Reprinted from Audio Magazine
April 1968

Equipment Profiles

This Month:

Crown CX822 Stereo Tape Recorder
AR Stereo Integrated Amplifier
Garrard SL-95 Automatic Turntable

Crown Model CX822 2-track Stereo Tape Recorder

MANUFACTURER'S SPECIFICATIONS—
Tape Speeds: Three, equalized; 15, 7½, 3¾ ips. Timing: 99.8% or 1.8 sec. in 15 min. and adjustable to ±0.05% short term. Wow and Flutter: 15 ips, 0.06%; 7½ ips, 0.09%; 3¾ ips, 0.18%. (Guar. max. for record, playback.) Record/Play Frequency Response: 15 ips, ±2 dB 30 to 30 kHz; 7½ ips, ±2 dB 30 to 20 kHz; 3¾ ips, ±2 dB 30 to 10 kHz. Signal-to-Noise Ratio: −57 dB @ 15 ips; −56 dB @ 7½ ips, −50 dB @ 3¾ ips. Stop Time: One-half in. @ 3¾ ips; 1-in. @ 7½ ips; 3 sec. from full rewind on 10½-in. reel. Start Time: Under 0.1 sec. Wind and Rewind: 1200 ft. in 45 sec.; 2400 ft on 10½-in. reel in 58 sec. Reel Size: 10½-in. (NAB) max.; 5-in. min. Distortion: Approaches threshold of measurability. Inputs: 2 per channel; high-Z mic. or line level. Opt. input transformers for low-Z mic. Tone Controls: Bass, 15 dB atten. or boost at 30 Hz; treble, 15 dB atten. or boost at 15 kHz. Outputs: Two per channel, 600-ohm unbal. One low-Z output (stereo phone jack) on front panel. Motors: Three. Drive, 1 Hysteresis synch. drive motor; Reel, 2 capacitor-run torque motors. VU Meters: Two 5-in. professional types with edge lighting. Bias Freq.: 100 kHz. Monitoring: Front-panel switch for ea. channel. Dimensions: 17½-in. high, 19-in. wide, 9-in. deep. Price (basic machine): $1790.00.

The Crown CX822 pictured here is probably the finest tape recorder that has been reviewed in these pages. In addition to delivering phenomenal performance, it incorporates numerous features and refinements that place this machine in a class by itself.

The Elkhart, Indiana manufacturer has, for example, introduced a computer-type logic system to prevent destructive operations; electronics is substituted for mechanical mechanisms in many instances; tape handling has been made more gentle and faster than ever before, while tape tensions have been drastically reduced; editing has been greatly simplified; construction appears to be rugged enough to withstand parachute drops; and Old-World craftsmanship is apparent at a glance, quickly substantiated by handling the well-engineered recorder.

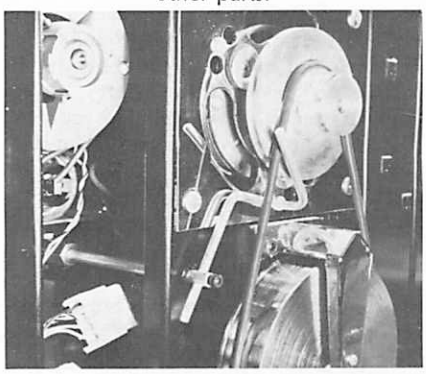
The Crown Model CX822 recorder is the latest model in the 800 series of recorders from Crown International. It consists of two detachable parts: the tape transport and the electronics assembly. Since the tape heads are part of the tape transport, all adjustments to the electronics affecting the combined performance of the transport and electronics are performed when the two are mated. So for descriptive purposes, let us consider the CX822 as one unit, breaking it down functionally, rather than physically.

To begin with, the CX822 is a two-track machine which works at three speeds. This means that the necessary speed changes (see Fig. 2) and selectable equalizations are built-in. (Crown's Model CX824 is a four-track unit, with high speed at 7½ ips and low at 1⅞ ips.) The machine accepts standard, plastic, EIA reels directly (see Fig. 3) onto the turntable or 10½-in. NAB reels with adaptors, which are furnished with the machine (Figs. 4 and 5). Each turntable is driven by a 1250 rpm capacitor-run torque motor with self-aligning bearings. Turntable braking is accomplished by electric means, whereby the motors are slowed by applying d.c. voltage to them. This contrasts with the solenoid-actuated mechanical braking system of most comparable machines. The type of differential electro-dynamo braking used here is a patented feature of Crown transports, whose brakes did not grab, jerk or need adjusting during our extensive tests, and work extremely well in bringing the tape to a smooth, gentle, rapid stop. A positive temperature coefficient resistance is used to provide the braking differential.

