

# Low-Cost Precision Magnetic Recorder for Professional Use

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Precision in manufacture and the utilization of new design techniques results in a magnetic tape recorder which compares favorably with the most elaborate units in the field.

**E**XTENSIVELY USED by the major networks and recording companies, the Ampex Magnetic Tape Recorder Model 200—described in a previous article<sup>1</sup>—has proven itself to be the ideal instrument for recording masters, network shows, and other program material where no deterioration in original quality can be tolerated. The many advantages of magnetic recording—simplicity of operation, ability to edit, re-use of the medium—combined with the faithfulness of reproduction heretofore never achieved practically in day-to-day operations, are steadily increasing the demand for this type of equipment.

In order to make all of the above advantages of magnetic recording more generally available to the professional

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<sup>1</sup> "Magnetic Tape Recorder of Broadcast Quality," by H. Lindsay and M. Stolaroff, AUDIO ENGINEERING, Oct. 1948

user, the new Model 300 recorder has been designed. The aim in the design of the Model 300 has been to make available the same high quality performance of the Model 200 in more compact form and at the minimum possible cost, with no sacrifice in reliability. This has been made possible by the development of many new principles and techniques.

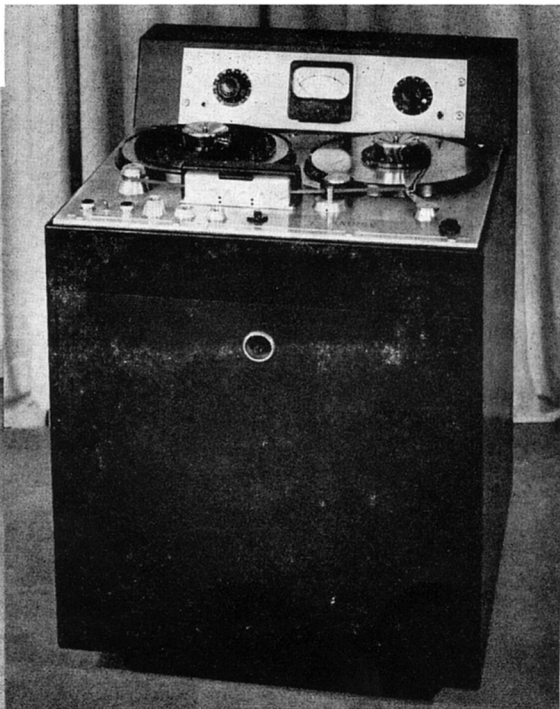
The Model 300 recorder consists of two basic elements: (1) the top-plate assembly, which contains the tape transport mechanism and head housing, and (2) the electronic assembly, which contains the power supply, record and playback amplifiers, and bias and erase supply. The basic units are designed for standard rack mounting, but may also be mounted in a console cabinet, as shown in Fig. 1, or in cases for portable use, Fig. 2. While the equipment is rather heavy in the portable form, approximately 75 pounds,

it was believed better to have it so rather than sacrifice anything in performance. With this portable unit, the finest recordings can be made at any location. No longer is it necessary to tolerate inferior program quality simply because events take place away from studio facilities. Complete full range programs can be obtained on remote pickups without the expense of telephone lines.

## Top-plate Assembly

In designing the Model 300, the proposed Standards of the NAB Subcommittee on Magnetic Recording have been followed throughout. Thus the tape speed is 15 inches per second, with an auxiliary speed of 7.5 inches per second. A single knob makes the speed change and the necessary equalization changes with it. Reels are 10½ inches in diameter with the standard hub agreed upon by the NAB Sub-

Fig. 1 (right). Ampex Model 300 magnetic tape recorder, console mounting. Fig. 2. Portable mounting of recorder shown in Fig. 1.



committee. They hold 33 minutes of tape at the standard speed of 15 inches.

Three motors are used in the drive system, one a dual-speed synchronous motor to drive the capstan, and the other two on the reel assemblies. All motors are very compact and light in weight, having been especially designed to Ampex specifications. The turntables holding the tape reels are attached directly to the shafts of the rewind and takeup motors. A holddown is used to lock the reels in place. The holddown is constructed in such a manner that it centers and locks the standard NAB reel, as well as the standard RMA reel, without regard to varying thicknesses. Motor shafts 5/16" in diameter allow the use of the smaller RMA reel. Mechanical brakes are employed for providing quick smooth stops at any speed without undue tape tensions and without allowing slack to form at any time.

The drive system was the subject for the most intensive investigation of any part of the machine. Many different types of drives were built up and studied. The various factors which produce speed variations were isolated and analyzed, and methods of construction were devised which eliminated their effect. The result is a remarkably wow-free and flutter-free drive, with a minimum of precise, close-tolerance parts. The fact that speed variations

have been removed by basic design principles rather than by excessive precision in manufacturing has greatly reduced the cost of the drive unit.

