Nakamichi DRAGON-CT

Computing Turntable

DRAGON-CT
The Final Word In Analog-Disc Reproduction!

Just as the incredible Nakamichi DRAGON Cassette Deck solved the "real-world" problem of bidirectional tape playback, so the DRAGON Computing Turntable solves the "real-world" problem of analog-disc reproduction—groove eccentricity.

Most discs are imperfect. The center hole may be oversized. It may be off center. Both conditions can occur on the same disc. When the groove is not concentric with the axis of rotation, wow increases tremendously, the stereo image becomes unstable, and distortion rises.

DRAGON-CT's Absolute Center Search system measures the actual groove eccentricity of each record and repositions the disc to ensure concentricity within 20 microns.

Correction is extremely, precise and, once it's achieved, eccentricity wow is gone. Pitch is rock stable, so is the stereo image, and music is reproduced with hitherto unknown clarity. You've not experienced the full potential of your record collection until you've heard your discs played on DRAGON-CT!

Even without its unique Absolute Center Search system, DRAGON-CT would be an extraordinary turntable. Its viscous-damped semi-automatic tonearm has remarkable warp-tracking ability and is a perfect match for today's best cartridges.

The unique Nakamichi SLT direct-drive motor eliminates belt-drive wow without introducing direct-drive flutter, and a double-cabinet dual-suspension system isolates the disc from external disturbance and contributes to DRAGON-CT's remarkable sonic clarity.

DRAGON-CT
An Extraordinary Turntable In Every Respect

Flutter-free direct drive

Many well respected turntables are belt driven to avoid so-called "direct-drive flutter." The belt compliance and turntable mass form a mechanical filter that helps prevent motor-torque variations ("cogging") from reaching the disc, but such systems have problems of their own.

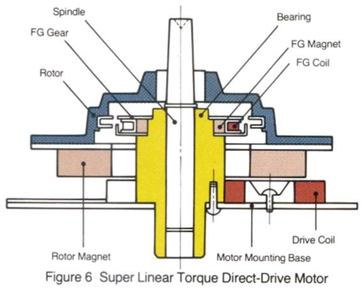


Figure 6 Super Linear Torque Direct-Drive Motor

It's difficult to ensure that a belt will run true, and any variation in belt path or belt thickness creates "belt-drive wow" that is equally as annoying as "direct-drive flutter." To circumvent *both* problems, Nakamichi developed the Super Linear Torque Direct-Drive motor.

Ordinary DD motors "cog" as the rotor shifts from pole to pole. The SLT motor doesn't! Its rotor generates a unique magnetic field that produces torque proportional to $\sin^2(\theta)$ where (θ) is the angle of rotation. The complementary pole produces a force proportional to $\cos^2(\theta)$. Total torque is equal to the sum of the two, and, since $\sin^2(\theta) + \cos^2(\theta) = 1$ for *all* angles, torque is perfectly uniform. There's no "cogging" and therefore no "direct-drive" flutter!

Thanks to the ultra-smooth drive, a heavy turntable isn't needed. DRAGON-CT's main platter weighs 3kg (slightly under 7 pounds), and has a moment of inertia of 380kg · cm^2. A relatively light platter can be balanced more perfectly than a heavy one, and it places less stress on the main bearing.

DRAGON-CT's bearing has special slits to circulate lubricant and maintain an extremely thin layer between the moving surfaces at all times. Thus, the bearing can be made to extremely tight tolerance and ensure absolutely smooth rotation.

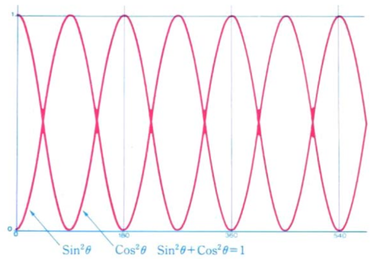


Figure 7 Motor Torque vs. Angle Of Rotation

DRAGON-CT's SLT motor provides all the benefits of direct drive and none of its problems. Absolute speed stability is ensured by a PLL FG servo that is locked to a quartz-crystal reference. The lock can be defeated to provide ±6% speed control at 33 or 45 rpm.

