The following paper deals with the Conveyor Belt Monitor, a device which can measure, very precisely, certain important parameters in steel cord conveyor belting. It is useful in determining if belting has been manufactured to end users' requirements and is vital as a condition monitoring tool on-site throughout the life of the belt. It employs high-technology magnetic measuring techniques, is not hazardous and is totally non-invasive.

STATE OF THE ART USAGE OF THE HARRISON CONVEYOR BELT MONITOR

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1. INTRODUCTION

Early in 1979, the CSIRO Division of Applied Physics at Lindfield in Sydney began work on a project which was to have far reaching effects in the materials handling industry.

Under the direction of Alex Harrison, an experimental device was produced. This device was to become known as the Conveyor Belt Monitor, and was designed to measure the steel mass present in steel reinforced conveyor belts. Successful field testing was carried out, and in November of that year, the first licence was issued by CSIRO for commercial development of the Monitor. It was at this time that the writer became involved, full time, in the project. Following a Research and Development period, during which major changes were made to the hardware and operational techniques were developed, the device was launched commercially in May 1981 via the Conveyor Belt Monitoring Service. Since that time the writer has personally scanned over one hundred belts, both on-site and in the factories of origin.

2. THE DEVICE

The conveyor belt monitor measures magnetic reluctance, is non-hazardous and is totally non-invasive. Its theory of operation has been previously documented (1), and is beyond the scope of this paper. However, a brief look at its current format is in order. The device falls into two categories:

1. The longitudinal scanner

This scanner consists essentially of a yoke through which a belt is passed while operating normally on-site, or on an inspection table in the factory of origin. Refer Fig. 1

By selective processing of the data obtained, three belt parameters are measured.

i) finite steel mass in the belt carcass,

ii) top and bottom cover thickness along the belt, and

iii) splice make-up.

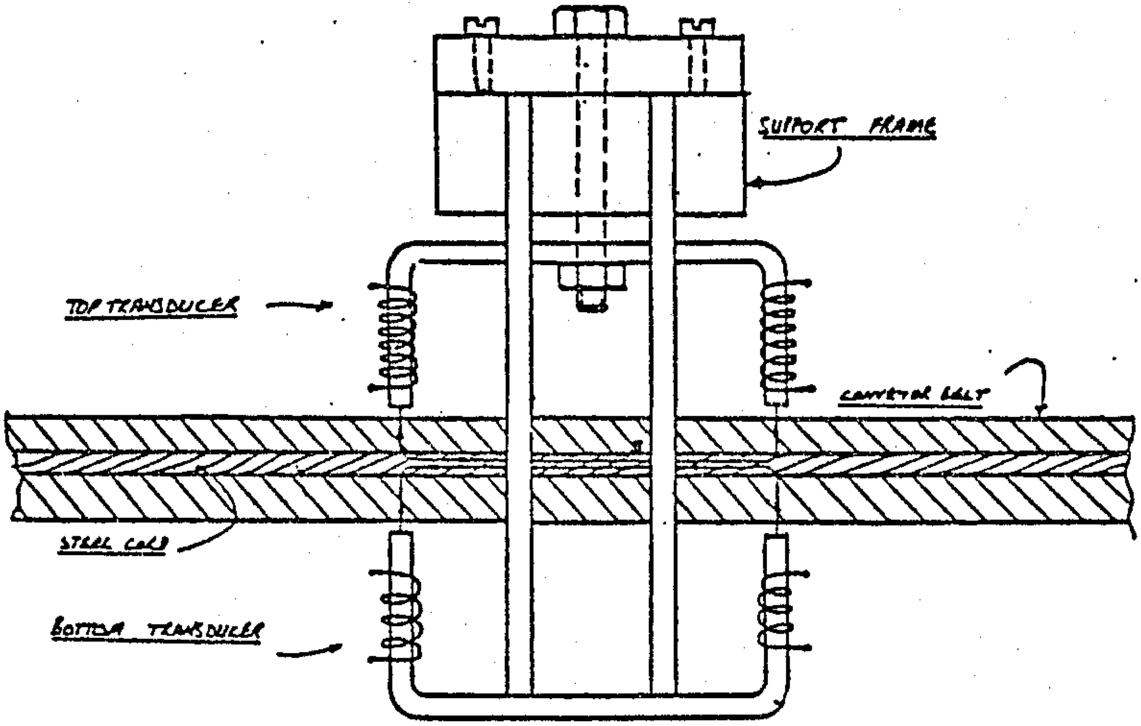


Fig. 1 The Longitudinal Scanner

2. The lateral scanner

This device consists of a hand-held probe which is passed across the belt in contact with the surface. Refer Fig. 2. The scanner is capable of measuring the finite cover thickness above and below each cord to within 0.5mm. Cord pitch and lateral cord displacement are also established. A variation of this device uses two probes running along each edge of the belt. In this way the position of the edge cord may be determined in relation to the finite belt edges (edge rubber dimension).

