

# The "Patrician" Gets a Home Workout

How to build the folded horn; what to do with the components;  
how to wire them internally and into your hi-fi audio system.

CULLEN H. MACPHERSON<sup>®</sup> and ROY C. CARLSON<sup>®</sup>

**S**Ocially speaking, the patrician and the manual worker have, traditionally, little in common. But a home constructor worker of sorts can build a "Patrician," providing he follows certain instructions laid forth here. For we are speaking not of "talkers" with windpipes, but of speakers with voice-coils—hi-fis ones. Economically speaking, the assumption is that one unit of work by a do-it-yourselfer audioist is pretty sure to get him a half-dozen tangible and intangible units of value. In other words, do something yourself, save something of your substance, and besides (another "gain") lose that creeping flabbiness in your muscle-flexor areas.

Hi-fi-ly speaking, "Patrician," Fig. 1, identifies a certain folded-horn speaker system. It contains a woofer, mid-bass driver, treble unit, and tweeters, with the proper crossovers at the proper frequencies. The interior horn assembly we are about to dissect and analyze—for you, in turn, to synthesize—is housed in a finished furniture cabinet 60 inches high over-all, 41 inches wide and 30 inches deep. It is not a simple one to build, but build you shall (as the saying goes) for the simple reason that, like many of us, your itch to get is not blessed with enough "scratch." Hire yourself then to the woodshop and get dimension lumber and sheets in sizes and quantities sufficient to make the necessary parts, sub-assemblies and assemblies, as will be shown further on.

## The Horn Assembly

The construction of this speaker enclosure has been boiled down to seven steps. We suggest you follow them, as they are basic to the successful completion of what, for want of these steps, could be a most confusing and perhaps frustrating undertaking. The interior horn assembly consists of the complete wooden acoustic structure necessary for the satisfactory operation of a 4-way corner type loudspeaker system. The sequence of procedure outlined here for the wood assembly duplicates the working parts of the Electro-Voice Patrician IV.

The horn assembly can be had in either of three ways: (1) The complete Patrician cabinet, which is supplied with furniture exterior, all the internal horn construction, and the speaker system mounted and connected ready to operate on delivery by hooking up to the proper terminals on your proper power amplifier. (2) The internal horn assembly

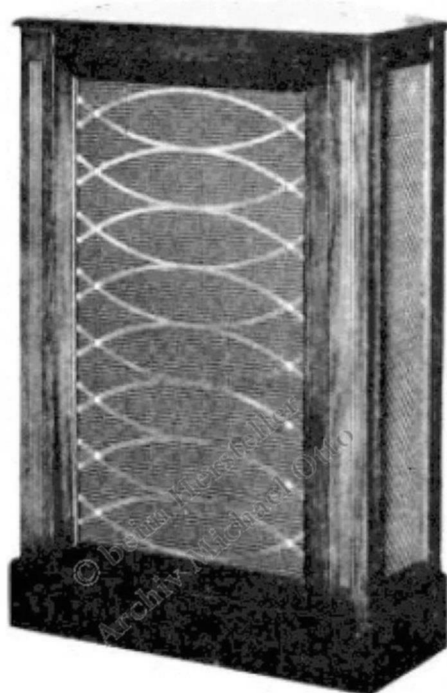


Fig. 1. The completed Patrician loudspeaker—a four-way system of excellent performance—which may be built by following the plans given in this article.

only, in kit form, which you proceed to put together as shown in the step-by-step isometrics, numbers 1 to 7 inclusive. This horn assembly is without the outer furniture casing. (3) The complete working drawings only, for this internal horn assembly construction, with the size, quantity and kind of lumber of wood needed for each of the parts. The dimensioned lumber specified ranges from 1/4-inch to 3/4-inch fir plywood B-D grade or better, to a solid dimensioned lumber like poplar of 1 1/8-inches to 1 3/4-inches thickness. Such is the province of this article.

## Parts and Patterns

The speaker units that come with the complete Patrician IV cabinet, and for which the kit or properly home-built horn are equally suitable, provide you with a system identified as the Electro-Voice Model 103-C Driver Components Package, consisting of some ten items:

- 1—18WK very-low-frequency (Lo-Lo) driver
- 2—A8419 low-frequency phenolic horn sections (complete set)

2—828 high-frequency drivers (complete set).

