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著者	沼澤　潤二
journal or publication title	IEEE Transaction on Magnetics
volume	23
number	5
page range	2476-2478
year	1987
URL	http://hdl.handle.net/10097/47771

IEEE TRANSACTIONS ON MAGNETICS, VOL. MAG-23, NO. 5, SEPTEMBER 1987

HIGH SENSITIVITY SINGLE-POLE HEAD WITH TRANSVERSE RETURN-PATH CORE OF FLUX

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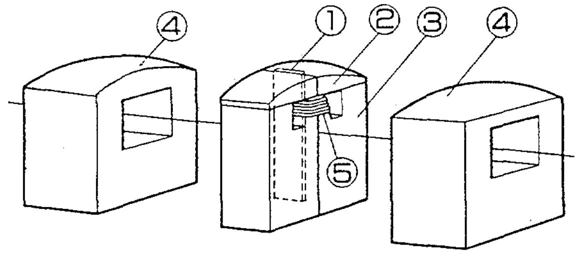
Abstract: A highly sensitive low noise and narrow-track width,main pole driven type single-pole head has been developed. This head is called TRF head (single-pole head with Transverse Return-path core of Flux flow). It is a kind of main pole driven type single-pole head which operates only on one side of the recording medium[1][2], and is based on a new idea incorporated in the flux return-path portion, to improve the recording and reproducing sensitivity and to reduce its system noise. The TRF head is especially effective for the recording and reproducing with narrow track widths. The development of this head has resolved the problem of insufficient sensitivity in conventional single-pole heads which was a barrier to using narrow track widths, and has provided the prospect of using narrow track width heads necessary for high density digital video recording.

INTRODUCTION

We have been pushing basic experiments and investigations on the high track density recording and reproducing characteristics of perpendicular magnetic recordings. So far, using conventional main pole driven type single-pole heads and a Co-Cr/Ni-Fe double-layer flexible medium, we attempted narrow track width perpendicular magnetic recording and reproducing. By means of these experiments, we found out that to use narrower track widths and higher recording area densities in perpendicular magnetic recording, higher head sensitivity and lower noise levels are both important. To obtain such higher head sensitivities and lower noise levels, it is conceivable to improve the characteristics of the head magnetic materials [3][4] and the head structure. The TRF head has an improved structure. This paper describes the features of this high-sensitivity and low-noise level TRF head.

STRUCTURE AND FEATURES OF TRF HEAD

Fig.1 is a schematic diagram of the structure of a TRF head for a flexible disk system. As may be seen from this figure, the flux return-path of the TRF head is not at its side core (where the magnetic material for return-path comes into contact with the medium through a non magnetic substrate), but magnetic material is placed on each side at a definite distance in the track width direction, and the magnetic material comes into direct contact with the medium. This arrangement eliminates the degradation of sensitivity caused by the comparatively large gap between the side core and the medium in conventional heads. Moreover, in this scheme, the problem of waveform interferences due to extra pulses arising when the side core portion comes into direct contact with the medium in conventional head, is eliminated, at least in principle. Fig. 2 shows the reproduced waveform at a recording linear density of 4.3 kFRPI obtained with the TRF head. It may be that no extra pulses occur.



1. MAIN POLE THIN FILM(Co-Zr-Nb AMORPHOUS)
2. SLIDER(CERAMICS, VICKERS HARDNESS=1500)
3. SIDE CORE(FERRITE)
4. TRANSVERSE RETURN-PATH CORE(FERRITE)
5. COIL

Fig. 1 Schematic diagram of the structure of a TRF head

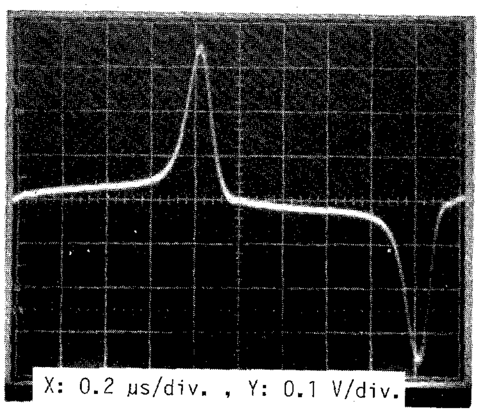


Fig. 2 Reproduced waveform at recording linear density of 4.3 kFRPI with the TRF head