Dual-suspension double-cabinet construction

DRAGON-CT's advanced suspension and unique cabinet make records sound better than ever! All too often, a poor suspension or a cabinet designed for "cosmetics" has ruined a good system!

Vibration and acoustic feedback destroy clarity if allowed to reach the disc. A stylus delicate enough to respond to groove modulation responds equally well to *any* vibration. Vibration can enter the system by transmission through the surface on which the turntable rests or by sound-wave pickup by the turntable enclosure. DRAGON-CT isolates the disc from *both* types of disturbance.

DRAGON-CT rests on four dual-suspension isolators. Surface vibrations are first filtered by elastomeric isolators at the base of each support. These absorb high-frequency vibrations very well but are less effective at low frequencies. Here is where the dual-suspension comes into play. Low-frequency vibrations reach only the *lower* mounting board.

Between it and the upper (main) mounting board are "damped-spring" isolators.

Spring compliance is chosen to resonate with the supported mass at an extremely low frequency and form a filter that isolates the turntable at all frequencies above resonance. The tuning frequency is so low that the suspension is effective into the infrasonic region. Elastomeric gaskets surrounding each spring damp motion at resonance and provide additional high-frequency isolation.

DRAGON-CT's outer cabinet is made of perforated metal that allows sound waves to pass through rather than induce panel vibration. Thus, the cabinet is free of resonance and remarkably impervious to airborne feedback.

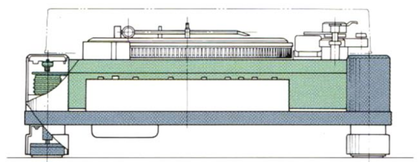
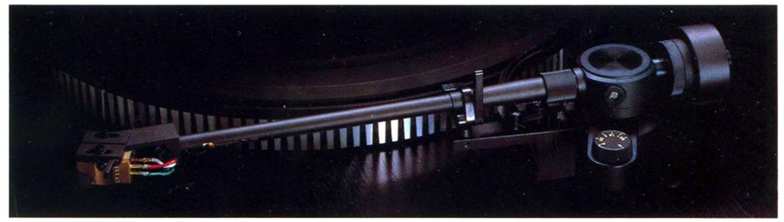


Figure 10 Double Cabinet Construction

Dustcovers are notorious for picking up sound and conveying it to the disc. DRAGON-CT's dust-cover is attached to the *lower* mounting board. The sound energy it picks up is filtered by the interboard isolation system and never reaches the disc.



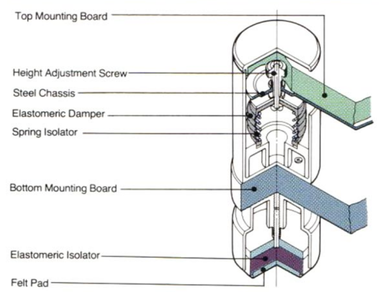


Figure 9 Dual-Suspension Construction

A semi-automatic viscous-damped tonearm designed for today's finest cartridges

The tonearm's job seems simple but is really quite complex. It must hold the cartridge securely, maintain the stylus in an optimum position with respect to the groove, transport the cartridge across the record without friction, be of sufficiently low mass to track warped records, and yet extremely rigid to avoid self resonance within the audio band.

