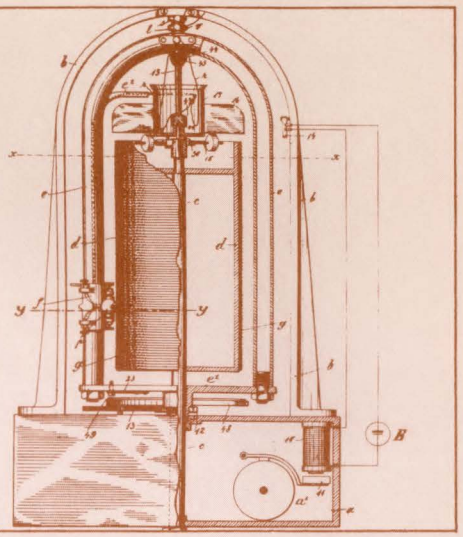
INSTRUMENTATION TECHNICAL INFORMATION NUMBER 3



RECURRENT SCANNER RECORDING

By J. W. Hebb

Recording applications sometimes arise which require recording of intermittent high band width data. The scanner tape recorder provides a method of recording which eliminates tape wastage during the period between data bursts.

A second application is in the transformation of pre-recorded data. This often takes the form of time base expansion or compression, spectrum analysis, or A/D conversion before the data is fed into a computer or read out onto a chart. In some cases, the data must be operated on in several ways. The recurrent scanning recorder developed by Ampex is a tool designed to aid in the problem of data condensation and analysis.

DATA CONDENSATION

Data condensation was necessary in the recording of weather photographs from Applications Technology Satellites (ATS) since large amounts of empty space were scanned by the satellite's photosensor during each revolution, putting the earth in view only 30 milliseconds of the basic 600-millisecond scan period. The recorder would thus pick up long gaps with no data while the tape moved at 120 ips, resulting in an excess of useless data and considerable amounts of wasted tape.

Ampex overcame this problem by developing a new recorder, the SK-1600, which uses a unique scanning-drum head design to allow large amounts of redundant information to be stripped out as it is recorded. The head is contained in a drum that rotates at about 100 rpm. Magnetic tape is carried past the head at 7.5 ips to yield a wide bandwidth head-to-tape speed of 120 ips. Electronic gating circuits synchronized to the desired data source turns on the head as data appears and turns it off as it moves away. As the tape moves in the opposite direction to the head, a suitable choice

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of tape speed makes it possible to pack successive blocks of useful information very close together. Thus, the recurrent scanning technique avoids the redundancy of data and concurrent waste of tape and evaluation time that would arise with conventional recording methods.

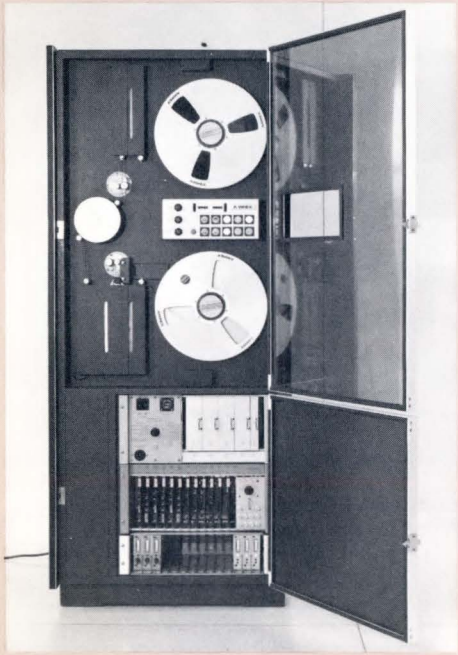

FIGURE 1: Ampex SK-1600 Recorder/ Reproducer/Scanner

In the satellite application, the unit is used to record cloud cover and duty cycle improvement data, and reproduce the data continuously with time base expansion from 120 to 7.5 ips. As the satellite rotates, a telescope with a photocell at its focal point receives reflected light from the earth's cloud cover and transmits the data in real time to a ground station for recording. The telescope moves slightly and takes a new line of data on each successive revolution. The camera points toward the earth for only about 20° of the 360° revolution; therefore, the duty cycle of the data is quite low.

