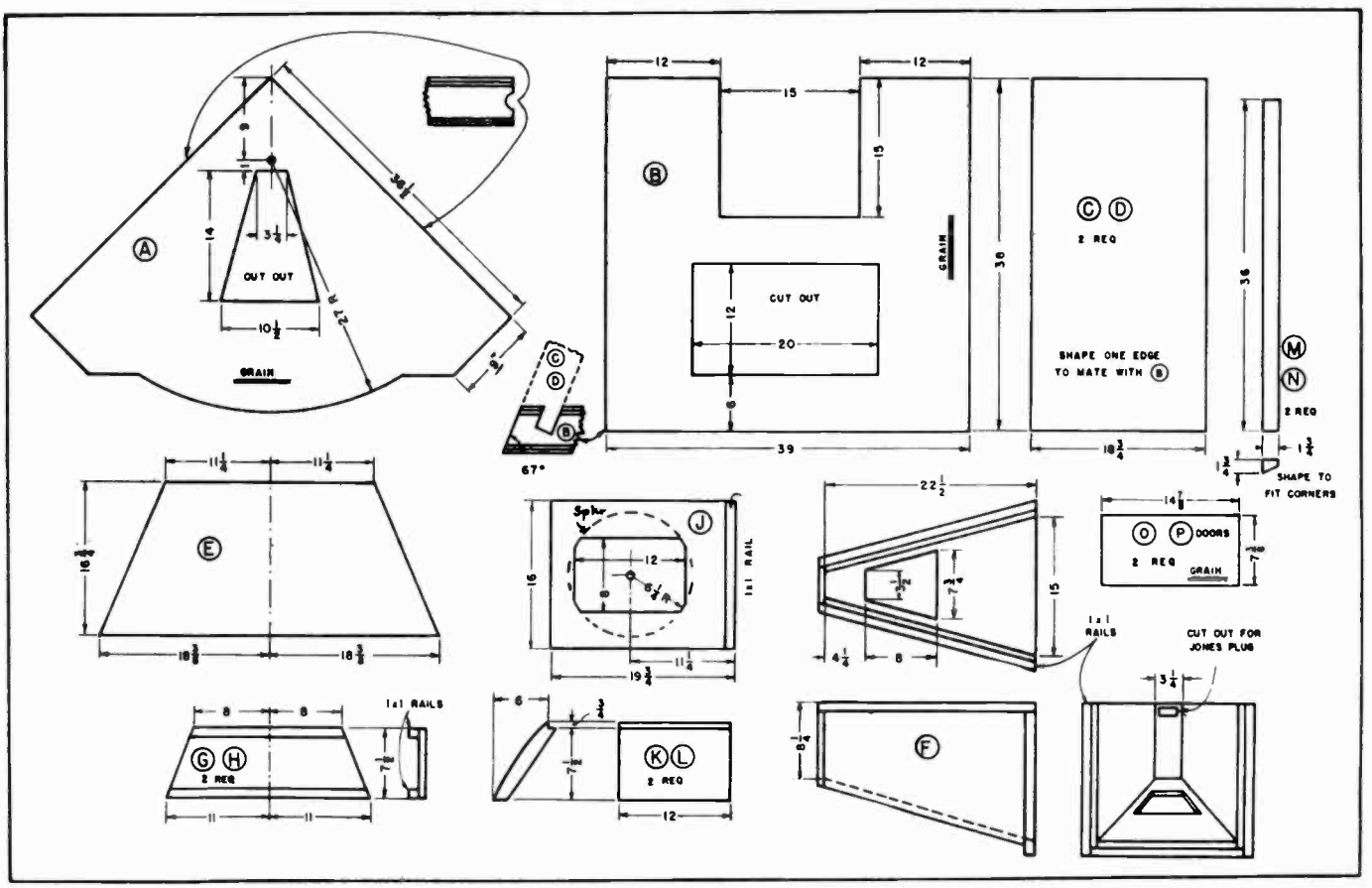

Fig. 5. Details of the pieces which comprise the lower cabinet, speaker well, and tube enclosure.

is located. For solid contsruction, ¾-in. material is recommended, with veneered hardwood being used for the top *A* and the front *B*. The doors *O* and *P* should be solid, or else veneered on both sides. The bottom *E*, sides *C* and *D*, speaker baffle *J*, and the tube enclosure *F* can be of less expensive fir plywood, also ¾-in. thick. The tube enclosure is a part of the acoustic chamber, which accounts for its seemingly over-solid construction.