We tried to make the deck misbehave by stopping a roll of super-thin ½-mil tape at high speed by rocking the tape back and forth, and by other tortuous combinations. Not only did we fail to foil the machine, but once motionless, the tape at the gate was limp (not under tension) and no stretch marks were to be found anywhere on the tape. All this despite its breakneck wind and rewind speed. It took exactly one minute to smoothly wind 1800 feet of 1-mil Mylar tape between 7-in. reels. The only apparent problem with this kind of braking would occur if there was a loss of electrical power during rewind, say. But the mechanical simplicity, reduction of maintenance and potential reliability of the CX822 far outweigh such an unlikely occurence as a power failure at the precise moment of rewind.

The stainless steel capstan shaft is centerless ground, hardened and highly polished. Its tip is of non-magnetic, chrome-plated stainless steel, and it is concentrically aligned with a four-pound flywheel of nickel-plated steel. The assembly is mounted in a ⅜-in. thick aluminum "tunnel" casting, five in. long, with self-aligning Oilite bronze bearings. The flywheel is driven by a centerless ground-neoprene drive belt

Fig. 2—Drive pulley and capstan flywheel system shown in 7½ ips position. The flywheel, driven by a seamless neoprene belt, is mounted on rear of capstan. Note flywheel bearing support. Belt can be switched from 7½ to 3¾ ips from front-panel push rod. The 15 ips speed change is done manually by stretching the band over the largest pulley. The belt can be replaced in seconds, without removal of other parts.



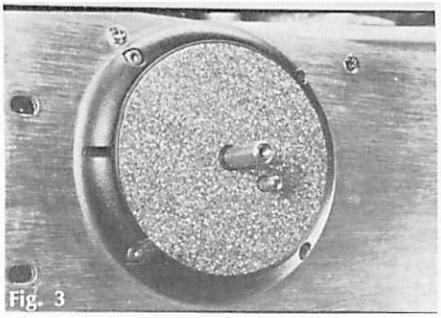


Fig. 3

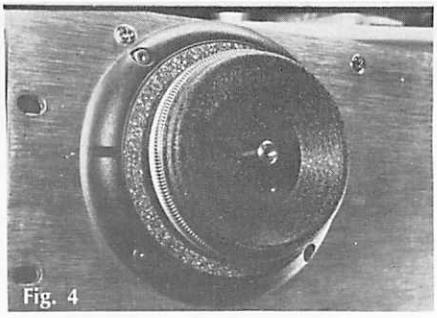


Fig. 4

Fig. 5

Fig. 3—Turntable set to accept 7-in. EIA tape reel.

Fig. 4—Turntable with NAB reel adaptor in place.

Fig. 5—Locking tape-reel holder is screwed on for use with all reels. Tightening holder compresses adaptor, causing adaptor spring to spread, and thereby applying tension to inside of NAB hub to hold it tight.

which slips over the flywheel and one of the three motor-drive pulleys. The capstan motor is a huge hysteresis synchronous device, permanently lubricated, ball-bearing drive motor. Ducted forced air flows over the drive motor, forced by its fan, and is forced out the side of the transport. An appropriate cutout is made in the case for this. The pressure roller that engages the capstan to pinch the tape and move it is made of neoprene, with a full Oilite bearing supporting the roller. The neoprene itself is ground to ±0.001-in. concentricity. Glass rod lifters lift the tape onto the heads in the play and record mode, releasing (thereby removing tape from the heads) during FAST FORWARD, REWIND, and STOP modes. See Fig. 6. A plug-in solenoid, designed for continuous duty, closes the gate, raising the tape lifters and pressure roller. See Fig. 7. Once the solenoid is seated, over 20 pounds of force applied to the pressure roller is required to unseat it. The extent to which Crown has gone to assure a friction-free, concentric, noiseless tape drive and guiding system apparently paid off because even at 3¾ ips, its lowest speed, the deck had 0.1% flutter and wow at most. At 7½ ips it was 0.07%; at 15 ips, 0.05%—a remarkable achievement, living up to the manufacturer's claims.