In this installation, record heads are mounted in a scanning drum. Reproduce heads are mounted in the conventional manner to make contact with the tape downstream from the scanning drum. The scanning drum is precisely phase locked to the satellite so that the record heads are in the proper place when the camera is pointing toward the earth. Record amplifiers are turned on only during the 20° satellite rotation. The tape capstan is also synchronized to the satellite to move the proper amount of unrecorded tape into the drum area. Lines of data that make up the complete picture of the earth are therefore laid end-to-end on the tape.

Next, the tape is fed into a reproduce section before going to the take-up reel. Since it has been time base expanded, it may be printed out directly or simply monitored to insure a proper recording. The tape can then be reproduced on any standard wide-band FM reproducer and for archival storage.

TRANSIENT PHENOMENA

The machine may also accept longitudinally recorded tape in IRIG format and perform repetitive analysis in the reproduce mode, such as the study of transient phenomena in oscilloscope display. Other applications include

(1) time base expansion or contraction in either the scanning mode and (2) sample-and-hold method of time base expansion of a particular wave form by sampling the data once for scan but sampling at a slightly later time on each revolution.

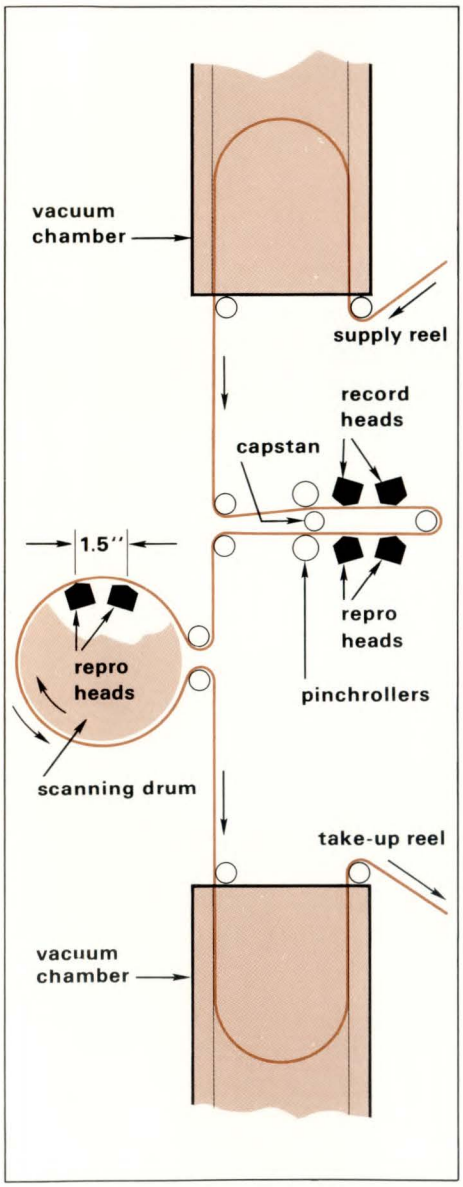

FIGURE 2: SK-1600 Scanning and Capstan Detail

Another configuration of the recurrent scanner, the converse of the satellite application, has reproduce heads mounted in the scanning drum. With this arrangement, a pre-recorded tape can be repetitively scanned and the data displayed on an oscilloscope for visual interpretation or photography. The drum may be slowed down and the data fed into an analyzer or an A/D converter. The scanned data will virtually stand still, while the data from different tracks are being correlated against one another.

Once the particular data of interest is located on the tape, a sample-and-hold system in conjunction with an X-Y plotter gives a direct plot of a particular scanned portion of the tape by taking a sample of the signal during each revolution of the reproduce scanner drum. That is, if a particular wave form were divided into 1000 equal parts, it would take 100 seconds to make a plot of the sampled wave form at 10 samples per second. Of course, the drum may be slowed down if the X-Y recorder or the sampler has a limited bandwidth.

APPLICATIONS

Specifically, there are a number of uses which immediately suggest themselves for this type of recorder/reproducer/scanner. A few of these are:

1. **Data Analysis**

   Pre-recorded data such as PCM Telemetry or multiplexed data can be repetitively examined over short periods of interest. This allows such techniques as photography or specific data coding problems, auto-correlation for signal-to-noise enhancement, cross correlation between tracks for determining cause and effect relationships, and sampling time base expansion/compression.

2. **Tape Testing**

   The usual problem in testing of magnetic tape is that short lengths of sample formulations have to be examined minutely for such characteristics as signal amplitude stability, surface conditions, and signal recording parameters. Short lengths of tape, either by sampling or through an entire reel, may be quickly compared through the use of the unit to determine process uniformity.