The sides, *K* and *L*, of the speaker well are shaped from two-inch white pine, and should be fitted to the opening in the panel. The speaker baffle is drilled with eight holes, and T-nuts for mounting the speaker are installed on the front before the "horn" is assembled. In addition to the pieces shown, a number of ¾ x ¾ strips will be needed for corner reinforcement. Parts *M* and *N* are for the acute corners at the front of the cabinet.

The details of the superstructure will be described in the following pages, and the parts are not shown in *Fig.* 5. However, it might be well to plan on another veneered piece nearly as large as the top *A*, since the grain should run parallel with the front of the cabinet, as shown by the shading lines. The two tops will cut readily from one panel of hardwood veneer.

Since this speaker is supposedly "functional," no attempt is made to disguise its appearance. The front of the low-frequency cone is visible in the speaker well, or horn, being protected by a screen of expanded metal. The inside of this horn is finished in dark blue lacquer, as are the sides of the cabinet and the edges of the two tops. The front and the top, together with the superstructure, are bleached oak, as is the tube mask. Lacquer covers the jointing of the speaker well to the panel, as well as the non-veneered edge of the top. If a uniform hardwood appearance is desired, the edges should be veneered—a job best done by the cabinet maker who cuts the pieces out. One caution is necessary—make sure that the top will fit the corner tightly. *Not all rooms have 90-deg. corners.*

Assembly

Once all the pieces have been cut out, the next step is that of assembly. Since some of the operations appear to be tricky, it is well to follow a certain procedure to avoid having to put the last few screws in with an offset screwdriver. The first step is to assemble the speaker well, which is a short exponential horn. Parts *G* and *H* are mounted on part *J*, using the shaped sides as spacers. Remember to put the T-nuts in place on the baffle before attaching the other parts. All joints should be glued, preferably with casein glue, and secured with 1¼—12 flathead wood screws, countersunk. This assembly should then be attached to the front panel, also with glue and wood screws. The shaped sides, *K* and *L*, are then fitted into place, also with glue and screws. Every joint in the cabinet is made with both glue and wood screws except that between the top and the lower section. This facilitates moving the entire unit. The top is attached only with screws, so it may be removed to enable the cabinet to pass through a 30-in. door.

After the speaker well is completed, the bottom is attached to the front, using a ¾-in. strip at the joint. The front extends clear to the floor, to eliminate the extra construction necessary for a recessed base. The bottom is thus inset, since the sides also extend to the floor. After the bottom is attached to the front, it is also secured to the speaker baffle. Next the corner braces are attached to the front, and the strips along the lower edges of the sides are screwed in place, ¾-in. up from the edge. The sides are then fitted into the groove in the front panel, and all joints screwed together. The tube enclosure is next mounted to the front, and supported at the back with a cross brace. The entire structure should now resemble that shown in *Fig.* 6, which also shows the ½-in. square furring strips for the sound-deadening lining.

At this point, the doors should be fitted, using ⅜-in. Soss invisible hinges which are mortised into the front and the doors. These hinges are the least obtrusive of any hinge available, and while they are a little difficult to mount, the final appearance warrants the extra effort.

Electrical Connections

To avoid external wires, some provision must be made to introduce the signal and an a-c line to the unit, since it will not be readily accessible once the cabinet is mounted in place. The power circuit is necessary for the TV chassis, as well as for a possible outlet for a lamp or clock as an ornament on top of the speaker. Since the speaker is designed to work from a radio-phono system housed elsewhere, the speaker signal must also be fed in. This is done at a small panel located just inside the lower right corner of the cabinet. One three-way male receptacle is used for speech, and a two-way male twistlock receptacle is used for the a-c line. The speech circuit goes to a switch which selects radio-phono in one position, or TV in another, and with an off position—the unused inputs being properly terminated. The output of the switch then goes to the dividing network, mounted on top of the speaker well, and thence to the two speaker units. Access to the high-frequency unit is had through an 8-terminal Jones receptacle, which also receives the input from the TV receiver and carries the a-c line up to the superstructure. This receptacle is mounted at the back of the tube enclosure, and permits removal of the top without disconnecting any wiring. The electrical circuits are shown in *Fig.* 7.

