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TANNOY 615 SPEAKER

Manufacturer's Specifications

System Type: Two-and-a-half-way floor-standing system with passive-radiator enclosure.

Drivers: Dual-concentric coaxial driver with 8-in. cone woofer and compression-driver horn tweeter, 8-in. cone woofer, and 8-in. passive radiator.

Frequency Response: 41 Hz to 30 kHz, ±3 dB.

Sensitivity: 92 dB at 1 meter with 2.83 V applied.

Crossover Frequencies: 400-Hz low-pass on separate woofer, 2.5-kHz low-pass and high-pass between dual-concentric tweeter and woofer.

Crossover Slopes: First-order, 6 dB/octave.

Impedance: 6 ohms nominal, 4 ohms minimum.

Recommended Amplifier Power: 10 to 175 watts per channel; maximum, 300 watts/channel peak.

Dimensions: 38⅜ in. H × 12½ in. W × 9¾ in. D (97.5 cm × 31.8 cm × 24.8 cm).

Weight: 46.2 lbs. (21 kg) each.

Price: $1,599 per pair in black ash or walnut; Model 6s1 base, $99 per pair.

Company Address: c/o TGI North America, 300 Gage Ave., Unit 1, Kitchener, Ont. N2M 2C8, Canada.

For literature, circle No. 92

Tannoy, one of Britain's oldest loudspeaker manufacturers, pioneered the use of dual-concentric drivers back in the 1930s. Most of the models in their current "Sixes" line have dual-concentric drivers whose woofer magnets serve as horns for compression tweeter drivers, while their woofer cones serve as horn extensions. The Model 615 is the top speaker in this line.

Tannoy's latest 8-inch, dual-concentric driver, used in the 615, has both an improved horn design and a structure the company calls a "Tulip" waveguide, said to produce truly spherical wavefronts, just in front of the tweeter. The horn is driven by a compression driver with an aluminum-alloy diaphragm and a Ferrofluid-cooled voice-coil. Coaxial or dual-concentric drivers have excellent coverage of the listening area because of their inherently coincident acoustic sources. The high and low frequencies emanate from the

The tonal balance of coaxial or dual-concentric drivers changes minimally with different listening locations and distances.

same point in space, thus providing well-controlled symmetrical coverage, that is, identical both vertically and horizontally.

Coaxial drivers come quite close to the acoustical-radiator ideal of constant directivity over a substantial frequency range. (I am intimately acquainted with such radiators, having designed constant-directivity horns for several manufacturers, and I hold three patents in this area.) A constant-directivity source, which has the same on- and off-axis frequency response, also has the unique advantage of having a power, or reverberant-field, response that is identical to its axial frequency response. This makes the source behave much more uniformly in different environments or locations in a room, resulting in a sound whose tonal balance changes minimally with different listening locations and distances.

In addition to the dual-concentric driver, the 615 includes an additional 8-inch woofer and a passive radiator that Tannoy calls a mass-tuned passive cone. The low-frequency portion of the system is a vented-box design with a passive radiator taking the place of the port. The passive radiator actually uses the same cone and suspension as the 8-inch woofers, but without a magnet or voice-coil, and thus has the same air-moving capabilities as either woofer does. At low frequencies, the two woofers operate in parallel, but above 400 Hz, the separate woofer is rolled off by the crossover. The cabinet forms a single cavity in which both drivers and the passive radiator operate. The cones of all three units are injection-molded of a mineral-loaded olefin copolymer plastic and are thicker near the neck section for increased rigidity at the driven point.

The enclosures are six-sided, which increases the cabinet's strength and minimizes wall vibration. This design also improves lateral dispersion by reducing edge diffraction. Identical grilles cover each of the three sound radiators on the front, and are attached with projections that fit holes on the cabinet front and hold the grille slightly off the cabinet's surface. The systems were supplied to me with optional molded-plastic bases that increase the footprint of the 615 to improve stability and also serve as attachment points

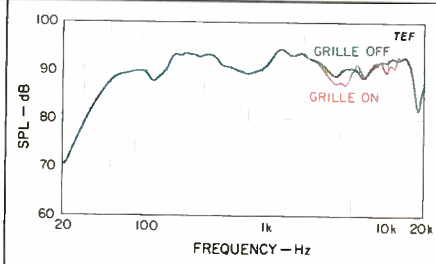

Fig. 1—One-meter, on-axis frequency response.

