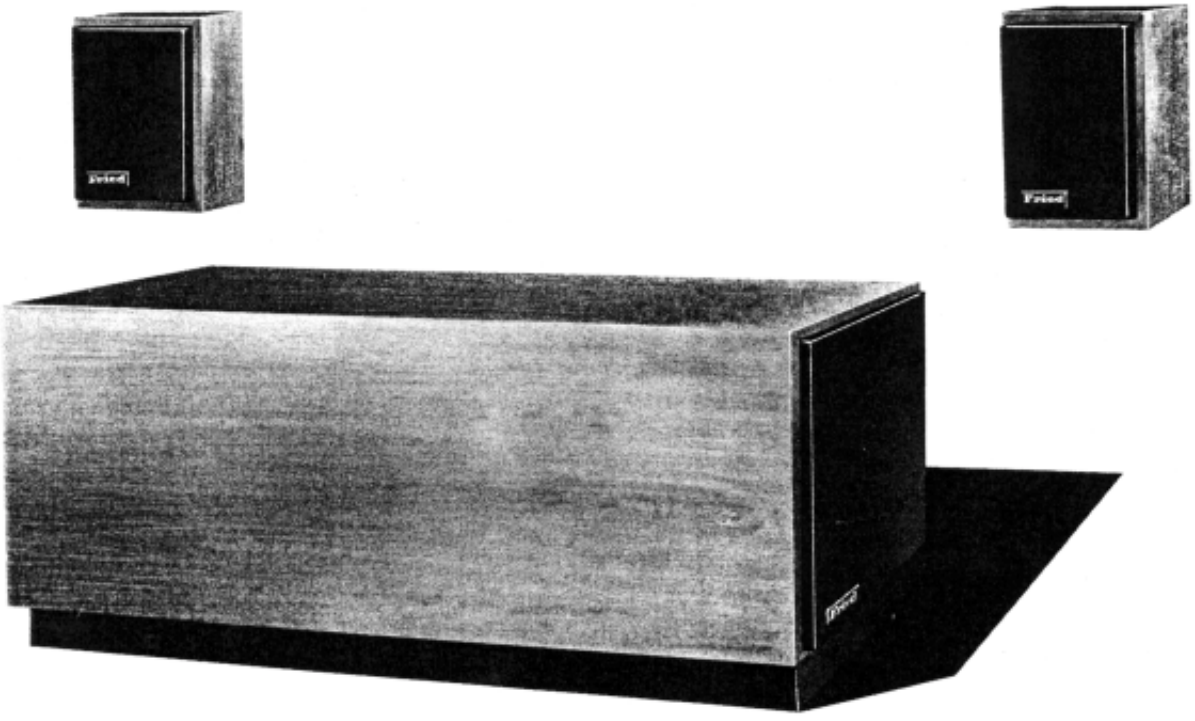
The MODEL H

An I M FRIED "Signature Series" Loudspeaker



I. INTRODUCTION.

Loudspeaker H is a new kind of loudspeaker, a superb addition to the I M FRIED "Signature Series", which we offer as an instrument for listening to music in the home. It is a different loudspeaker from those we have featured for the last decade; it is a significant change in emphasis among the various factors that contribute to high quality music listening. Therefore, we want to explain the origins, the development, and the unique kind of performance obtainable from our first loudspeaker using the multi-unit approach.

What do we mean by multi-unit? We mean the use of more than one enclosure to reproduce each channel of the musical range. Model H uses a double woofer enclosure to reproduce (separately) each channel of the very low bass frequencies; and two small units, called satellites, to reproduce the upper bass, mid range, and treble frequencies of each channel. Previous designs of ours have reproduced the entire frequency range from a single enclosure, with two enclosures for stereo.

The reasons for going to the added complexity of multi-unit design are explainable; Model H departs from the strict objectives of our past monitoring designs (data sheets available on monitoring designs, on request). In order to get somewhat different results, we develop and use different tools! This is not to say that all our previous research and development is "obsolete", for it is not, and we insist that, for the vast majority of listeners, the performance obtainable from our more recent single enclosures is ideal. But this does not negate the reality, that there does now exist a small group of perfectionist listeners searching for even greater involvement in the music, and for that rather small group we have conceived and created Model H.