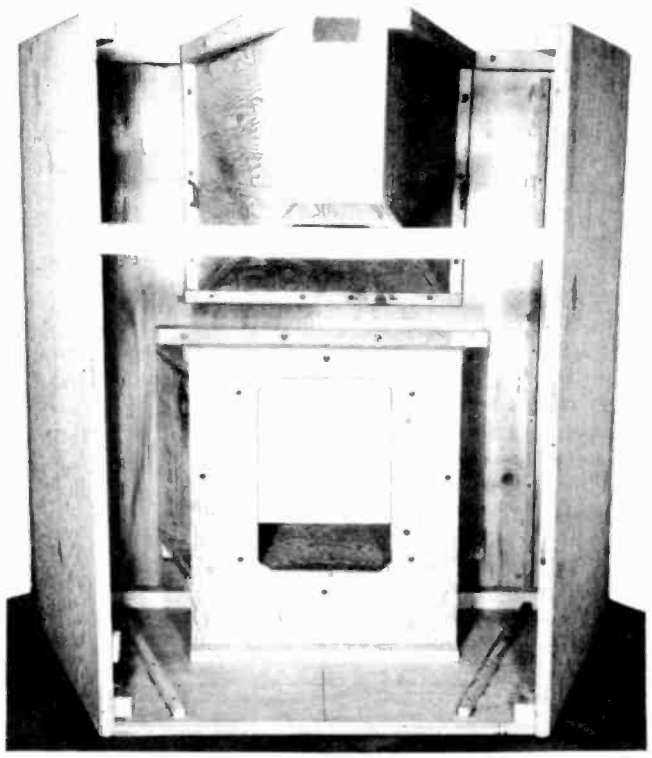

Fig. 6. View of the rear of the lower cabinet showing method of assembling the various sections.

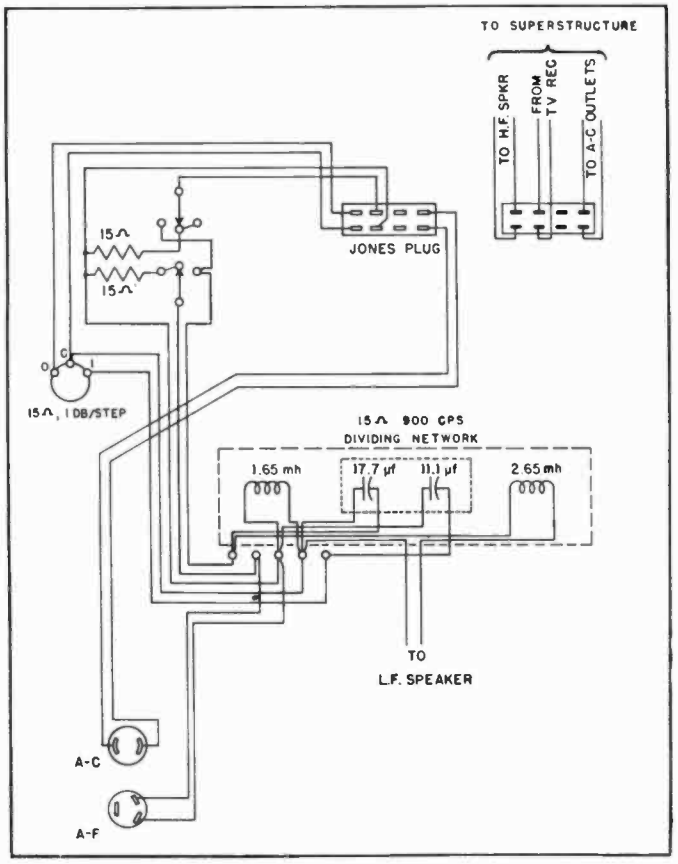

Fig. 7. Wiring diagram of the lower cabinet.

Preliminary Finishing

After the lower section is completely assembled, it should receive its first finishing operation. To protect the surface of the wood, the interior and the bottom should be given a primer coat of lacquer or some other undercoat. All cracks in the exterior should be filled with plastic wood, and the rear corners of the speaker well should be rounded out with fillets of the same material. After thorough sanding, the sides and the speaker well should receive a coat of an undercoat such as Firzite, which is an excellent filler for plywood. Finishing of the hardwood exterior should wait until the superstructure is completed in order that the two sections match as well as possible. Since most of the work on the lower section is now complete, the padding may be tacked in, using large-headed nails to prevent tearing out. Ordinary rug padding, such as Ozite, appears to be satisfactory for this purpose, although rock wool or Fibreglas is recommended by some constructors. The possibility of the fine glass shredding around a speaker cone argues against the use of either of the latter insulating materials, and the Ozite appears to do a satisfactory job of deadening without this risk. It is desirable to use two thicknesses over the larger areas, though the furring strips provide a good absorptive covering since there is an air space behind the padding.