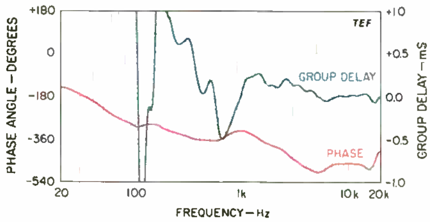

Fig. 2—On-axis phase response and group delay.

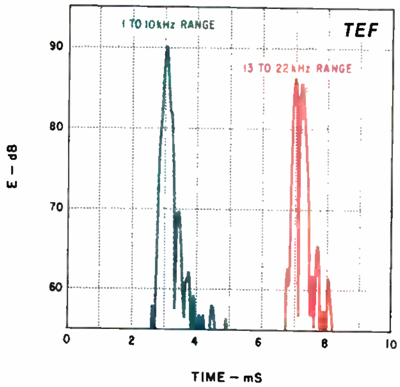

Fig. 3—One-meter, on-axis energy/time curves.

for either the mounting spikes or pads provided. These pads and spikes can also be screwed directly into the speaker cabinets.

The inside of the low-frequency enclosure is partially filled with a white polyester absorptive material. Most of the enclosure is constructed from ¾-inch-thick medium-density fiberboard. The top and bottom panels (Tannoy calls them end caps), and the portion of the enclosure separating the dual concentric's enclosure from the bottom portion of the cabinet, are made from injection-molded, mineral-filled polypropylene. The enclosure is reinforced very well with an internal top-to-bottom brace, which provides even greater stiffness beyond the multi-panelled construction. The drivers actually butt up against this brace for support, with a small amount of putty added between to eliminate vibrational contact.

The crossover of the 615 is of minimalist design and has only five parts: Two inductors, two capacitors, and one resistor. Parts quality is high, and iron-dust core inductors and polypropylene capacitors are employed. All connections use heavy-gauge wire and connect to the drivers with clips. The crossover is wired on a p.c. board attached to the rear-mounted input connection panel.

The connection terminal panel at the back of the system allows bi-wiring but also includes a unique captive assembly that slides out to connect the two sets of input terminals when the system is not bi-wired. The terminal wire holes are even large enough to handle a heavy cable in addition to the sliding connection straps.

Measurements

Figure 1 shows the 615's anechoic on-axis frequency response, along with the effect of the dual-concentric driver's grille. Measurements were taken on the center axis of the dual-concentric driver, at 2 meters with 5.66 V rms applied, and then referenced back to 1 meter. The response below 300 Hz was derived from 2-meter ground-plane measurements with the input reduced to 2.83 V rms to compensate for the ground plane's 6-dB boost.

The on-axis curve, although somewhat rough, is well extended and reveals a high sensitivity of 91.6 dB (close to the 92 dB specified) averaged over the four-octave range from 250 Hz to 4 kHz. A sharp, high-Q dip of 20 dB at 17.3 kHz is exhibited in the on-axis curve, although the tenth-octave smoothing of the axial curve in Fig. 1 partially masks the dip's severity. Excluding this dip, the curve fits within

The Tannoy 615's coaxial configuration pays off in vertical off-axis responses so well behaved as to look just like the horizontal curves.

a window of ±3.7 dB from 50 Hz to 16 kHz (referenced to 1 kHz) and therefore does not quite meet the manufacturer's specification. Below 40 Hz the response rolls off at about 18 dB/octave and is 10 dB down at 35 Hz from the 1-kHz level. The notch in the response at 110 Hz appears to be related to some internal resonance mode, because it was apparent even in a near-field measurement of the coaxial driver's woofer.