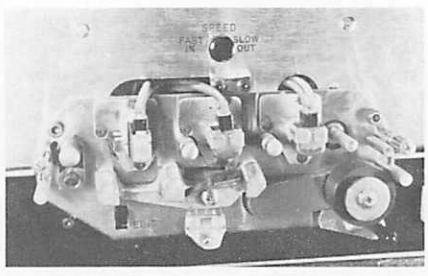
One of the unique features of the deck is its tape motion system, which is controlled by either the built-in, illuminated pushbuttons (four) or via remote control. Five leads are required for external control of FAST FORWARD, REWIND, STOP and PLAY/RECORD modes. Either momentary closure of a 4-V line at 40 mA or an external supply of 1.55 V as 5 mA will operate all four modes. But getting back to local control, the trick is in the built-in integrated-circuit "computer" system that stores the pushbutton commands, its memory retaining only the last command given it. It compares the last command with the present state of the deck—that is, the direction in which the tape is going and how fast—and executes that command in the safest way. The tape motion and direction sensor is shown in Fig. 8. For example, if the machine is going FAST FORWARD and the green PLAY button is pressed, the tape will come to a complete stop, the red STOP button is automatically illuminated (we didn't press it, remember) followed by the gate closing and the tape going into play motion as the green PLAY button lights up. All this without hands. Any command or combination of commands can be safely given at any time. If multiple commands are given to the machine, it will obey the following priority rules. (1st) REWIND or FAST FORWARD (except when in RECORD mode); (2nd) PLAY; (3rd) STOP. We found the tape motion command system to be as foolproof as Crown says it is, and could not beat the computer by design or by accident.

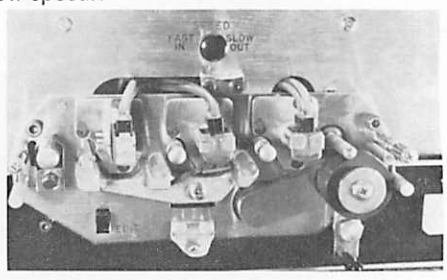
An automatic tape sensor is provided in the form of a photocell and lamp on the left end of the head assembly. This gives a continuous stop command whenever tape runs out or a transparent "window" in the tape is sensed. Because of the priority command setup, the STOP command may be overridden by holding down any other command. As was mentioned earlier, the control system performed flawlessly. In professional recording and editing application, the Crown's computer system acts as a time saver, which simplifies operation.

Every part of the deck is easily accessible. Part of the back swings out on hinges; the rest comes off with removal of a few screws. All motors are easily removable, as is the head assembly and printed-circuit cards. Relays are unplugged. Controls as well as connectors can be replaced with easy access (Fig. 11) everywhere. Surely, the CX822 is a serviceman's dream, considering the unit's inherent complexity.

The CX electronics, Fig. 12, is a solid-state, modular record/playback amplifier. Its purpose is to accept and condition input signals to properly drive tape recording heads and to provide playback facilities and proper equalization. The input circuit accommodates two inputs per channel, which are individually mixed on the front panel. Either or both can be high- impedance microphone or line level. A low-impedance option converts the high impedance mike inputs to low impedance and adds a balanced, low impedance +12 dBm 600-ohm output level which can be adjusted internally between −20 dBm and +18 dBm. The standard output level is +12 dBm unbalanced. The preamplifier response is essentially flat over the 10 Hz to 100 kHz range, exclusive of the required equalization and bias traps.

Figs. 6 and 7—(Left) Tape head assembly, gate open. (Right) Tape head assembly, gate closed (pinch roller up against capstan). Note elaborate guiding system of glass rods and chrome plated, hardened steel guides. Lever at lower right is used to manually close the gate for editing. Slide switch, at lower left, removes take-up reel torque for easier editing. Note easy access to heads from all angles. Azimuth and tracking are independently adjustable and are factory set and sealed. Molded cables connect to head and the entire head assembly. The assembly is removable and head covers snap off easily. The leaf-spring loaded pressure pad applies just a slight amount of tension to the tape against the record head. This might be used as an added flutter filter or to insure perfect contact at low speeds.





