The Care and Handling of Magnetic Tape

By MATTHEW HOEY

THE FIRST SUCCESSFUL experiments in magnetic recording were conducted about 1890. Metal wires were used in the early experiments. Since then magnetic recording has progressed through the use of paper tapes and steel tapes to its present usefulness in all forms of recording, i.e., computer, video, instrumentation and audio.

Knowledge of the proper care and handling of magnetic tape is essential whether the user is a scientist, technician or amateur. Magnetic tape applications include computers, satellite communications, and space technology as well as professional broadcast and home use.

Magnetic tape ranges in size from 0.150 in. wide to 6 in. wide, 0.0006 to 0.0019 in. thick, and from 150 ft to 9,200 ft long (Fig. 1). It consists of three principal elements: base material, binder and oxide.

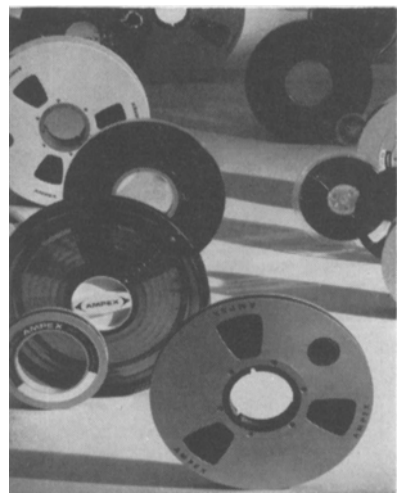

Fig. 1. Magnetic tape is available in a wide variety of sizes. Regardless of size or price, all tape should be handled with great care.

Base Material: The base material provides a means to hold the iron oxide and move it past the heads of the recorder in a controlled fashion. It must electrically insulate one layer of oxide coating from another to prevent print-through. It must also maintain resilience to provide good tape-to-head contact.

Polyester and acetate bases are the most common base materials. Generally, polyester has the best characteristics for most applications, i.e., strength, long life and relative stability in varying conditions and environments. Acetate, frequently used in less demanding audio applications, does not possess the stability and durability required for precision recording in computer and instrumentation recorders.

Binder: The binder joins the oxide to the base material. It must provide even dispersion of the oxide particles and confine them within a thin layer. It must also provide an efficient bond (adhesion) of the oxide coating to the backing material, and an effective bond (cohesion) of the magnetic particles to each other.

Oxide: The heart of all magnetic tape is the oxide particle itself. In virtually all precision tapes, the oxide used is gamma ferric oxide in a cigar-shaped particle approximately 0.1 μm thick and 0.7 μm long. These particles are suspended in the binder in much the same manner as almonds are held in a chocolate bar.

Computer Tape

Computer tape is the most critical because of the work that it must do. Information for computers is stored on tape in the form of minute electrical impulses across the width of the tape. Each row of these impulses represents one character and there may be from 556 to 1,600 characters/in. of tape. With this much information in such a small area it can be seen that any damage to the tape or any surface contamination will cause a loss of vital information.

One of the most common results of tape damage is "dropout." This can be caused by there being on the tape a nodule or speck of dirt that will pull the tape away from the head briefly. Dropout is especially detrimental in computer tape recording because any short loss of signal on a tape that contains 800 or 1,600 characters/in. can cause the distortion or loss of two or three characters, resulting in erratic information.

A standard reel of ½-in. computer tape, 2,450 ft long, with one nodule or surface defect that will cause a dropout at 800 characters/in., is equivalent to a highway 50 ft wide and 557 mi long (approximately the distance between San Francisco and San Diego) with one grapefruit sitting on it.

With this kind of sensitivity it is imperative that there be no smoking or eating in the areas where computer tape is to be handled; for example, a slight accumulation of foreign particles might easily change a payroll check from $125.50 to $25.50 (Fig. 2).

Video Tape

In video-tape recording the frequency range required to give good recording

Fig. 2. Smoking near magnetic tape can be harmful to the tape.

