Prescription for better bass:

THE AIR-COUPLER

By CHARLES FOWLER

IN THE first issue of HIGH-FIDELITY, the article "How To Achieve Full Bass Response" told about a method of speaker mounting which provided a remarkable improvement in the reproduction of low frequencies — simply, and at relatively low cost. The article created wide interest, and many requests for further information.

In this article, we shall provide additional details about the device used for bass reproduction: a speaker cabinet which we call an Air-Coupler. In addition, we shall report on a series of recently completed experiments which have brought about a substantial improvement in the powerful bass reproduction already made possible by the Air-Coupler. Complete *technical* details on the experiments are given in RADIO COMMUNICATION Magazine, beginning in the October 1951 issue. The articles are replete with charts, graphs, frequency response curves, and other impedimenta[1].

In HIGH-FIDELITY, we shall discuss the Air-Coupler without getting involved in technicalities which, to be entirely honest, relatively few people understand anyway! The system *works*, as a very large number of people have proven to their own entire satisfaction. Let's not, therefore, examine too closely into *why* the system works; far better technical minds than the author's have pondered the question at considerable length, only to conclude that, in theory, it cannot produce the results that are obtained in practice!

[1]For those to whom such things are a delight, copies are available at 35 cents each from Radiocom, Inc., Great Barrington, Mass.

As a specific and amusing instance of such scientific confuddlement, we recall the visit to our workshop of an engineer representing a company which manufactures a particularly well-known loudspeaker, which we shall call "XY". We were using a 12-in. XY speaker in the Air-Coupler at the time, and demonstrated to our visitor the wonderful, floor-shaking response we were getting at 20 cycles. This engineer insisted that we could not be using the XY speaker, because 12-in. XY units could not reproduce 20 cycles!

What is the Air-Coupler?

As has been discussed in previous articles in HIGH-FIDELITY, one of the great problems in the reproduction of low frequency sounds — bass notes — is that of coupling a large body of air to the cone of the loudspeaker. The device under discussion performs that function in an effective if somewhat unorthodox fashion. The Air-Coupler is a low frequency reproducing unit which utilizes any good 12-in. speaker, and which can be used with any good amplifier. It improves bass reproduction greatly when added to an existing amplifier and system of speakers. It is neither complicated nor expensive.

As can be seen from Fig. 1, the Air-Coupler is a long, rectangular box whose inside dimensions are 70½ by 14½ by 4½ ins. The speaker is mounted on the back panel, and faces *into* the box. The front of the Air-Coupler is totally enclosed except for a port or opening.

The Air-Coupler is usually fabricated from ¾-in. plywood, but it can also be made from other, thicker woods. Because the speaker tends to make the whole enclosure vibrate at low frequencies, the joints should be tightly glued and screwed together.

The Air-Coupler can be disposed of in any number of ways so long as it is heavily weighted or well anchored to the floor or wall. From the interior decorating point of view, one of its big advantages is that the small port is the only necessary opening into the room. For people who do not mind cutting a hole 14½ by 5 ins. in the floor, preferably near a wall, the Air-Coupler can be mounted under the floor as in Fig. 2. Since floor joists are customarily spaced 16 ins. on center, a net inside space is available of 14 to 14½ ins. This corresponds to the inside width dimension of the standard Air-Coupler. Therefore, the back panel, on which the speaker is mounted, can be cut to slip between the joists, and screwed to a 1 by 2-in. strip attached to the inside edges of each joist.

The Air-Coupler can be mounted between studs in a room wall, in a closet, or in the ceiling. In all these arrangements, the low-frequency speaker and its enclosure are completely out of sight.

If, as is often the case, structural changes to the house are not possible, the Air-Coupler can be laid on its 6-in. side so that there are 2 to 5 ins. clearance from the back of the speaker to the room wall. It can then be covered with a heavy board, and used as a magazine and book shelf, or the board can be covered with cushions and used as a bench or seat.

Further thought will suggest other ways of disposing of the Air-Coupler. The only important points are that it must be firmly anchored, and the port must face into the room, though its exact location in the room is of little importance.

From the decorating point of view, an indirect advantage of the Air-Coupler is that the remainder of the speaker system can be housed in almost any cabinet. It is customary to think that a good loudspeaker system requires a large enclosure. This is quite true — but only insofar as the reproduction of low frequencies is concerned. With an Air-Coupler, the frequencies below 350 cycles are fed into the speaker on the Air-Coupler. Only frequencies above this point are carried by the rest of the speakers in the system. Since it is a general rule of thumb that baffle or enclosure size is not important above 250 cycles, even a 15-in. coaxial speaker can be tucked away in a 3-cu. ft. enclosure.