- 1—T25A treble driver
- 1—6HD 600-cps diffraction horn
- 1—T35 very-high-frequency driver
- 1—X2635 four-way crossover network
- 1—8675 cable harness, including three AT37 level controls

The construction of the parts that make up the front section of the model 115 K horn assembly, shown in step 1 is detailed in drawings 12, 13, 14, 17, 18, and 22.

The construction of parts leading to step 2 is shown in details 5, 6, 7, 19, 20, and 21.

Step 3 construction is shown in details 3, 8, 10, and 11.

Step 4 is an interior assembly job, indicating where details 10 and 11 fit (as in step 3) and introducing detail 4.

Step 5 is the erected assembly of the 115 K low-frequency driver horn, complete at this point but for the addition of the diffraction horn assembly which fits over the top of the K horn. All of the foregoing five steps are shown in Fig. 2.

Step 6 is the mid-bass diffraction horn assembly, with its parts shown in details 1, 2, 3, 9, 15, and 25, Fig. 3.

Step 7 shown in Fig. 4, is the completed erection of the Patrician horn assembly with mid-bass diffraction horn housing added, and details 16, 23, 24, and 26. (Note detail 26, an acceptable alternate serving the purpose as well as the curvilinear detail 25 indicated in step 6, and easier for most of us to make, unless blessed with special tools for routing the top of part 3, shown in step 6).

## Working Out the Steps

What you do to get step 1 done, (Fig. 2): Place part 22 face down on a workbench or saw-horses. The face should be the better side of the fir plywood panel, which typically is a "wild" grained wood; you would choose the more restrained or cleaner appearing grain for the front. Four strips 12 and two 17's which abut the perimeter of the 21-inch square opening in the center, should be secured as shown, with glue and nails. Use enough glue ("Weldwood" or "Woodlock," for example) so that it oozes out from the joints as the pieces are butted together for nailing. All contacting edges, in fact, should be sanded before gluing and nailing, which will guarantee a tight fit and prevent air leaks throughout the completed horn, especially in the two cavities leading to the



back of the driver cone. Now tack or clamp part two 14's in position, flush on the outside of face board 22, but shorter than it by  $\frac{3}{8}$  in. at both ends. You've now laid in all the parallel pieces. Then place four strips 18 across strips 12 and 14, scribing guide lines for the mitre cut, as that is the way they will have to be set in for an airtight fit. Cut the mitres in the four 18's, then temporarily tack and clamp in place. Do the same with four parts 13, first laying them across 12 and 18 to determine the mitre. Cut it then; holding part 13 in place by hand scribe a line on part 22 around the insides of 12, 13, 14 and 18. Loosen temporary fastenings and glue and nail 13, 14 and 18, guided by the scribe lines. For added rigidity use  $\frac{3}{4}$ -inch square cleats at the points where 12, 14 and 18 are butted to 22.

#### Step 2

The strips you have just mounted and secured are the base for parts that will be laid flat across them, and should all be evenly level. This you can (and should) check by laying a straight-edge across the assembly, using the 14's as a guide for correcting any high or low spots among the sixteen (count them) pieces. Satisfied that they are uniformly level, you can now lay down part 21, which is the board with the round speaker opening in it. Glue and nail it in place, using an excess of glue to assure an airtight fit for all vertical members.

Erection of the cone is facilitated by temporarily tacking two pieces of scrap wood 1 in. thick across the 17's and tight against 21. Tap your hammer lightly to tack parts 5 temporarily at their intersection with 21. Use another piece of scrap plywood to stick up from board 21 all the way to the place to be occupied by part 7, at the apex of the cone-to-be. Holding a 19 with one hand, scribe location guide lines on 21; then scribe another guide line for parts 20. Be sure to mark the pieces correspondingly so that you can secure them where they belong without mismatching. Remove parts 5 (you have tacked them temporarily) to enable you to glue copiously and then nail the two 19's and the two 20's to panel 21. Now you are free to secure parts 5 (the two sides of the cone), by gluing and nailing to the 21's; and at the apex where parts 6 (cleat details inside the apex) and the lower end of part 7 meet. With 5 as a guide, check for absolute level with a straight-edge laid across 6 and 7.

#### Step 3

This shows the assembly of the ramps—there are two, one at the top, the other at the base of the horn assembly.