Information from both longitudinal and lateral scanners is recorded on data cassette for archival purposes, with a hard copy being produced on chart paper for immediate use.

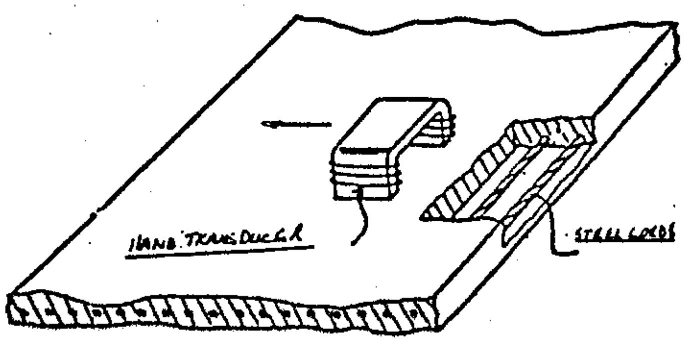


Fig. 2 The Lateral Scanner

3. INDUSTRY ACCEPTANCE

As indicated, access to both devices was offered in May of 1981 via a

As more and more findings were substantiated, confidence in the technology grew. Operator techniques also improved and a much better understanding of the value of the device emerged. It is now possible to define, more precisely, the role the Monitor can play in the safe and efficient operation of steel cord conveyors.

4. CURRENT RECOMMENDED USAGE

The Monitor provides a basis for an on-going belt care programme. This begins in the factory during manufacture, with a modified version of the lateral scanner being used to detect anomalies in cord placement. It has been found that some belting suffers from vertical or lateral cord displacement, during manufacture. The Monitor can define, very precisely, the extent of this displacement and remedial measures can be implemented, where appropriate. A big feature of the Monitor is that it is totally non-invasive and, therefore, its scanning can be continuous. In this way measurements for the entire belt are possible rather than from test samples taken from the ends of manufactured lengths.

From the end users point of view, belting can be checked in the factory, prior to delivery, to determine if it has been manufactured in accordance with agreed design criteria.

It is important to establish what profiles exist in the new belting, if meaningful measurements are to be made on an on-going basis, to calculate field wear rates. To illustrate this point, Figs. 4(a) through 4(e) show some profiles obtained from unused belting direct from the factory.

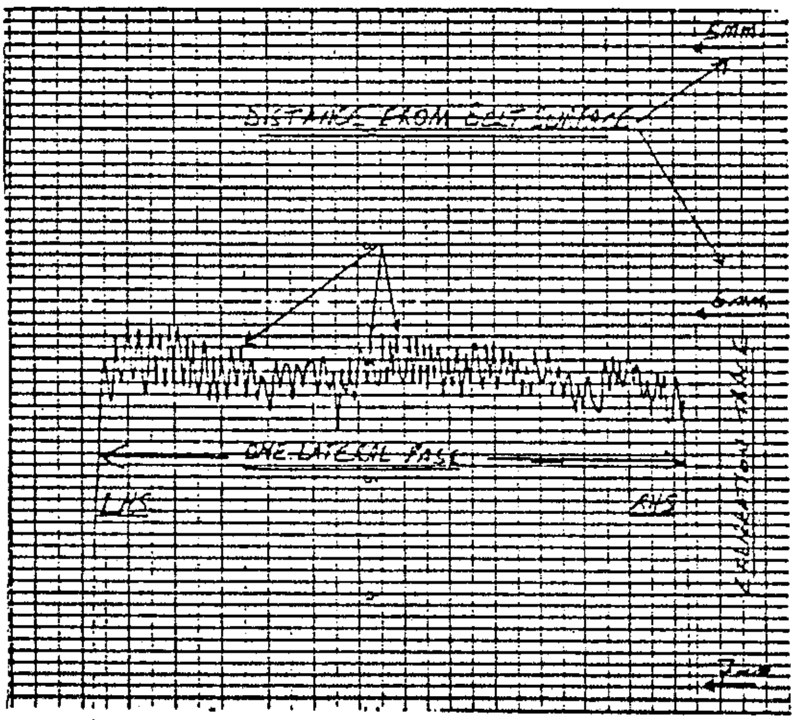


Fig. 4(a)

Fig. 4(a) shows a trace produced by one full lateral pass across the bottom cover of a belt with a nominal pulley cover thickness of 6mm. The peaks in the trace (arrowed) represent the tops of the cords as the probe passes over them. The dips result from the spacing between cords. To determine the finite cover thickness above a cord, the level of the