The right and left units matched closely, within ±0.6 dB, below 16 kHz. Because of the significant response changes caused by the grille, these and all subsequent measurements were taken with the grilles off.

Figure 2 shows the phase and group-delay responses, referenced to the tweeter's arrival time. The phase curve stays within a compact, 180° envelope from 200 Hz to 20 kHz. The group delay is fairly flat above 1 kHz but exhibits minimum-phase irregularities at 105 and 650 Hz due to dips in the axial response (and hence irregularities in the phase response) in these same areas. If these dips were equalized flat with a minimum-phase equalizer, the phase and group-delay responses would become much better behaved.

Figure 3 divulges the system's 1-meter, on-axis energy/time response for 2.83-V signals in two frequency ranges. For the left-hand curve, the test parameters were chosen to accentuate the system's response from 1 to 10 kHz. The main arrival, at 3 mS, is well behaved but broadens at the base, and there is a single significant delayed arrival, at 300 µS, about 21 dB down. The other curve, which has been shifted to the right by 4 mS for clarity, shows the results of the sweep covering the range from 13 to 22 kHz, where the tweeter exhibits severe peaks and dips. The curve reveals two sharp peaks of roughly equal level separated by about 200 µS. This behavior could be due to an internal acoustic problem in the construction of the tweeter's compression driver and/or horn. Fortunately, the aberrations are high enough in frequency so that audible problems are minimal.

Figure 4 displays the normalized horizontal off-axis responses of the 615. Normalization has been carried

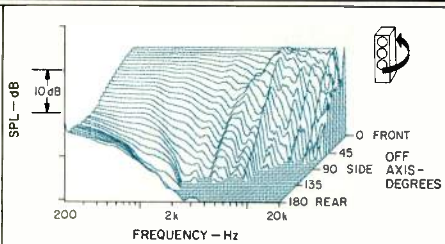

Fig. 4—Normalized horizontal off-axis frequency responses.

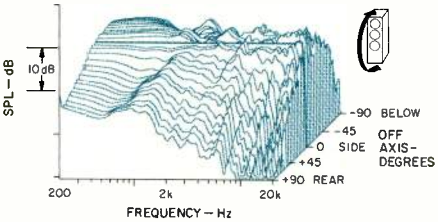

Fig. 5—Normalized vertical off-axis frequency responses.

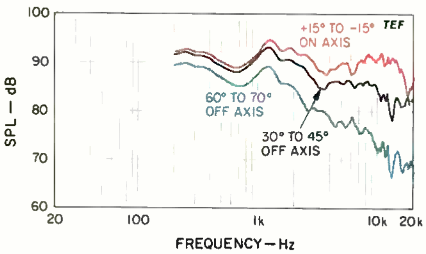

Fig. 6—Mean horizontal responses, from Fig. 4 data; see text.

out only up to 16 kHz; normalizing the on-axis dip above this frequency would create a misleading hump in the off-axis response, shown at the rear of the graph. The horizontal coverage is very well behaved.

The normalized vertical off-axis responses are shown in Fig. 5. In the center of the graph (front to rear), the on-axis response is in bold, and the above-axis responses are in the front of the display. The 615 exhibits excellent vertical off-axis behavior, without any aberrations in the crossover region. The curves are so well behaved that they could be mistaken for the horizontal off-axis curves. The coaxial configuration of the Tannoy's mid- and high-frequency drivers pays off abundantly here.

Figure 6 shows the NRC-style mean horizontal on- and off-axis responses. The mean vertical responses are not presented because they were essentially the same as the horizontal responses (except for some greater directivity below 1.5 kHz), a very rare trait. The mean axial (+15° to −15°) horizontal response is very close to the on-axis response. The 30° to 45° mean response is also close to the axial curve but has reduced level above 7 kHz. The 60° to 75° mean response rolls off relatively smoothly above 3 kHz, reflecting the smooth increase of directivity of the dual-concentric driver in this region. Neither the horizontal nor the vertical mean curves had the sharp peaks, varying with direction, that speakers with spaced drivers exhibit at crossover. The individual curves (not shown) that were averaged to make each mean curve were all quite closely packed, also a rare characteristic.