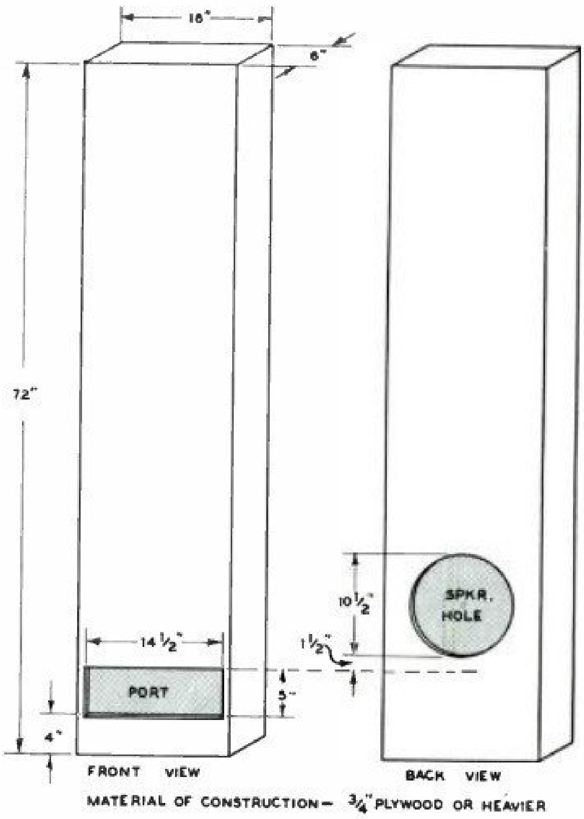


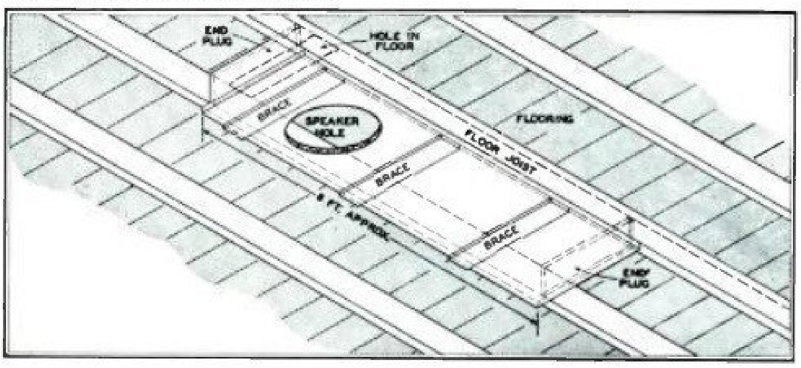
Fig. 1. The original Air-Coupler was a long, rectangular box.

What Other Equipment Is Necessary?

It was stated above that frequencies below 350 cycles were fed to the speaker on the Air-Coupler, and that those above were handled by the other speakers in the system. To divide the frequency spectrum into these two sections, a crossover, or dividing, network must be used. This is the only equipment, other than a speaker and the wood for the Air-Coupler, required for a complete installation.

Easily assembled components for dividing networks operating at 350 cycles are available commercially, and at reasonable cost. Only two coils or inductances, and two capacitors are required. The coils can be designed and wound by the home experimenter, if desired. Complete details on their construction were given in the December

Fig. 2. Dimensions of the Air-Coupler are such that it can be mounted between floor joists. It may be necessary to mount the cover between the beams, so as to make the inside depth of the Air-Coupler not more than 4½ ins.



1950 issue of RADIO COMMUNICATION.[2]

It should be pointed out that dividing networks can be designed to operate at any desired frequency. It has been found that best results are obtained with the standard Air-Coupler if a crossover frequency of 350 cycles is used.

Experimental Work With Air-Couplers

So much for the background of the Air-Coupler design. Built exactly according to instructions, and combined with a middle-range speaker and tweeter, or with a coaxial speaker and connected to the amplifier through the proper dividing network, the Air-Coupler will provide an astonishing improvement in bass reproduction. Any professional carpenter or moderately skilled hobbyist can construct the case. The rest of the assembly is simplicity itself.

On the other hand, those who are experimentally inclined can have many hours of audio fun working with the basic Air-Coupler idea. Fundamentally, it draws upon three different principles of loudspeaker enclosure design: air column, Helmholtz resonator, and acoustic labyrinth. Each of these basic principles has been thoroughly explored from the theoretical viewpoint. But when the three are combined into a single unit, it requires an analog computer to determine in advance, what result may be expected. Hence, the practical way to make progress with the Air-Coupler is by guess and by gosh. This means that the non-technical hobbyist is just as likely to make a radical improvement as the man with fourteen academic degrees after his name.

Since the original series of articles on the Air-Coupler started in the October 1950 issue of RADIO COMMUNICATION, hundreds and hundreds of people have worked with it. Some have followed the basic design to the letter, and secured results which they usually described by "never heard anything like it". Others have gone far afield. O. C. Hoggren, in Chicago, has managed to fold the Air-Coupler so that it is more compact; he is one of the few to develop a successful folded design. L. C. Gallagher, in Dallas, has a 14-ft. Air-Coupler in his floor. And so it goes.

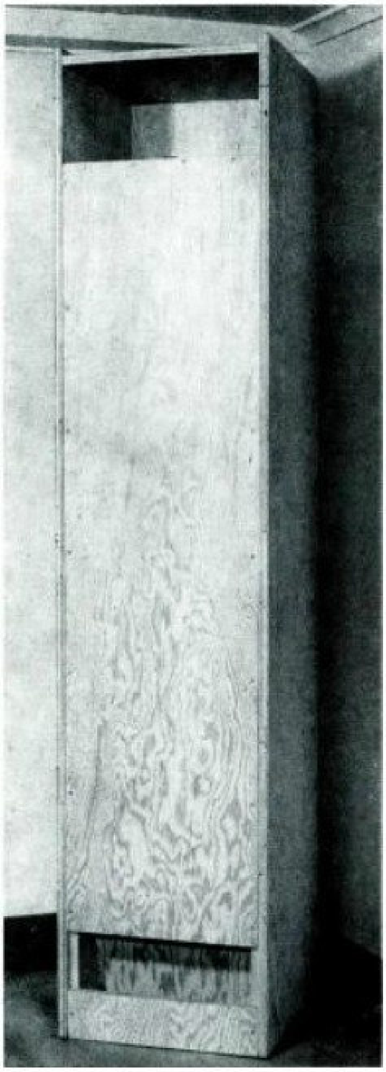


Fig. 3. A reflex enclosure for the Air-Coupler

Our group at HIGH-FIDELITY and RADIO COMMUNICATION has continued to experiment. Milton Sleeper, our publisher, started the first wheels turning, a long time back, and then withdrew from the battle to devote his attention to other matters. Roy Allison was most instrumental in the early work, and was just about to get his slide rule going again when the Navy remembered him from days gone by. Apparently, the Navy tired of hearing about Air-Couplers, for they released him last August. Now, as Editor of RADIO COMMUNICATION, his return to the fold will be felt by all Air-Coupler enthusiasts when they begin reading the series of articles in his publication, describing the changes that have been wrought in the basic Air-Coupler construction.