The Superstructure

All of the cabinet above the top—lettered (A) in *Fig. 5* on page 94—is called the superstructure. It is primarily an ornament, since it serves no function except to enclose the high-frequency unit and horn and the TV chassis. This section is permanently attached to the top, and when the speaker is to be moved, the top and superstructure are detached from the lower cabinet, since the complete assembly will not go through a standard door.

The actual measurements will depend upon the high-frequency horn and unit selected and its placement so as to leave room for the TV chassis. *Figure 9* shows a view of the interior with a standard RCA 630TS blank chassis in place—since the cabinet was designed to house this particular receiver which is available in kit form from Tech-Master Products Company at a considerable saving over the completed model. Since some modifications must be made, it seemed desirable to start from the blank chassis and build the entire receiver—the true experimenter's viewpoint.

In the figure, it will be noted that some of the controls on the rear apron are hard to reach, due to the lower strip of the frame. Therefore, the design shown in *Fig. 10* differs slightly from the photo. Except for the top panel and the two side panels, the material is pine, and is assembled with casein glue and flat-head wood screws. The side panels and the top are removable, the latter by a simple method.

Since it was not considered desirable to have screws showing on the top, the fastening consists of two 5/16-in. rods, threaded on both ends, which extend from the center deck

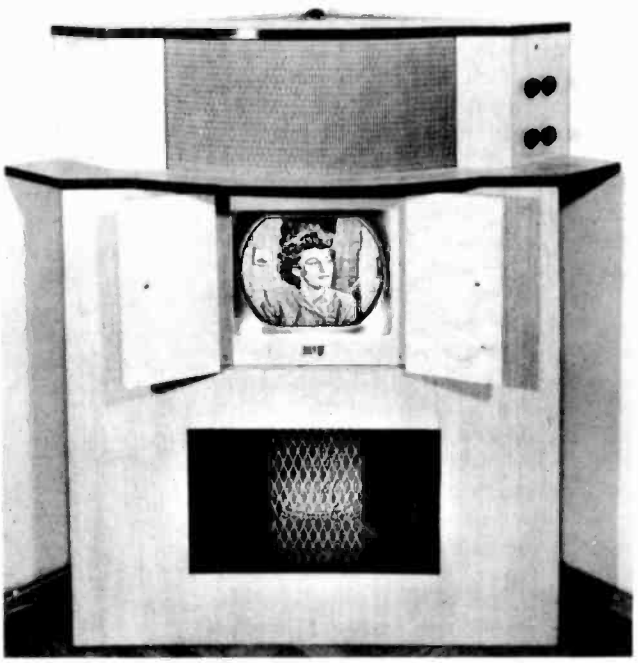

Fig. 8. The completed two-way speaker system in modern corner cabinet, with a 12-inch TV tube in optimum location for best illusion.

and engage two T-nuts which are set into the top panel and fastened with flat-head wood screws. Wing nuts are threaded onto the lower ends of the rods and peened on so they serve as handles, as shown in *Fig. 11*. The cotter keys keep the rods from dropping out of the hole in the upper framework, so there is no difficulty in engaging the T-nuts when the top is put in place.

The triangular cut-out is filled with a perforated metal grille to serve as ventilation for the TV receiver, which draws nearly 300 watts, and consequently needs free circulation of air. The two side panels are assembled of ⅜-in. veneer, of the same wood as the tops and the front; they are simply screwed to the grille support. The TV controls are brought through these panels—the channel switch, fine tuning, picture and sound-volume controls at the right—by means of shaft extensions. The brightness and hold controls vary d-c voltages, and are extended from the chassis with long leads and placed in symmetrical positions on the left side panel.

Since the two controls on the right use concentric dual knobs, the method of extending these shafts is shown in detail in *Fig. 12*. This requires long rods and conventional shaft couplings for the center shafts, and a brass tube with bushings for the outer control in order to clear the couplings, as shown.