A low-frequency, high-level sine-wave sweep disclosed a solid enclosure with minimal cabinet resonances. Only a moderate top-panel resonance at 300 Hz was evident. The woofers did not exhibit any dynamic-offset effects up to their excursion limits of about ±0.25 inch. Below 400 Hz, the excursions of the coax woofer cone and the lower woofer were essentially equal. With an input level of 5 V rms, the coax and the lower woofer exhibited a sharp reduction in excursion at 29 Hz, which indicates the tuning point of the passive-radiator vented box. At this frequency, the passive radiator's excursion was quite large. However, at higher levels below 35 Hz, the passive radiator ran out of excursion at about 0.6 inch, peak to peak. At levels above 5.3 V rms, at and near 29 Hz, the system's distortion increased suddenly when the passive radiator reached its excursion limit. Above this level, both bass drivers also rose to their excur-

The 615's high sensitivity and high efficiency were apparent from the moment I began my listening.

sion limits, because the loading effect of the passive radiator is negligible when it reaches its limit. Everything was okay at 5.3 V rms, but the system went bananas at 5.4 V rms, an increase of just 0.2 dB! The level must be reduced below 5 V rms to stop this nonlinear behavior. At 25 Hz and below, the input cannot be raised above about 3.5 V rms (only 2 watts into the rated 6 ohms) without the passive radiator running out of gas!

The air-moving capability of the 615's passive radiator is actually quite small in comparison to the capability of the main woofers. A good rule of thumb for system design of passive-radiator vented boxes is to use a passive radiator that has at least two times the air-moving capability of the main radiators. Assuming equal excursion capability, the size of the passive radiator in this Tannoy system should be in the range of four 8-inch woofers, or roughly the size of a single 15-inch woofer!

The crossover consists of all first-order filters with a series RC impedance-correcting network in parallel with the separate woofer. Near-field measurements of the lower woofer showed that its acoustic output rolled off above 400 Hz. Separate measurements of the individual high and low acoustic outputs of the coax (made by separately driving the bi-wire inputs) revealed that the upper crossover is at 1.75 kHz rather than the stated 2.5 kHz. These individual output measurements (not shown) indicated that the acoustic roll-off slopes of the coax are about 12 dB/octave down to the −10 dB point. Beyond this, the outputs roll off much faster. Phase measurements indicated that the individual outputs are essentially in phase at crossover and are 6 dB down. Lobing does not occur in a coax, no matter what the phase relationships of the individual drivers are, because the acoustic centers of the high and low sections are essentially coincident.

The 615's impedance, plotted over the extended range of 10 Hz to 20 kHz, is shown in Fig. 7. Three low points are evident, with the lowest a relatively low 2.8 ohms at 190 Hz. A minimum of 2.9 ohms at the 29-Hz vented-box resonance of the passive radiator system is also noted. The impedance reaches a

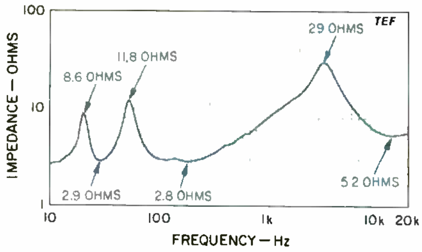

Fig. 7—Impedance.

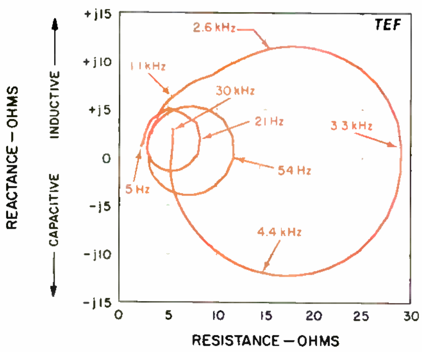

Fig. 8—Complex impedance.