3. **Signal Formatting**

   As noted in the satellite application, this recurrent scanning technique removes data redundancy and provides a continuous record for subsequent playback on a normal IRIG compatible system for bandwidth reduction. Other standard or non-standard formats can be set up as needed.

4. **Data Rate Change**

   Another application exists in slow-scan video recording. An auxiliary record head placed ahead of the scanner records multiple channels at a low frequency commensurate with a low longitudinal tape speed, such as 125 kHz for 7-½ ips forward speed. The scanning drum then rotates at a rate to give 120 ips tape-to-drum speed and a resultant output frequency up to 2 MHz. This means that the previous 800 ms of data recording at a frequency of 125 kHz will be reproduced every 100 ms at an output frequency of 2 MHz. Other record-to-reproduce speed ratios are possible providing the output drum limit at 120 ips is observed.

SUMMARY

Briefly, the Ampex SK-1600 is a complete recorder/reproducer/scanner which may be used as a recurrent scanner or in the conventional recorder/reproducer modes. Either standard pre-recorded IRIG format magnetic tapes may be scanned or the record section may be used to record new (dubbed) tapes. The unit essentially consists of a closed loop capstan system (which may contain a complete set of record heads and a complete set of reproduce heads) for controlling tape motion, a scanner drum containing a complete set of reproduce heads and pre-amps, a tape reeling system, a complete set of record electronics, a complete set of reproduce electronics, and control electronics to allow all the functional modes listed.

Although the machine is primarily designed to be a scanner capable of repetitively scanning any 12-inch segment of tape at one of seven different head-to-tape speeds, another version includes complete record capabilities for standard 14 track IRIG format on one-inch tape. This version can be used as a conventional recorder/reproducer or data can be recorded to be scanned. Since IRIG format is maintained, tapes recorded on conventional recorders can be reproduced and scanned on this machine.

The machine maintains a complete 14 channel record/reproduce capability at a 2 MHz or 1.5 MHz bandwidth at 120 ips (IRIG) and proportionally less bandwidth at lower tape speeds. Any 12-inch segment of tape can be repetitively scanned at 10 scans per second at a head-to-tape speed of 120 ips with a data bandwidth from 400 Hz to 1.5 MHz or 2 MHz.

FIGURE 3: Scan Speed – 120 ips
Horiz. Scale – .1 sec.
Vert. Scale – 5 V/cm

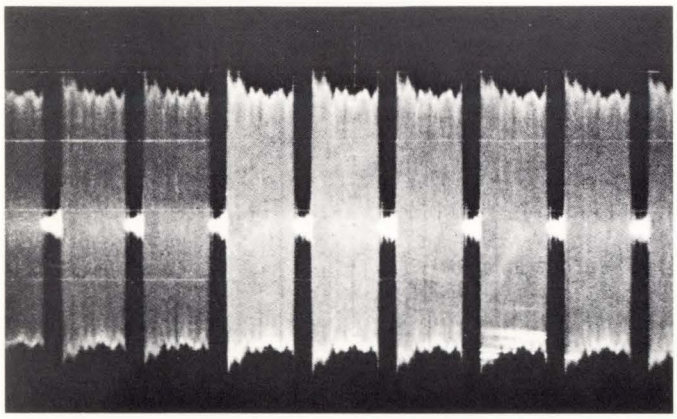

FIGURE 3.

FIGURE 4: Scan Speed – 30 ips
Horiz. Scale – .1 sec
Vert. Scale – 5 V/cm

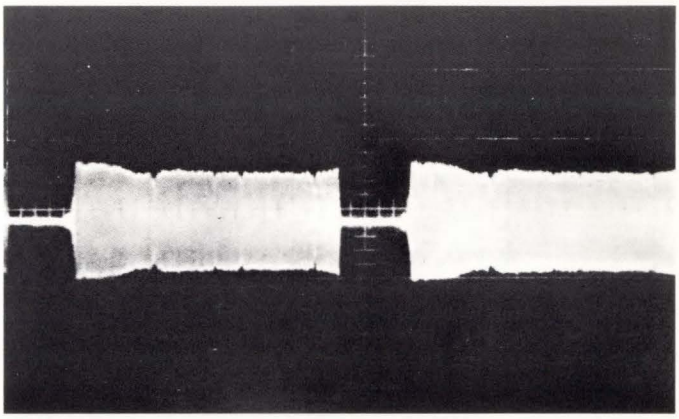

FIGURE 4.