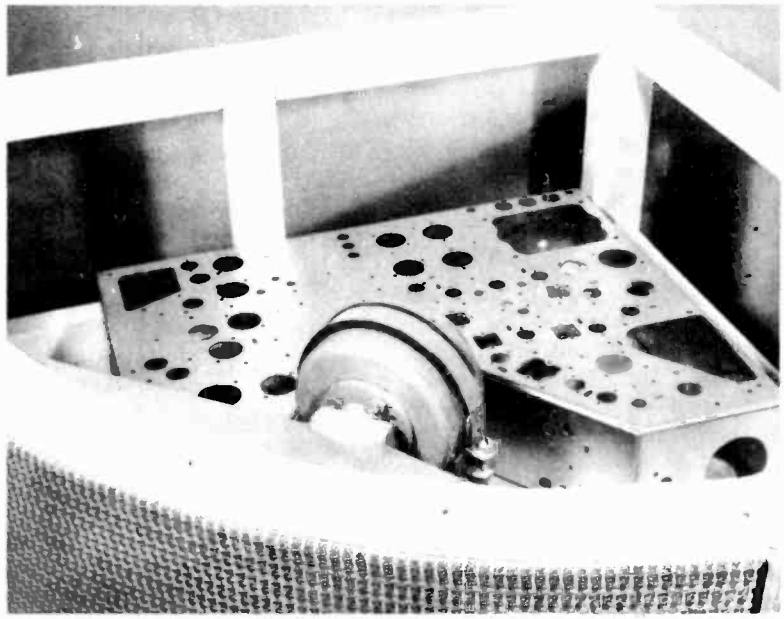

Fig. 9. Interior of the superstructure, showing the positions occupied by the television chassis and the high-frequency horn and unit.

It may be desirable to include an a-c outlet on the top so as to accommodate a lamp or clock. It is equipped with a length of wire to plug into a dual outlet on the TV tube cover, which also mounts the high-frequency speaker unit, and a plug which receives the output of the TV receiver. All connections to the top section are carried through an 8-terminal Jones plug and receptacle, the latter being mounted on the back of the tube housing.

The screen in front of the high-frequency horn consists of another piece of perforated metal, covered with a piece of plastic grille cloth. Since the color obtainable did not appear entirely suitable with the finish of the woodwork, a piece of black buckram was placed between the metal and the plastic cloth to darken the over-all effect. This effectively hides the high-frequency horn, although both the perforated metal and the horn should be painted a