During Allison's absence, the writer continued his experimental efforts, using an approach quite unorthodox from the engineering point of view. An examination of the original design reveals that the sound from the back of the speaker is "wasted". In a floor or wall installation, it is totally lost. It seemed logical to try to utilize this sound by bringing it around to the front, where it could reinforce the sound from the Air-Coupler port. A reflex coupler, Fig. 3, was designed and promptly named, because of its bulk, the "telephone booth". Results were quite astonishing; the sound certainly poured forth in a way not previously experienced. This design was described in the May 1951 issue of RADIO COMMUNICATION, as an experimental model. Allison promptly advised us that it wouldn't work, since the radiation from the back of the speaker would cancel that from the front. This may be true in theory, and it may be true at one or two specific frequencies, but the *overall* effect was fantastic. Pedal notes on organ records such as the Bach *Toccata and Fugue in D Minor* shook the entire room.

The next undertaking was to reduce the telephone booth to reasonable size by designing a corner enclosure.

At that point, Alan Macy entered the picture as an enthusiastic, spare-time worker, and Allison returned from the Navy. A major redesign job was undertaken and this time, the technical approach was followed throughout. Thus Allison read the orders of the day, Macy and the writer did the carpentry and generally provided background noise.

[2]Reprints are available at 10 cents each.

Equipment Used for Tests

A large amount of measuring equipment was brought together for the tests. The photograph, Fig. 4, shows it assembled in one corner of our library-workshop. In essence, the test set-up was this: a Sylvania audio oscillator provided pure sound from 20 cycles on up to 20,000. This was fed into a Williamson-type amplifier, previously found to have the necessary flatness of response in the range under examination. The output of the Williamson was connected to whatever speaker was being tested.

It is quite simple to measure the impedance of a speaker voice coil over a range of frequencies, and it is often assumed that actual frequency response follows the impedance curve. However, it has been shown that there is not necessarily any continuous correlation between the impedance of the voice coil and sound power output of a speaker and its enclosure. Hence, we approximated, as closely as possible, the test set-up used by speaker manufacturers and acoustic laboratories.

The actual sound output of various experimental Air-Couplers was picked up by an Altec 21-B microphone (used because of its exceptionally flat response even at very low frequencies), amplified by a McIntosh 50-watt amplifier, the output of which was read from the Hickok vacuum tube voltmeter. Frequency runs were made on each piece of equipment separately so that compensation could be made for even slight deviation from flatness.

Room Acoustics

For our first test, we set up the microphone and other equipment right in the workshop, and began taking readings over a frequency range from 20 to 200 cycles. Here we ran into a phenomenon which causes engineers who design equipment for home use to turn grey prematurely: room acoustics. For the first frequency run, we had the microphone set up 5 ft. away from the "telephone booth". At several frequencies in the 20 to 200 range, the meter indicated almost no sound. Yet, at those same frequencies, we could very definitely hear sound and lots of it! If the microphone were moved to a different position, the frequencies at which there was "no sound" would change.

This phenomenon can bring the most careful work of a design engineer to naught. Even if every link in the chain of audio reproduction could be made absolutely perfect — flat sound source, flat amplifier, and flat speaker and enclosure — still, the frequency response heard at any given spot would *not* be flat. The frequencies at which sharp peaks and valleys occur will change drastically, depending on the microphone location in the room, the shape and size of the room, the number and position of its furnishings, and the degree to which the walls are covered with drapes and other sound-deadening or deflecting materials.

This is not the time to go into a study of room acoustics. That subject will be dealt with in future issues of HIGH-FIDELITY (in the next issue, for that matter, by no less an authority than G. A. Briggs), but the point is brought out here to emphasize once again the importance of adapting and adjusting a high fidelity system to the conditions under which it will be used.

Fig. 4. Equipment used to test frequency response of experimental Air-Couplers included a Sylvania audio oscillator which was fed into the Williamson-type amplifier, directly above it in the illustration. Power supply for the Altec 21-B microphone is shown to the right of the Williamson. The microphone (moved near the equipment for photographic reasons) was connected to a Pickering preamplifier, which was modified to remove bass compensation circuits. This, in turn, was fed into the McIntosh 50-W-2, at right on desk. Output of the 50-W-2 was measured on the Hickok VTVM.

For our tests, room acoustics forced us outdoors, to operate under "free field" conditions. Literally, we took all the equipment to a location where there were no near-by buildings or other objects which would reflect the sound from the speaker back to the microphone. Dozens of Air-Couplers were built, tested, torn down, rebuilt, and retested. Allison gave off with the theories, and the two carpenters struggled furiously to keep up. At one point, theory got so far ahead of human frailty that though the meter reading was splendid, no sound could be heard!

At another point, the carpenters got ahead of the design engineer, and Allison was hard put to it to come up with theories which would account for the various results achieved. A port size would be changed, "just to see what happens". "Such and such will happen", Allison would say. If it didn't, he would think fast and decide, "Well, that was based on the assumption that the results would follow the behavior pattern of an air column. If you had given me time to think, I would have realized it would follow a Helmholtz resonator pattern, which, of course, accounts for the results achieved". Then the carpenters would make some more background noise, and the tests would proceed.