The bias oscillator consists of a pair of push-pull connected power transistors operating into a ferrite cup-core assembly. The circuit produces a clean 100 kHz signal for bias and erase. Bias current is adjustable from the front panel, using the VU meters as relative indicators. Erase was highly effective, producing a level better than 61 dB down from 0 VU. The 5-in. illuminated and accurately calibrated VU meters indicate any of four selector-switched modes of operation. They can show input level, output level of the tape, output level leaving the machine after the output level controls, or a combined source and tape level which is used for echo effects .They also show bias voltage, which is proportional to bias current, and calibrated to correspond to 0 VU. Output level of the machine is controllable at the front panel and the same controls are used to regulate monitor headphone levels during recording.

Front panel electronic controls include: selector switches for output and meter, separate treble and bass controls for each channel that are usable for recording and playback, four input level controls; separate output level controls, a play-record switch that has a press-to-move-button safety interlock and separate positions for reading bias voltage with the VU meters, and bias adjustments. All these controls operate separately and independently on each channel and are sensibly laid out across the front face. The 3-speed equalization switch is common to both channels. The versatile control setup, coupled with a high signal-to-noise ratio, makes this machine useful for such applications as "sound on sound" recording where tone shaping is required, for example.

Since the record function is interlocked mechanically, electrically and visually, it's almost impossible to record or erase or ruin a recording by accident. For example, the deck won't go into REWIND while recording, though it will go into REWIND from PLAY. Such awkward intentions are common even in professional use, when confusion and hurry conspire to overide common-sense rule, and it seems that tape machines can never be too goof-proof.

A regulated 30V power supply is employed to make the CX electronics nearly independent of line voltage variations, and to insure stable operation in all modes when the load changes suddenly. The supply is built-up on a printed circuit card. Additional filtering and de-coupling of the power supply lines is used within the various circuits, where needed.

Performance

The Crown CX822 easily met its specifications. Its frequency response was flat and balanced, with no evidence of peaks. The measured playback response at 7½ ips, shown in Fig. 10, comes out to 50 to 15,000 ±1.2 dB, at 60 dB signal-to-noise ratio. At 3¾ ips the playback signal-to-noise ratio measured 57 dB. The measured record/play frequency response, using Scotch 203 tape, is shown in Fig. 10. It can be summed up as: 30 to 28,000 Hz ±2 dB at 15 ips, 20 to 20,000 Hz ±2 dB at 7½ ips, and 20 to 10,000 Hz ±2 dB at 3¾ ips. The measured frequency response closely matched the individual factory-run curves which accompanied the sample machine.

Harmonic distortion of the record electronics was less than 0.2% at 10 kHz. A 10 kHz signal recorded at −10 VU yielded a record/play distortion of less than 1%, measured while recording. It was even less in the other parts of its frequency range, as well as when playing back (not recording simultaneously). This is outstanding. IM distortion of the record electronics was better than 0.1%. Off the tape, while recording, it was 1.5% on left channel and 1.3% on right channel, which is also especially fine. The record/playback signal-to-noise ratios were measured at 15 ips, yielding −55 dB left, −57 dB right; 7½ ips, produced −56 dB left, −58 dB right; 3¾ ips, −54 dB left, −56.5 dB right. Crosstalk at 1 kHz was down a phenomenal −63 dB, which is really negligible since it is below the noise level.

The minimum input required for 0 VU was 0.1 mV through the low-level high-impedance mike input and 0.5 V through the high-level line input. Thus, this is a highly sensitive machine, suitable for every conceivable type of input. The VU meters, which are driven by their own drive circuit, respond the same regardless in which sensitivity range the main amplifier is operating. There is also plenty of level for monitoring stereophones—no matter how inefficient a pair is chosen. A standard 0 VU recorded tape produced 2.5 V out.

