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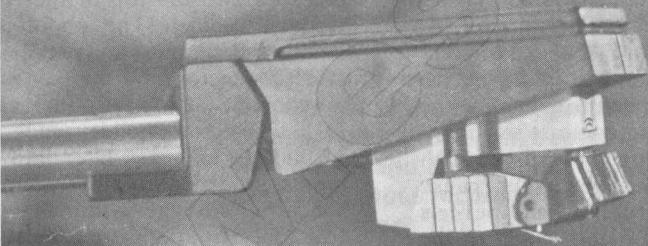
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TECHNICAL TALK

By JULIAN D. HIRSCH

Nakamichi 700 Cassette Deck



THE new Nakamichi 700 three-head cassette recorder incorporates most of the features and the essential performance of their \$1,100 "professional" cassette deck at a much reduced price. Although the Nakamichi 700 is still expensive by cassette-deck standards, there are two strong mitigating factors: its performance is essentially comparable to that of open-reel decks in the same price range, and the high-end cassette recorders from other manufacturers are fast approaching the price level of this striking new contender in the tape field.

In its basic features, appearance, and performance, the Nakamichi 700 is unique. Its "Tri-Tracer" head assembly includes separate recording and playback heads whose gap widths are respectively established at 5 microns and 0.7 micron for optimum performance of each function. There are separate recording and playback amplifiers and Dolby circuits, providing the off-the-tape monitoring capability usually found only in open-reel recorders. The tape is driven through a closed-loop, dual-capstan sys-

tem by a feedback-controlled d.c. motor which maintains constant speed over a wide range of line-voltage and frequency variations. A second motor drives the cassette hubs. The solenoid-controlled transport is operated by flat touch keys, flush with the panel, which move almost imperceptibly under finger pressure.

The control functions are conventional (PLAY, STOP, REWIND, FAST FORWARD, RECORD, and PAUSE), and there is an IC logic system to prevent improper operation. A small light inside each button glows when it is activated. The controls can be operated in any sequence, except that RECORD can be engaged only from a STOP condition. One can go directly from rewind to fast forward, or vice versa, and from fast speed directly to play. The machine pauses for only a fraction of a second before going into the new mode. This is in contrast to a number of high-quality open-reel decks with logic-control systems, which must pause for several seconds to allow the tape reels to stop completely before going to the new speed. The Nakamichi 700 is designed to operate in a vertical position.

Pressing the EJECT button opens a vertically hinged door and cassette carrier. The tape moves from bottom-to-top, instead of the more usual left-to-right, and it can be viewed through a narrow backlit slot in the door. Two large, illuminated peak-level meters read both recording and playback levels. They are not affected by the playback-level controls. There is a stereo headphone jack for 8-ohm phones, and a three-digit index counter with a "memory" switch. If the counter is reset to zero at any point on a tape and the memory system is engaged, the tape will stop at that point when rewind.

Two pairs of concentric recording-level controls set levels for the line and microphone inputs (for 600-ohm dynamic microphones). A third input for a "blend" microphone drives both inputs

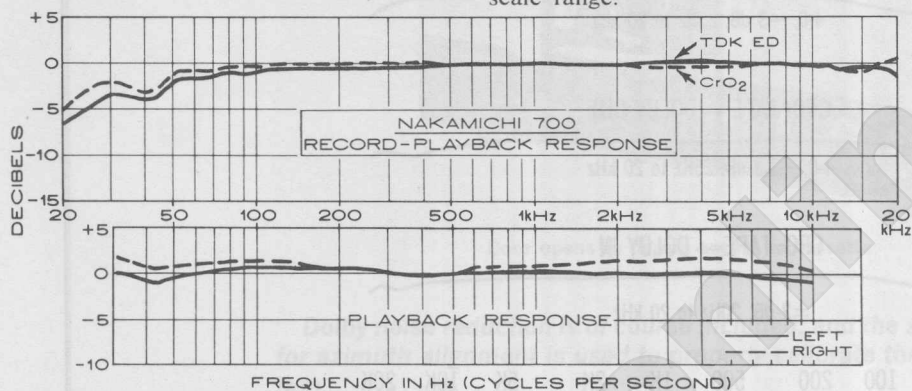
to provide a center "solo" position, and it has its own level control. All inputs can be mixed, and the microphone preamplifiers are switched off until a plug is inserted in the microphone jack so that they cannot affect the overall signal-to-noise ratio when recording from line inputs. Another pair of concentric knobs controls playback volume through the line outputs and the headphone jack. Pushbutton switches control power, tape bias, and equalization for "normal" and CrO₂ tapes, the Dolby circuits, a recording-level limiter, and monitoring from source or from tape.