Another feature of the drive system is instant starting. When the tape is threaded up, the takeup tension arm is moved into position, which starts the capstan motor. This same arm also automatically stops the machine when the tape runs out or in the event of tape breakage. When the START button is operated, a rubber idler clutches the tape against the capstan and the tape comes up to speed in less than 0.1 seconds. This feature is useful in editing and in cueing programs.

The following pushbutton controls are provided: START, STOP and RECORD. Since these controls are relay operated, they may be governed from a remote location. A selector switch controls the mode of operation, either NORMAL PLAY, REWIND, OR FAST FORWARD. The machine can be readily shifted from one mode of operation to the other, except that in returning to NORMAL PLAY from fast winding, the machine automatically stops to avoid breaking the tape by clutching it into the capstan while moving at high speed. The ability to shift back and forth at will from REWIND to FAST FORWARD assists in editing operations, as the tape can be shuttled back and forth over a given length to determine

the exact location of a particular point in the program.

#### Head Housing

New heads have been designed which have improved performance characteristics with smaller physical size. Because of the extremely short wavelengths at the high extreme of the audio spectrum at the lower tape speeds, extreme precision in head construction is required to insure interchangeability of recordings on various machines without loss of high frequencies. While a slightly curved gap does not affect the performance of a single machine (the gap effect is readily equalized), such curvature will make it impossible for a group of machines to be aligned so that recordings can be indiscriminately interchanged among them without high-frequency discrepancies. An indication of the accuracy required may be illustrated by the fact that if one edge of the gap is displaced from its proper position by .0003 inches, the response at 15,000 cps will fall off by 2 db. Precision methods of manufacture, combined with the most rigid inspection procedures, assure that the heads will have the required uniformity.

The head housing is a complete plug-in unit containing erase, record and playback heads. Separate record and playback heads retain the valuable feature of allowing direct monitoring

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Fig. 3. Model 300 recorder (left) beside the Model 200, illustrating the reduction in size in the new unit. Also shown is the extended-range speaker system used for critical listening tests. The unique Smith-Selsted tweeter (center) provides flat response up to 20,000 cps.



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from the tape. Opening the gate of the head housing removes the tape from contact with the heads for fast winding. Threading is extremely simple, as the tape can be merely dropped between the open gate and housing with no fear of snarling or catching. Tilt adjustments are provided on the record and playback heads so that they may be aligned while the machine is running.

## Amplifier Assembly

A great deal of work has gone into the simplification of all electronic components to reduce size and cost. Wherever possible, costly transformers have been eliminated, and dual tubes such as the 6SN7 have been used to reduce space requirements.

The recording amplifier has a bridging-input transformer, which can be used either matching or bridging, and the amplifier has sufficient gain to record from any line level from -30 VU up. Ample recording current is provided so that no distortion is introduced by the recording amplifier well beyond the current necessary to saturate the tape. A screwdriver gain control is provided, as well as a high-frequency equalizing adjustment and a bias current adjustment.

A novel bias and erase supply has been provided which leaves the tape remarkably quiet, and which is un-critical to voltage variations and other adjustments.

The playback amplifier will deliver + 25 dbm at 1 per cent total harmonic distortion into a 150- or 600-ohm line. This is ample reserve for the normal operating level of + 4 VU to + 8 VU. A screwdriver gain control is provided, and a high-frequency equalizing adjustment for flat playback response from a standard tape.

Overall performance characteristics are well within the proposed NAB

standards. Frequency response is  $\pm 2$  db from 50 to 15,000 cps at 15 inches per second, and  $\pm 2$  db from 50 to 7500 cps at 7.5 inches per second. The signal-to-noise ratio is better than 60 db measured in accordance with the NAB definition (ratio of peak recording level to total unweighted noise level recording zero signal; peak recording level is that point at which the overall total harmonic distortion does not exceed 3 per cent measured on a 400 cps tone).

At the 15-inch speed, flutter and wow are well below 0.1 per cent. This measurement is made on a bridge which measures all flutter components from zero to 300 cycles, using a signal of 3000 cycles. At 7.5 inches, the flutter and wow are less than 0.2 per cent.

The final test of performance is in listening. The most critical test that can be made is the "A-B" test, whereby the output of the recorder is compared with the input by rapidly switching the monitoring equipment between input and output. Because of the minutely detailed comparison which can be made at the time of switchover, slight discrepancies between two systems can be detected by means of the A-B test which would never be noticed if the systems were listened to separately. When making critical A-B tests on the Model 300, using live program material of the most exacting nature, and with the highest quality amplifier and speaker systems, it is impossible to distinguish recorded material from the live program.

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