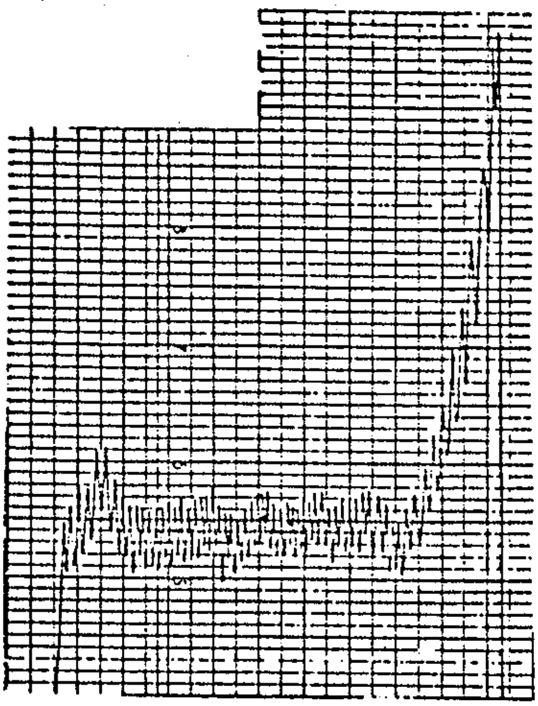
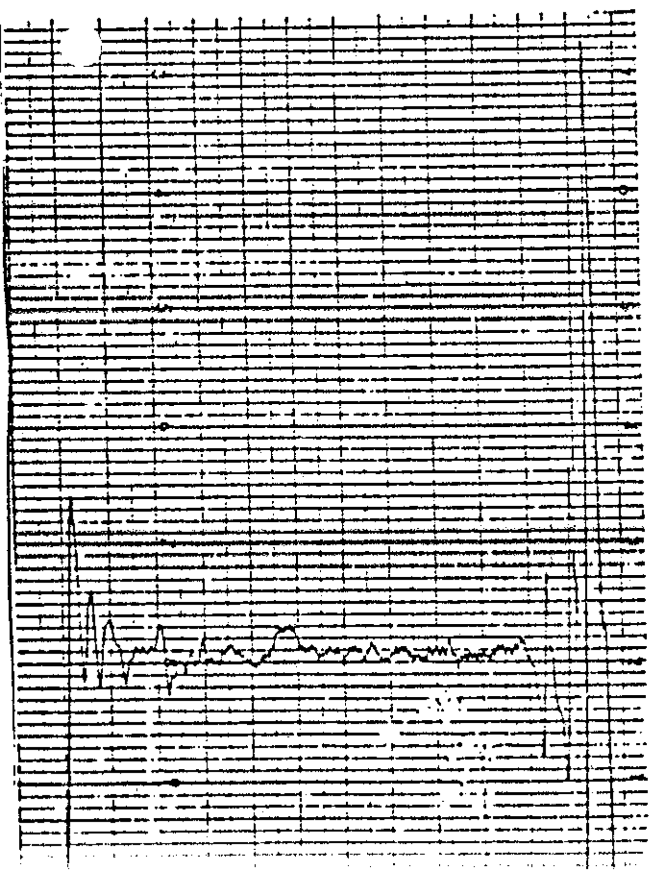


Fig. 4(b)

Fig. 4(b) shows a trace produced from the same belt at a different location. Here it is obvious that vertical cord displacement does exist. This cross-section of belting is outside AS 1333 specifications in the cover thickness domain. The traces shown in Figs. 4(c), 4(d) and 4(e) were all produced from new belts. It is obvious, therefore, that very complex profiles can exist in unused belting.



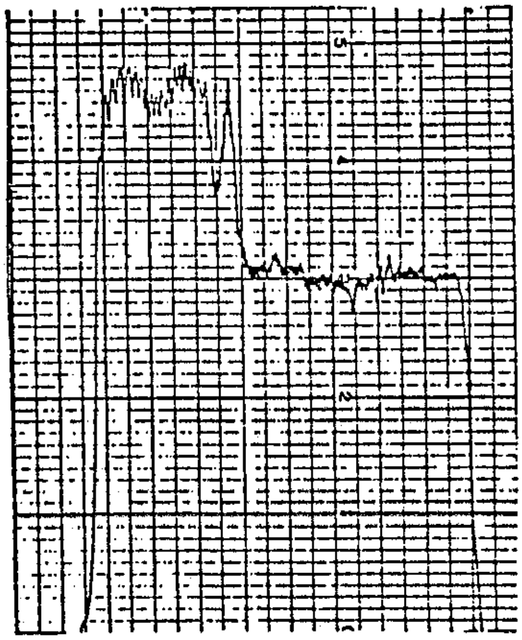


Fig. 4(d)