The Final Design

One day, when rainy weather necessitated a postponement of our outdoor tests, Allison got all his theories going at once and developed the design shown in Fig. 5. The overall size of the Air-Coupler was not changed, but partitions were to be placed inside the unit in such a way as to produce two tubes or air columns, one 7 ft., the other 9 ft. long. Thus, instead of a single 6-ft. air column with a resonant peak at approximately 46 cycles, the new design called for two air columns which would resonate at 30 and at 40 cycles. The result should be smoother response at very low frequencies, and added sound power output at these frequencies.

Subsequent tests confirmed Allison's hopes in every detail. Overall response in the range from 20 to 200 cycles was considerably improved. Response was flatter and cleaner. Screwing the front and back panels to the internal partitions strengthened the Air-Coupler and reduced the possibility of panel resonance. Low frequency response between 20 and 40 cycles was improved.

Total sound power output on orchestral selections seemed to be greater, though actually it was slightly less. The apparent increase was due to the fact resonant peaks were flattened, thus producing better balance throughout the frequency range of the Air-Coupler.

The dimensions of the outside case, as given in Fig. 5, are the same as for the original design. The change lies only in the addition of the partitions which form the two air columns. Readers who have Air-Couplers can add the partitions very simply. Others are urged to follow the new design from the beginning. The Duplex Air-Coupler, as we named it, can be installed in exactly the same locations (floor, wall, ceiling, closet door, or on its narrow side as a bench or magazine shelf) as the original design.

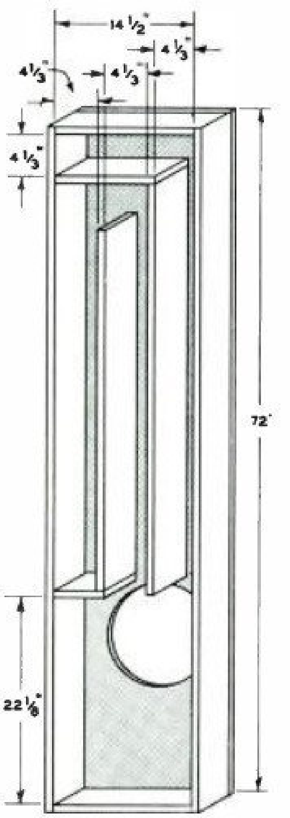


Fig. 5. The drawing shows the dimensions and arrangement of inside partitions added to the standard Air-Coupler.

Corner-Mounted Air-Coupler

It still seemed logical to try to use the sound from the back of the speaker to reinforce that from the front. With the old Air-Coupler mounted in the "telephone booth", a marked improvement in total sound power output had been achieved. It was logical to hope, at least, that the same result could be secured with the Duplex. However, since we wanted also to redesign the telephone booth into a more compact corner-type enclosure, we started our experiments with this design in mind.

It is obviously more complicated to design such a structure, because cancellations can occur between the sound from the main opening and that from the reflex port. Furthermore, a whole series of new enclosure characteristics must be taken into consideration. Another air column is involved; so is another Helmholtz resonator.

Once again, the problem was approached from a try-it-and-see viewpoint. Corner-mounted Air-Couplers were built, tested, redesigned and retested. The design which has produced the best result so far is shown in Figs. 6, 7, and 9. The photographs in Figs. 6 and 7 are of the test model. The internal structure of the Duplex Air-Coupler is clearly visible in Fig. 6; the overall front appearance is shown in Fig. 7. The type of construction shown in these two illustrations is adequate for experimental purposes, but it should not be followed in a final set-up, because it is impossible to keep the three front panels, as shown in Fig. 7, from loosening up after a few hours of use.

Therefore, the construction method shown in Figs. 8 or 9 should be followed: a Duplex Air-Coupler should be built and then screwed and glued to a large front panel, 35¾ ins. wide and at least 78 ins. high. This panel can then be attached directly to the walls of a room, as in Fig. 8, or two back panels constructed and the front panel attached to them, as in Fig. 9.

All tests of this type of design indicated that total sound power output was greater than with the Duplex Air-Coupler by itself, but the frequency response curve was not as smooth. However, (and Allison was chided about this!) efforts to achieve a smooth frequency response curve can reach a *reductio ad absurdum:* a point where frequency response is perfect, but there isn't any sound! The final design represents a compromise between flatness and sound power output.

Reducing the size of the reflex port to 3 ins. will improve flatness but cut down total sound level; increasing the port size to 9 ins. will improve sound power output noticeably, but exaggerate the peaks and valleys in the frequency response curve.

Construction of a Free-Standing Enclosure

The design shown in Fig. 9 should be followed if a free-standing corner enclosure is desired. The unit is completely enclosed by the two back panels, so it can be moved around and put in any convenient corner.

If a permanent installation is possible, the two back panels can be omitted. The front panel is then attached very firmly to two walls which form one corner of a room. Note that it will be necessary to notch out the lower corners of the front panel to fit snugly over the baseboards. A triangular piece of plywood or heavy board is fitted to close the top of the unit, between the front panel and the walls. The bottom of this board should be exactly 78 ins. from the floor, so that the correct reflex port size is maintained. However, the *total* height of the front panel is immaterial so long as the minimum dimension of 78 ins. is maintained. Thus, the entire corner of a room, from floor to ceiling, can be closed in, and the front panel papered or painted to match the rest of the room.

Conclusion

There are now four Air-Coupler designs: the original 6-ft. unit, the *Duplex* 6-ft. Air-Coupler, the "telephone booth", and the *Triplex* corner arrangement. A fair comparison of the four versions is difficult to make. A *visual* comparison — that of the meter and the frequency response chart — shows that the Duplex 6-ft. Air-Coupler, installed in the floor, wall, or ceiling, will produce the best balanced bass, but not the greatest volume of sound. Beyond this, no flat-footed statement can be made, because other comparisons must be made on an *aural* basis. And there may be a considerable difference between what a meter shows when a speaker-and-enclosure is tested in an open field by near-perfect equipment with pure sound — and what a *human* ear hears when the same speaker-and-enclosure is tested on symphonic music (far from *pure* sound!) reproduced from an *im*-perfect phonograph record on *average* equipment in a room which, acoustically, is probably poorly designed. In other words, *it is to be expected* that the visual and the aural comparison will correlate. But, it does not always happen that way.