What is gained by the multi-unit approach? Conversely, what is lost? For a full answer, we must go back in history and development. We here are noted for fostering throughout the world the concept of ultra wide band, monitoring quality reproduction, taking it from the lab and introducing it to the home market. Indeed, our past designs, employing transmission line technology developed by us—speakers such as the IMF-KELLY "TLS" of 1965, the MONITOR and the legendary STUDIO—are landmarks in the art; and thousands of these loudspeakers are in use in homes all over the world, offering reproduction of music approaching the original.

II. WHY WE DEVELOPED MODEL H.

Newsletter readers are familiar with a subwoofer system designed by us some time ago for psychoacoustic studies into the hearing process, a dual channel transmission line designed for laboratory use. We did make this available to our dealers and their customers. Subwoofer S, as it is called, is the catalyst which has propelled us into our first multi-unit loudspeaker system! For it introduced us to a whole group of music lovers searching for realism on and beyond the single enclosure concept, the concept which till now has been our only approach.

This group has complaints to make concerning our line of single enclosure monitoring loudspeakers, complaints which may be extreme, but which we believe to be valid—for perfectionists. What they said was that, as fine as our loudspeakers were, the music still appeared to emanate from inside two enclosures ("boxes"). What they were seeking, they said, was a more "open" sound, or a lack of "boxy" sound. In seeking this, they had gone through the "omni" speakers (cf. Newsletter 8), and many of them were currently enmeshed in the planar, or dipole, loudspeakers—the kinds of loudspeakers that we had last investigated and discarded back in 1962 (cf. Newsletters 1, 2)!

A major part of the fascination of music reproduction, for us, is the turning into physical reality of subjective impressions. Indeed, long ago, we wrote about this combined art and science, "psychoacoustics"; and more recently, we wrote about "Ambisonic" sound, in Newsletters 9 and 10; which is intimately related to how the human hearing mechanism translates physical reality into subjective feeling, i.e., to psychoacoustics. Therefore, as a challenge to us, we had to translate and define in physical terms, in "real" terms if you will, what these people meant—those who admired the honesty of our monitoring approach, but still wanted more "open" sound.

The first lesson we learned, looking into the situation, was that many people were merely objecting to the presence of two loudspeaker enclosures prominently placed in the listening room. Long ago, the BBC found that new loudspeakers could only be fairly evaluated for sonic excellence and accuracy, if they could not be seen! So, in all the BBC researches (cf. Newsletter 7), the speakers on test were always placed behind gauze curtains.
In short, what the eye sees, the ear hears! We have for a long time here suggested that all speaker evaluations be carried out with closed eyes—and that seemed to be enough, provided the loudspeakers were actually excellent in the monitoring sense, to remove the sense of two boxes. However, most people just don't enjoy the idea of listening with closed eyes, or don't want to think about it. Instead, some of them have actually gone on to exotic designs, "boxless" speakers such as the dipoles, on the general premise that, if you can't see a box, you can't hear a box (for this discussion, we must dismiss the people who find most dipole loudspeakers to sound "boxy", or resonant, as they do to this auditioner!). This, we believe, explains why some people have been willing

to accept dipole loudspeakers with obvious and severe deficiencies, and with appalling measurements, as home loudspeakers—they sound "open", and maybe later a subwoofer can be added, etc . . . .

We started thinking, that if a loudspeaker could be developed with measurably superior performance as a loudspeaker, i.e., matching the performance we had in our monitoring loudspeakers, but without two visually obvious enclosures, the eye would not be able to convince the ear that it was hearing "box" sound! In short, we might be able to develop a high quality alternate approach to loudspeakers, other than our monitoring loudspeakers, one without the psychological barrier of "box" sound.

You may ask, "Why not design a planar speaker?" To which we quickly reply, that we got rid of them over a decade ago, because of the insoluble and serious problems built into them (cf. Newsletters). We continuously research new drive systems and designs; we remain convinced that planar speakers just don't come close to providing modern standards of performance. We found out a long time ago the built in problems of dipole electrostatics, of ribbon speakers; and nothing to date has changed our minds.