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ranges from a few hundred cycles per second to several million cycles per second. To record such a range of frequencies, a high head-to-tape speed must be available. This is normally made possible by placing video heads in a drum and rotating the drum at high speeds. The combination of tape movement and head rotation results in a writing speed (relative tape to head speed) of approximately 1,000 in./s and up. The heads mounted on the rotary drum protrude approximately 3 to 4 mils. As the drum rotates, each head digs into the tape a minimum of 2 mils. This penetration is required to maintain intimate tape-to-head contact. As the high-speed head digs into the tape it places extreme stress on it. In addition to the extreme stress resulting from this penetration, tremendous point contact temperatures are generated at the heads. Heat is one of the worst enemies of tape and shortens the life of the tape.

Because of this high speed and temperature, even the slightest deposit of grease on the surface will attract foreign particles that can cause severe head wear.

Dropouts in video tape are defined in the same way as in computer tape. In video recording, the heads sweep across the tape at such a high rate of speed that when a nodule lifts the head from the tape there is a relatively long period of time before the head and tape come together. To record one complete frame, or picture, requires a ½-in. × 2-in. segment of tape. Many tape surface defects are longitudinal in nature, such as scratches, and they will appear as standing patterns on the monitor affecting numerous lines, whereas foreign particles may affect only one or two lines or less. Some new video tapes require burnishing or "running in," running the tape through the tape recorder two or three times, to minimize the effect of surface imperfections.

Since video tape is up to 2 in. wide it appears more rugged than narrower tapes. As a result many operators tend to abuse it, but video tape is susceptible to physical damage and it should be protected. Guiding is most critical, and edge damage to any degree, however slight, will affect the recording performance. The tape itself should not be handled, nor should it touch any surface that could contaminate it. The operating area should be as dust-free as possible to minimize head wear and temporary dropouts. Transports should be cleaned thoroughly on a regular basis, and an active, effective cleaning program should be maintained in the tape library as well as in the recording studio.

Instrumentation Tape

Instrumentation-tape dropouts are similar to those experienced in computer and video tape. Tape abrasiveness and associated head wear have long been the important consideration of instrumentation tape. With the advent of extended bandwidth recording techniques there have been many changes and improvements, one of which has been head design. The head gap was reduced from 80 μ in. to 25 μ in. and the tape wrap angle was altered to provide more intimate tape-to-head contact at the gap. With this configuration, a new head/tape parameter was introduced, which may be referred to as gap integrity. Conventional tapes used on wideband systems destroy the gap integrity and create a "gap-smear" condition. Gap smear is the result of material being worn from the leading edge of the pole pieces and forced into the gap, creating a magnetic short.

There are three grades of tape abrasiveness relating to gap smear; highly abrasive tape, moderately abrasive tape, and very low abrasive tape. A highly abrasive tape will not necessarily cause gap smear because it will wear off both sides of the gap cleanly, thus preserving gap integrity. A moderately abrasive tape will wear the leading edge and set up a coldflow condition, thereby forcing head material into the gap, creating a magnetic short.

A tape that is very low in abrasive characteristics will wear the head evenly, but at a very low rate. Gap integrity is preserved, and head life is extended as well.

In the case of wideband instrumentation tape, care and handling becomes more critical as a result of the extremely tight physical tolerances. Specifically, wideband instrumentation tape surfaces are much smoother than other precision tapes such as computer and video. The standard instrumentation length is 9,200 ft as opposed to 2,400 ft for computer and 4,800 ft for video.

Audio Tape

Because audio recording requires much less frequency response, less information to be recorded, and its playback requirements are generally not as critical, audio tape specifications are not as demanding as tapes in the other recording areas. However, for maximum tape life and performance, it should be handled as though it were a precision tape.

Because most audio tape is used in the home, extra care should be taken because of the more casual storing conditions. Keep food and drinks away from the tape storage area, store tapes in a cool, dry place, and keep the recorder clean at all times. To get the high quality reproductions you paid for it is necessary to take some time and care in the handling of the tape and recorder.

When tape is exposed to wide fluctuations of temperature and humidity, the base material expands or contracts, setting up tremendous internal stresses in the tape pack. This stress will induce distortion beyond the elastic limits of the base material which in turn renders the tape useless for its intended purpose.

General Handling and Storage

Tapes do not wear out. They are retired from service because of damage caused by improper handling and storage. If all tapes could be stored in a controlled environment, they could theoretically last forever —but this is impractical. In the absence of a perfect environment, tape is best stored in an area that is kept within "people conditions," that is 70 F and 50% relative humidity.

