A SIMPLE SYNCHRONISATION METHOD FOR REPRODUCING TAPE-RECORDED PROFILES

by W. N. Li
Department of Geophysics, Imperial College, London
and D. Taylor Smith
Marine Science Laboratories, Menai Bridge, North Wales

ABSTRACT

A simple method has been used to obtain synchronism in the reproduction of tape-recorded continuous reflexion profiling data for graphic display. By use of a 2-channel recording technique a reference signal, from a precision graphic recorder, can be simultaneously recorded with the acoustic data. This reference signal can then be used to govern the speed of the graphic recorder during play-back, totally eliminating any graphic distortion caused by tape speed deviation. The technique can be used with any relatively inexpensive tape recorder and can, consequently, broaden at low cost the scope of any sub-bottom profiling system or, for that matter, any profiling system which employs a precision graphic recorder.

INTRODUCTION

There are many advantages to recording acoustic data, acquired by continous reflexion profiling, on magnetic tape. The fundamental advantage is that the recorded data can be played back and examined under a variety of different processing conditions each adapted to reveal some special feature of the traversed region. A further important advantage is that by means of tape recording, in conjunction with the usual graphic recording, a guarantee can be effected that the acoustic data is continuously collected; this cannot be achieved when the graphic system is used by itself. In addition to all this the tape can either be cleaned after analysis and used again, or it can be stored and, in the event of an advance in interpretation involving new instrumentation, the data can be re-processed with the new technique. These features are familiar to most people.

However, a major difficulty generally encountered in reproducing a tape-recorded signal free from distortion is the presence, in almost all tape recorders, of a certain amount of deviation in tape speed. This is mainly due to the fact that the tape transport mechanism is essentially a friction-controlled device, consisting of a capstan and roller assembly, which is rather sensitive to any slight change of tape tension as well as to environmental conditions. While the use of a precision frequency power supply to drive the capstan motor can eliminate that part of the speed deviation caused by any variation of the shipboard mains frequency, the remaining part of the speed error can only be controlled to a variable extent and is impossible to remove completely. Generally speaking the more expensive the tape recorder the smaller is this speed error. Unfortunately, even with elaborate and costly equipment, a great reduction in tape speed accuracy can usually be expected when the recorder is used for shipboard measurements where mechanical vibrations and a corrosive atmosphere are prevalent.

The effect of speed drift shows itself very obviously when tape-stored correlated data are visually displayed on a graphic recorder. For most tape recorders used professionally an acceptable speed tolerance is about $\pm$ 0.25 %; the usual flutter accompanying such a speed deviation is negligible for most practical purposes. Such a speed drift, however, would have dire results if it appeared in a play-back of sub-bottom profiling data. With a fixed speed deviation of this kind a horizontal geological structure would appear at a dip of 1/400: for a 1-second graphic sweep the structure would disappear off the edge of the paper in less than 7 minutes. And for the more general case where the tape speed drifts randomly within its tolerance, the reproduced picture would be extremely distorted.

This problem can be solved in a very simple manner with the simplest of tape-recording equipment provided that some synchronising signal can be provided between the normal graphic recorder and the tape recorder, and which is common to both.

CORRECTION TECHNIQUE

Most precision graphic recorders have the common feature that the helix is driven by a gear train which is actuated by a synchronous motor. The speed of the motor is carefully controlled by means of a precision power supply which is itself controlled by a tuning-fork or crystal oscillator. The overall frequency variation in such a system is less than 1 part in 10^5. By recording the tuning-fork, or crystal output simultaneously with the sub-bottom acoustic data, the relative timing of any particular event in the data with respect to the tuning-fork reference signal can be fixed. During play-back, from the tape to the graphic recorder, the stored reference frequency can be used to drive the synchronous motor so locking the motion of the helix to the data being reproduced.