Any loudspeaker is a compromise solution, which is why people who have been working at them a long time, such as ourselves, generally know how to make more satisfactory loudspeakers. In enclosure loudspeakers, one factor of great importance is the shape and size of the enclosure. Until some "genius" repeals the laws of physics, satisfying bass reproduction, the massive transient wave fronts one hears at a live performance, can come only from a large enclosure. Despite the wild promotional claims of the "air suspension" enthusiasts, no one has ever heard real instrumental bass out of what the industry calls "pint pot" speakers. As our followers know, our MONITORS always had more realistic bass than our STUDIOS, just because they were larger (and more expensive).

Conversely, small dimensioned enclosures are much more ideal for upper mid and treble propagation and dispersion. Tall, thin enclosures have better lateral dispersion than squat, short enclosures. Small enclosures, with treble propagated close to the upper edge, have better vertical dispersion. The mirror image, "controlled dispersion" designs of our monitoring loudspeakers take advantage of these physical laws, as far as is possible with large enclosure systems. We have always worked within the confines of the laws of diffraction from enclosures, in the earlier designs. We have always known that we could do a much better job, if the enclosure were made much smaller.

The classical text writers, accordingly, suggested that a loudspeaker ideally should change dimensions with frequency—increasing its size as the frequency of interest decreased. The ideal loudspeaker, then, among other virtues, would have an "expanding sound source". Regrettably, most current loudspeakers pay little or no attention to acoustic principles; instead, their promoters make exaggerated claims of virtues which are patently untrue. Any loudspeaker in a short, squat enclosure must be bad; any loudspeaker with a six foot diaphragm must be bad! (cf. P.J.Walker's classic articles on theory of dipoles; the modern apostles of them ought to read those articles!)

Our previous designs did pay attention to acoustics, within the single enclosure confine. When we found that a sizeable number of people were willing to get involved in greater complexity and expense, for sake of "realism", we were free to design a system for the home which, in accord with acoustical laws, and our perception of sound, can be closer to ideal for home listening (though perhaps not ideal for the laboratory monitoring function).

That is why, after some fifteen years of dedication to the principles of monitoring loudspeakers, we now offer a technically advanced and acoustically correct alternate kind of loudspeaker, for the group of people who prefer to go beyond high quality single enclosure systems, into multi-unit systems capable of offering more "realism". Model H is such a loudspeaker, a multi unit "state of the art" loudspeaker system, incorporating all our past experience and know-how in designing and manufacturing "state of the art" loudspeakers; to which we have added certain advanced technologies we didn't have before; and with (as with all our loudspeakers) provision for incorporating other improvements as the "state of the art" advances.

III. ORIGINS OF THE DESIGN PRINCIPLES

Model H is a refinement of our own advanced technologies, in no sense a rebuttal of them; whereas so many "miracle" loudspeakers claim to repeal all that has gone before. The same basic modes of construction and design that have produced our loudspeakers to date are used, such as our unique "flow through" transmission lines, and our use of plastic coned drivers specifically formulated for each frequency range. It is just that we have reoriented the ways of using them, in order to reach a different objective, a different kind of listening. A tremendous amount of input came together, other researches and findings from varied sources, which, added to our own past researches and current continuing research, did result in this new Model H loudspeaker. We frankly know of no other company than ours which

might have combined all of this into a new loudspeaker. To cite a few of the special "inputs":

1) Our Ambisonic research and our subwoofer S. This proved to us that phase shifts in the deep bass were used by the hearing mechanism of the human being, to help locate and recognize bass instruments of the orchestra. An ideal bass propagator must have very wide response, must be linear in its range, and must be separated from other channels of data (i.e., a "common" woofer for both channels is out).
2) Percy Wilson's theory of "resistive" vis a vis "reactive" loudspeakers. This noted British authority asserts that loudspeakers presenting a reactive load to amplifiers will perform poorly on musical program, even though on steady state measurements they may be fine. He lists as the classic reactive loudspeaker, the air suspension types. He lists as the most resistive loudspeakers the large horns and transmission lines; and these loudspeakers are the ones which can reproduce musical wave forms and violent transients.
3) The British concrete bass horns. We have heard and been overwhelmed by the IMF-CRABBE system, two 13½ foot concrete horns coupled to modified middles and tops from the IMF MONITOR (for a full description, see Hi Fi News, March, 1972). It did set us thinking, opened the doors to further investigations, and resulted in Project H.