Because of the magnetic properties of tape a storage area should be chosen away from any stray magnetic fields. A steady field of dc current, a permanent magnet, or a concentrated field of ac current can all be considered as stray magnetic fields and should be avoided when choosing a storage area.

Good handling practice dictates that reels of tape should always be handled by the hub

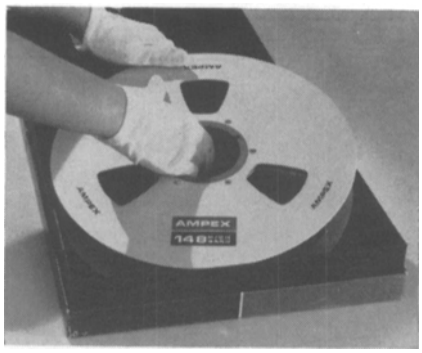


Fig. 3. The wrong way to remove tape from its box. Improper handling of tape reels damages the flanges and thus shortens the life of the tape.

(Fig. 3) and never by the flanges (Fig. 4). Handling by the flanges could squeeze the flanges into the tape pack causing tape damage. It is conceivable that ½-in. computer tape could have the edge tracks of the 9-track configuration fall within 0.001 in. of the edge of the tape. The normal shuttling operation of a computer will invariably leave the tape pack in an uneven state, with tape edges protruding slightly. Plastic computer flanges are not rigid enough to withstand flexing if exposed to rough handling. With the use of an airtight cannister, such as the Ampex all-plastic cannister with a hub supporting ring, this type of damage can be eliminated.

Many people think that because a particular machine uses ½-in. tape it will use any ½-in. tape. This is not true. Each magnetic tape is designed and manufactured with a particular type of machine in mind, and should be used only on that recorder. For example, any attempt to use audio tape on a video recorder may result in total destruction of the tape and damage to the heads.

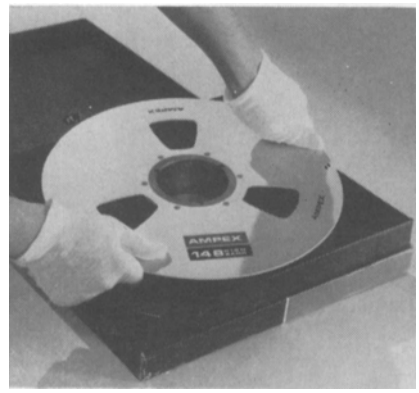


Fig. 4. Proper handling of magnetic tape includes lifting the reel of tape from its container by the hub and lower flange.

When threading the machines, care should be taken that the tape is placed carefully around the various guides and head drums (Fig. 5). Enough slack should be given so that there is no unnecessary pull or stretching on the tape as it is threaded. The tape should remain completely threaded while on the machine and should be rewound to one reel or the other before it is removed.

One of the important areas of tape care is the operating condition of the recording machine itself. All areas that come in contact with the magnetic tape should be kept clean and free of any foreign material. The recording heads should be checked and cleaned periodically and should be replaced at the end of their recommended life. Trying to get a few extra hours out of the recording heads or guides may result in the purchase of several new reels of tape because your old tape has been rendered useless.

If tapes becomes wrinkled or damaged, it is best to record the information on another tape and remove the damaged portions.

