into the measurement, usually between 0.03 per cent and 0.05 per cent.

Inexpensive harmonic-distortion analyzers and audio generators, such as those made by Eico and Heath, have residual distortion as low as 0.06 per cent. Although this limits accurate measurements of distortion to values over 0.3 per cent, it does not preclude their effective use in measurements at lower levels. When we obtain distortion readings between 0.06 and 0.1 per cent, we recognize that the amplifier's distortion is, at most, comparable to that of the test equipment. When this occurs, we do not become unduly concerned, but merely report the fact that our instruments are not capable of measuring the true amplifier distortion.

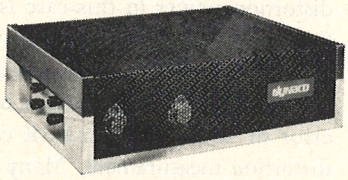
Sometimes a manufacturer who has devoted great effort to reducing his distortion to the vanishing point (and has had to design special test equipment to measure it) is disturbed by the fact that our equipment cannot provide reliable measurements much below 0.1 per cent. I sympathize with him, but I have never seen it seriously suggested that a reduction of distortion from 0.2 per cent to 0.02 per cent has the slightest effect on the audible performance of an amplifier. Any amplifier which is too good for us to measure accurately is *very* good indeed, and higher praise would require an immoderate use of superlatives on our part.

In a subsequent column, I will comment further on the significance of distortion at very low and very high power levels, and on the peculiar problems of high-level distortion measurements.

EQUIPMENT TEST REPORTS

By Hirsch-Houck Laboratories

DYNACO STEREO 120 POWER AMPLIFIER



● OVER the past decade, Dyna amplifiers have achieved an enviable reputation for uncompromised quality at bargain prices. Either in the form of easy-to-build kits or as factory-wired models, the Dyna units have consistently matched or surpassed the performance of competitive models costing far more.

As we see it, the "secret" of Dynaco's success has been in their refusal to incorporate gadgets or passing fads into their products. Sound engineering practice, combined with deceptively simple yet highly effective circuit design, has characterized every Dyna product we have tested over the years.

It has been obvious for some time now that transistors have gone beyond the fad stage. Dyna was understandably reluctant to release a transistorized amplifier until they were sure it could at least match the performance of their vacuum-tube models. They have unquestionably achieved that goal in the new Stereo 120 power amplifier. The Stereo 120 is rated at 60 watts per channel continuous output (both channels driven) with less than 0.25 per cent distortion between 20 and 20,000 Hz. These specifications are slightly better than those of a *pair* of the very popular vacuum-tube Mark III Dyna amplifiers, except that the Stereo 120 is considerably smaller, lighter, and cooler than *one* Mark III.

Practically all of the weaknesses of early transistor designs have been eliminated from the Stereo 120. It has practically unmeasurable distortion at almost any power below maximum output. It is completely stable under any conceivable load or drive condition. The transistors are nearly immune to damage from overdriving or short-circuited output leads. The Stereo 120 has no controls or adjustments, internal or external, except its power switch. An electronic delay prevents the turn-on "thump" experienced with some solid-state amplifiers.

The input impedance of the Dyna Stereo 120 is 100,000 ohms, which is high enough for it to be driven by most preamplifiers, including current models of the Dyna PAS-2X, PAS-3X, and the soon-to-be-released solid-state PAS-4. A simple modification of older Dyna preamplifiers will permit them to operate with the Stereo 120.

Although the Stereo 120 is rated for 8-ohm loads, it will drive 4-ohm loads with no diminution of power, and will deliver nearly 40 watts to 16-ohm loads. Large amounts of a.c. and d.c. feedback are used to reduce distortion and (more important) to make the amplifier meet its specifications without the use of specially selected transistors. A patented protective circuit limits the maximum current that can be drawn by the output transistors (under short-circuit conditions) to a safe value. A similar circuit protects the power supply against short circuits. The power supply is regulated to insure full output-power capabilities with line voltages from 100 to 130 volts. (Most amplifiers lose an appreciable portion of their available power if the line voltage falls below 120 volts.) Another advantage of the Stereo 120's very effective power-supply regulation is that it provides essentially the same power rating by continuous-power measurement or by the so-called "music-power" rating method.

