MODEL 10XD STEREO

In the last year or two a steady stream of requests has come from our marketing department for a Tandberg tape recorder that can handle 10½" spools. The requests have been put forward against a background of recent developments in some of our most fruitful export markets. The 10½" spool was for a long time regarded as almost the exclusive province of professionals, but now it is becoming fairly commonplace for keen amateurs.

When we started developing the 9000X we were undecided between the choice of a 7" spool and a 10½" spool. Eventually we decided on a 7" spool for a number of reasons. One of the reasons was the belief that the particular design of the 9000X could give us certain experience that we needed before we began on the larger and more complicated task of designing a 10½" spool machine.

Now we know that decision was the right one. With the knowledge and experience gained from the 9000X project, particularly during the development and marketing stages, we felt more able to tackle the 10XD. Besides, we were able to include some features that the market has now showed us it wants.

It is clear from the exterior of the 10XD that it comes from the same stable as the 9000X and the 9100X. This means that the principles used in chassis construction, the braking system with friction brakes and electrical brakes, the servo-controlled tape tensioning and so on are the same. The tape path is the same, and all the audio facilities and most of the circuit design points have been borrowed from the 9000X. At the same time the 10XD has a number of advantages over the 9100X as you will see from the following detailed description.

10½" spools

The facility for using 10½" spools is obviously the most striking item of news. The larger and more powerful spool motors required to handle the larger and heavier spools have been placed in a new position to make room for the spools. This has necessitated changes in the lay-out of the mechanical braking system and the tape tensioning system. Otherwise the same principles which were used on the 9000X and the 9100X have been retained.

Spool sizes from 10½" down to 5" can be used. For spools with NAB hubs, NAB adapters should be used. Two NAB adapters and one empty 10½" metal spool will be packed with every machine.

15" per second tape speed

The 10XD has three speeds. We have chosen 15" per second as the highest speed because this speed is very much used by professionals. In the old days 15" per second was necessary to achieve satisfactory recording quality. Today it is not so important. However, this high speed is important when it comes to editing tapes. But there is a price to pay and this price is bad tape economy. However, the Tandberg Crossfield system gives exceptionally good results right down to 3¾" per second. So with 15", 7½" and 3¾" per second, the 10XD should meet all the requirements of all the users.

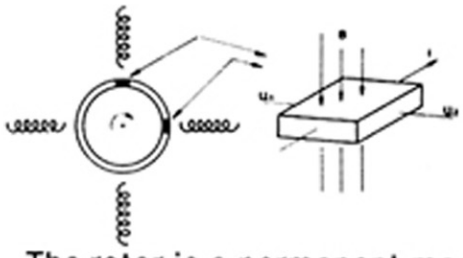
Servo-controlled speed regulation /d.c. capstan motor

The requirements we ourselves placed on the tape speeds and speed tolerances made it necessary to abandon our traditional system employing a hysteresis synchronous motor and idler-wheel transfer mechanism.

The choice fell on a servo-controlled d.c. capstan motor with belt drive between the motor and the capstan/flywheel. A more detailed description follows.

Capstan motor

We chose a d.c. capstan motor which was able to run at the high speed required (about 5000 revs/min) without difficulty so that it could, via a suitable transfer system, provide a tape speed of 15" per second. A conventional d.c. motor with its brushes and commutator can generate sparks which lead to induced bursts of noise in the magnetic heads and amplifiers. To avoid this danger in the 10XD we have employed a brushless d.c. motor. The brush/commutator system has been replaced by Hall-effect devices and transistors. The motor functions according to the following principle (see figure).