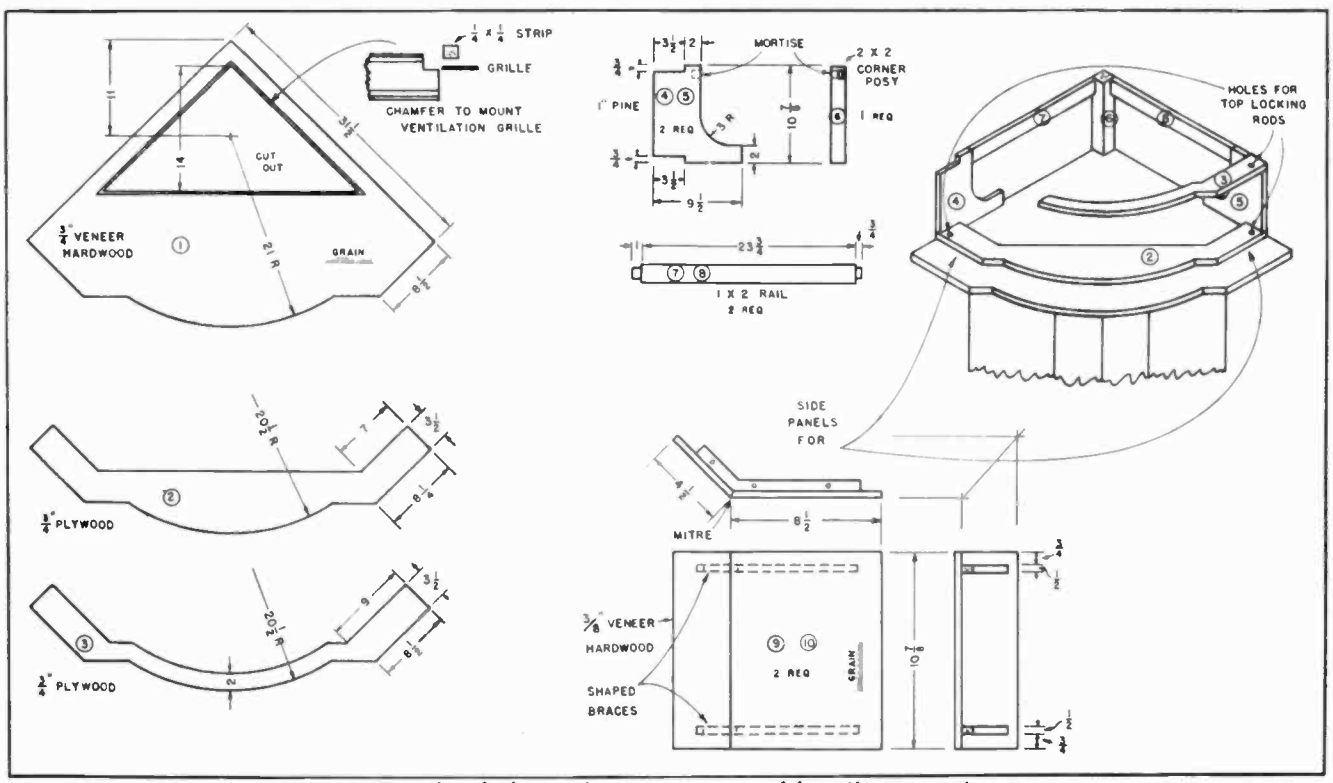

Fig. 10. Details of the various parts comprising the superstructure.

light color so as to avoid the appearance of a dark mass behind the cloth. Although it is claimed that the speaker is functional and not too much effort is expended to disguise its appearance, the grille in front of the high-frequency horn was added as a concession to over-all eye-appeal.

H-F Speaker Mounting

It is necessary to provide access to the tube compartment, so the high-frequency horn and unit are quickly demountable. Jumbo banana plugs were mounted on the front corners of the horn, and on the mounting block for the unit, and jacks were set into the framework for the front pair, and into the tube cover for the rear ones. The electrical connections for the high-frequency unit are carried on the latter two, and the entire h-f speaker may be lifted bodily from the jacks when necessary, without the need for watching phasing. The a-c outlets and a receptacle for the TV output are on the same tube cover, and all connections are carried through a short jumper cable to the male Jones plug.

Needless to say, the high-frequency speaker must be phased correctly before its final position is determined. This is best done by feeding a tone at crossover frequency to the speaker and reversing the high-frequency leads until the greatest output is obtained from the entire system, preferably measuring the output by a microphone and another amplifier with a volume indicator at its output. Then the high-frequency speaker is moved backward and forward until the maximum output is obtained. If the additional equipment is not available, put a tone at the crossover frequency on the system, and listen to first one speaker and then the other, moving the ear up and down in a plane parallel with and about 18 inches from the front of the cabinet. If the speakers are correctly phased, there will be a continuous tone heard from one speaker to the other. If not, there will be a null somewhere between them. At the crossover frequency (900 cps for the constants shown in *Fig. 7*) it should not be possible to detect any

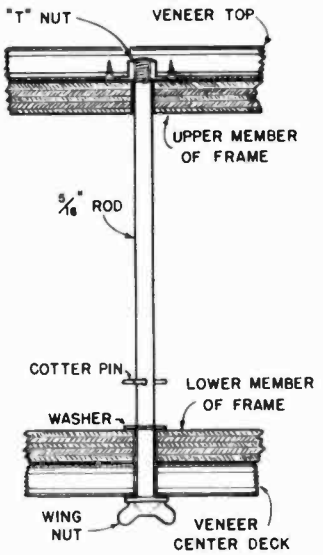

Fig. 11. Method of fastening the top to the superstructure without exposed screws to mar the appearance.

difference between the two speakers as the head is moved up and down. Try moving the high-frequency speaker backward and forward until there is no difference between the two sound outputs, then check by listening to male voices on the complete system Optimum results can be obtained without instruments if necessary, and the lack of them need not deter anyone from assembling a satisfactory system. It is suggested, however, that after deciding upon the correct position and phasing for the high-frequency speaker, this position be marked carefully. Then, live with the system for a week or so before making the mounting permanent. Try shifting the unit back and forth while listening to a familiar record or program. Make sure that the optimum position is determined before the job is considered complete. Using the network shown in *Fig. 7*, the front of the high-frequency horn will just about coincide with the front of the cabinet when phasing is correct.