To truly appreciate this machine, you must *use* it, of course. At the outset, tape threading is delightfully simple and, therefore, accomplished quickly. There are no tensed compliance arms around which the tape must go. Just shove the tape into the slit formed by the head covers and you're in business. Editing facilities are great, too. There's a newly designed editing tape (cue) lifter, for example, and under the head cover is a slide switch to shut power of the takeup reel motor,

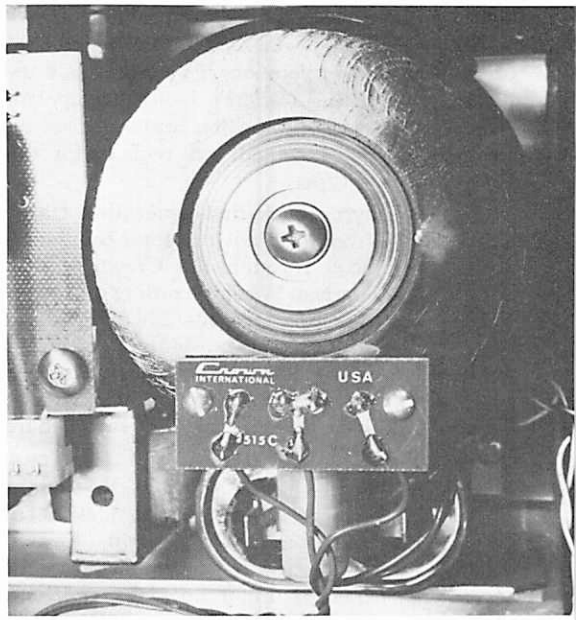
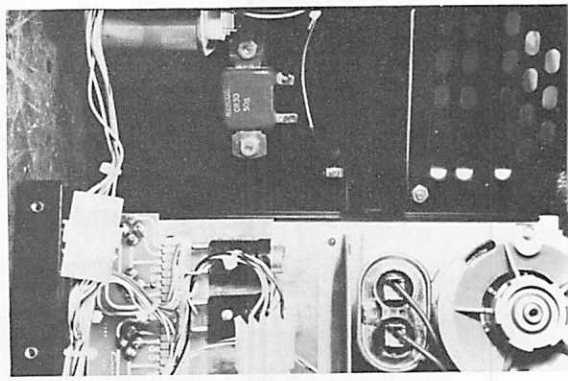


Fig. 8—The tape motion and direction sensor is installed on rear of the supply motor, as shown above. When the supply reel moves the slightest amount, it causes the shiny disc at center to move from its rest position in the same direction as the motor turns. After about 5 deg. of rotation, the disc reaches its stop and halts. During its journey, however, its slits (not seen) interrupt an appropriate light beam created by the lamp whose base is visible below the motor. The light (or absense thereof) triggers a photocell which energizes a relay through gates. When the disc begins to turn in the opposite direction, it activates a different photocircuit, which then energizes a second relay. The information gleaned by the motor and direction sense circuit is used by the computer to come up with proper commands to control tape motion.

Fig. 9—Tape control pushbuttons are attached to the rear of a printed circuit card (bottom-left). Take-up reel motor is at top, with ballast resistor and capacitor on swing-away panel at left.



thus simplifying editing jobs. You can "rock" between fast forward and fast rewind to your heart's content as a result of the CX822's fool-proof control system. Tape tension limits are set by a switch for small-size reels or for the larger type.

Playing back first-generation transfers from original masters, the sound produced through the Crown CX822 was peerless. When recording and playing back from records and FM broadcasts, there was absolutely no aural difference between the original and the copy at 15 ips. The same held true at 7½ ips, though, theory says, there should have been.

The machine was taken to a night club, where it was pushed, kicked (in its case), and, in general, treated rather callously to simulate what might be expected under normal conditions. The rugged unit, with its 50% thicker panel and added structural members (as compared with previous models), continued to operate like the professional-quality unit it is. Recordings made of piano music and a Regina music box were entirely faithful to the original, thanks to the CX822's low order of wow and flutter, among other highly prized characteristics. We had to use good condenser mikes to fully appreciate the quality of sound that this machine is capable of recording. Using a pair of calibrated ribbon types in our possession, the Regina music box exhibited better "highs" than evident in playback, for example. But the difference was already apparent before going onto the tape, as monitored via headphones. Switching mikes produced a recording almost indistinguishable from the real thing.