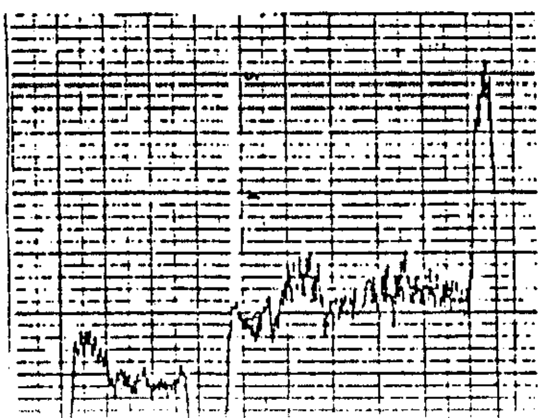


Fig. 4(e)

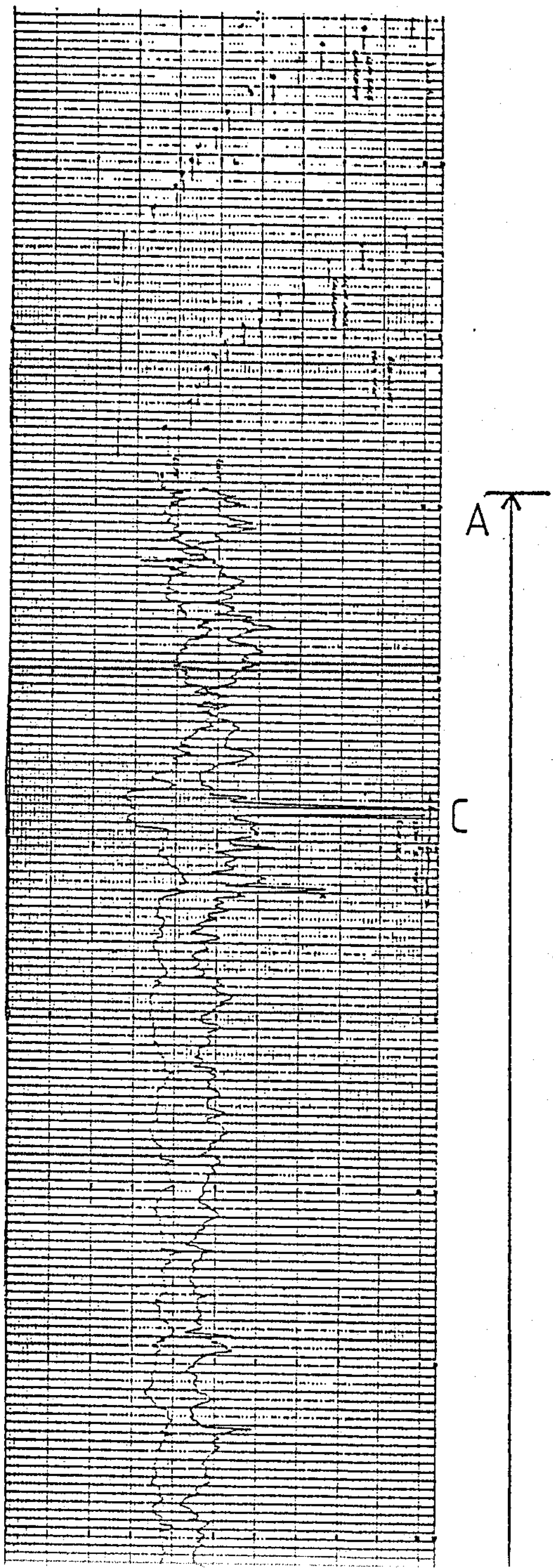


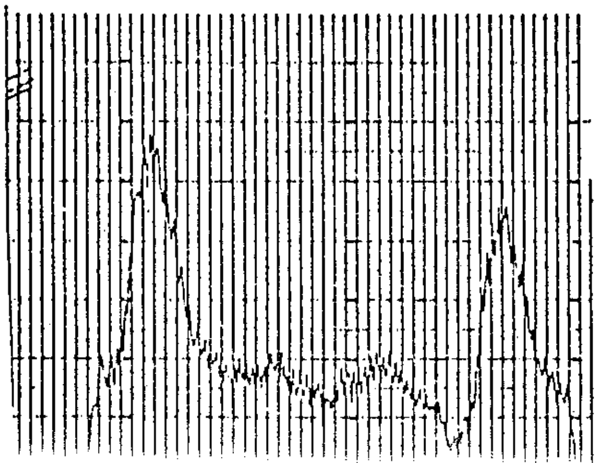
Fig. 5

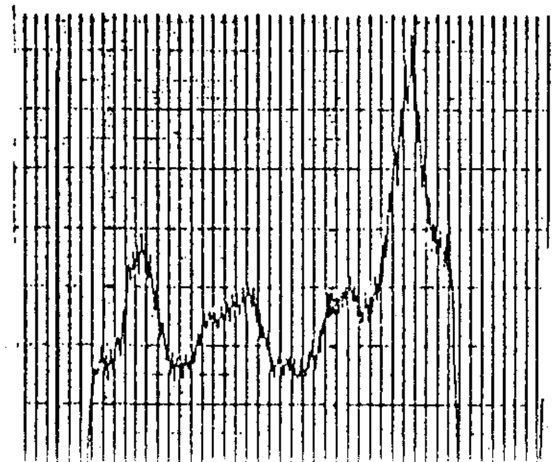
The traces in Fig. 5 were produced using an edge rubber dimension monitor. The position of the traces on the paper indicates the instantaneous location of the edge cord in relation to its appropriate edge of the belt. Traces of both left and right edge cords are carried on the same chart paper, and appropriate calibration traces are provided. The scanning is continuous and the distance A-B represents a 100 metre length of manufactured belt. It can be seen that the position of the edge cords falls substantially in the 10-30mm. range. However, at location (c) the right-hand edge cord is seen to be displaced to within 6mm. of the edge. Random measurement of the position of the edge cord using a physical probe, a popular practice, almost certainly would not have detected this anomaly, as the effect extended for only 300mm. along the belt.

Given that a length of belt has been manufactured to the satisfaction of the end user, or that it is acceptable on the basis that any pre-existing anomalies have been identified and discussed by all parties, the belt is transported to site and spliced up to form the composite belt.