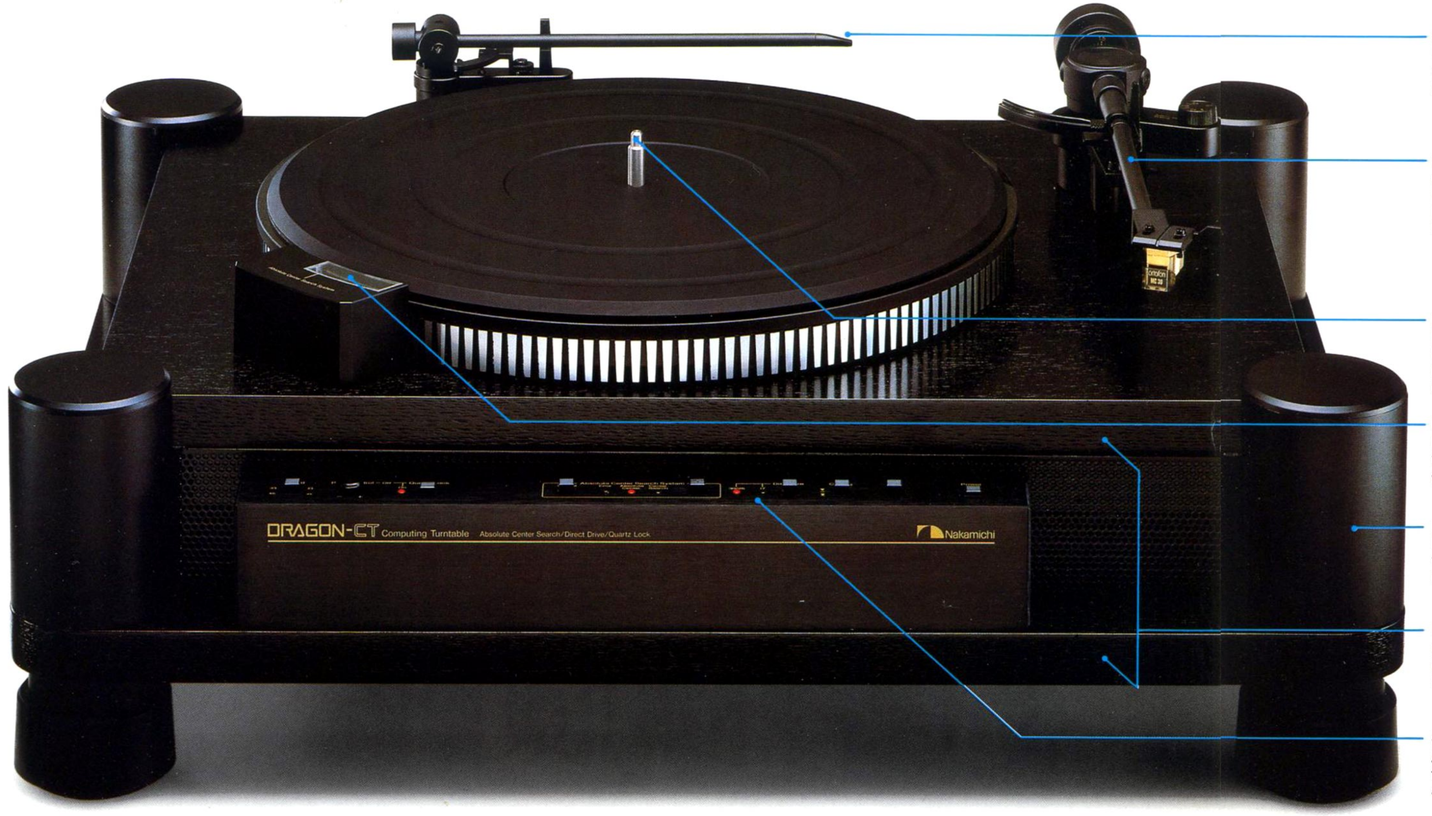
DRAGON-CT's tonearm meets these requirements perfectly. It is a straight arm with an offset head to minimize tracking error and it is formed of high-rigidity high-strength material to prevent self resonance. Effective mass is reduced by locating the connector extremely close to the pivot. The connector is designed to ensure rigidity, and its gold-plated self-cleaning contacts minimize loss when using low-output moving-coil cartridges.

The arm is statically and dynamically balanced in both planes and supported by bearings of the highest quality. A large-radius precision bearing provides vertical movement and is precisely located to enhance warp-tracking ability. The counterweight is dynamically decoupled by a special damper assembly to reduce dynamic mass and enhance clarity. Silicone-oil viscous damping further improves warp-tracking ability and greatly reduces low-frequency crosstalk.

The DRAGON-CT tonearm is semi-automatic. At the end of play, it lifts and returns to rest. Playing performance has not been sacrificed in *any* regard to achieve this convenience! An optical sensor monitors the arm's position without adding drag. At the leadout groove, the sensor activates a linear motor that lifts and returns the arm. An oil-damped arm elevator helps ensure smooth manual cueing.

An *integrated* disc-playing system

DRAGON-CT is a complete record-playing system designed to extract optimum performance from your favorite cartridge. Its carefully balanced design and unique features place it in a class by itself!