The concensus of those who have heard various versions of the Air-Coupler in the author's workshop-library (a room roughly 15 by 15 ft. in size) is this:

Best all around results, and best balance between smooth

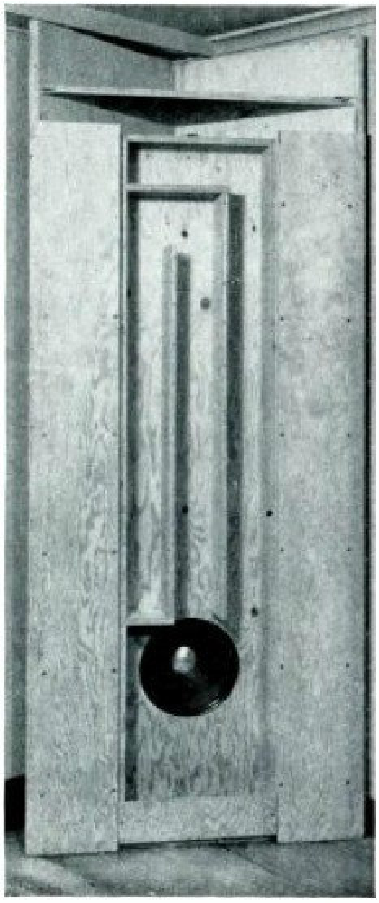


Fig. 6. Left: By mounting the new Duplex Air-Coupler in a corner enclosure, sound power output was improved considerably. For experimental purposes, two 9-in. panels were attached to each side of the Air-Coupler. In the photograph, the 16-in. front panel of the Coupler has been removed to show the internal construction.

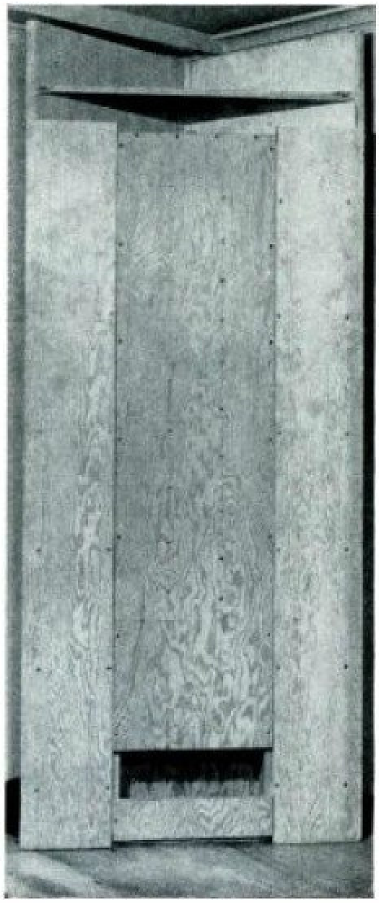


Fig. 7. Right: Experimental corner Air-Coupler with all panels in place. For final construction, a solid piece of wood should be used instead of the 3-panel construction shown here. In this way, not only neater appearance but more solid construction is achieved. In the experimental model shown here, the two back panels are 84 ins. long, to permit adjustment of reflex port size.

frequency response and sound power output, will be achieved by installing the Duplex Air-Coupler in the floor, wall, or ceiling. The original 6-ft. unit, installed in a similar location, will give greater sound power output from 40 cycles up. On an occasional orchestral selection, one with single notes at very low frequencies, the hills and valleys in its frequency response curve may be noticeable. In 98 cases out of 100, the *overall* results will be called extraordinary.

Similarly, the Duplex Air-Coupler in a corner enclosure will give greater sound power output than a floor-mounted Duplex, provided the reflex port is kept around 6 ins. in height. For optimum sound power output, still as judged by the ear and not by the meter, the telephone booth in conjunction with the original Air-Coupler is the answer. However, this design is likely to give an overpowering bass, so strong and dominant that steps must be taken to cut it down to proper balance with the rest of the frequency spectrum.

However, as was stated at the beginning of this article, the last word on Air-Coupler design is yet to be written. For the experimentally inclined, any number of modifications can be tested. It is sincerely hoped that readers working with the Air-Coupler will report their results to the author. These will be published in future issues of HIGH-FIDELITY for the benefit of all who have, or plan to have, Air-Couplers.

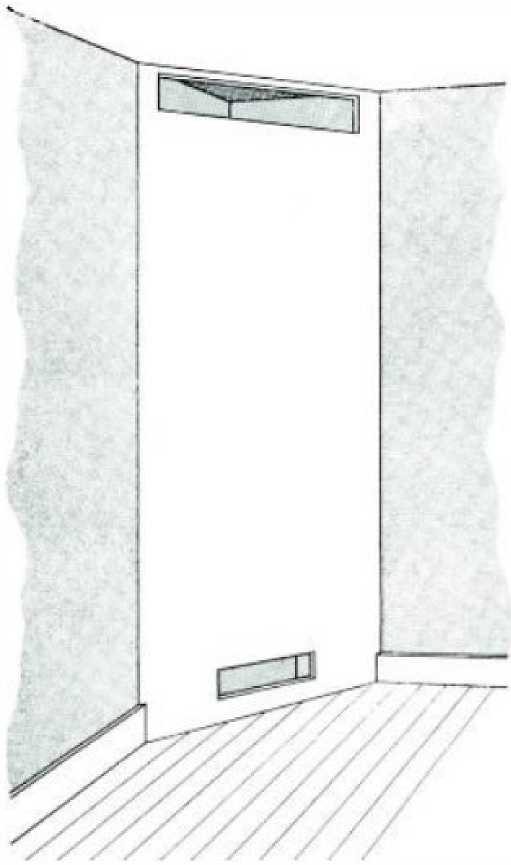


Fig. 8. Above: The front panel of the Triplex Air-Coupler can be mounted in the corner of a room. The two back panels can be omitted, as can the triangular piece which forms the bottom. The front panel can be extended to ceiling height if desired, then papered or painted to match the rest of the room.