TV Receiver Placement

The entire superstructure was planned to house the Tech-Master kit receiver, since this model has an excellent reputation for performance. Other models could undoubtedly be fitted into the space if desirable, but this chassis has a cutout for the tube which fits around the high-frequency unit with efficient utilization of the space. With the chassis selected, however, it is certain that performance with 12 or even 16-inch tubes will be satisfactory. If the kit is to be built for the purpose, the controls normally mounted on the rear apron might be relocated on the main chassis deck in the area normally occupied by the focus and deflection coils.

Connections to the picture-tube socket should be made through a 5-prong socket and plug, and those for the focus and deflection coils should be made with an octal socket and plug. It is necessary to carry a ground connection to the brackets which mount the two coils so as to have a ground for the outside coating of the tube, as well as for protection during adjustments. For the high-voltage connection, it is suggested that a banana jack be installed on the Bakelite insulating strip where the lead normally leaves the high-voltage compartment. This permits the chassis to be removed for servicing without unsoldering any connections.

The picture tube is a Sylvania 12LP4, selected because it is directly interchangeable—except for size—with the 10BP4 normally used with the 630TS receiver. The requirements for deflection angle are nearly identical, and the d-c and signal voltages necessary are the same. The Sylvania tube has an essentially flat screen, and features an ion-trap type of electron gun. For best results, these two characteristics are important, and they governed the choice of the tube. The screen size with this tube is 8½ x 11 in.

The focus coil and the deflection yoke are mounted on the hand-hole cover in the tube compartment, uscover in the tube compartment. The tube is centered in the compartment, with padding all around for protection. The leads are brought up through notches along the side of the tube compartment cover. The positioning of the tube is shown in *Fig. 13*. A plastic mask is mounted on a ⅜-in. oak front panel, providing both protection for the face of the tube and masking for the picture area.

Woodwork Finishing

In the cabinet shown, the front and tops are oak veneered, treated in the blond "rift" finish. This is a

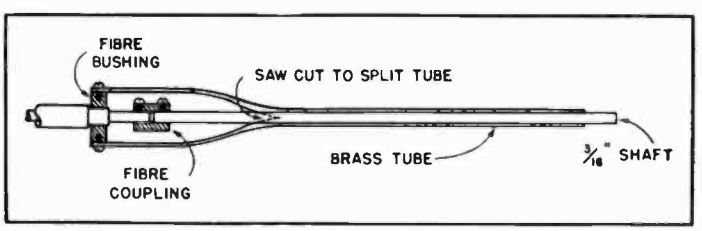

Fig. 12. Manner in which the television receiver dual controls are extended to the control panel by extension shafts.

simple operation, consisting solely of painting the well-sanded oak surface with one coat of Firzite, allowing it to dry for about five minutes, and then wiping it off. The white remains in the grain of the wood, and gives an interesting finish. After the paint dries for about 24 hours, the surface should be waxed thoroughly. The speaker well, the sides, and the edges of the tops are lacquered with two coats of ensign blue Larcoloid, which gives a glossy finish from a brush coat.

This particular treatment may not appeal to everyone, but it is modern and attractive, and requires a minimum of work. Since the entire design is essentially modern, it is felt that the surface treatment should also be modern.

After the cabinet is completed, it should be permanently installed as previously outlined. Two rings are mounted at the sides of the tube compartment. To these are attached 8-in. lengths of chain, which are connected in turn to 4-in. turnbuckles. Another length of chain is attached to the other end of each turnbuckle, and looped as closely as possible over a large screw hook inserted in the floor right in the corner of the room. The turnbuckles are then tightened up, sealing the top against the wall. Originally it was planned to use a steel cable, but the difficulty of attaching the hooks and turnbuckles to the cable ruled it out after a few trials. The chain is much simpler. It may be desirable to deaden the chain with a cloth sleeve over it, or by lacing venetian blind cord through the links The gasket used for the top is a 5/16-in. braided clothesline, tacked on the ends and glued into the groove for its entire length. The sides of the cabinet are spaced from the wall by ordinary door stops—adjusted to the required 1½ in. by selecting the point at which they are attached to the cabinet.