The various inputs and outputs are recessed into the top of the recorder's wooden cabinet. The phono-jack line inputs and outputs are paralleled by a DIN connector, and the pair of 1/4-inch microphone jacks is also duplicated in a DIN connector. A slide switch inserts a 15,000-Hz low-pass filter into the line inputs, if needed, to prevent any stereo-subcarrier leakage in the output of an FM tuner from affecting the recorder's Dolby circuits. Finally, there is a connector for an optional remote-control unit, which operates at the end of a 15-foot cable and duplicates all the transport controls. In the rear of the recorder are screwdriver-adjusted Dolby recording-level controls which use a built-in oscillator test signal.

As with any tape recorder, the recording and playback heads of the 700 must be exactly aligned in azimuth. The playback head is factory-aligned, but for optimum results, the recording head must be aligned for each individual cassette on which a recording is made. The Nakamichi engineers have devised a remarkably simple, fast, and effective method of doing this. Pressing a CAL button next to the EJECT button opens a vertically hinged door, revealing a TEST TONE switch, a screwdriver adjustment for the playback-head azimuth (for factory use

only), a record-head azimuth-alignment knob, and a slider-type pitch control.

When the cassette to be recorded is loaded, the test tone is switched on and the machine placed in the record mode. Two small light-emitting diodes (the "alignment beacon") on the subpanel flash alternately when the head-alignment knob is properly set. If only one light glows, the alignment knob is turned slightly until they flash alternately. The process takes less time to accomplish than to describe. The tape speed is fixed at $1\frac{7}{8}$ ips during recording, and in playback when the pitch control is set to its center detented position. To correct the pitch of recordings made on other machines having incorrect speeds, the pitch control can vary the playback speed ± 6



per cent. The deck is $20\frac{1}{2}$ inches wide x $10\frac{11}{16}$ inches high x $5\frac{1}{8}$ inches deep, and weighs a hefty 28 pounds. The price of the Nakamichi 700 is \$690 and the remote-control accessory is \$49.

● **Laboratory Measurements.** The Nakamichi 700 is factory-adjusted for TDK SD tape, which we used in our tests. Nakamichi also packages their own CrO_2 cassettes, which we used when appropriate. The playback frequency response, from a Nortronics AT-200 test tape, was ± 1 dB from 31.5 to 10,000 Hz. The record-playback frequency response with TDK SD tape was ± 1 dB from 47 to 20,000 Hz, with a slight drop at lower frequencies. This was the first cassette recorder we have tested which required extending the response measurements above 20,000 Hz. The overall response varied only 5 dB from 20 to 21,000 Hz.

We tried TDK ED tape also, obtaining essentially similar results. With Nakamichi CrO_2 tape, the performance was improved (!) at both ends of the frequency range, and was an almost incredible ± 1.5 dB from 46 to 22,500 Hz, or 5 dB overall variation from 20 to 23,000 Hz. The importance of the record head-alignment process was illustrated by the response measured with the CrO_2 tape cassette using the alignment setting previously established for the TDK SD cassette. The output began to drop above 6,000 Hz and was down 5 dB at 12,500 Hz.

The FM multiplex filter worked well, introducing an insignificant 1-dB peak at 16,000 Hz, and then attenuating the signal more than 10 dB at 19,000 Hz and 25 dB at 20,000 Hz. The Dolby circuits tracked very well, affecting the overall response by less than 1 dB over the 20 to 20,000-Hz range, at any level from -20 to -40 dB. The level meters of the Nakamichi 700, which are carefully identified as "dB meters" rather than the carelessly applied "VU meter" designation employed by so many recorder manufacturers, actually had response characteristics closely approximating those of a true VU meter, with a very fast rise time, slightly slower fall time, and negligible overshoot. Their calibrations were also very accurate over the full 20-dB scale range.

A signal input of 87 millivolts (line) or 0.58 millivolt (mic) produced a 0-dB recording level, with a corresponding playback output of 0.95 volt. Microphone overload occurred gradually, at about 150 millivolts. The distortion with a 1,000-Hz, 0-dB signal was 1.8 per cent with TDK SD, and 2 per cent with CrO_2 tape. The standard-reference 3 per cent harmonic-distortion level was reached with an input of about +2 dB with both types of tape. The noise level, referred to the 3 per cent distortion level, was very low: -54.5 dB without Dolby and -62 dB with it, using TDK SD tape. With CrO_2 tape, it was slightly better: -57 dB without Dolby and -62.5 dB with Dolby. The noise increase through the microphone preamplifiers at maximum gain was actually too small to measure, although a minute increase in high-frequency hiss could be heard.

The recording limiter had no effect on signals under the +1-dB level. With higher inputs, it went into action rapidly—the attack time was a small fraction of a second—to reduce the gain and to prevent overload and distortion (although it cannot control transients of very short duration). The release time was more gradual, requiring about 2 seconds to restore normal gain when the overload was removed. In a steady-state measurement, a +6-dB input produced 6.2 per cent distortion without the limiter, which reduced the distortion to 2 per cent when it was switched on.

