Tape Recorders

Question:

Iron powder sticks to a permanent magnet. If you sprinkle iron powder on a strip of recorded audio tape, will the iron powder stick?

Observations About Recorders

- They put sound or sound information on tape
- They can reproduce the recorded sound
- A tape can hold several channels of sound
- The speed of the tape's motion matters
- Tapes are vulnerable to heat and magnetism
- A tape's leader can't record sound

Sound in Air

- Moving pressure fluctuations
- Created by compressing & rarifying the air
- Heard by detecting pressure fluctuations

Representing Sound with Current

- Microphone measures air pressure changes
- Produces current in a wire that is proportional to the air pressure shift, up or down
- This current isn't "sound," it *represents* sound
- It contains enough info to recreate the sound

Representing Sound with Magnetism

- Recording head uses "sound" current
- Produces magnetization on a tape that is proportional to air pressure shift, up or down
- Magnetization isn't "sound,"*represents* sound
- It contains enough info to recreate the sound

Magnetism in Matter

- Most atoms are magnetic
  - Electrons in atoms orbit and spin
  - Electrons are charged
  - Moving charge is magnetic
  - So atoms are usually magnetic
- Most solids are non-magnetic
  - Atomic magnetism sums perfectly to zero
  - Atomic magnetism is virtually invisible

Magnetic Materials

- A few materials retain some atomic magnetism
- Ferromagnets – atomic magnets aligned
- Antiferromagnets – atomic magnets anti-aligned
  - Cancellation is perfect
- Ferrimagnets – atomic magnets anti-aligned
  - Cancellation is imperfect

Soft and Hard Magnets

- Ferromagnets usually hide their magnetism
  - Material spontaneously forms magnetic "domains"
  - Domains randomly align so as to cancel
- Exposure to magnetic fields aligns the domains
  - Domain walls shift so as to align with the field
- Soft magnetic materials – domains shift back
- Hard magnetic materials – domains stay put

Permanent Magnets

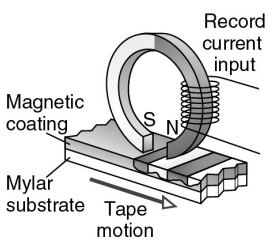
- Made from hard magnetic materials
  - Difficult to magnetize with outside field
  - Difficult to demagnetize when field is removed
- Fabricated in non-magnetic state
- Then magnetized by an intense, pulsed field
- Demagnetized by heat, shock, and strong fields

Single Domain Particles

- Tiny particles contain only one domain
- Single domains magnetize by magnetic flipping
- Long, thin particles are hard to "flip"
- They make excellent tiny permanent magnets
- They are the basis for magnetic tape
- Magnetic tape is covered with such particles

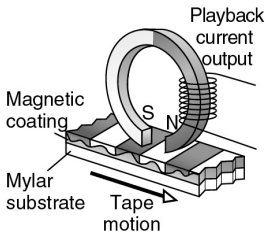
Recording Tape

- "Sound" current sent through ring-shaped electromagnet
- Split in ring develops north and south poles
- Nearby tape region becomes magnetized



Playing Back Tape

- Tape moves past gap in ring-shaped electromagnet
- Fluctuating magnetism in ring induces current in playback coil



Recording Details

- Louder sound → deeper magnetization
- Higher pitch → closer magnetic reversals
- Stereo → two separate magnetic tracks/heads
- Noise reduction → high pitch expansion
- Pitch control → tape speed control
- Sound degradation → magnetization damage

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