The lower one is made up of parts 8, 10, and 11, glued and nailed together; the top unit uses parts 3, 10, and 11. To do this properly, tack a cleat or piece of wood scrap  $5\frac{3}{8}$  in. from the edge of part 8 (which is the "base") and fit part 11 against it. Then, 16 in. away towards the narrow end of "base" 8, place another cleat or block to hold part 10. Now glue and nail 10 and 11 to 8. Do the same with 3, 10 and 11, gluing throughout

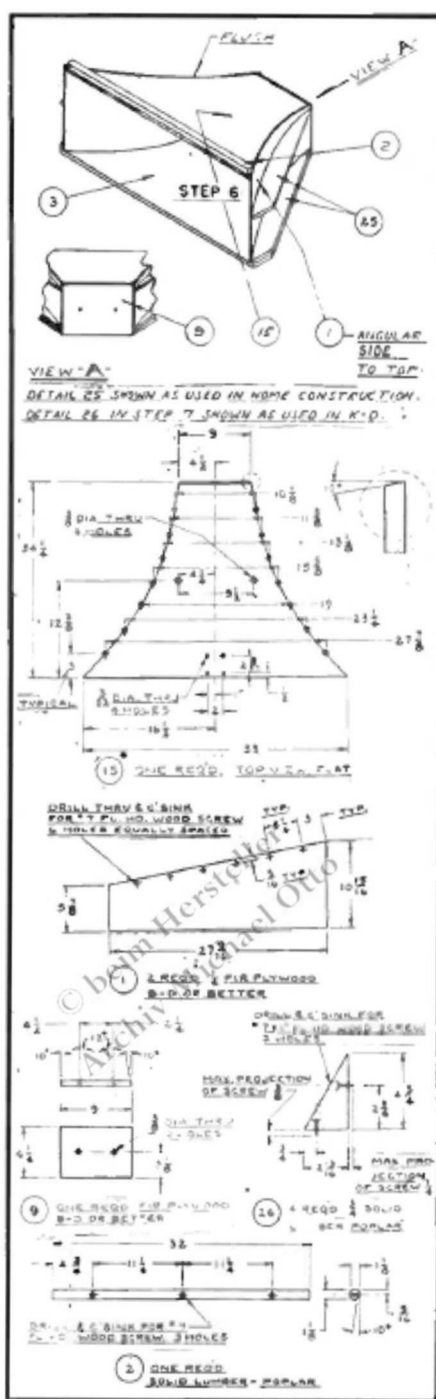


Fig. 3. Wood parts and assembly for the diffraction horn assembly which tops the low-frequency section.

thus providing the ramp for the base sub-assembly of the bass horn.

#### Step 4

Now mount the encompassing side wings, the two parts 4. Glue and nail the 4's to panel 21. If needed, you may use wood screws to secure 4 tightly to 21. Add dummy spacers across the back of the assembly to hold 4 parallel. Now try the fit of the base sub-assembly (built as in step 3). Do not force it to fit. If sides 4 spring out, then trim parts 10 and 11. Glue and nail 8 and 4 only.

#### Step 5

Follow the same procedure as to fitting the top sub-assembly. Do not force the

fit, but follow through as in step 4. Glue and nail 3 and 4, then complete gluing and nailing 4, 10 and 11 on both assemblies.

#### Step 6

To ready the mid-bass diffraction horn sub-assembly for its place atop the 115 K horn housing, assemble parts 1, 2, 9, and 15 as in Fig. 3. Scribe a line on the angular side of 1, about  $\frac{5}{8}$ -inch in from the narrow end. Glue and nail 2 and 15, then glue and nail 1 and 15, with the scribed line flush with the narrow end of 15. And when you have glued and nailed 9, this assembly is complete.

#### Step 7

Glue and nail cleats 16 to 3, Fig. 4, which is the top of the folded horn; keeping 1 at right angles to 3, glue and nail gussets to suit. And make sure that an airtight seal exists where the diffraction horn sub-assembly sits atop the K horn. Do this by adding adhesive-backed, airtight sponge rubber weatherstripping,  $\frac{1}{8}$  by  $\frac{3}{4}$  in. along the inner outline of 24. Do the same around the exterior of the front loading panel opening in 23.

Airtightness is an absolute requirement and we suggest that this can be further assured by gluing with the types of glue mentioned above,  $2\frac{1}{2}$ -in. strips of muslin or broadcloth over all joints in the interior of the cavity. Or you may use wood filler or plastic wood instead. Careful application of either should give the desired degree of airtightness.

Note that it is necessary to install a 14-inch wide deflector board at the rear, and for the full height, of the K horn (step 5 dotted lines) if you intend to operate it without an enclosing cabinet.