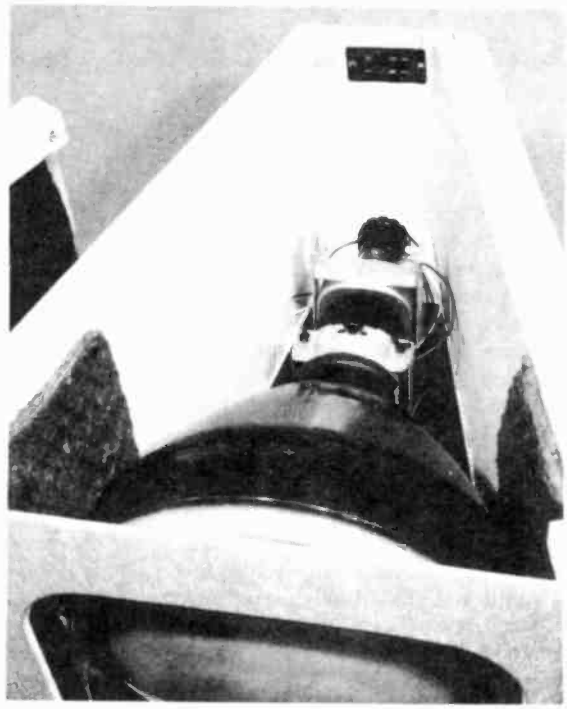

Fig. 13. Mounting of picture tube in compartment, showing relative position of various components.

Performance

Subjectively, this speaker system seems to be the answer, in the opinion of the writer and of several others who have heard it. It gives the feeling of a wide source of sound, as would be expected since the separation between low- and high-frequency speakers is approximately 33 inches from center to center, and the very low frequencies come from the side vents. The overall width of the speaker from wall to wall on the plane of the front is 65 inches. This wide-source effect is pleasant in the extreme and until it is experienced, the listener may doubt its advantages. A similar effect may be obtained for a trial by connecting two or three speakers to the output of an amplifier, and placed well apart.

Figure 14 shows the measured sound output with an Electro-Voice Model 630 microphone and a sensitive a-f voltmeter, the microphone being at a distance of six feet from the front of the cabinet. The curve is corrected for the measuring equipment as completely as possible. The tones above 200 cps were obtained from a warble-frequency record, while those below were obtained from an audio oscillator.

The signal input was held constant at the input to the 6AS7G main amplifier, which is flat from 20 to 13,000 cps, so the output represents the actual operating characteristics of the speaker with its normal driving amplifier.

The efficiency is evaluated by comparing the setting of the high-frequency attenuator with that used when the identical components were assembled with a 7-½ cu. ft. reflexed cabinet of conventional design. With the old cabinet, balance was obtained with 6 db in the h-f attenuator, while only 4 db is required with the corner speaker. This indicates that the low-frequency speaker is 2 db more efficient in this cabinet than it was with the standard box.

This is the second speaker built using the same principle of design, and the results in both cases certainly seem to justify the expectations. Performance compares favorably with medium-size theatre systems, and it has "presence"—the intangible characteristic of realism which gives the desired feeling that the performer is actually in the room.

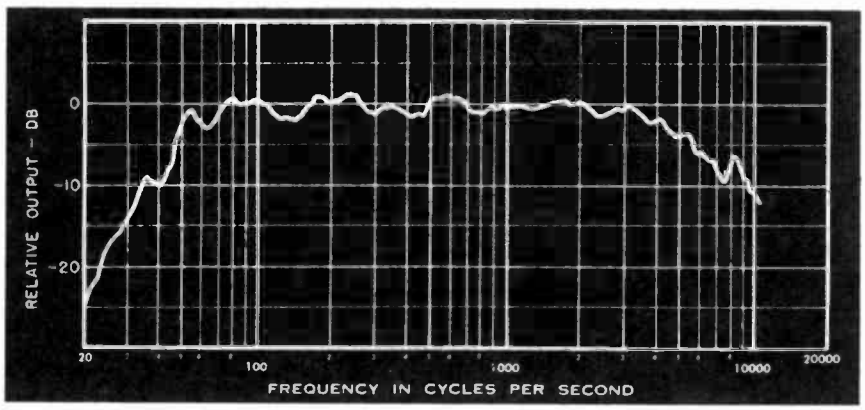

Fig. 14. Measured response curves. showing performance