Sensor Arm
Measures groove eccentricity and determines error correction.

Semi-automatic viscous-damped tonearm
Low-mass tonearm with interchangeable arms for today's best cartridges.

Nominal-Center Reset Button
Resets turntable to nominal center before Center-Search operation.

Center Search Rod
Relocates Center-Search turntable to ensure perfect groove concentricity.

Dual Suspension System
Dual isolators eliminate vibration over a broad range of frequencies.

Dual Mounting Boards
Steel reinforced upper board ensures excellent tonearm/turntable coupling.

Control Panel
All controls are located outside the dustcover for easy access.

Absolute Center Search Eliminates Groove Eccentricity

The effects of groove eccentricity

Certainly you've seen tonearms weave as they play an eccentric groove. The effects of this seemingly innocuous motion are startling! If the disc rotates at constant angular velocity and the tonearm weaves, instantaneous groove-to-stylus speed changes, generating "once-around" wow which increases towards the center of the disc.

Groove eccentricity occurs if the disc spindle hole is off-center or oversized—two very common disc-manufacturing problems. International standards allow a concentricity error of 0.2mm and a hole diameter of 7.24mm to 7.33mm. The average turntable spindle ranges from 7.05 to 7.15mm in diameter so, even if everything is "within spec," groove eccentricity can be as much as 0.34mm. This much error produces peak wow of over 1/2% at the inner grooves!

Since groove-eccentricity wow can be much greater than that of the turntable, specs are usually based upon direct measurement of the turntable drive system and ignore the "real-world" problem. But what good is a "perfect" turntable in a world of imperfect records?

Groove eccentricity causes other problems too. As the tonearm weaves, the stylus shifts back and forth, changing separation, interchannel phase, and distortion. The stereo image wanders and phase-sensitive ambience-restoration systems fail to function properly. Even with an in-spec record, phase error can approach 90 degrees at 10 kHz!