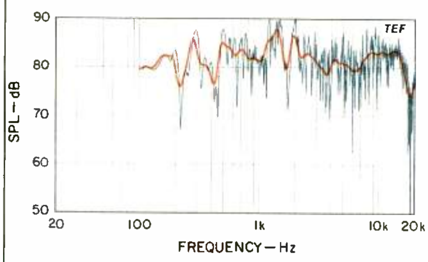

Fig. 9—Three-meter room response.

high maximum of 29 ohms at 3.25 kHz. The total curve thus has a high max/min variation of 10.4 to 1 (29 divided by 2.8). The system will be quite sensitive to cable resistance because of this variation and the relatively low minimum impedance. Cable series resistance should be limited to a maximum of about 0.036 ohm to keep cable-drop effects from causing response peaks and dips greater than 0.1 dB. For a standard run of about 10 feet, wire of 12 gauge or larger should be used.

The 615's complex impedance, plotted over the range from 5 Hz to 30 kHz, is shown in Fig. 8. The phase of the impedance (not shown) varied considerably, reaching a maximum angle of +50° (inductive) at 18 Hz and a minimum angle of −45° (capacitive) at 5.5 kHz. The Tannoy will be a moderately challenging load for some amplifiers because of its low and relatively reactive impedance.

Figure 9 shows the 3-meter room response with both raw and sixth-octave smoothed curves. The 615 was in the right-hand stereo position, aimed at the listening location, and the test microphone was placed at ear height (36 inches, essentially on the dual-concentric driver's axis) at the listener's position on the sofa. The system was driven with a swept sine-wave signal of 2.83 V rms (corresponding to 1.33 watts into the rated 6-ohm load). The sweep's parameters were chosen to include the direct sound plus 13 mS of the room's reverberation. Between 2 and 16 kHz, the smoothed curve is well behaved and fits within an envelope of ±2.5 dB. Excluding roughness from 1 to 2 kHz, above 500 Hz the smoothed curve is actually quite close to the on-axis response. This indicates that the reverberant-field power response of the speaker is close to its axial response, a direct result of the smooth on- and off-axis response of the dual-concentric driver.

Figures 10 to 12 show single-frequency harmonic distortion versus power level for different musical notes. The power levels were computed using the rated system impedance of 6 ohms and run from 0.05 to 50 watts in 30 steps of 1 dB each.

Figure 10 shows the E_1 (41.2-Hz) harmonic distortion. At full power, the second and third harmonics reach significantly high levels of about 10% and 27%, respectively. Higher order harmonics also reach significant levels. Some compression above 20 watts is noted in the fundamental and in the second and third harmonics. Even including compression effects, at 50 watts the Tannoy generates a fairly loud 99 dB SPL at 1 meter at 41.2 Hz.

On vocals, the Tannoys presented a very lifelike, up-front sound that was quite pleasing.

In Fig. 11, the A_2 (110-Hz) harmonic distortion, the second harmonic reaches a moderate 5% or so at 50 watts, with the third at only 1.3%. Curiously, the third harmonic reaches an intermediate peak, falls, and then rises to its final value as power is increased. At 110 Hz with an input of 50 watts, the speaker generates a fairly loud 105 dB SPL at 1 meter.

Figure 12 shows the A_4 (440-Hz) harmonic-distortion data. The second harmonic reaches only 2.6% at full power and the third harmonic only 0.44%. At 440 Hz and 50 watts, the system generates a loud 108 dB SPL.

Figure 13 shows the IM created by mixing 440-Hz (A_4) and 41.2-Hz (E_1) tones of equal input level. The IM distortion rises to a significant 22% at 40 watts. Interestingly, the IM distortion does not drop very quickly with decreasing power, remaining at a fairly high 6% even at 1 watt. Overall, the 615 exhibited substantially high distortion in the E_1 (41.2-Hz) harmonic measurement and in the IM test but reasonable distortion at higher frequencies.