The rotor is a permanent magnet. The stator has four windings. Placed on the stator there are also two Hall-effect devices displaced 90° from each other. Hall-effect devices are semiconductors with the following characteristics: assuming a constant current (i) and allowing a magnetic field to go through the device, we will get two voltages out of the device (u_1) and (u_2). The magnitude of two voltages will be determined by the magnitude of the magnetic field. In our motor the Hall-effect devices are exposed to a

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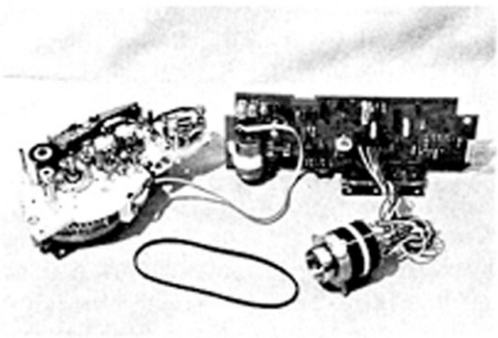
roughly sinusoidal magnetic field when the motor rotates. The voltages from the two devices influence the transistor circuits which are connected in series with the individual windings. As a result the currents in the windings flow in the correct order determined by the position of the rotor at any particular instant.

Belt drive



Components forming the servo-control system.

The capstan motor is mounted at the correct distance from the capstan/flywheel and the magnetic heads. A belt connects the motor and the capstan/flywheel. We could have chosen a direct drive for the capstan, but our experience tells us that this arrangement can cause mechanical and electrical interference with the heads thereby adversely affecting the S/N ratio and the wow and flutter.

Servo-control

A d.c. motor is dependent on one or another form of control system to hold a given constant speed. For any particular type of motor it is possible to design a relatively simple control system. But in our experience these simple control systems allow far too much tolerance on the speed. Furthermore they do not correct for deviations in the transfer system between the motor and the capstan (deviations caused by variations in load and friction).

In the 10XD we have put stringent requirements on speed accuracy. We therefore chose a servo-control system based on a tachometer which senses the rotation speed of the flywheel. The 10XD has therefore a closed system which eliminatestions in the transfer system from the motor.

With a precision adjustment procedure a toothed wheel is centred and clamped to the flywheel. A semiconductor speed sensing system consisting of a light emitting diode and a photo-transistor is mounted so that it bridges the teeth. When the flywheel rotates the teeth interrupt the light beam from the diode to the transistor. The output from the photo-transistor is therefore a chopped waveform (pulses) with a frequency that directly depends on the rotation speed of the flywheel.

The chopped waveform is passed through an a.c./d.c. converter and compared with a reference voltage. Undesirable speed variations on the flywheel/capstan result in a correction signal (the difference between the output from the a.c./d.c. converter and the reference voltage) being applied to the motor to raise or lower its speed.

A potentiometer permits the three speeds to be adjusted exactly. The system is stable and therefore independent of temperature, mains voltage, and mains frequency. The tolerance for the speeds is set to a maximum of ± 0,3%. As may be seen in the performance specification, the performance for wow is also exceptional. Because of the type of capstan drive system used on the 10XD, speed changes are carried out electronically which means that there is virtually no mechanical work done by the speed selection knob, and it is very light to operate.

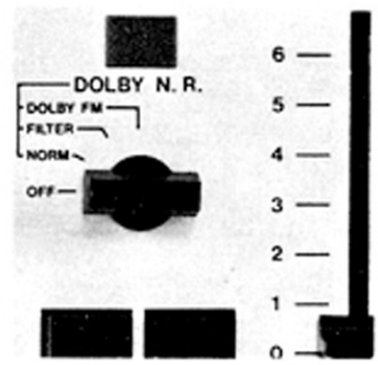
A detail of the speed servo control system.

As an accessory a PITCH control can be delivered which permits manual adjustment of the tape speed within limits of ± 10% approx.

DOLBY N.R. B-TYPE

The Dolby noise reduction system has turned cassette recorders into Hi-Fi equipment. The principle of this system has been described in a number of technical journals and also in earlier issues of News from Tandberg.