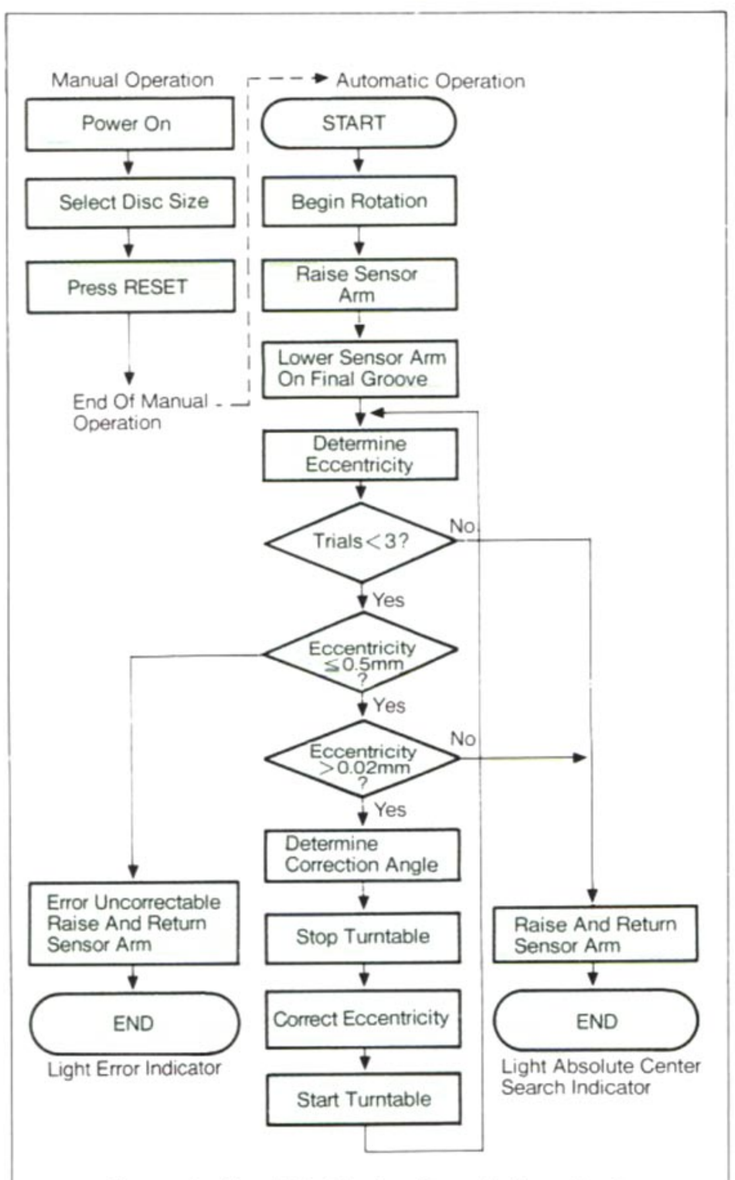


Figure 1 Absolute Center Search Flowchart

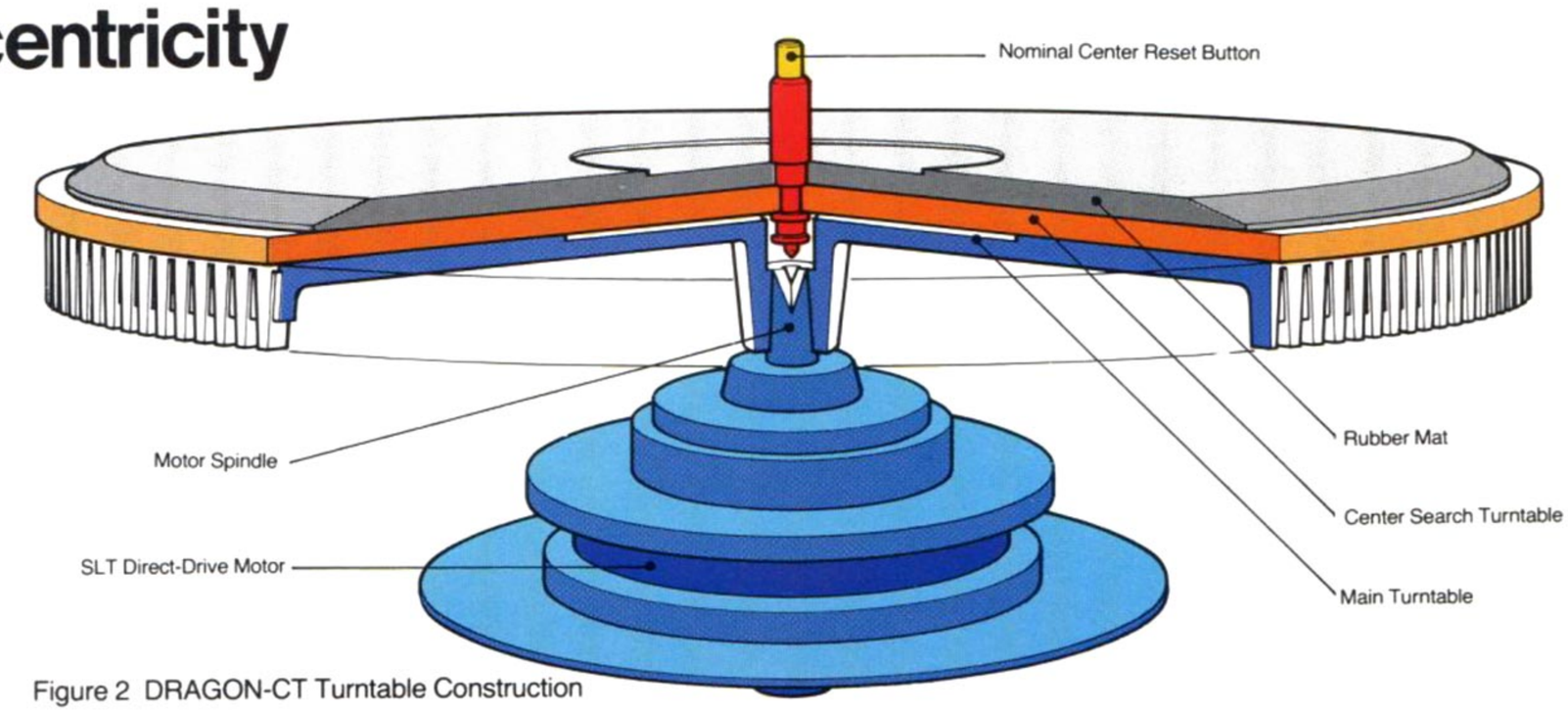


Figure 2 DRAGON-CT Turntable Construction

Nakamichi Absolute Center Search

DRAGON-CT's turntable is layered. A thin Center Search platter rests on the main platter and can move horizontally with respect to it. A rubber mat rides on the Center Search platter and supports the record. The Absolute Center Search system relocates the Center Search platter until the record *groove* is concentric with the axis of rotation.