#### The Electronic Assembly

The wood construction described above is based on the Klipsch principle of folded corner-horn loading. It has been designed to house the model 18 WK low-frequency driver in a K type reproducer, but scaled up 16-2/3 per cent. When the Patrician IV or its properly self-made facsimile is placed in a corner, the folded throat of the bass horn becomes part of the entire room, allowing the large wavelengths of the second and the upper parts of the first audible octave to be formed properly. The low-bass driving section reproduces the first three octaves, to the first crossover point at 200 cps.

Taking over for only the next one-and-a-half octave range to 600 cps is a separate horn, used as an indirect radiator, with two 828HF driver units, for the mid-bass section. The horn load is fabricated of wood and phenolic tubes, one of which is shown in Fig. 5, and reproduction down to 200 cps is handled much more satisfactorily than a horn assembly made of metal.

The treble range, from 600 to 3,500 cps, is reproduced through the Electro-Voice Model T25A driver exhausting into a 600-cps 6HD diffraction horn. Fig. 6. Other frequencies not a part of this range are excluded, but are reproduced by the T35 Super-Sonax very-high-frequency driver, using an integral diffraction horn.

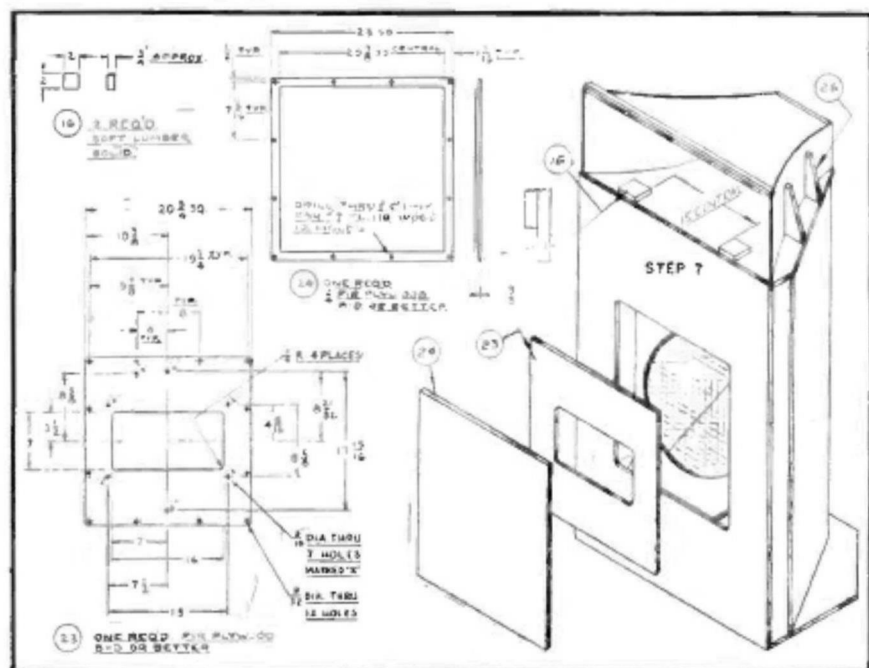


Fig. 4. Steps for assembling the diffraction horn to the low-frequency section.

With this unit the remaining octaves in the audible register above 3,500 cps are accomplished with practically unmeasurable distortion. The proper allocation of this spectral energy is controlled by the X2635 crossover network. It divides the amplifier power into four separate portions, eliminating upper harmonic and intermodulation distortion from one driver in the region covered by the next.

See (as in Fig. 7 A, B, C, D) how these components are interconnected for optimum reproduction efficiency. The electronic schematic has also been translated into placement-perspectives of these parts. These, in addition to the step-by-step drawings for building the wooden acoustic structure, have been prepared to clarify the entire procedure for the hi-fi enthusiast who might prefer to add his manual efforts to the integration of a 4-way speaker system for a fuller enjoyment of his signal-source hi-fi equipment.

#### Step 1

Begin the installation of the driver components in the acoustic structure by laying the horn on its back and removing the front cover and the speaker mounting boards, at the same time marking the tops for proper re-assembly after the 18 WK low-frequency driver has been placed on the center of the mounting board.

