"Scrape Flutter"[1] and Tape Compliance (Elasticity) Bibliography

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1 P. H. Werner, "The Mechanical Properties of Various Magnetic-Recording Tapes and Their Influence on Recording Quality", ***Bulletin Technique PTT 30***, 173...180 (1952 May) (In French and German; rough translation available at Ampex Tech. Info. Service, #MRB787). (PTT=Schweitzerische Post Telegraphen und Telephon Verwaltung, Bern.)

In operation all tapes exhibit longitudinal vibrations which give rise to undesirable modulation of the recorded signals. The frequency of the vibration is determined from the elasticity, specific gravity, length, and tensile stress. Loading vs. elongation curves for several proprietary tapes show very similar moduli of elasticity but widely varying yield and breaking points. The resonance frequencies of 1 m lengths of all these tapes were calculated. Experimental checks also were carried out by stretching the tape length between the cutter of a gramophone recording head and the needle of a pickup, the pickup output exhibiting a peak as the input frequency to the recorder passed through the tape resonance. The resonance frequencies of all the tapes lay within the range 675...860 Hz. Fixed guides and heads give rise to aperiodic vibrations in the tape due to friction, and a method of measuring this effect, similar to a dynamic brake test, is described. The needle of a pickup presses against the tape and indicates the vibration amplitude. Rotating guides, having no motion relative to the tape, act as barriers and prevent propagation of the vibrations beyond them. Accordingly, all guides should rotate if possible. Furthermore, an additional rotating guide can be introduced with advantage between recording and playback head.

2 R. J. Youngquist, "The Problem of Wow in a Magnetic Tape Drive", ***Thesis, University of Minnesota*****:** 1952

The "propagation of longitudinal displacement waves in magnetic tape" is worked out mathematically, but the existence of a resonance phenomenon is not mentioned.

3 R. A. von Behren and R. J. Younquist, "Frequency-Modu1ation Noise in Magnetic Recording", *Jour. AES 3*, 26...30 (1955 Jan)[3]

Certain noise effects associated with high-frequency recorded signals are attributab1e to rapid fluctuations in the speed of the magnetic tape as it passes over the recording heads. The high-frequency tape flutter may be caused by resonant longitudinal vibrations which are excited by random frictional forces. The flutter rate can be determined theoretically from a consideration of the mechanical properties of magnetic tape, and the calculations verified by actual measurement with a frequency discriminator and spectrum analyzer.

4 C. B. Sacerdote, "A Survey of the Mechanical Properties of Magnetic Tapes," ***Pubblicazioni Dell'Instituto Elettrotechnico Nazionale "Galileo Ferraris"***, No. 409, 16 pp. Ampex MRB1114 (1955) (In Italian). Translation available.

A report on some experimental investigations, dealing in particular with the static tensile stress, elongation, modulus of elasticity, elastic hysteresis, dynamic properties and resonance characteristics of various types of magnetic tapes. Graphs of the mechanical properties of the tapes and diagrams of equivalent circuits are shown, with description of apparatus; details of the actual tapes are not given.

5 C. B. Sacerdote, M. Caciotti and G. Sacerdote, "Wow in Sound Reproduction Systems" ***Onde Elect, 35***: 62...70, (1955 Jan) (In French and German; the section "The mechanical properties of the tape" only is available in English translation at Ampex Tech. Info. Service, #MRB1115)

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[1] "Scrape flutter" is the colloquial name for speed variations in tape transports due to longitudinal vibrations of the tape. This is also sometimes erroneously called the "violin string effect" (a violin string executes transverse vibrations).

[2] Bibliography compiled by J. McKnight, Ampex Audio, Sunnyvale, Calif. 1963 Aug. Revision: 1967 May. Computer scan and minor editing, 2001 July 3. The "Ampex Tech Info Service" no longer exists, but J. McKnight holds copies of these papers.

[3] In my opinion, this is the best English introduction to this subject.

6 P. Smaller, “An Experimental Investigation of the Noise in Magnetic Tape Recording and Reproducing Which is a Function of the Tape Characteristics” Ampex Research Report 104: (Aug. 1957) ; also published as “The Noise in Magnetic Tape Recording Which is a Function of the Tape Characteristics, ***Jour. AES, 7***: l96-2O2 (1959 Oct).

Measurement of scrape flutter is described. Direct spectrum analysis of the modulated carrier is performed, showing the fm sidebands.

7 E. Belger and G. Heidorn, “Longitudinal Vibrations in Magnetic Tapes” ***Rundfunktechnische Mitteilungen,, 3***: 51...55, (1959 Feb) (In German. Translation available at Ampex Tech. Info. Service #01624.) (MRB 1492)

These vibrations cause frequency modulation of the recorded signals. Series of tests show that the frequency of the resulting sidebands cannot be reconciled with the known static values of the modulus of elasticity (E) of the tape base material. The dynamic values of E musts in fact, be 20...60 % higher than the corresponding static values, rising with vibration frequency. The tests also show that the modulation index is of the order of 0.6 % while the breadth of the sidebands can be attributed to causes analogous to those encountered in spectroscopy. Of many tentative means suggested for reducing the vibrations one alone appears practicable, namely, the inclusion of an idler roll between the recording and playback heads. Direct spectrum analysis of the modulated carrier is performed, showing the fm sidebands.

8 W. Wolf, “Electromechanical Analogs of the Filter Systems Used in Sound Recording Transports”, ***Technische Mitteilungen aus dem Betriebslaboratorium fuer Rundfunk und Fernsehen (BRF) 5***, 1...9 and 49...58 (1961 March and June). (In Gerrnan–translation published in ***IEEE Transactions on Audio AU-l4-2***, 66...85 (1966 June).

The dynamic compliance of the tape is studied, particularly at frequencies below 1500 Hz.

9 W. Parthey, “Elastizitätsmodul Bandföriniger Proben” (“Modulus of Elasticity of Tape-shaped Samples”), Diplom-Arbeit, Technische Universitat Dresden, Institut für Elektro- und Bauakustik, (Thesis, Technical University of Dresden, East Germany) 1962 January. (Microfilm and hard copy obtained from the University by J. McKnight; not translated from the German).

The self-resonance of tape samples of 1 m length is studied, in order to extend the theory and practice begun by Wolf (see Nr. 8), Sec. VI, B. Thus the data applies to studies of “scrape flutter” but not to studies of low-frequency mechanical resonances (tape compliance and reel mass, for instance).