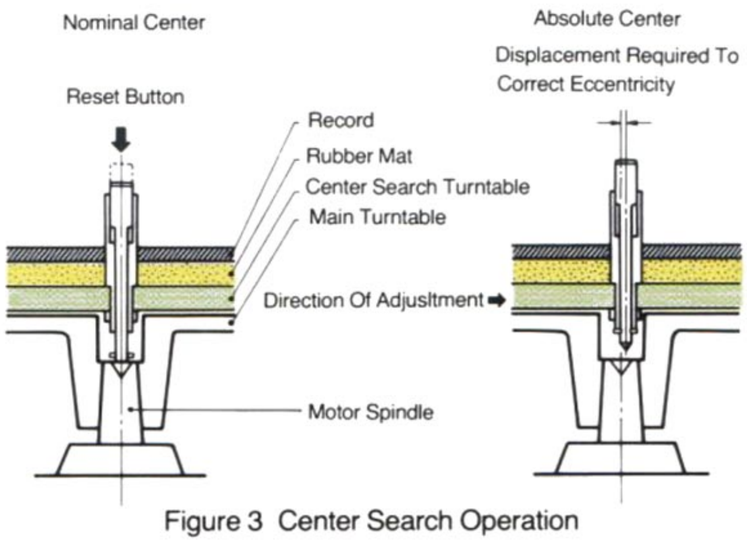
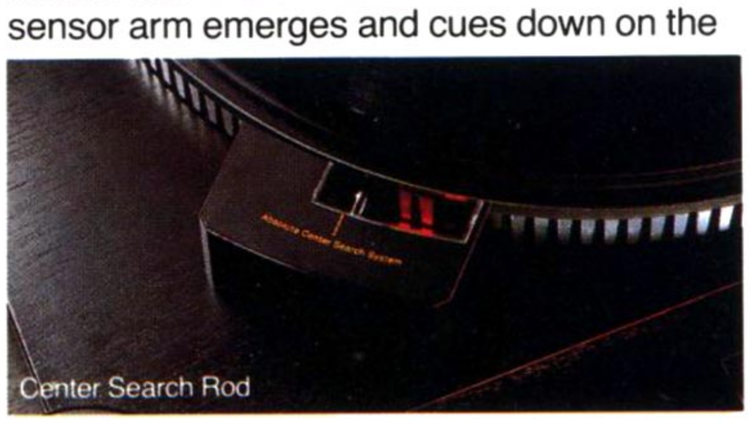


Figure 3 Center Search Operation

Pressing the spindle aligns the Center Search Platter with the Main Turntable and acts as a "reset." In this condition, operation is exactly the same as with any other turntable. After Absolute Center Search (right figure), the axis of the Center Search Platter is offset with respect to that of the Main Turntable by the precise amount needed to ensure that the record *groove* is concentric with the axis of *rotation*.

Any eccentricity can be resolved into two components: an offset and the vector along which it occurs. To correct the eccentricity, the disc must be moved the proper distance along the proper vector.

When Absolute Center Search is initiated, a sensor arm emerges and cues down on the final groove. The arm tracks the record and weaves in response to groove eccentricity. A sensor generates a signal equivalent to the motion, and a microprocessor measures and stores its value.