HIFI/STEREO REVIEW's kit builder, who built the unit for this test, reports that the construction manual for the Stereo 120 is in the Dyna tradition of clear, straightforward, step-by-step procedures. The three circuit boards that comprise the right- and left-channel driver stages and the power-supply circuits are prewired (and pretested), which makes possible a total assembly time of about five hours for the kit. The protective circuit in the power supply practically eliminates any possibility of damage resulting from wiring errors.

In our laboratory tests, we found the distortion of the Dyna Stereo 120 to be literally unmeasurable with our instruments under most conditions below full-power operation. This is no reflection on the test instruments, which have a residual distortion of about 0.06 per cent, but is rather to the credit of the Stereo 120. At a full 60 watts per channel, the distortion was under 0.1 per cent from 30 to 7,000 Hz, rising to 1 per cent at 20 Hz and to 0.2 per cent at 20,000 Hz. At lower powers it was under 0.1 per cent from 20 to 10,000 Hz, reaching 0.13 per cent at 20,000 Hz with 30 watts output. *(Continued on page 34)*

TECHNICAL TALK

By JULIAN D. HIRSCH

● AMPLIFIER-DISTORTION MEASUREMENTS—PART I: Paradoxical though it may seem, the distortion of an amplifier is most difficult to measure at *both* extremes of its power-output range. In the power range between 1 watt and a few decibels below its maximum power, a typical high-fidelity amplifier presents no measurement problems. At very low power outputs, noise and hum may affect the measured distortion, while prolonged operation near the clipping (or overload) level frequently results in nonrepeatable measurements and sometimes damages the amplifier.

Let us first define the basic procedure and terminology of distortion measurement. *Harmonic distortion* is the generation of frequency components at integral multiples of the input frequency. For example, a 1,000-Hz input signal fed to a non-distorting amplifier will produce an output only at a frequency of 1,000 Hz. If the amplifier is less than perfect (and all are, to some extent), the output will contain traces of the second and third harmonic frequencies of 2,000 and 3,000 Hz, in addition to the fundamental 1,000-Hz signal. Higher-order harmonics, if present, are usually at a much lower signal level than the second and third harmonics.

The measurement process consists of feeding a low-distortion test signal to the amplifier under test and then measuring its total output. The harmonic analyzer is adjusted to suppress the fundamental test signal in the amplifier's output. The remaining signal is read on a meter as a percentage of the original input signal. A number of commercial harmonic-distortion analyzers are available, all of which contain the necessary tuning, switching, and metering circuits for measurements in the range (from 20 to 20,000 Hz) covered by the instruments.

REVIEWED THIS MONTH

●

Dynaco Stereo 120 Amplifier
KLH Model Twelve Speaker System
Shure M-68 Microphone Mixer

The distortion measured by such an instrument contains all the harmonics, plus any noise and hum that may be present in the output signal. In other words, everything present in the output signal, other than the fundamental frequency component, is lumped in a single meter reading as *distortion.*

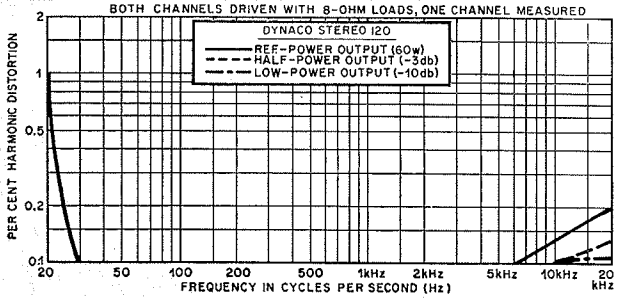
Unfortunately, every amplifier adds a certain amount of noise (either subsonic "flicker" or hiss, as well as hum) to the signal passing through it. Consider a hypothetical audio amplifier whose noise level is 70 db below its full power of 30 watts. In this case, the noise power output is 3 microwatts. If the distortion at 30 watts is 0.3 per cent (or −50 db), the distortion power is 300 microwatts, far larger than the noise. A distortion measurement can therefore be made at this level with good accuracy, unaffected by noise and hum.