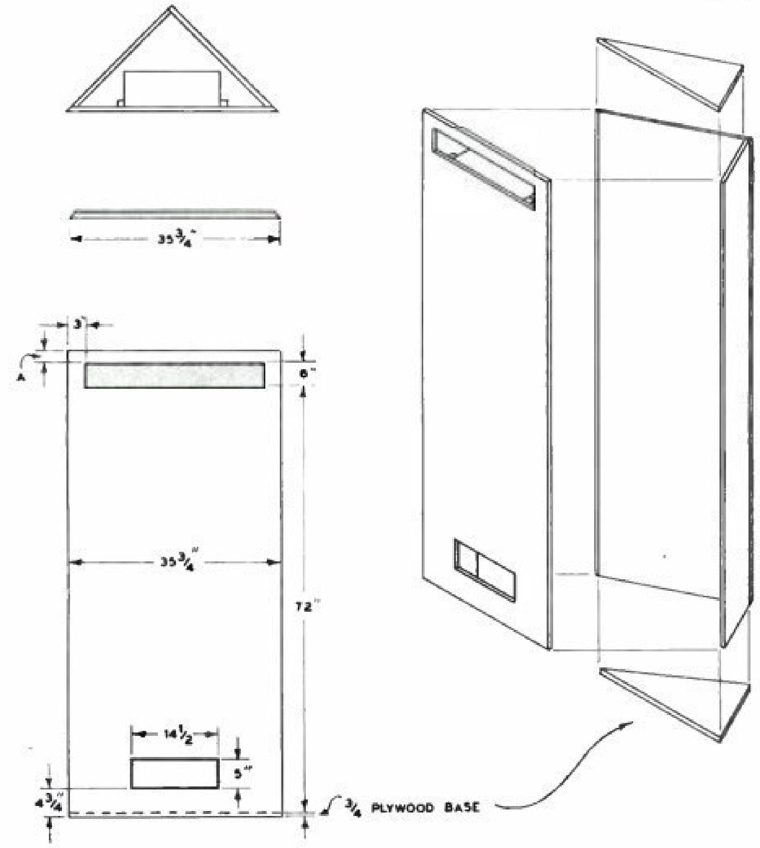
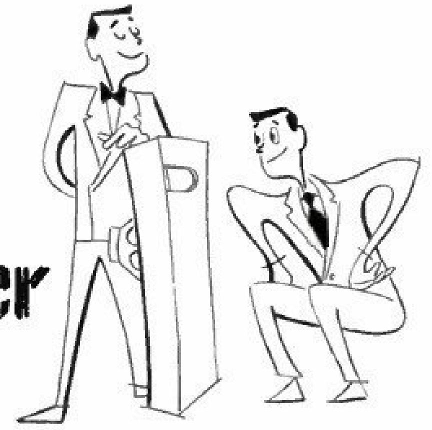


Fig. 9. Left: Complete measurements for the construction of a free-standing corner Air-Coupler. Wood at least 3/4 in. thick should be used, and all joints should be securely screwed and glued together. Dimension "A" should be at least two inches, and can be made large enough so the front panel reaches to the ceiling.

Roy F. Allison's "Junior Air Coupler"



The Junior Air-Coupler

by Roy F. Allison

QUITE SOME time ago, soon after Charles Fowler, Alan Macy, and I had finished work on the dual air-coupler,[1] Alan remarked wistfully that the six-foot monster we had assembled was just fine for a man who had a place in which to put it — but, as for him, he'd like to get his hands on something considerably less elephantine, something that would fit comfortably in his apartment-sized apartment. Of course (he added quickly), it would have to *act* like an air-coupler.

It was agreed that such a miniature was highly desirable but equally improbable. We hadn't done any serious work on miniaturization, but we had heard that others had, with results that were invariably somewhere short of remarkable. Then, too, the blisters from our last stint at woodworking were yet fresh in our minds, if not on our hands. We suggested sympathetically to Alan that he scout for a larger apartment.

A short time later Marsh Giddings, a mutual friend, was bitten by the hi-fi bug. In the process of providing moral support while he writhed in the agonies of equipment selection and installation, we discovered that Marsh was a first-rate wood craftsman, and that he had wonderful and complicated tools for the work. It was inevitable that references to a miniature air-coupler should once again appear in our conversations, particularly those in which Alan had a part. Finally, under the influence of some of his very good Scotch, Marsh and I agreed to work with Alan on a condensed air-coupler.

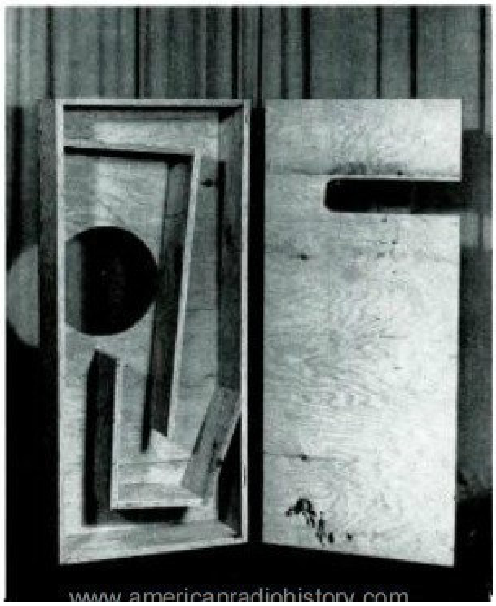
In order to eliminate obvious impossibilities and to make certain we would use all our energies in working toward a desired goal, we spent several evenings in discussion before a piece of wood was cut. It was fairly obvious that air columns of large cross-section would be more efficient than those of smaller effective diameter. On the other hand, a large air column has sharper resonant peaks than a small one. We might get by with a smaller speaker driving a single column, if the latter were small enough — but would it then be hopelessly inefficient? We thought that this should be our first line of attack. If it failed, then we would try a larger column, and then two medium-sized columns.