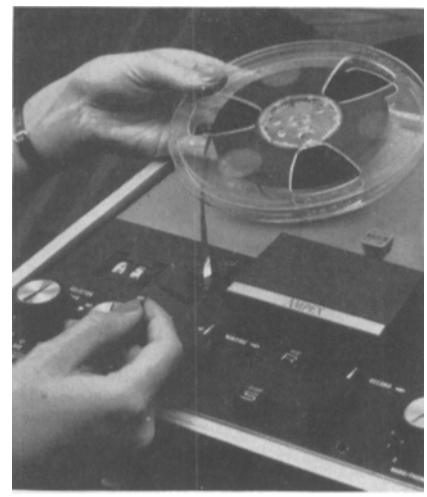


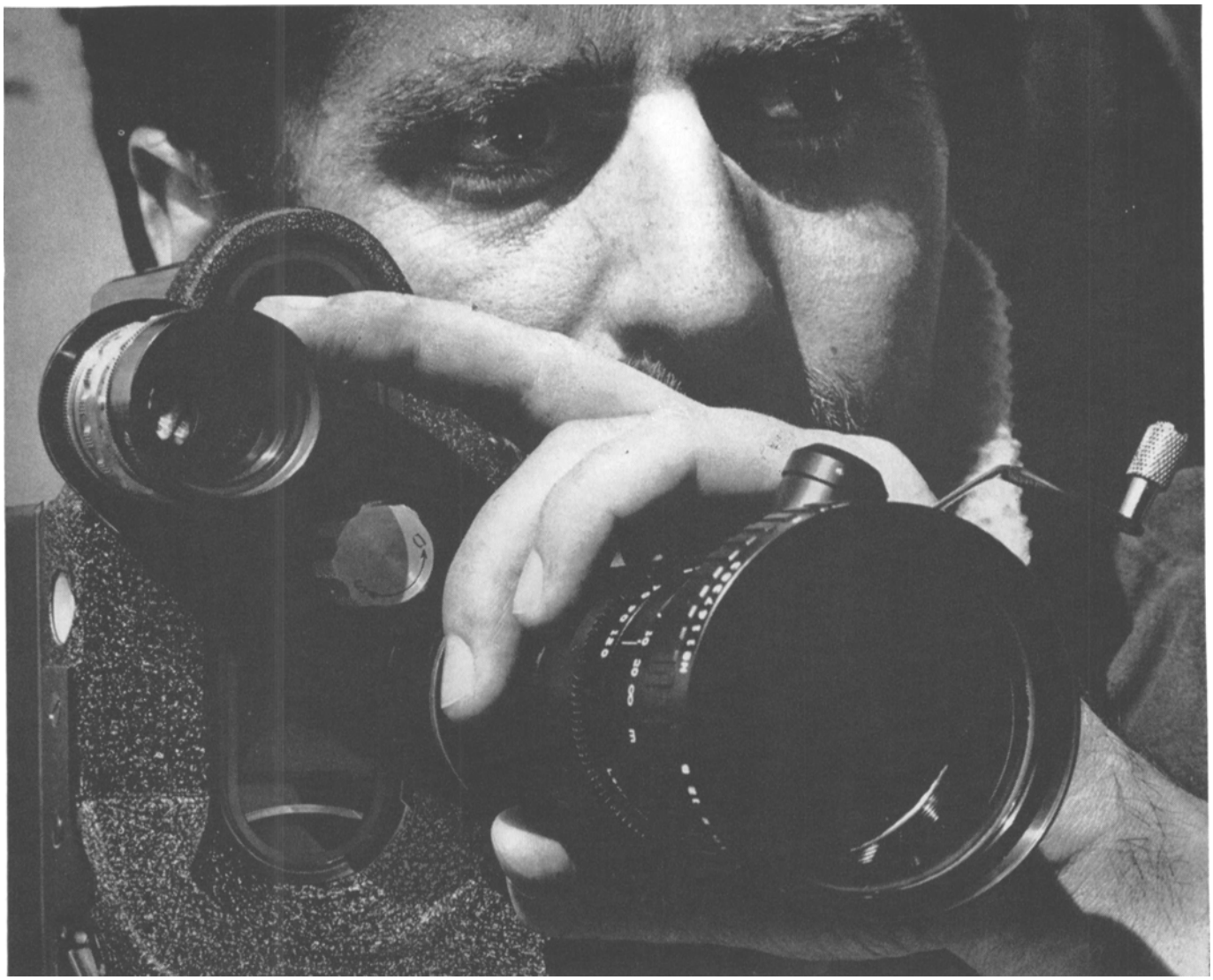
Fig. 5. When magnetic tape recorders are properly threaded, head wear and damage to the tape are greatly reduced.

When magnetic tape is shipped by the manufacturer it is placed in a container that is designed to keep the tape at a constant temperature and to keep out dust and humidity. In most cases this shipping case will make the best and safest container for storing the tape. Tape should be in one of two places — either on the transport ready to work, or stored in the original shipping container, *never*, unprotected, on a table or a shelf.

The most familiar but least understood component of precision magnetic tape is the reel. Everyone takes the reel for granted and does not realize the significant contribution a properly designed reel makes to proper system performance.

Each of the four types of tape — computer, video, instrumentation and audio — has reels that were designed especially for its particular application.

Although proper care and handling take a little more time and effort such will pay off in the long run with extended tape life and top quality reproductions.



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