#### Step 2

Drill holes in it for mounting by placing the speaker with two opposing rim holes on a vertical center line, with the speaker terminals showing on either side of the top hole. Your guide to drilling the necessary holes for the bolts is a sure one if you now make markings on the mounting board through the bolt holes on the rim of the speaker shell. Then drill six  $\frac{1}{4}$  in. holes in the mounting board in these locations; also drill one  $\frac{3}{16}$  in. hole near the terminals just outside the speaker frame.

#### Step 3

Use  $\frac{3}{16}$  inch carriage bolts,  $1\frac{1}{4}$  inches long, with both flat (under the bolt head) and lock washers (at the nut end) to bolt the woofer into place. Tighten the carriage bolts just snug enough to hold the loudspeaker firmly in position. If you draw the bolts too tightly at this stage you may warp the speaker frame and cause the voice coil to rub. Now take up the wiring harness kit which comes packed with the speaker, and run the long single red and black pair from the speaker through the  $\frac{3}{16}$  inch hole. A knot tied on the speaker side will prevent the cable being pulled out. Attach the wires to the terminals of the 18 WK as follows: red wire goes to black terminal and the black wire to the red terminal—and you will enjoy proper phasing when operating the system later. ("A" in Fig. 7).

Replace the baffle board with its speaker, taking care to seal the board tightly against the sponge rubber gasket material. Draw the speaker leads through the top opening of the horn and out to

the back. Close the throat of the large horn by screwing the front cover back into place, and be sure that it makes a tight seal with the gasket.

#### Step 4

The foregoing three steps in the process of fitting the speaker system components together were handled with the K horn on its back. Now return the assembly to an upright position. And here we invoke, again, (see AT HOME WITH AUDIO April, 1954) the thought that to do this kind of job comfortably, the working top of bench or table should be at about the height of your bent elbow, standing erect. Whether you work with parts held horizontal or vertical, the use of a surface at or very close to the suggested height should land you in that area of comfort which means greater efficiency, surer results.

Returning the assembly to an upright position, guide the bolts projecting from the ends of the low-frequency horns (A8419) through the holes in the back plate of the smaller wood horn, using the rubber spacers provided to insure an airtight fit. Run large cap screws and washers through the top of the horn into the brackets of the phenolic tubes, and tighten by hand only. Neither should you use force to push the two wood shim blocks under the brackets, where they rest on top of the K horn. Start the wood screws through these brackets and into the shims only, stopping short of going into the top panel of the large horn. Play the shims until the brackets of the phenolic tubes have been lifted so that the bolt moves freely through the hole at the back of the board. Secure the wood shims with a brad, then turn the wood screws through into the top of the K horn board. Tighten the cap screws just snugly enough so that the tube bolt is free through the back hole. The final move at this stage is placing the washers and nuts on the bolts through the back and tighten snugly, but not too, to avoid strain on the phenolic horn tube.

The photograph (Fig. 8) of a phantom wash drawing of the K horn with woofer in position and the inset of the midrange high-frequency and very-high-frequency units above, shows that the installation of these units is basically simple, despite

Fig. 5. One of the two mid-bass driver units assembled to its phenolic three-pass folded horn. Two of these units "exhaust" into the large diffraction horn of Fig. 3.