We decided to fix a maximum size for the overall enclosure. If it were to offer no real advantage in space-saving over the standard six-foot model, the whole project would be pointless. Arbitrarily, we limited the size to what could be installed, with the rest of the equipment, in a space no longer than that taken up by a typical radio-phonograph console. Thus, maximum dimensions were set at 42 by 18 by 12 inches. With this somewhat hazy plan, we began cutting plywood and cultivating more screwdriver blisters.

First, as agreed, we tried columns of small cross-section driven by an 8-inch speaker. The speaker was coupled to the column at various points from top to bottom, and the port was varied in size and position, with unvarying results — practically nothing. After a good many unsatisfactory hours, we became tired of hearing the speaker cone flutter violently as soon as the oscillator disk was set below 40 cycles, and went on to bigger things.

It is certain that the Editor would cut out the horrible details of the larger single-column trials if I were to relate them. Therefore, I shall simply say that while they did show that a small air-coupler could produce quite

Apartment-size Air Coupler measures 42 by 18 by 12 inches



[1]That saga was related in the Winter 1951 issue of HIGH FIDELITY. For the benefit of any audiophile who may have been living underwater for the past two years, an air-coupler is a bass enclosure — for sub-woofer use only — which contains closed air-columns. We tried models with one air-column; we tried them with two. But almost invariably we found that performance improved as size increased. Of one of our later models, a visitor said he'd hesitate to open it up; it looked as if Boris Karloff might walk out.

a lot of low-frequency sound, these models were all disconcertingly prone to favor one or two specific frequencies at the expense of the rest of the bass range. In short, they were boomy as a rainbarrel.

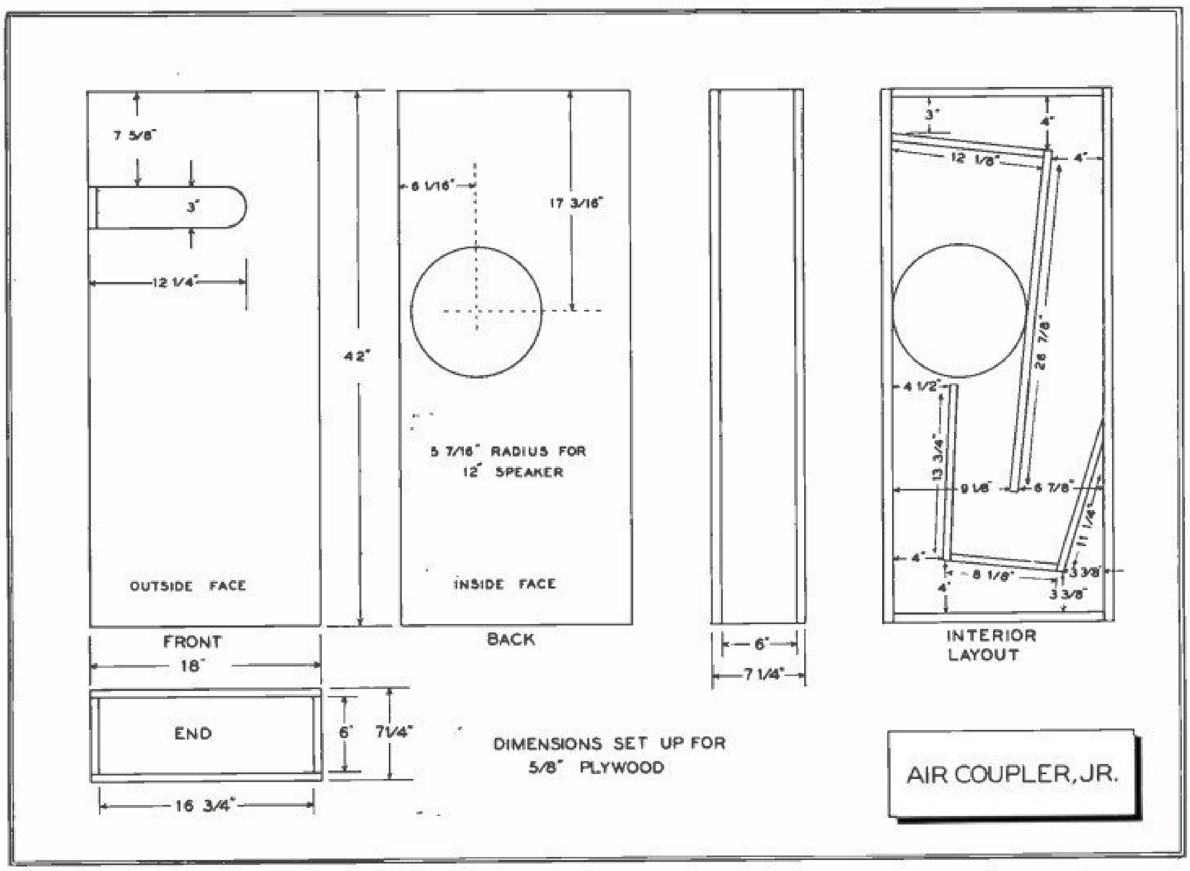
The problem then was to discover some magical shoehorn that would enable us to squeeze two or more distinct columns of reasonable length and cross-section into our allotted volume. There followed many discussions — some spirited, others tinged with an if-we-had-any-sense-we'd-go-home tone. Eventually, of course, the shoe-horn was found. Someone had drawn a series of long v's in a half-hearted doodle. He stared at the drawing for a few moments and the idea dawned slowly; he showed the doodle to the others, who caught the idea at once. It was basically quite simple, after all: the air at the closed end of a quarter-wavelength column cannot move longitudinally at all, and for that reason does not require any cross-sectional area. There is little air movement but high pressure anywhere near the closed end, so that the column need have only a small cross-section there. At the open end, of course, most air motion occurs, and this should be as large in area as possible to minimize frictional losses. Why not use a tapered column, provided that the taper can be made gradual? Up to twice as much effective column could be then contained as in an equivalent rectangular space.