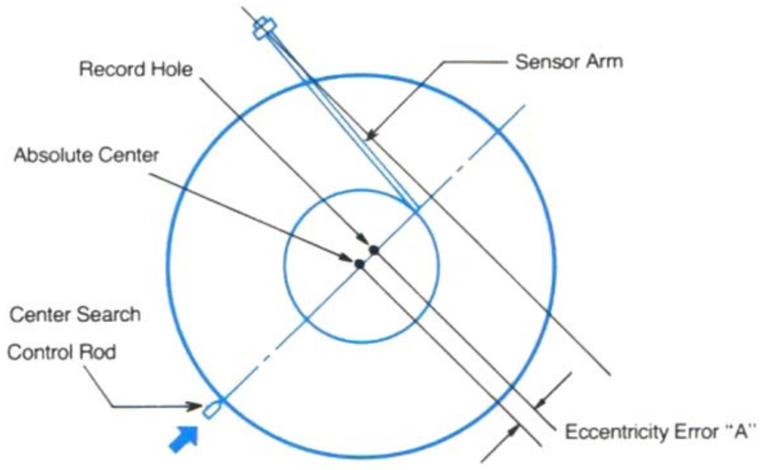


Figure 4 Location Of Sensor, Spindle, And Control Rod

Sensor stylus, turntable spindle, and Center Search Control Rod are colinear. The turntable stops at the point where the sensor produces maximum output, and the Control Rod nudges the Center Search Platter into position.

Absolute Center Search is completely automatic and controlled by a microprocessor. The concentricity error of a test record and its correction is shown in the figure below. After Absolute Center Search, concentricity error is reduced from ±0.4mm to well under ±0.02mm—less than 20 microns!—and once-around wow is reduced by the same factor—from 0.23% to 0.015%!

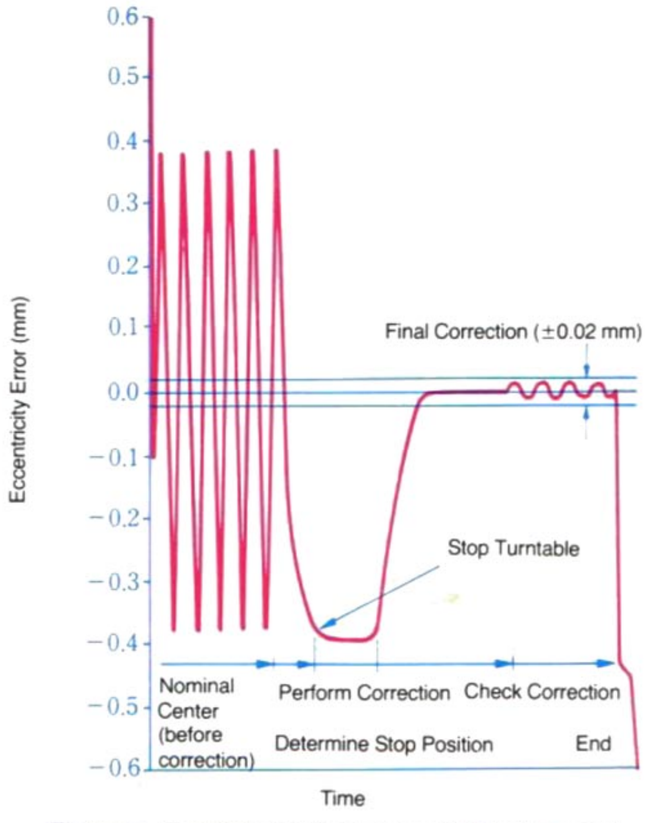
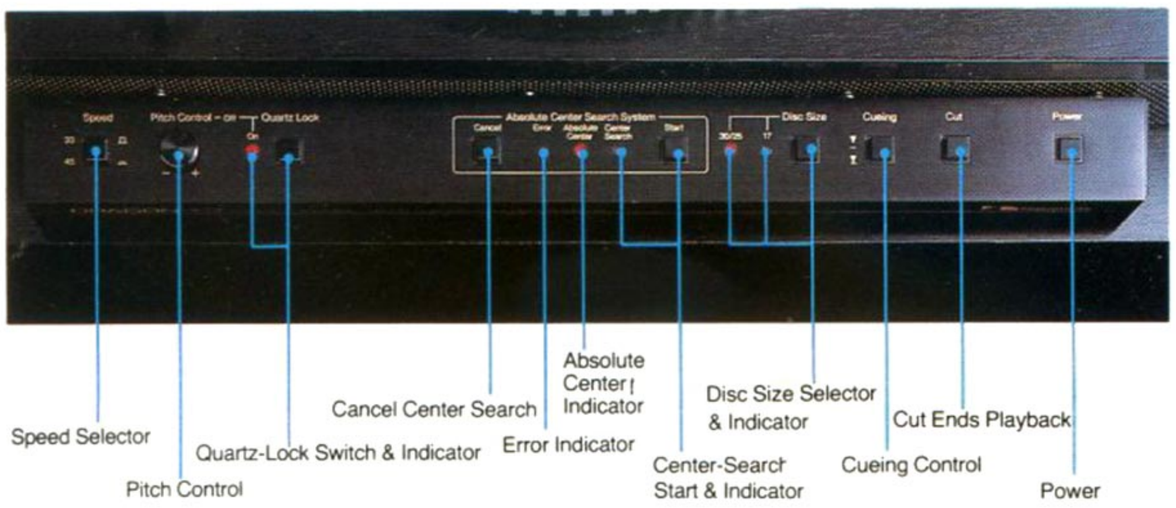