It is recommended that a full longitudinal scan now be performed on commissioning to provide a "signature" of the new belt. Important information on the make-up of splices is also obtained. This information, together with data obtained in the factory, is used as the basis for all future measurements.

After an appropriate period of normal use, say six to twelve months, depending on tonnage conveyed, lateral scans are performed at various known locations and compared with the base data, to determine if any wear profiles are beginning to emerge. Once an indication of wear profiles has been recorded, it is examined to assess if its characteristics are satisfactory. Over the past twelve months, results have shown that correctable abnormal wear profiles have substantially reduced the useful life of a number of belts. If an unsatisfactory profile is detected then further investigation, on-site, may indicate the cause of the anomaly, and remedial measures may be undertaken, where appropriate, to eliminate or minimise the effect. Figs. 6(a) through 6(e) show a variety of wear profiles recorded over the past twelve months.





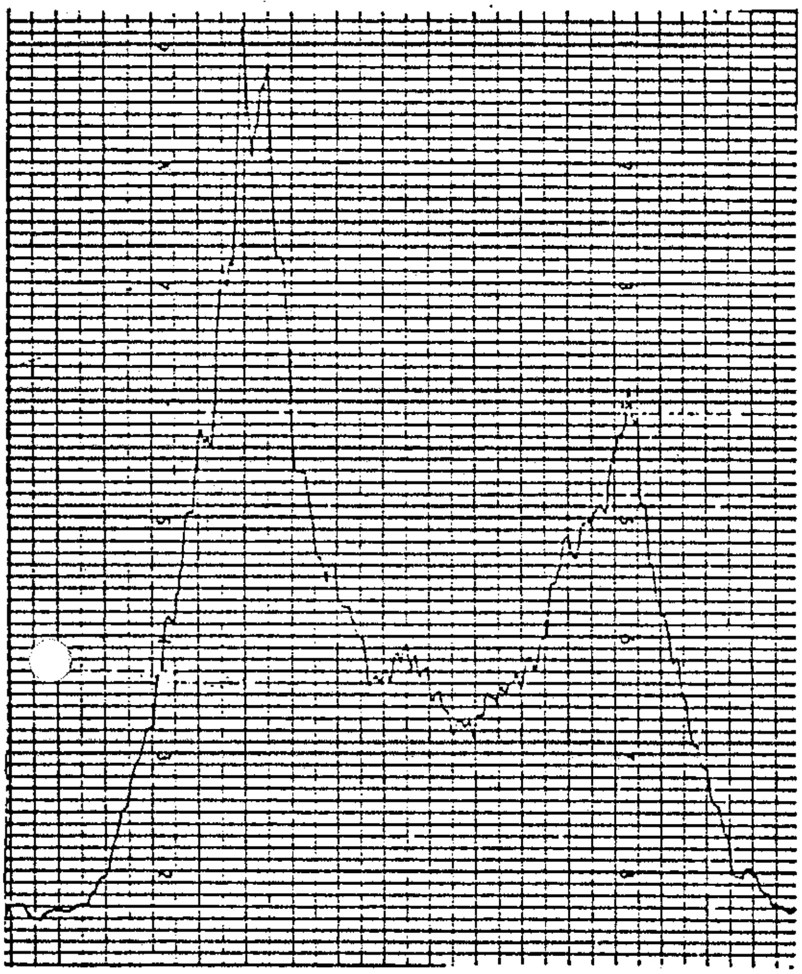


Fig. 6(c)