Our first model utilizing this principle showed us that we were on the right track at last, and also that the tapered-column design yielded an additional benefit. It tended to reduce the high-amplitude harmonic resonances which had always been troublesome with columns of uniform cross-section. The result is a smoother frequency response.

At this stage, the sawdust really began to fly. We determined the optimum column thickness (i.e., from speaker-wall to vent-wall) early in this part of the work by gradually reducing it from the maximum of 12 inches in steps of ½ inch, making relative output and frequency response tests at each decrement.[2] The optimal thickness, considering efficiency smoothness, and convenience, seemed to be 5¾ inches inside. Using ⅝-inch plywood, this results in an outside thickness of 7 inches. It was then relatively simple, if time-consuming, to adjust column lengths, port area, and speaker and port placement for best results. The final design is shown in the drawings and photographs.

All the later tests were made with a University 6200 speaker, with which we are very well satisfied. We didn't make exhaustive tests with other 12-inch speakers, since we were certain that they would work also, as they do with the six-foot model. We did try an 8-incher, to see what would happen. Just a flutter. *Continued on page 111*

[2]Basically, these tests were made in the same way and with the same equipment as described by Charles Fowler in the Winter 1951 HIGH FIDELITY



AMPLIFIER SYSTEM

Continued from page 110

After consulting with the Scott engineers, this hitherto unclaimed feature boils down to this: with recorders which have *separate* playback heads, the high level input of the recorder can be connected to the upper left-hand jack shown in Fig. 2. The output of such recorders can be connected to the upper right-hand jack. With these connections, the Dynaural on-off switch on the front panel performs some peculiar functions: in the OFF position, the input to the recorder can be monitored; in the ON position, the output of the recorder can be monitored.

With recorders which do *not* have separate record and playback heads, the output of the recorder should be connected, not to the upper right jack but to one of the high level inputs (two center and lower right jacks, Fig. 2). The Dynaural switch should be left in its OFF position.

In either case, the tone and volume controls will have no effect on what is fed to the tape. The input selector switch and the equalization positions *will* effect tape input.

The foregoing presupposes that the Dynaural unit is not being used. In some cases — such as transferring old 78's to tape — it is desirable to have it in the circuit. Then, the input to the Dynaural unit should be left connected to the upper left hand jack, as usual; the output from the suppressor can be connected to the input of the tape recorder.

Summary

It goes without saying that the Scott equipment is excellent, in design and workmanship, as is the sound it produces. It is flexible — and listenable. It has deservedly won a great deal of praise for the flexibility of its "front end" — there is plenty of control in the tone controls. With proper use of the noise suppressor, many an old or worn record can be brought out of the hopeless category and provide enjoyable listening. — C. F.

JUNIOR COUPLER

Continued from page 82

According to our tests, made at comfortable living-room level, the junior air-coupler appears to have a response flat within ±3 db from 28 to 180 cycles, and within ±5 db from 25 to 200 cycles. Above 200 cycles, strange things happen (as they do with all air-couplers above their useful ranges). Consequently, a crossover frequency of 175 cycles or lower is recommended. Both 175- and 125-cycle crossover networks have been tested, and there seems to be very little apparent difference. Those who have mid-range speakers good down to 60 cycles or better will undoubtably prefer to use a 125-cycle network; those who are not so forrunate will find it safer to use the 175-cycle network.

We who have worked with the junior air-

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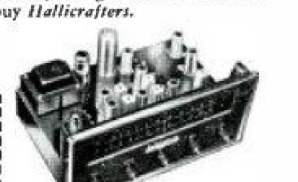

JUNIOR COUPLER

Continued from page 111

coupler for so long are convinced that it sounds as good as the standard six-foot model; perhaps better at medium and low volume levels. Allowance must be made, of course, for the fact that we are familiar with it, and familiarity (in audio) breeds not contempt, but acceptance.

Certainly, the junior model does not have the tremendous maximum output of the large dual or triple air-couplers, nor quite the room-shaking capacity. Two factors are responsible for this; first, it is somewhat less efficient and, second, it is not so heavy, so that less mechanical coupling to the floor is obtained. We don't know what the result would be if it were fastened rigidly to a wall or the floor, or made a part of a very heavy cabinet. This has not been attempted because it was designed specifically for those who cannot make such installations, or prefer not to. However, when fastened in the base of a console-type cabinet, or simply finished as a separate small enclosure, the junior air-coupler is still a most satisfactory bass reproducer.

LIKE ANY air-coupler, the junior model must be assembled with both screws and glue. With either alone, joints are likely to loosen in a matter of weeks. Screws should be placed no more than 12 inches apart, and at least two should be used on each side of all internal partitions. About a half gross are recommended. Glue should preferably be of a waterproof type.

Dimensions shown in the drawings are for ⅝ plywood. If desired, the front and back panels can be of ½-inch plywood (or glued hardwood) and the sides, ends, and internal partitions of 1-inch nominal hardwood.

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