Figure 5 Eccentricity Correction Of Test Record

DRAGON-CT FEATURES & BENEFITS

- Eccentricity wow is eliminated by the unique Nakamichi Absolute Center Search system.
- Belt-drive wow is eliminated by the Nakamichi SLT Direct-Drive system.
- Direct-drive flutter is eliminated by Nakamichi's "cog-free" Super Linear Torque DD motor.
- Surface and airborne vibrations are eliminated by an unusual dual-suspension double-cabinet construction.
- The precision semi-automatic viscous-damped tonearm has exceptional tracking accuracy and warp-tracking ability.



- One-touch ultra-smooth cueing prevents stylus damage and can be operated with the dustcover closed.
- One-touch "cut" control returns the arm and stops the turntable.
- Quartz-locked PLL FG servo provides absolute speed stability or ±6% pitch control at either operating speed.
- Vertical tracking force is adjustable from 0 to 3 g in 0.1-gram increments. Independent anti-skating control.
- 500-gram disc stabilizer reduces record warp.
- Gold-plated pin-jack outputs ensure complete flexibility. Low-resistance oxygen-free-copper cable supplied.
- Independent adjustment of each isolator provides convenient turntable leveling.
- Attractive professional styling complements any decor.

DRAGON-CT With Dust Cover

DRAGON-CT SPECIFICATIONS

• Turntable Specifications

Drive System	Direct Drive
Drive Motor	Quartz PLL DC, brushless, slotless, coreless Super Linear Torque motor
Operating Speeds	33-1/3 rpm & 45 rpm
Pitch Control Range	±6%
Main Platter	1.4 kg aluminum diecasting 310 mm diameter, 18 mm thick
Center Search Platter	550 g glass 303 mm diameter, 6 mm thick
Start-Up	Within one revolution
Speed Deviation	Unmeasurable with quartz lock
Speed Drift	Unmeasurable with quartz lock
Wow and Flutter	0.008% (WTD RMS, FG direct) 0.03% (WTD RMS, after center search)
Signal-to-Noise Ratio	Better than 78 dB (DIN B)
Moment of Inertia	380 kg · cm²

• Tonearm Specifications

Type	Straight balanced viscous-damped arm pipe
Total Arm Length	305 mm
Effective Arm Length	237 mm
Effective Arm Mass	14 g (without cartridge)
VTF Adjustment Range	0–3 g
Allowable Cartridge Weight	4–11 g
Cartridge-Change Principle	Pipe interchange
Cartridge Offset Angle	21° 30′
Stylus Overhang	15 mm
Maximum Tracking Error	+2.5° to −1°
Arm Elevator	Oil damped

• General Specifications

Power Requirements	100, 120, 120/220-240, 220 or 240 V AC; 50/60 Hz (according to country of sale)
Power Consumption	23 W
Dimensions	546 (W) × 230 (H) × 421 (D) mm 21-1/2 (W) × 9-1/16 (H) × 16-9/16 (D) inches
Weight	Approx. 20 kg; 44 lb 1 oz

• Design and specifications subject to change for further improvement without notice.

TA-100 Tonearm Pipe
Optional arm pipes facilitate cartridge interchange.

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Printed in Japan S-8311350A