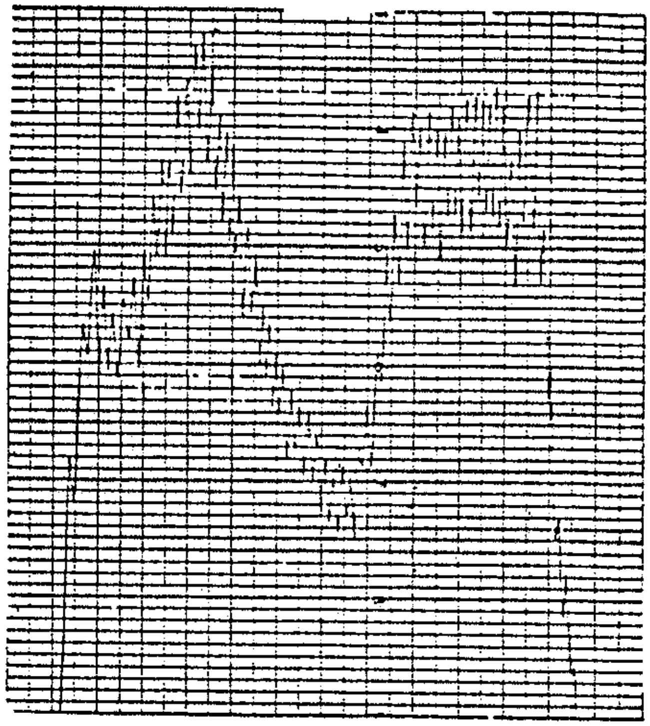


Fig. 6(d)

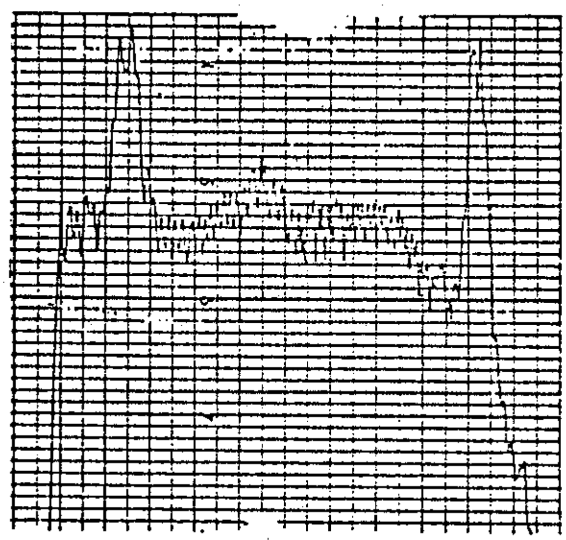
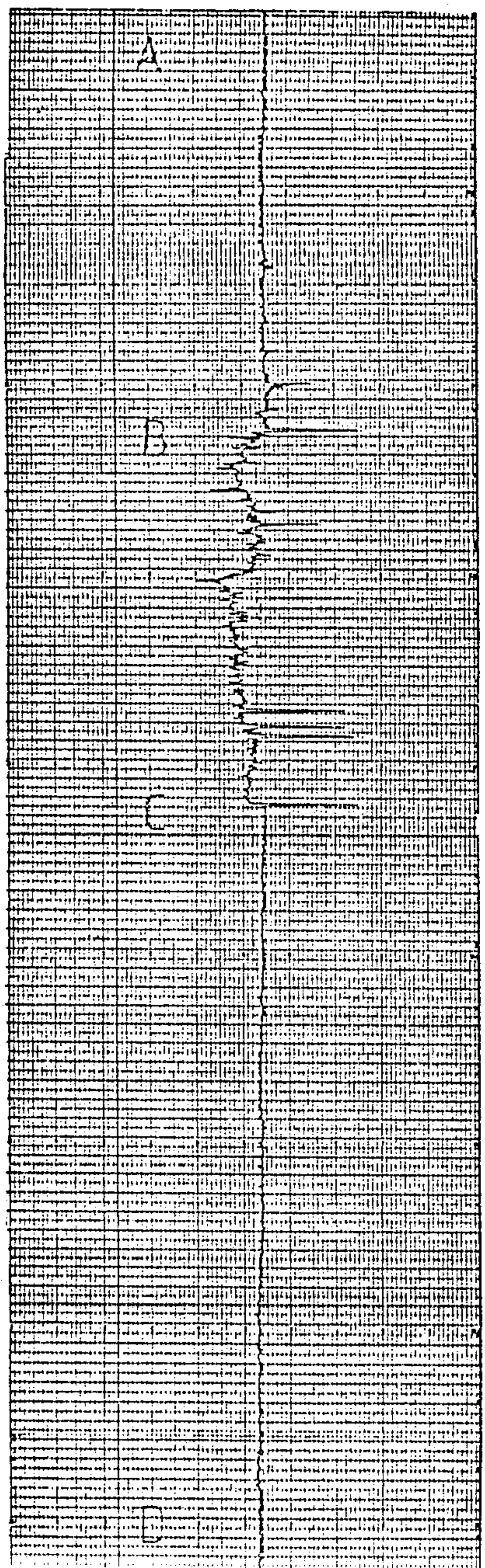