The tape speed was within 0.1 per cent of its correct value, and could be varied in playback over a +6, -5 per cent range. We could not measure the 700's combined wow and flutter because it was below the residual level of our test tape. The combined recording-playback flutter was only 0.07 per cent (average, unweighted), which is approximately what we usually measure on open-reel machines in the price range of the Nakamichi 700. A C-60 cassette was handled in fast forward and rewind in about 57 seconds. Headphone volume was adequate using 8-ohm phones.

● **Comment.** As our test data indicate, the Nakamichi 700 is an extraordinary cassette recorder. It really cannot be compared with other cassette machines, since its higher price removes it from direct competition. One of the most severe tests of a tape recorder's overall frequency response and dynamic range is to record random "white" noise, such as an interstation FM tuner hiss, and compare the playback with the incoming signal. Even some of the best open-reel machines produce an audible change in the noise sound, especially when operating at $3\frac{3}{4}$ ips, and more especially when their recording-level meters read higher than about -10 dB (because of tape saturation by the very high frequencies in the noise signal). No cassette recorder we have previously tested has come close to passing this test, at any recording level.

The Nakamichi 700, at a 0-dB recording level, had no audible effect on the sound of a random-noise signal. It therefore came as no surprise that, in an A-B, source/monitor comparison while taping the best records we have, we could hear no difference between the original and the recorded programs. A tape deck with this ability, plus a very low flutter, is capable of making truly professional quality recordings. In the audio world, the term "professional" has lost much of its meaning through unwarranted use, but we must say that it is the best way to describe the Model 700.

The price of the Nakamichi 700 places it squarely in competition with some very fine open-reel tape decks in the \$600 to \$1,000 range, and Nakamichi welcomes this comparison. Ignoring the inescapable fact that cassette editing is difficult to the point of being impractical, it seems to us that the only respect in which an open-reel recorder can "out-test" the Nakamichi 700 is in overall dynamic range, including the advantages in equalization offered by the wider tracks on a $\frac{1}{4}$ -inch tape. Perhaps no one will ever use the Nakamichi 700 to make a critical master tape, but for any less-demanding purpose, we would rank it for now as the best cassette recorder we've tested—and one of the best tape recorders of any type we have ever used.

A Dream Cassette Recorder



The name Nakamichi may not be familiar (yet) in the U.S., but Nakamichi Research, Inc., in Tokyo has been responsible for the design and distribution of many of the tape cassette mechanisms used by better-known tape recorder firms here and abroad. Some time ago, the senior Mr. Nakamichi decided to devote his efforts to the creation of the very best-performing, feature-laden cassette deck he could design—one that would duplicate the performance achievable by better open-reel tape decks. Price was not a factor, since the machine was to be strictly for professional use. The resultant deck, known as the Nakamichi 1000, cost \$1,100 and, as might have been expected, found its way into home systems despite its price and original intended market. Impressed with its sales success, Ted Nakamichi, son of the inventor, established a U.S.-based subsidiary on Long Island, New York and soon afterward, a consumer version of the Nakamichi 1000—known as the Nakamichi 700—was developed. This time the emphasis was placed on consumer acceptance and on the retention of as many of the features of the 1000 as possible at a selling price of just under \$700.

The effort, in our opinion, has been more than successful. The most outstanding feature of this machine is its three-head configuration. Despite the minimal access to the traveling tape in a cassette, Nakamichi found a way to incorporate separate erase, record, and playback heads, thereby enabling the user to monitor a recording as it is being made, in the same way as when using a three-head open-reel deck. This development led to the need for a foolproof method of head-gap azimuth alignment for, as Nakamichi points out, a misalignment between record and playback heads of as low as three minutes ($1/20$ th of a degree) is the maximum that can be tolerated if response out to 20 kHz is to be achieved at the cassette's running speed of $1\frac{1}{2}$ ips. Conventional alignment techniques were abandoned in favor of an alignment beacon, in which phase-difference signals between incoming and recorded signals are detected by digital techniques and fed to two LED pilot lamps. The user is directed to rotate an alignment control each time a new tape cassette is inserted until the two pilot lamps flicker intermittently. The procedure takes a few seconds and insures perfect azimuth alignment every time a recording is made.

Stereo's Product Report

by Leonard Feldman and Norman Eisenberg

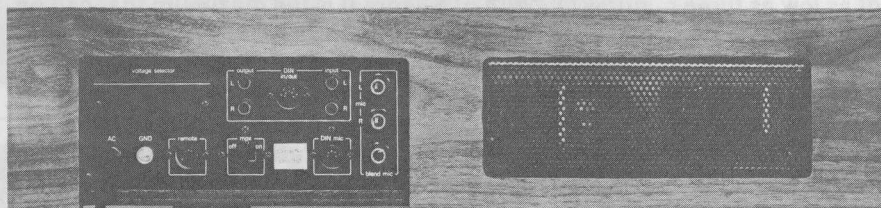


Door opens to permit access to cassette.