The Tannoy's short-term peak-power input and output capabilities are shown in Fig. 14. The measurements were made by applying a 6.5-cycle, third-octave-bandwidth tone burst at each third-octave frequency. The peak electrical input power, seen in the lower curve, was calculated by assuming that the measured peak voltage was applied across the rated 6-ohm impedance. From a low of 2 watts at 20 Hz, the peak input power rises with frequency. It reaches a plateau of about 550 watts at 100 Hz, drops somewhat to 350 watts, and then rises to 2,400 watts above 1 kHz (120 peak volts across the rated 6-ohm load). The depression near 300 Hz was likely due to inductor overload in the woofer portion of the crossover.

The upper curve in Fig. 14 shows the maximum peak sound pressure levels the system can generate at 1 meter for the input levels shown in the lower curve. Also shown here is the "room gain" of a typical listening room at low frequencies, which adds about 3 dB to the response at 80 Hz and 9 dB at 20 Hz. The peak acoustic output rises rapidly with frequency up to 200 Hz, where it reaches a level of about 120 dB. After a slight dip, the output rises to a maximum near 125 dB and essentially follows the ups and downs of the on-axis response. Although this speaker's peak power handling is on the low side, its relatively high sensitivity (efficiency) results in high peak outputs.

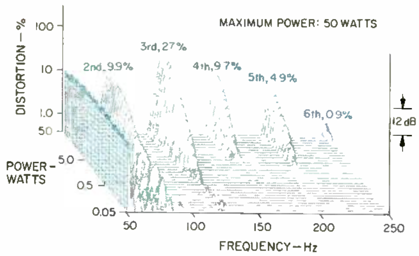

Fig. 10—Harmonic distortion products for E_1 (41.2 Hz).

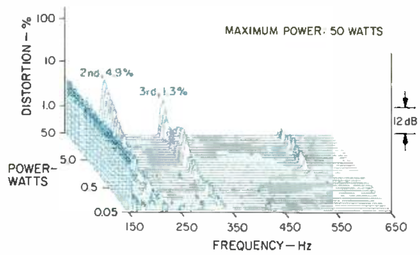

Fig. 11—Harmonic distortion products for A_2 (110 Hz).

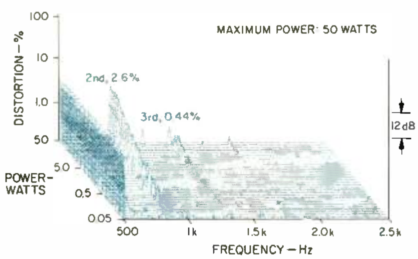

Fig. 12—Harmonic distortion products for A_4 (440 Hz).

Quite usable levels of 100 dB SPL or higher can be attained with one speaker at 35 Hz and above, with room gain, and a stereo pair can reach even higher low-frequency levels with bass material common to both channels.

Use and Listening Tests

The 615s are quite attractive. The black ash finish of the samples I tested fit in well with the furnishings of my listening room, though I find the walnut version even more attractive. For my listening, I used the optional stands (whose large footprint adds stability and which can be filled with lead shot or sand to lower the center of gravity) and the supplied spikes.

Tannoy sent me several very extensive, informative white papers describing many aspects of their "Sixes" line, including such topics as industrial design, materials technology, dual-concentric features, and bi-wiring. The four-page owner's manual, covering the use and installation of the "Sixes" line, suggests that the 615s be placed away from walls and corners and spaced 2 to 4 meters apart, and that the listener sit a bit further from the speakers than they are from each other. The company also suggests removing the grilles for serious listening, which I did. For the best stereo image, the speakers should be pointed either directly at you or with their axes crossing in front of you.

I placed the 615s in my customary locations: 10 feet from the sofa, separated by 8 feet, and well away from the rear and side walls. The speakers were aimed towards my listening position and not tilted back, which placed my ears directly on the axis of the dual-concentric drivers. The equipment lineup consisted of my usual Jeff Rowland amplification and Onkyo and Rotel CD players. Listening was done with and without bi-wiring, using Straight Wire Maestro cables.