Fig. 6(e)

Once a satisfactory wear profile has been established, the on-going programme begins. Regular lateral scanning performed at, say, twelve monthly rests, will indicate a progressive reduction in cover thickness. This reduction, plotted against tonnage, will provide a finite wear rate. This wear rate in turn, when plotted against time, will give an indication of when the belt will become unserviceable through reduced cover thickness. Cover wear rate is an important parameter in belts used to move burdens with high impact damage characteristics e.g. bauxite.

Regular longitudinal scanning will establish if the covers are wearing uniformly, section to section. Also, should degradation of the cords through corrosion etc. occur, then these effects will be detected and their progress monitored. Fig. 7 shows some longitudinal scans processed to measure finite steel mass.

In Fig. 7(a) the sections AB and CD represent normal belting, whilst section BC shows substantial steel losses. The spikes extending to the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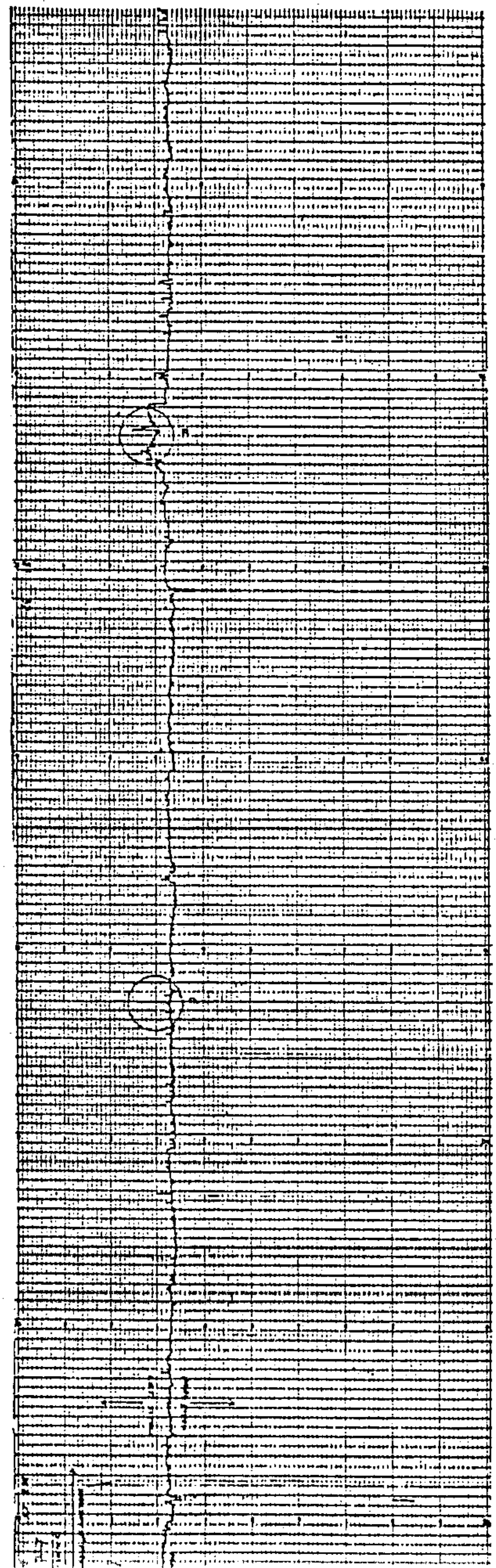

5. THE FUTURE

Basically, the conveyor belt monitor provides a means of measuring, continuously and non-invasively, various well-defined belt parameters. It is logical, therefore, to assume that the monitor could become part of the manufacturing process, providing improved quality control and a better end product.