INSTRUMENTATION

A schematic diagram of such a record/reproduce sub-bottom profiling system, as outlined above, is shown in figure 1. A standard Mufax 18-inch chart recorder has been modified such that a photocell assembly gives out programmed trigger pulses. These pulses are used for triggering the acoustic analysis equipment as well as for the normal acoustic transmission control. A fork oscillator provides a 1 kc/s, 0.4 volt peak-to-peak output which is fed to the Channel 1 input of a Tandberg stereo tape recorder at the same time as an acoustic signal is being recorded on Channel 2; the acoustic signal, of course, is recorded also via amplifiers and filters on the Mufax. During play-back the 1 kc/s signal, with its output adjusted to the original voltage level, is fed from the tape recorder to the input stage of the motor drive amplifier. A change-over panel jack, installed at the back of the Mufax recorder, ensures an automatic isolation of the fork oscillator output from the following amplifying stage whenever the reproduced synchronising signal is plugged in.

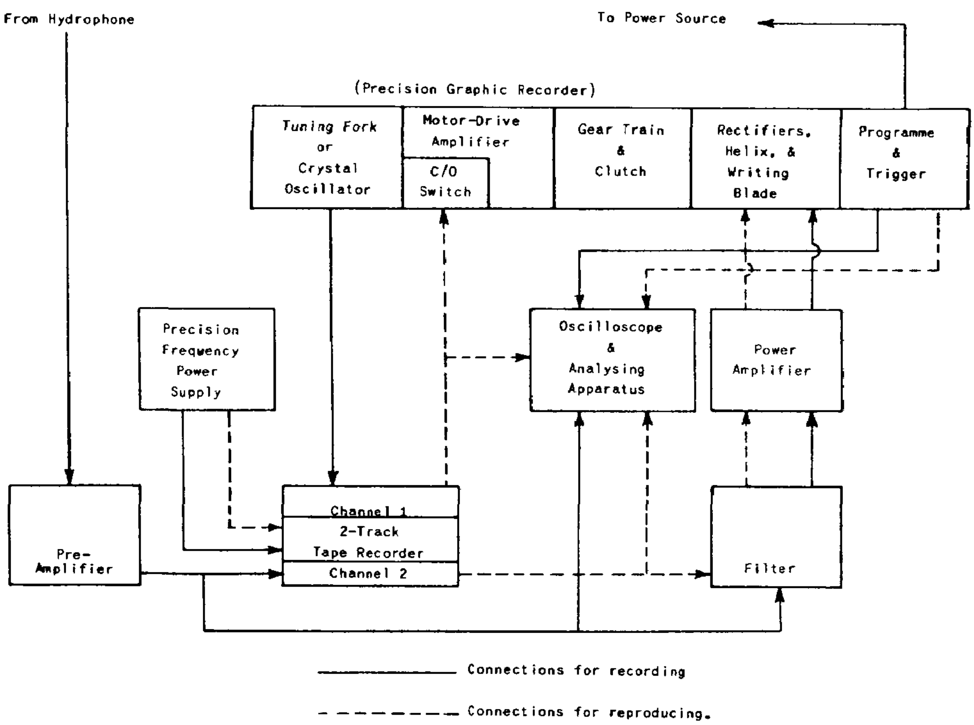

FIG. 1. — Block schematic of a synchronised record/reproduce sub-bottom profiling system.

The 1 kc/s synchronisation signal has a further use : it provides a visual sinusoidal time reference to any data observed on the oscilloscope