Thus, we were ready for a new approach; we had heard more "realism"; we had the tools. All the factors were prepared; and so we have designed, and proudly present Model H, as one of the I M FRIED "Signature Series" loudspeakers.

IV. THE SUB WOOFER SYSTEM

The foundation of Model H is a dual transmission line subwoofer system, developed from our now famous Model S, and refined for home use. A new 8 inch plastic driver, with very high flux density, is used in each line; this driver has faster rise time and damping than the larger driver used in Subwoofer S and the MONITOR; it is also more efficient. Accordingly, the enclosure size has been reduced from 6 feet (Model S) to 3½ feet long, with no loss of efficiency and only marginal loss of extreme subsonics. Each line is a "free flow" line; one starts and finishes at the left hand side of the enclosure; the other at the right hand side. The two lines, lying side by side, mutually brace and strengthen each other. Each bass source is physically 3½ feet from the other, close to the satellite speaker (see illustration) for that channel; facilitating phasing and aiding time delay adjustments (instructions come with the speaker). The measured length of each line is over 7 feet; however, the edge-on "free flow" filters inserted in each, decreasing with the taper toward the open end, dampen and retard air flow. so that the effective acoustic air path is over nine feet.

So far, our description of each line varies not at all from a description of earlier lines by us. However, there is one very important difference, a difference that results from a profound change of opinion by us on measuring techniques. Heretofore, each of our loudspeakers was designed to furnish flat acoustic bass output under anechoic conditions; Model H is designed to furnish flat acoustic bass output under room conditions, both channels driven, with the woofer away from corners, walls, or floor. The nature of the damping is, in technical terms, much closer to the "critical" condition, which means:

1) Less impedance rise at subsonic frequencies, providing even better power transfer, and less susceptibility to subsonic disturbances.
2) Even better "attack" and "decay" characteristics (more "impact").
3) Less "boxy" sound, even under violent transient excitation, as from deep piano or bass drum.

By calculation, Model H should have a 14Hz cutoff. Actual measurements will be discussed later. However, it can rattle windows at 14Hz, so that it must roll off slowly. The dual woofer system of Model H is, then, a highly refined and advanced version of the lines we have been developing and researching for many years, searching for methods of simulating the "real thing". To our knowledge, gained from all over the world, only the English inbuilt concrete horns are better. They represent untold investments in time, money, structural alterations to the building, and final adjustments. Short of them, Model H's refined performance is a revelation to us, and to the musicians and recording engineers who have heard it. Its virtually complete absence of coloration, or "boxiness", is astounding; it has nothing in common with "loudspeaker bass". The dynamic range of bass on imported discs is a revelation; most common comment is to acknowledge that records are far better than anyone ever thought—and you will agree, first time you hear a bass drum hit on Model H!

V. THE SATELLITES

The rest of the musical range (mid bass, mids, and highs) is handled by the satellites, one for each channel, measuring only 11" high, 8" wide, and 6" deep. These are small by design, because that is the way to obtain the desired psychoacoustic and reproducing characteristics for Model H. Like all our current design work, these satellites have antecedents in the art and in our prior design work. The drivers used are: 1) An improved version of the plastic driver first used in our MONITOR, and now

in our Model R; 2) A tweeter used in our Model R, similar in design (same engineer) to the older super tweeter of our MONITOR! The same two drivers are adopted for use in the newest of the world famous BBC MONITORS, the LS3/5A.

We repeat and emphasize that the satellites are designed to satisfy the criteria for Model H. Since they are so small, the eye does not force the listener to hear two separate sound sources; rather, the listener knows that such large sound cannot possibly come from them, and ignores them! Consequently, there is no "two box" sound. The satellites can be placed most anywhere, on stands, on bookshelves, on window ledges, so long as they are placed behind the woofer, in relation to the listener.

