more when oil cooled, at least for the relatively brief periods normally involved in testing. To permit testing of the amplifier's performance into both 4- and 8-ohm loads, each load bank is made up of two 20-resistor ladders, each having a value of four ohms. These can be used separately to give two four-ohm loads or connected in series (see Figs. 1 and 2) by a short loop of busbar to provide an eight-ohm load.

A second load device, particularly useful when conformity to published specifications is one of the important considerations of the test, is an IHF-standardized loading network that deliberately simulates the reactive-impedance characteristic of a typical hi-fi loudspeaker with a resonant R-L-C network. The loading network tests the ability of the amplifier to deliver power into a loudspeaker at frequencies near the speaker's fundamental resonance, where substantial voltage/current phase angles exist.

The simplest way to use such a load

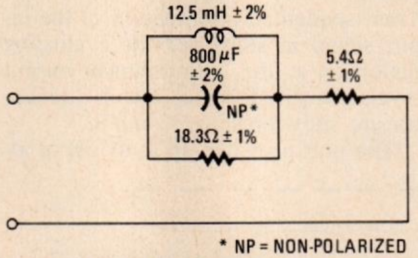


**FIG. 3—IHF-STANDARDIZED load used for speaker simulation. Component values are critical.**

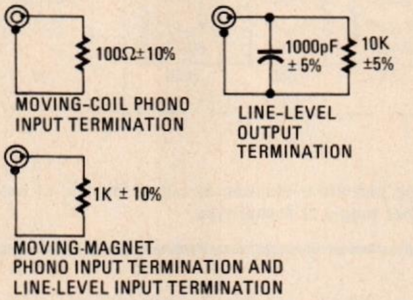


**FIG. 4—SCHEMATIC DIAGRAM of the three common low-level input and output loads.**

is to measure the difference between an amplifier's power output into a resistive load and into the reactive load, using an input signal in the 40- to 70-Hz range. The more involved procedures and formulae for formally determining an amplifier's *reactive load rating* as defined by the IHF are contained in their publication IHF A 202 (available for $7.00 from EIA-Institute of High Fidelity, 2001 Eye St. NW, Washington, DC 20006. Make check for $7.00 payable to EIA/CEG). These should be used when you test to verify an amplifier's published performance. Construction details are shown in Fig. 3.

The third loading device is a box that contains the standard low-power loads connected to the inputs and outputs of an amplifier or receiver for phono and line-level testing. These have also been standardized by the IHF, and schematics for several types of input and output terminations are shown in Fig. 4. They may be easily built into a chassis box with phono or BNC connectors.

## White-noise "Pinking" Filter

ONE OF THE MOST COMMONLY USED signals in high-fidelity testing is random noise. It is a noise signal that has, at any given instant, a gaussian (random) distribution of both frequencies and amplitudes. So it also has a long-term average amplitude that is linear across the audio spectrum. That distribution enables rapid testing of audio components. A random-noise signal is injected into the device under test and the device's output is analyzed for changes in the noise spectrum. Any change, of course, indicates a nonlinearity.

For use in lab testing and service work, random noise commonly comes in two varieties: "white" noise that has equal total energy distribution per *cycle bandwidth*, and "pink" noise that has total equal energy distribution per *percentage bandwidth*. When analyzed by a constant-cycle bandwidth analyzer (a 1-Hz or 10-Hz band analyzer, for instance) white noise exhibits flat total amplitude response; while pink noise exhibits flat total amplitude response when measured by a constant percentage bandwidth analyzer, such as a 1/3 or 1/10 octave analyzer.

Each type of noise is commonly used with its complementary analyzer. Using white noise with a constant-percentage bandwidth analyzer, that has

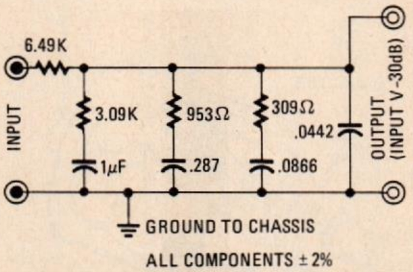


**FIG. 5—PINKING FILTER. This device converts "white" noise into more useful "pink" noise.**

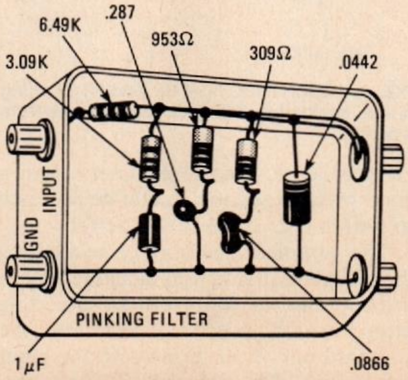


**FIG. 6—PICTORIAL DIAGRAM showing suggested layout of pinking filter components.**

an analysis window that becomes wider and wider as frequency rises, yields a noise-amplitude characteristic that rises at a predictable 3 dB per octave.

Pink noise analyzed by a constant-cycle bandwidth analyzer, whose window has a width that remains constant regardless of frequency, produces a response that falls at 3 dB per octave.

Most audio analysis work calls for constant-percentage bandwidth analyzers, so pink noise is by far the handiest test signal to have on the bench. Yet many noise generators produce only white noise. To convert a white-noise source to pink noise, a pinking filter is required. The filter (see Fig. 5) is a passive R-C network, so there are some limitations on the impedances of the equipment to be tested, if accurate frequency response is to be achieved. The output impedance of the device preceding the filter (usually a tape out or preamp out) should be no greater than 1k. The input impedance of the stage following the filter no less than 20k. The filter may be built into a small metal box (Fig. 6). Its input is connected via banana plugs directly to the front-panel outputs of the random-noise generator. A second pair of banana jacks, binding posts, or a phono jack are used for the output connector.

Component values here are critical. See May, 1980 "Hobby Corner" for information on making your own precision resistors.