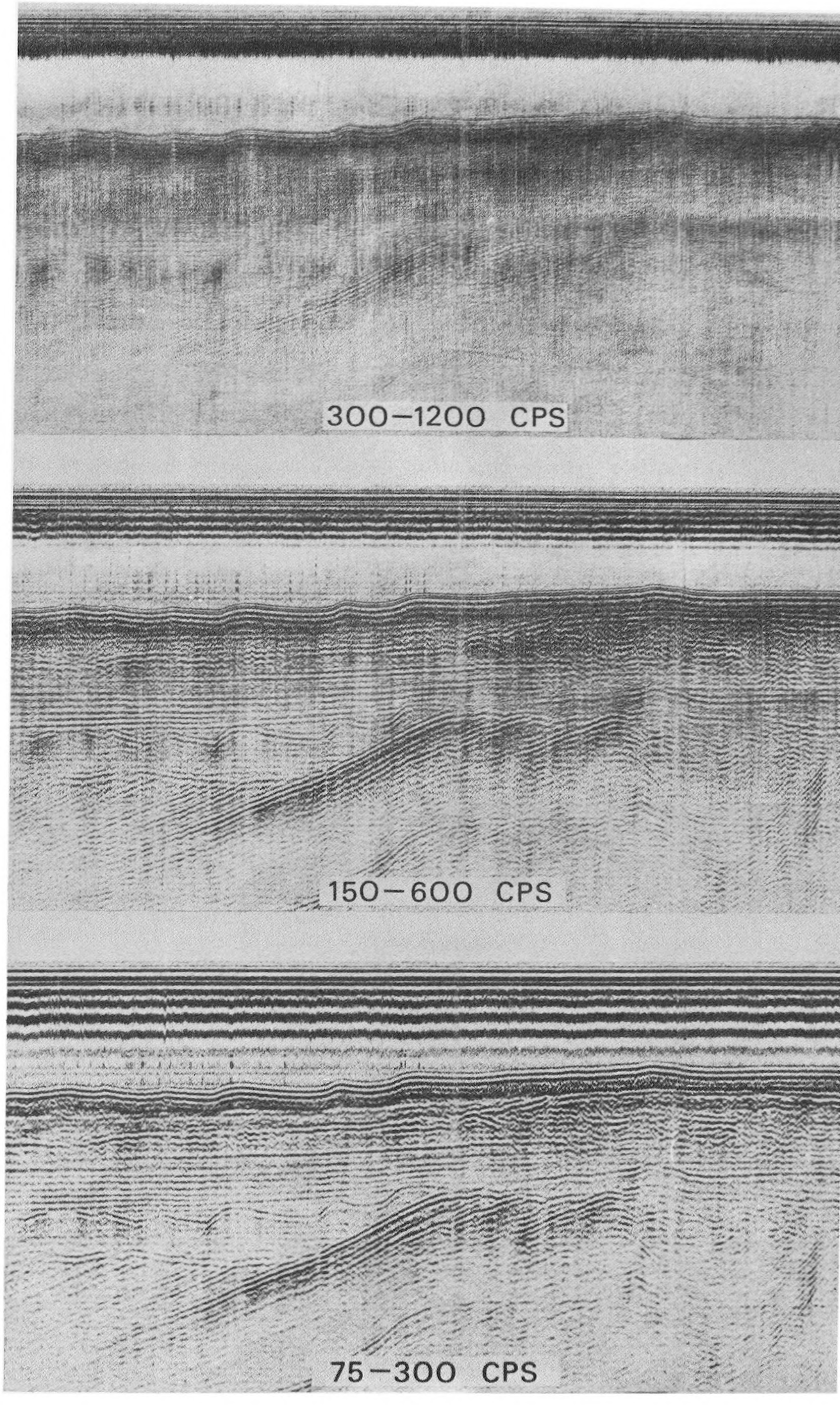

FIG. 2
Reproduced sparker sub-bottom profiles, with different filter settings, via tape recorder play-back.

as well as providing a frequency datum when the acoustic information is examined with a spectrum analyser.

One further point requires mention : as the Tandberg tape recorder is relatively inexpensive, an external precision frequency power supply has been used. To counteract the adverse effects of ship-board conditions, the use of such a unit is desirable in order to maintain the data quality. Most professional tape recorders are supplied with an internal constant frequency source for the capstan motor.

DISCUSSION

Sample records of a section of a sparker traverse synchronously reproduced through three different filter settings are shown in figure 2. Examinations of this kind are necessary for a qualitative interpretation of the record as well as in providing a correlative graphic monitoring during quantitative investigations, such as spectrum analysis, of the various transmitted and reflected pulses.

For the Mufax recorder, the locking-in of such a synchronisation process is effective for all tape speed deviations up to ± 35 %. It must be noted, however, that such synchronisation is not a speed drift control; it is simply a correction for the effects of a speed drift.

This technique can be applied to any continuous data recording system which employs a precision graphic recorder or similar device. Any 2-track tape recorder which has a tolerable flutter can be used without the necessity of purchasing expensive equipment. Full graphic play-back facility can therefore be easily incorporated at low cost into any precision profiling system.

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