With the TRF head, where the return-path core consists of a magnetic materials placed at a definite distance on each side in the track width direction and slides while in direct contact with the medium, there is a possibility of an adverse effect. During recording or reproducing the return-path core may erase, or crosstalk with, the signal which has already been recorded on the medium with which it is in contact. The results of the measurements made in this respect indicated that during the recording, almost no effect on a previous recording could be detected. During reproducing, crosstalk from the track with which the return-path core was in contact, was very low, about -47 dB or less. Table 1 shows the parameters of a test-manufactured TRF head for flexible disk system,and a conventional main pole driven type single-pole head and the Co-Cr/Ni-Fe double-layer flexible disk medium used for comparative measurement.

0018-9464/87/0900-2476$01.00©1987 IEEE

Table 1 Parameters of the TRF head, the conventional single-pole head and 3.5-inch Co-Cr/Ni-Fe double-layer flexible disk medium

HEAD		
Thickness of main pole (Tm)		0.4 μm
Track width (W)		50 μm
Number of turns (N)		30
MEDIUM	Co-Cr layer	Ni-Fe layer
Thickness	0.36 μm	0.40 μm
Ms	382 emu/cc	621 emu/cc
Hc	900 Oe	0.65 Oe

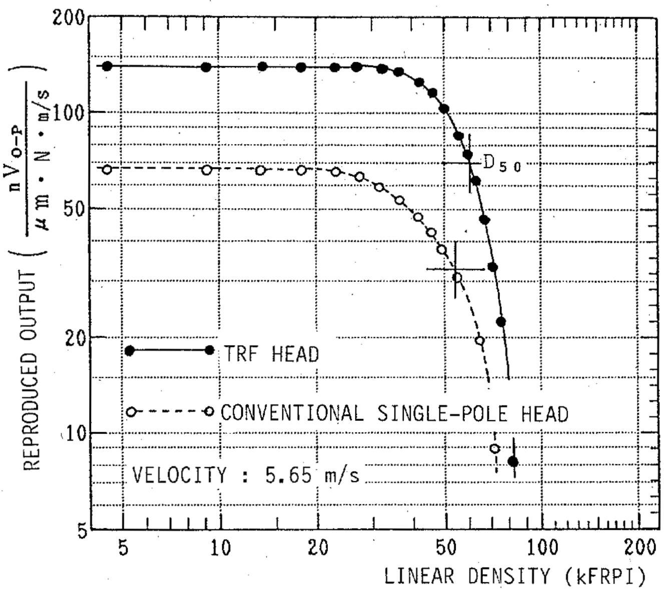


Fig. 3 Dependence of reproduced output on recording linear density

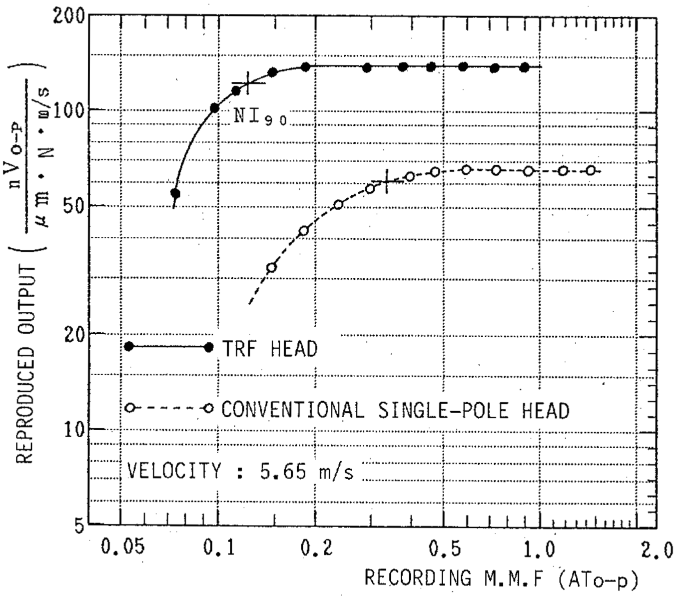


Fig. 4 Relationship of reproduced output vs. the recording current (at 9 kFRPI)