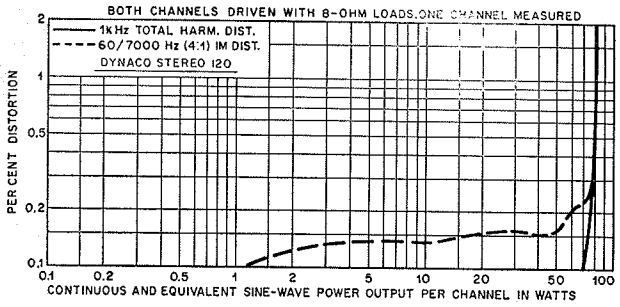
Suppose that at an output of 0.1 watt (a typical listening level), the distortion is still 0.3 per cent. The distortion power in this case is only 1 microwatt. When this is added to the 3 microwatts of noise, the meter indicates a distortion level of about 0.6 per cent. In this example, if the contribution of the noise is ignored, an error of about 100 per cent can be introduced into the distortion measurement. Many amplifiers are not as good as the one used for the example above, and hence much larger measurement errors can be expected in such cases.

Distortion analyzers have provision for examining the distortion component on an oscilloscope. An experienced eye can easily distinguish between true harmonic distortion and noise, hum, or any other masking signal. The oscilloscope also helps one to determine whether the distortion is predominantly second or third harmonic, or both. It is a virtual necessity in measuring harmonic distortion and analyzing the significance of the reading.

The preceeding discussion is predicated on the use of a perfect, distortionless signal source. Any distortion present in the input test signal will appear in the output as well, in addition to the distortion generated by the amplifier. Ideally, the test signal should have less than one-tenth as much distortion as the amplifier being tested. In practice, a reasonably valid measurement can be made if the signal has one-fifth as much distortion as the amplifier.

Many amplifiers nowadays have distortion levels of 0.2 per cent or less under most conditions, and figures under 0.1 per cent are not uncommon. It would seem, therefore, that a generator whose distortion exceeds 0.02 per cent is unsuitable for testing a good modern amplifier. The generators with very low distortion are quite expensive and are used chiefly in precision a.c. measurements in calibration laboratories. Furthermore, the distortion analyzer itself introduces some distortion





At 1,000 Hz, harmonic distortion was under 0.1 per cent from 0.1 watt to 70 watts. Intermodulation distortion was under 0.1 per cent below 1 watt and reached 0.2 per cent at 60 watts. The frequency response was perfectly flat, as indicated by our meters, from 20 to 20,000 Hz. Hum and noise with an open input were 80 db below 10 watts, or 88 db below 60 watts. An input signal of 0.7 volt will drive the Stereo 120 to 10 watts per channel, more than enough for any normal listening situation.

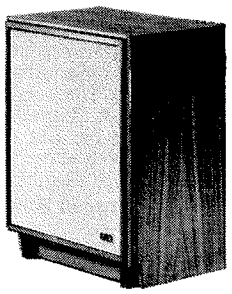
We checked the maximum power, at the point where the waveform became clipped, into different load resistances. At 4 ohms, the output was a staggering 90 watts, although this could not be maintained for long and actually corresponds to the often-used "music-power" output rating. At 8 ohms, the clipping level was 66 watts, and at 16 ohms it was 37.5 watts.

As a test of the protective circuits, we drove the amplifier to full power and short-circuited the speaker-output terminals. One sample of the Stereo 120 withstood such brutal treatment indefinitely; another, after several such shorts, blew out one channel. This sort of test is, of course, not really representative of the conditions encountered in use. At less than full power output, both samples of the Stereo 120 were unaffected by short circuits of any duration.

We agree with Dyna's own appraisal of the Stereo 120. Its sound quality is easily equal to, though not better than, a pair of Mark III amplifiers. Considering that the Mark III is widely accepted as being one of the finest power amplifiers ever produced for home use, this is a noteworthy achievement. Comparing the sonic quality of the Stereo 120 with that of any other premium transistor amplifier would be a difficult and probably fruitless endeavor. However, we can state that we have never heard an amplifier that sounded better. The Dyna Stereo 120 kit costs $159.95. It is also available factory-wired for $199.95.