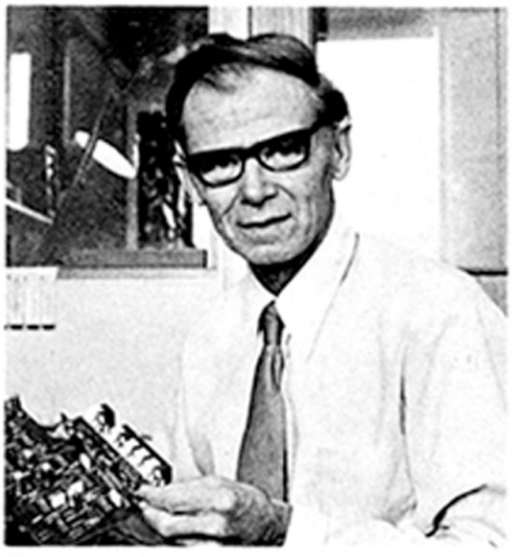
The Dolby B system is employed in the 10XD. This has brought a significant improvement in the signal/noise ratio. Tape hiss from modern tapes is already very low and only during for example, the most delicate violin tones is it possible to hear the hiss from the loudspeakers. But with the use of DOLBY even the most hyper-critical listeners will be satisfied.



The 10XD has a switch marked «DOLBY N.R. B-TYPE» with four positions. This switch makes it possible to record or play with or without Dolby. If the 10XD is connected to a tuner, Dolby can be used when recording stereo transmissions. A filter is brought in so that the stereo pilot tone is substantially attenuated. This is necessary for the Dolby processor to operate correctly. When the switch is in the position «Dolby FM» recordings can be made of programmes that have been «dolbyized» in the transmitter. The 10XD can also be used as a decoder for this type of «dolbyized» programme when the tuner itself does not have a decoder.

New logic control

The method we chose for driving the capstan meant that the logic control system for the spool motors and solenoids had to be

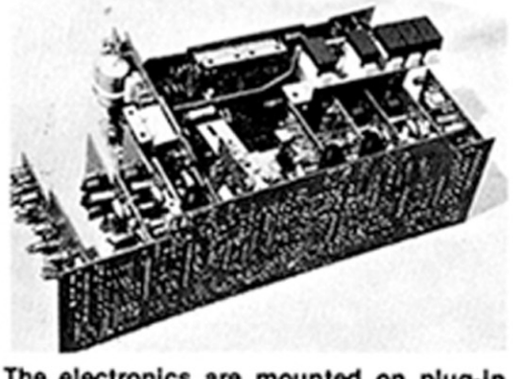


Senior Engineer Ole Melvold

re-designed. Our experience from the 9000X and new technological advances gave our specialists in this area (under the leadership of Engineer Ole Melvold*) additional opportunities to raise the quality and reliability even further.

Controlling the braking

A sensor system based on a light-emitting diode and a photo-transistor detects motion in the take-up spool motor. When the braking phase comes to an end and the tape stops, the sensor passes this information to the logic control. When the machine is required to go directly over to the play mode from the spooling mode, the machine will instantly go to play when the braking phase is ended. The delay on the 9000X and the 9100X for the corresponding operation has been eliminated.



The electronics are mounted on plug-in printed circuit boards.

Flying start

Direct switchover from play to record is possible on the 10XD. This is achieved when the REC and PLAY buttons are pressed simultaneously. The logic circuits ensure a smooth start for the bias oscillator and connection of the record amplifiers. The switchover to record takes place without any embarrassing clicks.

Fast acceleration

When the machine starts in the record or play mode, the large spools and the high tape speed put big demands on the tape transport. The logic circuits are conditioned by the positions of the speed selector switch and the 10½" REEL switch so that the take-up spool motor receives extra voltage during the first 0,2 second after switch on. This short burst of extra voltage gives the motor a chance to produce that extra bit of acceleration in the start-up phase. Evidence that this extra kick is being given to the motor is provided by the WIND button which lights up while it happens. Together with the right-hand tape-tensioning arm the motor ensures that take-up of the tape starts without any embarrassing loop formation or jerking.

Improved circuit design

The logic circuit in the 10XD is a compact unit built up around only 8 integrated circuits and the necessary output transistors. One and the same type of circuit has been used in all positions. This makes servicing much r simpler. The pull-in phase for the pinch-roller and the brake solenoids is governed by a common monostable. This gives a pull-in time which is designed to be exactly the time required for precise and positive operation of the solenoid. It guarantees that the solenoid does not receive the high pull-in power for a longer period than is necessary. The danger of the armature winding being overheated has thereby been eliminated.