Is the 15 ips speed worthwhile? For master tapes, undoubtedly yes. Insofar as our ears are concerned, though, the "extra" sound quality achieved over 7½ ips is only a wee bit better in high-

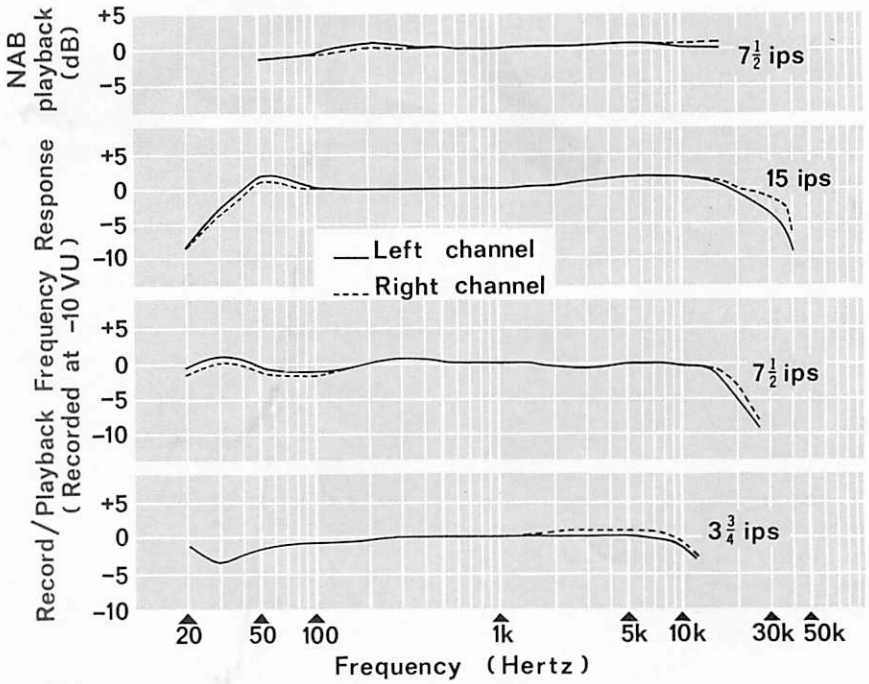


Fig. 10–Record/playback response of Crown CX822 stereo tape recorder.

frequency response, and then on music which has high-energy content here (say, above 16 kHz). The truth is, that the performance of this machine at 7½ ips is so good that, except to meet a professional recording need or for playing back 15 ips tapes, the 7½ ips speed would serve equally well (as offered in the model CX824).

Aside from large size and heavy weight, which cannot be avoided, the only area where the bull's eye of perfection went very slightly astray was the NAB reel adaptors. The problem here, shared by most other machines which offer them, is that when you screw on the cap to spread the spring which holds the hub, the spreading does not take place evenly. This causes very small eccentricities, which, at high speed, results in the tape not being wound as smoothly as it could. [*Crown will have a new NAB reel adaptor available in the near future which overcomes this minor deficiency. The center hub will be larger, and it will include three "feet" so that it can't twist due to spring tension—Ed.*] But this aside, the new Crown CX822 is capable of providing the most faithful reproduction of sound through the magnetic recording medium that we have observed to date. And it does it in as foolproof and as easy a way as we've seen. It is the machine for the tape enthusiast who wants and can afford the best.

(Accessories supplied with test sample were four CX2 playback amplifiers, $180; a 2CX6 output amplifier, $50; 4/X low-impedance balanced mike inputs and outputs, $100; model X carrying case, with complete access to front and rear of the recorder, $59.)

Fig. 11–Underside of electronics chassis.

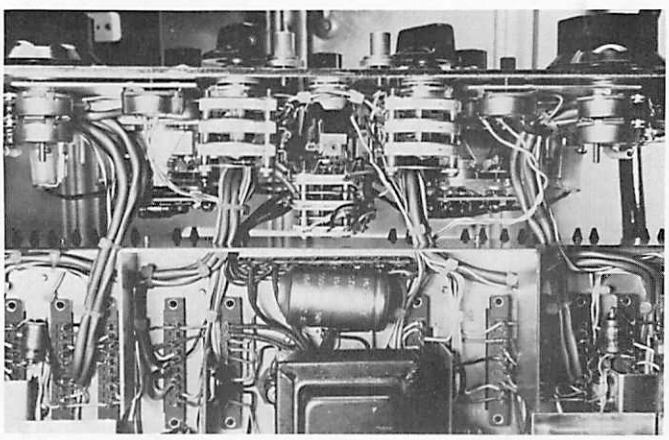


Fig. 12–Back view of complete electronics chassis.