For more information, circle 187 on reader service card

KLH MODEL TWELVE SPEAKER SYSTEM



● WE HAVE observed that the products of any one speaker manufacturer tend to have a basic similarity in sound character. This is to be expected, since the designer's "taste" in sound or his personal philosophy of speaker design will inevitably be expressed, for better or for worse, in his creations. In respect to KLH's speakers, we have always found them to be especially clean, open-sounding units with outstanding transient response. As one progresses from the least expensive to the most expensive KLH models, the improvements are largely in the bass region and power-handling ability. The new top-of-the-line Model Twelve, in addition to following this trend, has an exceptional mid-range and high-end plus several other noteworthy features.

The KLH Model Twelve is a full-size floor system with no pretensions to compactness. It measures 29 x 22¼ x 15 inches and weighs some 85 pounds. The cabinet houses a single 12-inch woofer, two 3-inch mid-range cone speakers, and a single 1¾-inch tweeter. The nominal crossover points are 500 and 4,000 Hz, and the nominal impedance is 8 ohms. Although the acoustic-suspension principle is employed in the Model Twelve, the relatively large enclosure permits moderately high efficiency to be attained. KLH rates the system as suitable for use with amplifier powers of 25 watts or higher, and our tests confirm this.

Part of the KLH Model Twelve system is a unique contour-control box. This is a compact (9 x 10 x 2½ inches) walnut-finished box that contains the crossover-network components, plus four switches that permit a limited control of the system's overall musical balance in segments of about one and one-half octaves. The frequency ranges affected by the contour switches are 300-800 Hz, 800-2,500 Hz, 2,500-7,000 Hz, and 7,000-20,000 Hz. The low-bass response is left fixed as a reference. Each control permits a slight boost or cut (2 to 3 db) of the indicated frequency band. Anyone operating the switches casually might not detect any change in sound character. However, listening to broad-band noise, such as FM interstation hiss, clearly reveals the effect of the contouring. This feature gives the discriminating listener the opportunity to tailor the system response to his own situation, in a manner not possible with conventional speaker-level controls or amplifier tone controls.

Recognizing that the subtle effects of the contour control can be best appreciated from the normal listening position, KLH has provided a 40-foot, four-wire cable to connect the contour-control unit to the speaker system. The controls can be located in the listening area, where the speaker response can be adjusted as desired. If this type of installation is inconvenient, the control unit can be mounted on the rear of the speaker enclosure, where it is held by Velcro hook-and-pile strips. An 18-inch cable is provided for interconnection of the units when so installed.

In accordance with our usual practice, we measured the response of the KLH Model Twelve at eight different points in the listening room. The averaged data show an overall response of about ±5 db from 30 to 15,000 Hz (the upper limit of our microphone calibration), with all contour controls in the flat position. The response curve is free of sharp irregularities, and its general contour sug-

(Continued on page 36)

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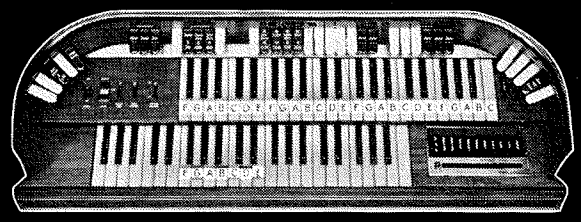

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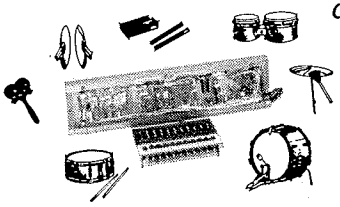

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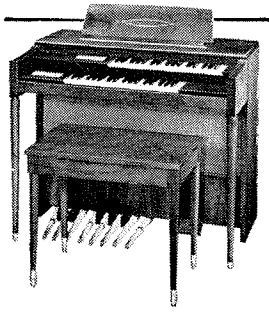

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