FIGURE 5(a) & 5(b): Scan Speed – 60 ips
Horiz. Scale – 200 μsec
Vert. Scale – 5 V/cm

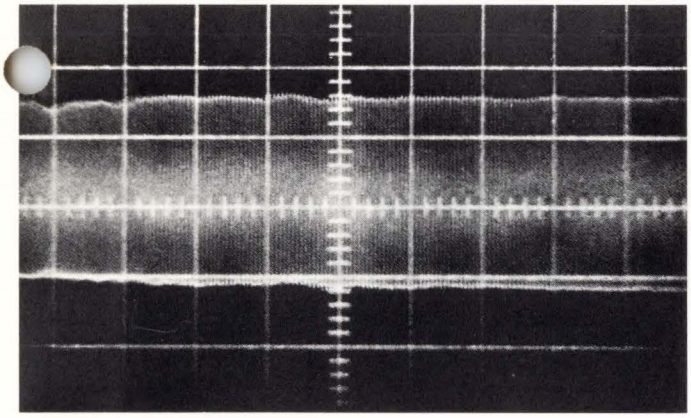

FIGURE 5(a).

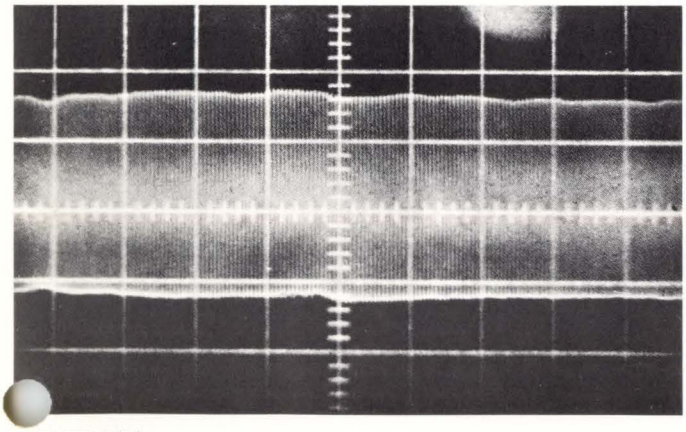

FIGURE 5(b).

FIGURE 6(a) & 6(b): Scan Speed – 60 ips
Horiz. Scale – 200 μsec
Vert. Scale – 5 V/cm

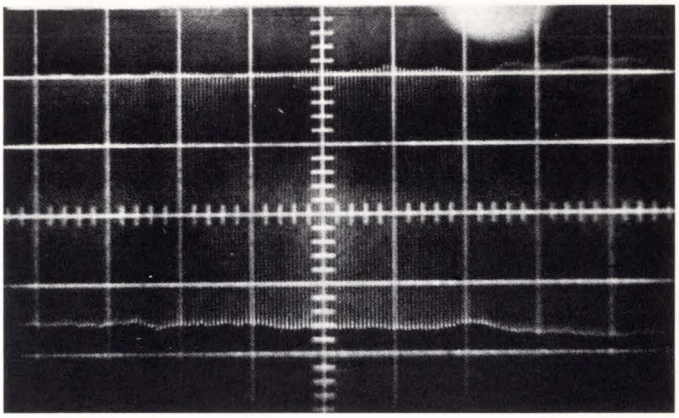

FIGURE 6(a).

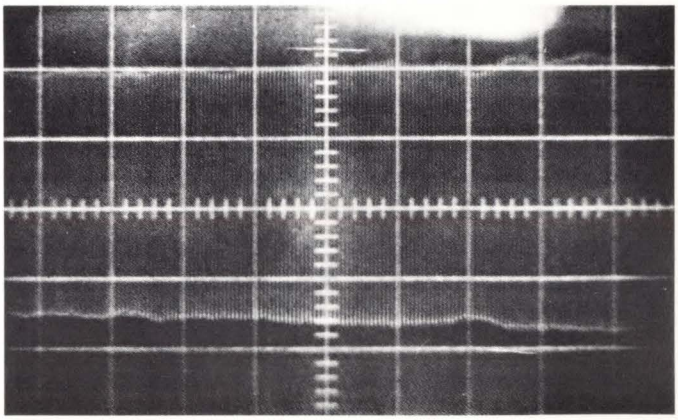

FIGURE 6(b).

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