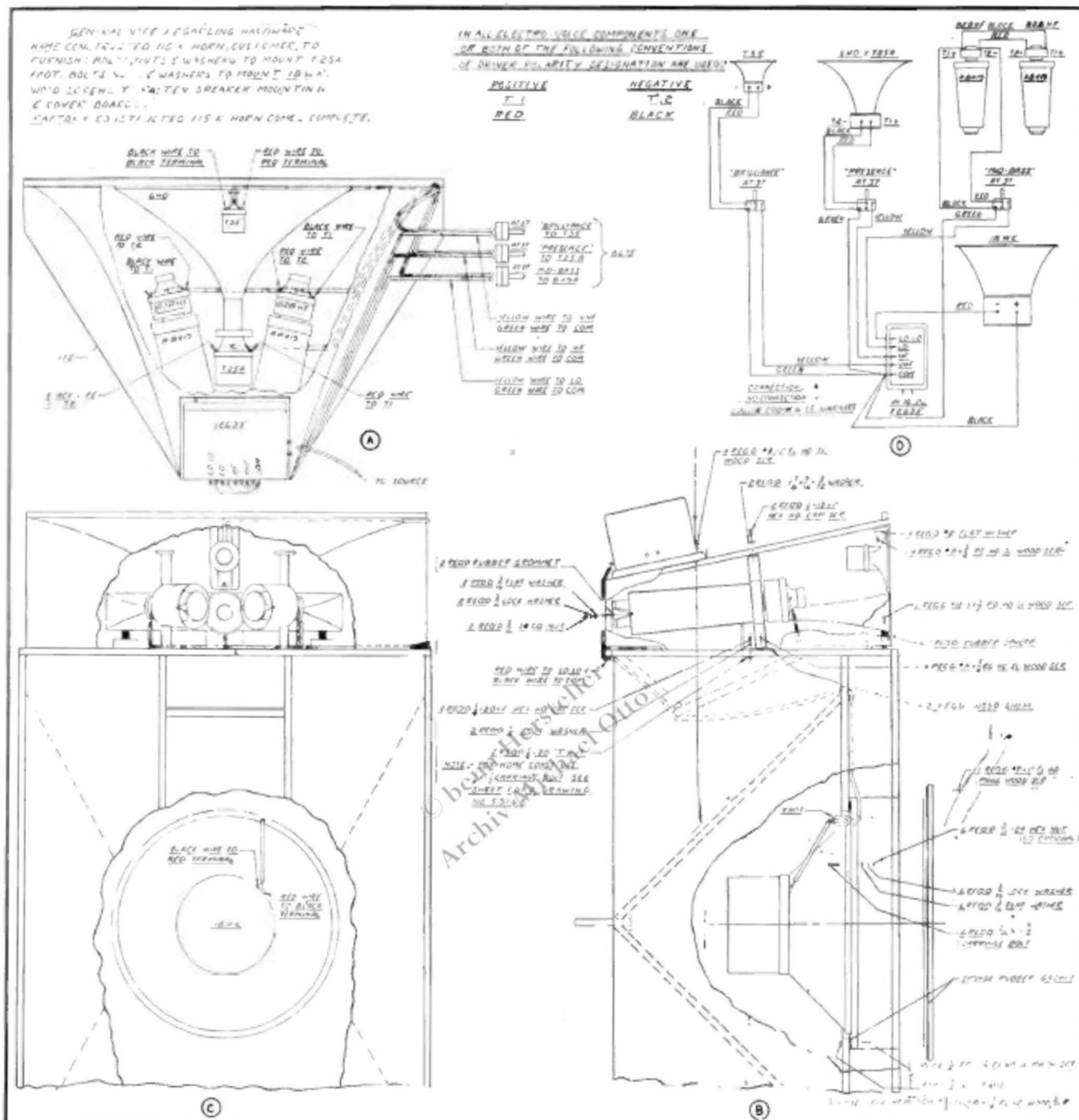


Fig. Electrical connections and placement of the elements of the complete loudspeaker system.

the fact that step-by-step instructions may appear to describe a rather complicated procedure. Our photograph brings to plain view the brackets, shims

and supports that you are required to secure with the flat, round, hex and Phillips wood screws; the carriage bolts, nuts, washers, as well as a machine

screw here and there, as and where indicated in the cross section (see "B" in Fig. 7).

#### Step 5

Install the pair of 828HF drivers with terminals facing toward the front ("A" in Fig. 5). Screw these into place on the re-entrant horns. Connect the T1 terminals of the two drivers together, and do likewise with the T2 terminals. Connect a black wire to the T1 terminal of the left unit, and a red wire to the T2 terminal, and bring these wires out past the left front edge of the 200-cps horn assembly, stapling to the bottom board. Finally, mount the crossover network with output terminals toward the back, and centered (as in "A", Fig. 5), which also

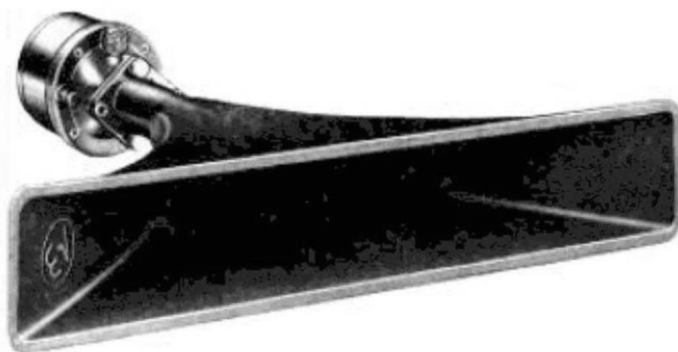


Fig. 6. The treble range driver and horn, which radiate the frequency range from 600 to 3500 cps.