Since they are small, laterally, mid frequency energy is dispersed across the stereo stage, creating a very big image. Since the tweeter is very close to the top edge, the upward dispersion of the highs is accentuated; so that the sound image opens up vertically. We feel upward treble dispersion is the missing ingredient in almost all loudspeakers; and we think this is the important ingredient to recapture the sense of space and grandeur one feels in a large concert hall.

Since the baffle board is small, the first diffraction from the edges is, in acoustic parlance, "early", and indistinguishable (by the ear) from the driver impulse. Again, the clarity of attack, and of all instruments, is the result—one heard by all listeners (some of whom complain that the sound is "too clear" for them!).

Since the entire enclosure is small, it is inherently rigid and acoustically "dead". The interior air space is damped with our time honored and developed system of edge-on, "free flow" foam filters. We found that this system produces less "early reflection" back to the driver than any random stuffing system. The enclosure, driver, and damping together produce an acoustically inert combination, devoid of "colouration".

Each satellite reproduces the range from 100Hz upward with an astounding clarity, accuracy, smoothness, absence of "colouration"; and with a large apparent sound source; one that first auditioners simply cannot, thus do not, believe. Indeed, it is possible to turn on just one side of Model H and fool listeners into thinking they are hearing stereo! Each satellite, acting as a point source propagator, produces an image more smoothly and accurately than any possible combination of multiple drivers in array, or strip diaphragms. Listening proof is that solo instruments are portrayed with a realism (from proper "resolution"), in the midst of vast orchestral crescendi, that is impossible from other propagating media. Never does the solo violin stretch left to right; never does the piano jump around the room; never does the soprano voice bloat itself vertically!

VI. THE CROSSOVER SYSTEM

Last, but not least, part of the Model H is the crossover system, which we developed specifically for it, using the very latest technology. Other parts of Model H are refinements of past developments from research; the crossover is a virtual breakthrough design. Its development took more time and involved more returning to "first principles" than any other part of the system. Reinvestigated were the technology of crossover design, in light of the most recent researches (mostly in England and Denmark) reported on in the technical journals.

First we considered, and summarily rejected, the various kinds of electronic crossovers, i.e., those which divide the spectrum before the amplifiers, using one for each division. We had used these back in 1948, on the corner horns we then used. Electronic crossovers do help, in some circumstances, but we dismissed them for Model H because:

1) They help with drive systems which have wildly varying impedance curves, or efficiencies (horns, electrostatic hybrids). They do very little to systems with resistive and flat impedances, which are inherently phase coherent (ours).
2) The little they may do is more than negated by the extra cost, complexity, heat dissipation problems; and increased costs of maintenance from breakdown.
3) They must be phase compensated in any case; this can be done readily with speaker crossovers, where the drivers are resistive (see above).

So, we decided to use a speaker crossover system for Model H. Our previous research on impulse performance indicated that the nature and damping of the crossover is one of the vital factors for optimum operation (cf. Newsletter 10). Recent research by others, and ourselves, indicates that:

1) Crossover points should be far removed from the mid range of musical frequencies. Particularly critical is the crossover from woofer to mid range, since this is close to the maximum energy of music (650 Hz), and where the ear is most critical of phase mixup. Should the crossover be near this frequency, and be to units which must be crossed over rapidly (as with the current range of mid domes), it is almost impossible to avoid "transient burp" effect (a fluctuation in music reproduction which sounds like flutter, but worse).
2) Six db per octave slopes are preferable, since

they can be "phase linear" at crossover. However, the drivers used must be capable of reproducing smoothly two octaves beyond the crossover point.

3) Provided the drivers are smooth per above (no paper cone breakup!), slow rates permit a more linear power transfer; provide an easier (more resistive) amplifier load; and generally are more efficient power wise. Summarized, less power is wasted in the crossover, more goes to the drivers, to reproduce the dynamics of music.