Fig. 3 shows dependence of reproduced output on the recording linear density of the TRF head compared with a conventional head without Transverse Return-path Core. Fig. 4 shows the relationship of reproduced output vs. the recording current in comparison similarly to Fig. 3. In Fig. 3 and Fig. 4, the head-to-medium relative velocity was 5.65 m/s. As may be seen from these figures, the recording and reproducing sensitivity of the TRF head is more than twice as high as that of a conventional head. Fig. 5 shows

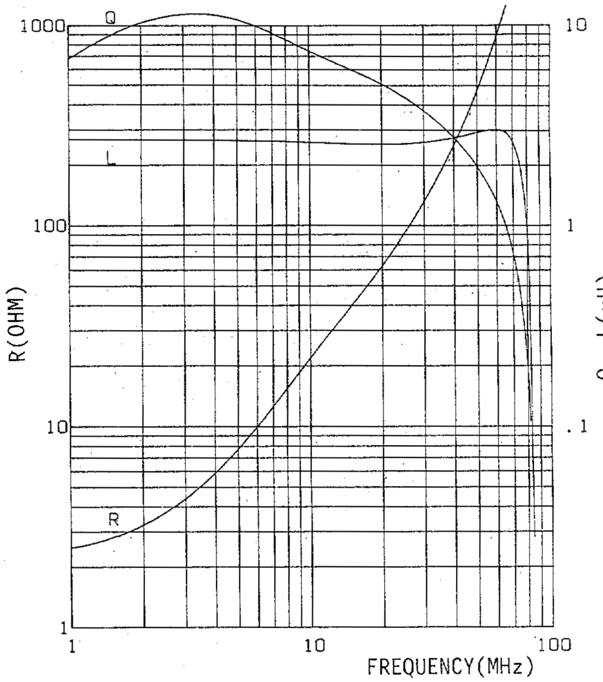


Fig. 5 Frequency characteristic of the impedance (L,R,Q) of the TRF head

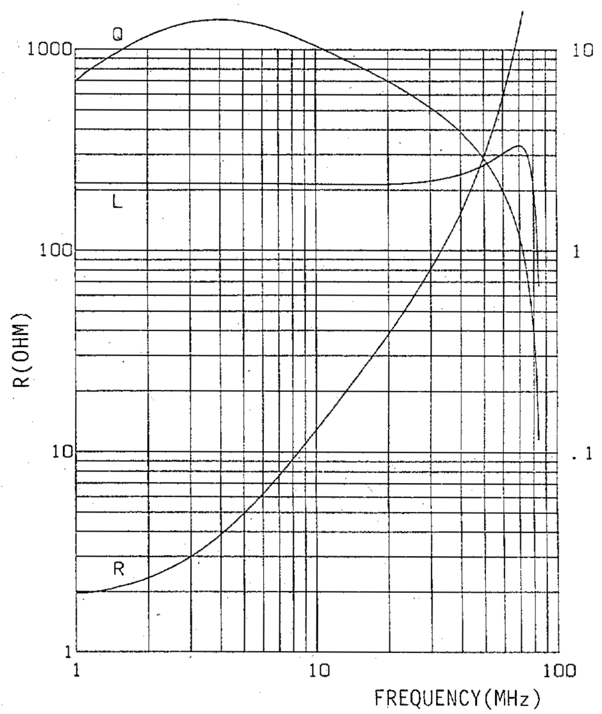


Fig. 6 Frequency characteristic of the impedance of the conventional single-pole head

the frequency characteristic of the impedance (L,R,Q) of the TRF head. It may be said that in this figure what mainly causes head impedance noise is thermal noise due to the resistant component (R), and the smaller this value the lower the head noise level is. Fig. 6 shows the frequency characteristic of the impedance of a conventional head for comparison. When comparing of the resistant component of a conventional head with that of a TRF head, the noise voltage of the TRF head, is a little greater while the reproducing sensitivity is more than twice as greater. To explain this more clearly, Fig. 7 and Fig. 8 show the noise spectra of a TRF head and a conventional head for the same medium, same track width(50 µm) and same linear density(50 kFRPI). In Fig. 7 and Fig. 8, the head-to-medium relative velocity was 6.0m/s. From these figures, it may be seen that the TRF head, as compared with a conventional head, is almost free from degradation of CN ratio caused by instrument noise (power summation of amplifier noise and head impedance noise) during reproduction. Table 2 shows the recording and reproducing performance of the TRF and conventional head. From the data given above, it has been confirmed that the TRF head has a sufficiently high recording and reproducing sensitivity (NI90=0.12 ATo-p at 9 kFRPI,Output=140 nVo-p/(µm N m/s) at 9 kFRPI) and low noise characteristics for the primarily intended narrow-track width and high density perpendicular magnetic recording system.