On first listening, the high sensitivity and efficiency of the 615s were immediately apparent. These speakers presented a wide, very realistic soundstage with an excellent uniformity of coverage. The speaker's tonal qualities are quite independent of listening position. On the pink-noise stand-up/sit-down test, the 615s actually had slightly better vertical coverage than

The Tannoy 615s deliver excellent stereo imaging and soundstaging plus clean reproduction of high-level transients.

my B & W 801 reference systems, which are very good in their own right!

On pink noise, the Tannoys added a tonal coloration that was not present with the B & Ws. Because of the 615s' evenness of coverage, however, the coloration remained the same no matter where I listened from! Equalization should work well here, because the 615s' unusually uniform directionality would ensure that the equalized signal would sound the same to all listeners. I wish I had had the time to investigate this further.

On program material with high-level bass passages, the 615s tended to muddy the higher ranges when the bass was present. This effect was quite evident on high-level pedal sections of *The Organ Works of J. S. Bach, Vol. 4* played by Jean Guillou (Dorian DOR-90151). On most other program material, the bass level and extension were quite adequate. As long as the frequency range of the program material was limited to 35 Hz and above, these speakers did quite well. On band-limited third-octave pink noise, they could not generate any usable low end on the 20- and 25-Hz bands if driven at a level that did not overload them. With the low-frequency band-limited noise, the onset of overload occurred quite suddenly as level was increased. At higher frequencies, however, the Tannoys generated quite usable levels.

On vocals, such as soprano Julianne Baird singing with Colin Tilney playing harpsichord on *Musica Dolce* (Dorian DOR-90123) or Linda Ronstadt on *Mas Canciones* (excellent traditional mariachi music, Elektra 61239-2), the 615s presented a very lifelike, up-front sound that was quite pleasing.

The Tannoys' high efficiency and sensitivity serve them well in reproducing program material that has high crest factor (ratio of peak to continuous power). This was demonstrated on the recording of fireworks on the Pierre Verany *Digital Test* CDs (PV.788031 and PV.788032). The aerial explosions could be turned up to truly realistic levels on the 615s, but my Rowland amplifiers ran out of gas trying to get the B & Ws up that loud! The 615s also did extremely well on producing the realistic levels and the "horn bite" typical of live trombones and trumpets on

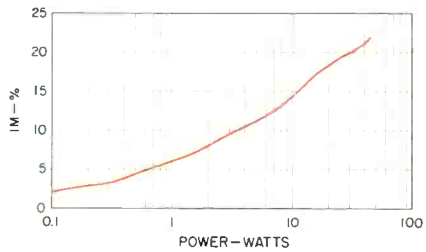

Fig. 13—IM for 440 and 41.2 Hz mixed in equal proportion.

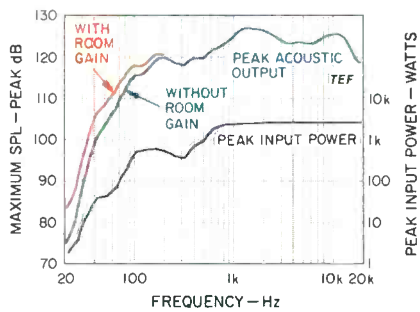

Fig. 14—Maximum peak input power and sound output at 1 meter on axis.

The Age of Swing, Vol. 1 by the BBC Big Band (a super big-band recording, Bainbridge BCD 2511).

To sum up, the Tannoy 615s present quite a package of contrasts. On one hand, they have excellent stereo imaging and soundstage capabilities due to their superb evenness of coverage, and they also provide clean reproduction of high-level transients due to their high sensitivity and efficiency. On the other hand, they exhibit moderately rough frequency response and are vulnerable to overload on high-level, low-frequency program material. Yet on balance, I feel the pluses far outweigh the minuses. These speakers' good looks and reasonable price make them good competitors and quite worthy of audition.

D. B. Keele, Jr.