Therefore, for the vital crossover point, woofer to mid, we installed a six db per octave crossover, crossing over the two units between 50 and 100Hz! This we could do, because the woofer we have selected is designed to go cleanly to 3KHz, and the mid driver has a 30Hz free air resonance. We used a more conventional rapid slope crossover, carefully phase compensated, for the mid to tweeter changeover; because no tweeter units are available for "slow slope" use; because the ear is not so phase sensitive in this region. (However, we are hoping to find acceptable units soon.)

The physical crossover system is contained in a screened box; in this box are the very large air cores for woofer crossover, plus quality capacitors, and the other air core chokes. A switch on the box, the Impulse-Perspective Control, permits incremental changes in system rise time (Fast, Normal, Delayed). Included is speaker fusing, by channel.

VII. TECHNICAL CRITERIA OF THE DESIGN

A few final notes on Model H: It is the first loudspeaker we have designed (and probably the first one from anywhere), in which impulse performance has taken precedence over frequency plots! Let us explain. Research has established that the hearing mechanism is more influenced by the accuracy of transient recreation by a loudspeaker, than it is by the flatness of frequency response. Unfortunately, as one English authority has wryly commented, it took us years to teach reviewers (and everyone else) the importance of frequency response, and it may take even longer for us to teach them that impulse response is more significant! More importantly, final adjustments favoring impulse accuracy may upset frequency balance or smoothness.

In every case, where there has been a conflict between impulse performance and frequency response, the former condition has been observed. Model H is almost entirely a system based on the known parameters for accuracy, i.e., impulse performance. Yet, the frequency performance of Model H is, as we will explain, equal to or better than any of our former designs—for home listening.

VIII. MEASUREMENTS

Our former designs are monitor oriented. Final measurements on them are taken in anechoic chambers, for each loudspeaker. Model H is not a monitoring loudspeaker; rather, it is a system concept, for use in the home. Thus, the measurements we have made on it, vis a vis frequency, are in actual listening rooms. We measure the response of the entire system with "Real Time" Analyzers, which give fast measurements of system response at various listening positions—close up, far away, standing, sitting. In such positions, Model H measures plus or minus a few db from 20 Hz to above audibility. Response on either end, beyond the limit of the measuring equipment, seems to taper slowly, per the design. It follows, then, that transient inputs at frequency extremes will be reproduced properly (abrupt cut offs produce overhang on transients).

On noise inputs, used to measure and evaluate smoothness, Model H presents a broad, smooth continuum from wall to wall of the room end. It has virtually no "Venetian blind" effect (rapid alternations as one moves one's head around, or from side to side in front of the speakers), and much less of the "tunnel effect" vertically than one hears from most other loudspeakers. Indeed, the high performance seems ideal, up and above the satellites. Model H has no abrupt image jumps; rather, everything is smooth and gradual.

How loud does Model H play? The bass unit is large; its size dictates overall efficiency. The crossover system has very little insertion loss (see above), and the drive systems are more linear than in our previous designs. Because of these factors, Model H can produce levels approaching or exceeding those of live music, from moderately powered (under 100 watts per channel) amplifiers. Peak levels over 100db. are handled with ease and lack of strain. However, Model H was not designed for use in discoteques or ball parks; those seeking reproduction levels beyond the threshold of pain are counseled to seek elsewhere. Ordinary good record playback equipment will suffice. If the user has an advanced record playback system, i.e., with low rumble, adequate anti acoustic feedback shielding, and a stable arm-cartridge combination (see Newsletters), levels up to 12db higher may be safely reached; in addition to which, there will be a worthwhile extra purity of bass.

IX. "SOUND"

After all the above: How does Model H sound? Capsule descriptions:

1) Closest I have heard to the IMF-Crabbe horns.
2) First large source loudspeaker that also plays chamber music!
3) Stupendous!
4) Too clear (bright) for me!

We do have a problem in describing the sound of Model H, because, as the above indicate, it all depends (the re-

action) to what the listener has accustomed himself. Even those accustomed to our own MONITOR seem to react unpredictably; only those conditioned to our own Model R seem to like Model H at first audition (or those who like live music and hear it often).