The 10XD can be remotely controlled by the same unit used on the 9000X and 9100X, the Tandberg Remote Control Unit 9.

FERRITE PLAYBACK HEAD

The contour effect in the playback head which gives an uneven frequency response in the low frequency region, is particularly relevant at 15" per second. Our magnetic head department has therefore designed a new playback head for the 10XD where the contour effect is reduced by an increase in the width of the head front.

Against a background of technological development in ferrite we chose this material for our heads. Earlier problems with the grain size, porosity, permeability, saturation inductance and temperature drift have been solved, so that ferrite now really does recommend itself as a magnetic head material. Also the technique with glass-lined gaps which before was complicated and expensive has now been simplified.

The ferrite-core in the playback head of the 10XD means that the head has very great wear resistance.

THE PLAYBACK AMPLIFIER

As previously mentioned, the new playback head has given the 10XD some excellent characteristics. At the same time the requirement for reduced contour effect has made the head more sensitive to external fields. This could reduce the signal/noise ratio. So we had to design a new playback circuit which, in a clever way, eliminates this problem.

The head winding's mid-point is earthed, and the two «hot» ends of the winding are connected each to its own input on a field-effect transistor differential amplifier. By adjusting a potentiometer in the differential amplifier the system becomes balanced so that the unwanted induced noise voltages from the motor and the transformer are cancelled. The same design makes the tape recorder less sensitive to noise from nearby electrical equipment and plant. The combination of a ferrite head and a field-effect transistor input gives the very best solution from the point of view of noise characteristics.

A low-noise integrated circuit is used to achieve the required frequency corrections according

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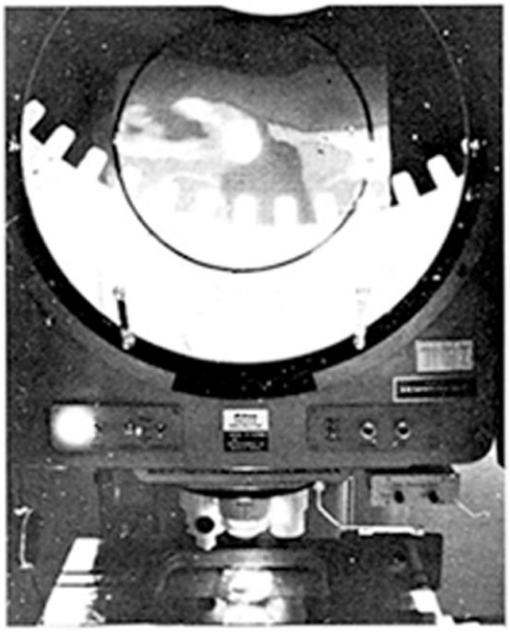
* «Logic control of tape recorders» AUDIO, April 1973



The teeth of the toothed ring on the flywheel are duly checked.

10XD

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to the following specification: the corrections follow the NAB standard with 3189 μs, and 50 μs for 15 and 7½ ips, and 90 μs for 3¾ ips.

RECORD AMPLIFIER

To provide the 10XD with a generous overload margin on the record side of the amplifier system, we have used a push-pull record amplifier. We have thereby ensured that on every occasion it will be the magnetic tape itself that will be the limiting factor for distortion when a recording is being made.

It is also worth mentioning that the 10XD is adjusted so that when the tape is fully magnetized, i.e. the needle is coming up to 0 dB on the level meter, the maximum harmonic distortion will be 0,2%.

EXTERIOR

In most ways the exterior of the 10XD is like the exterior of the 9100X. However, the 10XD is necessarily bigger and heavier.

An extruded aluminium profile on the face of the tape recorder gives it a unified look. The profile has been shaped as a handgrip so that it is easy to lift and carry.

The turntables are in electrolized aluminium. The rubber pads have been made conducting so that static electricity, which easily accumulates on metal spools, is allowed to leak away. Sparks will therefore not be generated.

From the final test of the 10XD, where the tape recorder is used together with other top equipment from Tandberg.

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