Dolby noise reduction is of course included, and the same test tone used for azimuth alignment is used to properly calibrate the built-in Dolby system.

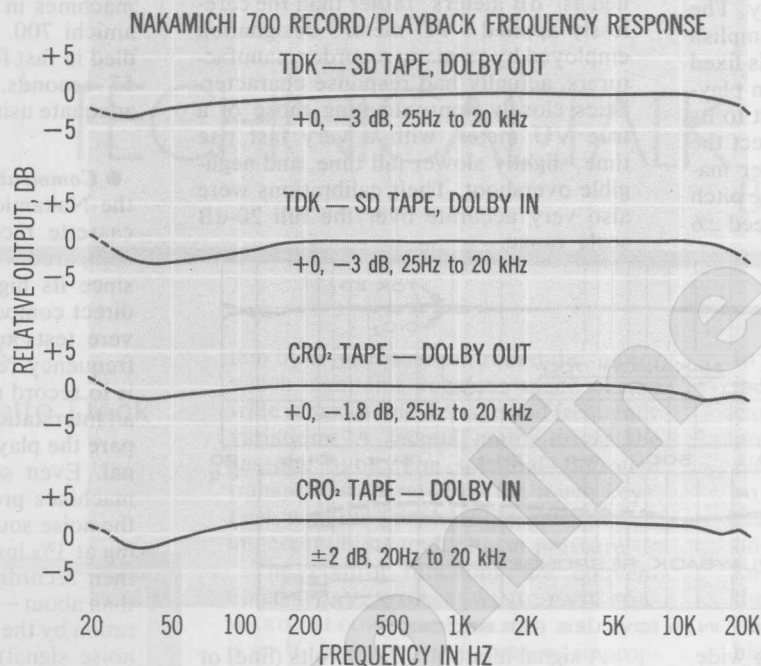
The transport uses two DC drive motors in a closed-loop double-capstan system, further smoothed by two large staggered flywheels. A front panel view of the 700 is shown in the photo. The transport pushbuttons at left require only a light touch to set the IC logic controls which activate the various drive modes. You can switch from fast forward or rewind directly into the play mode with no danger of tape spill or breakage and, as further protection, there is an instantaneous-acting tape-spill-proof device that turns off the machine in the event of such a mishap. Eject and calibrate buttons cause the two compartment doors to pop open. With the calibrate compartment door open, access is gained to the azimuth control, the test tone switch and a $\pm 6\%$ pitch or speed control, enabling the proper reproduction of tapes recorded on other machines that may have been less accurate in speed than the 700.

Other front-panel features include a peak limiter switch, a switch for selecting correct bias and equalization for either ferric or CrO₂ tapes, the Dolby on/off switch, a tape monitor switch, dual concentric controls for input level, output level, microphone level, and even a third microphone input level control for feeding a center-channel microphone input. Large, illuminated peak-reading VU meters, phone jack, memory counter, and separate power on/off switch complete the front-panel layout. The rear (or upper)



Connections are made on this panel.

The following is an evaluation of the Nakamichi 700 which was printed in the Spring Issue of STEREO, and it is based on personal use plus laboratory-test checkouts by quality-minded technicians.



Response curves—see text for explanation.

panel (the 700 can be operated horizontally or vertically) is shown in the photo. It has three microphone inputs, a pair of line inputs, the two outputs, a DIN microphone connector socket, a socket for a remote control option accessory, and an FM MPX filter switch.

What about actual performance? We used the Nakamichi 700 for about a week, recording all manner of test tones as well as music from a variety of program sources (many of which were not "good enough" to show off the 700 properly). Results of our measurements can be summarized in just a few sentences, but the numbers obtained represent a level of performance that is a whole order of magnitude better than what has previously been accomplished in the cassette format. Frequency response for normal and CrO₂ tapes is plotted in the graphs with and without Dolby. Verbal superlatives won't help—the curves speak for themselves!

Weighted (DIN 45507) wow and flutter was measured as 0.09% for play-only and 0.1% for the complete record-play cycle. Signal-to-noise, using Dolby and CrO₂ tape (unweighted), was an impressive 55 dB referenced to 0-dB record level at 1 kHz, while total harmonic distortion, using normal tape (and based upon the same test frequency and reference level), was 1.5%. At lower recording levels, distortion dropped to well below 1.0%.

The Nakamichi 700 is one of those rare electronic products that cannot be fully appreciated by reading its description and performance specifications. One has to use it, live with it for a while, and experience its elegance, its smooth transport action, and, above all, the wideband, noise-free performance of which it is capable to realize that it truly embodies everything that is good about cassette tape.