Model H is not a "close up" or a "distant" loudspeaker, not a "hard sounding" or "soft" loudspeaker; not "bass-ey" or "bass shy". Indeed, these phrases have been so often used by critics and reviewers that they have become meaningless as serious criteria. In spite of which, we will try to give you some idea of what to expect, from Model H.

From well recorded program material Model H produces a spacious sound image, stretching from left of the left satellite and right of the other; and going back to the distant wall of the recording hall. It also produces an illusion of spaciousness above, so that much of the sound appears to emanate from the space between the orchestra, the proscenium arch, and the ceiling of the hall. Solo instruments do not appear as much left and right, as forward left, back left, forward right, and back right. Solo voice, and other instruments one might expect to hear from stage front appear in bas relief, in front of the orchestra. The stereo stage is, in summary, more in depth, and slightly less sharply defined, left to right, than in our current monitoring oriented loudspeakers.

Let us comment on this spaciousness. One authority in England has commented that the problem in stereo is how to achieve spaciousness without sacrificing specificity. Omni loudspeakers produce a pseudo spacious sound, pseudo because the sound has no specificity, and in fact has little or nothing to do with the original program (cf. Newsletters). Model H is not that kind of speaker. It does not produce thirty foot wide pianos, wavering choruses, six foot tall soprano voices; or "double mono" (two separate performers, one in each channel); or "ghost" images (as in television, blurred repeats of the original sharp image—most noticeable with violin soloists). The stereo from Model H is rock steady, result of the design, which does not ignore, but is in accord with, the laws of sound propagation. Model H, above 100 Hz, is basically a point source propagator, one for each channel, and that is why the image remains fixed and clear, no matter what the music, no matter what the reproducing level.

Below 100Hz, Model H is an omni radiator, or, more properly, two omni radiators. While the bass frequencies are omni directional, we have found that phase and arrival time differences are interpreted by the hearing mechanism, and are required to give the bass impact and position of live instruments. Indeed, we feel that even more data (such as in quadraphonic playback) helps the ear primarily at the very low frequencies, to distinguish "real" from "reproduced". So, there is late arrival data from Model H, too, as the output reaches the side walls and is reflected into the room, and to the listener. The impact of deep bass on Model H is something to experience. It is less colored, freer, and more dynamic than anything else we know, excepting the giant concrete horns. To hear the boom of a bass drum, or a cello playing vibrato, or a plucked double bass; or, more subtly, a guitar, a harpsichord, proves to be more than we expect from loudspeakers—in that it does not sound like a loudspeaker with these instruments.

This self same ability at "resolution" of musical timbre exists over the entire audible spectrum. Everything is a bit crisper than expected (as noted before, some people say, a bit "too bright"), a bit closer to live instrument sound. Indeed, no one has to guess whether it is a piano or a xylophone; one can even tell what kind of piano—or whether it is a German or a French oboe. The ability to resolve the instruments of the orchestra permits good program material to come through with incredible clarity and a sense of dynamic realism that puts a whole new focus on home music listening . . . . and leads to a new method of listening. First time listeners to Model H invariable set the introductory level too high, so that the later program overwhelms their ears. The increased dynamic range of Model H, result of all that has been described here, must be heard to be believed.

Hall ambience, long a hallmark of our kind of reproducing systems, is even more audible, on a given program. The entire sound image is freer, more three dimensional, more in space. This "open" quality is the listening proof of extreme phase linearity in the system, the absence of abrupt phase shifts in the mid band. It was in the grand old designs of long ago; it is back, with the added advantages and smoothness made possible by modern cone and enclosure technology.

Model H goes well beyond current high quality standards, in imaging and dynamic capability. It is an exciting loudspeaker to hear and to own; it makes one want to try beloved recordings to hear them in new ways. Yet, it is not recommended for every man. For, it is large, expensive (though the kit mitigates the expense), not a monitoring (close up) speaker; and probably too musically intense for the majority of home listeners. It should be used in a room not less than nine feet wide and twelve feet long. Listeners should be several feet away from the system, to give it a chance to merge into one stereo image.

Instructions for setup and use are included with the system (including simple home "impulse" tests). The kit version comes complete with drivers, damping material, wire, fuses, connectors, assembled crossover box, cabinet plans, and instructions.