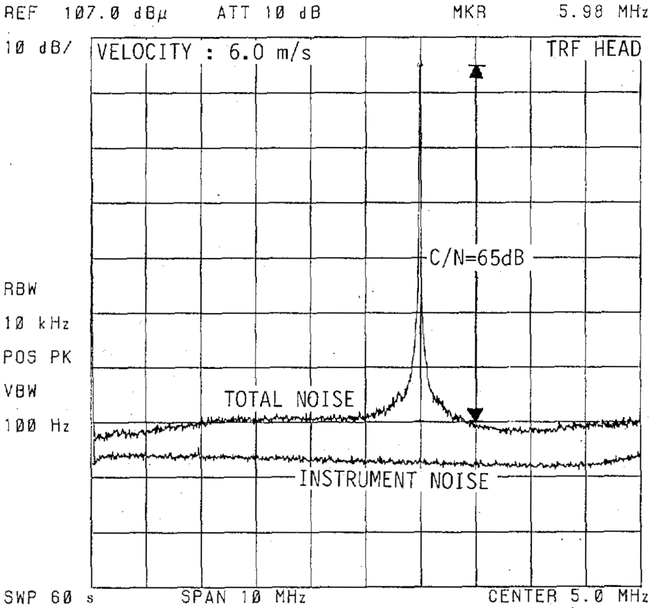


Fig. 7 Measured noise spectrum and CN ratio of the TRF head for the Co-Cr/Ni-Fe double-layer medium

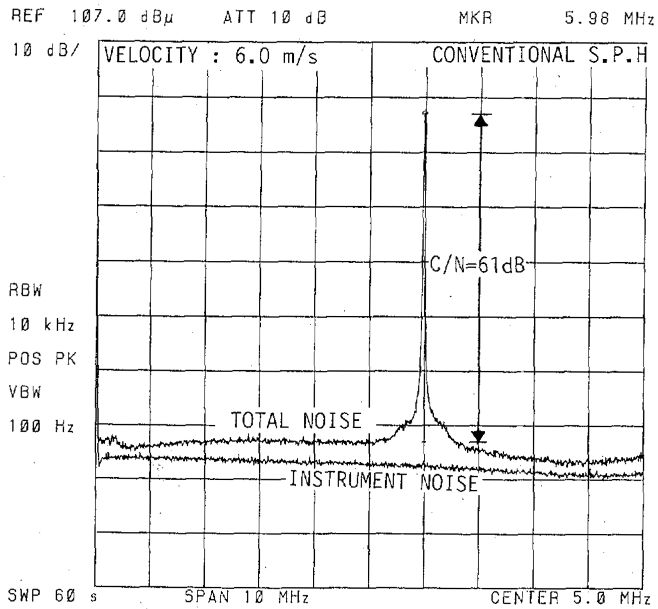


Fig. 8 Measured noise spectrum and CN ratio of a conventional single-pole head for the Co-Cr/Ni-Fe double-layer medium

Table 2 Recording and reproducing performance of the TRF and conventional head

	TRF HEAD	CONVENTIONAL HEAD
Reproduced output at 9 kFRPI (nVo-p/(µm·N·m/s))	140	68
NI90 at 9 kFRPI(ATo-p)	0.12	0.32
D50 (kFRPI)	62	58
C/N (dB) at 6MHz Band width 10 kHz	65	61

CONCLUSION

A newly developed TRF head was test-manufactured and was measured and evaluated. It was found that it is excellent for the high-sensitivity and low-noise characteristics, so that in video recording, for which narrow track width and high recording area density are required, there is little influence of the head impedance noise, and as a result, a CN ratio of the TRF head is 4 dB higher than that of a conventional single-pole head in the same recording medium and same recording conditions.

ACKNOWLEDGMENT

The authors wish to thank the member of Tokin Corporation who made an effort to improve the recording medium in our study. Further, we thank Dr. K. Yokoyama of NHK for his support.

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