A revision of the current method used to measure manufacturing specifications may also be in order, with the hard copy records of the monitor forming part of future manufacturer/end user contracts.

Another encouraging prospect for the industry as a whole, is the possibility, through regular monitoring, and use of a revolutionary splice bonding measurement technique, to insure steel cord belts against breakage in the field. Lengthy discussions have taken place, in this regard, and an underwriter has been found who is prepared to accept this type of insurance risk.

This paper has dealt with the monitoring of steel cord conveyor belts only. By using different types of transducers, and modified techniques, it is anticipated that the device will be used to measure important parameters in cable belts, haulage ropes and a host of other materials handling components.

REFERENCES

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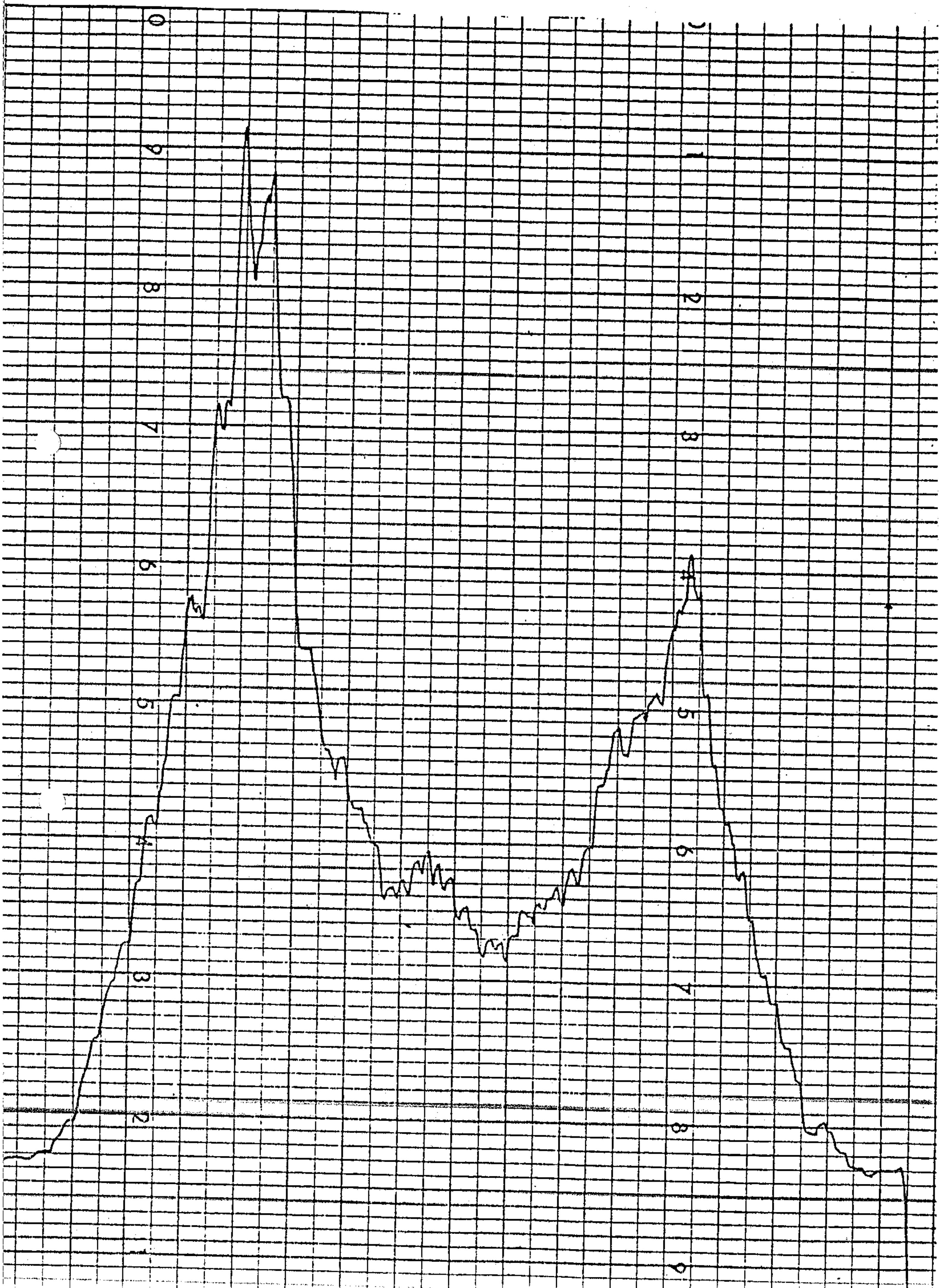

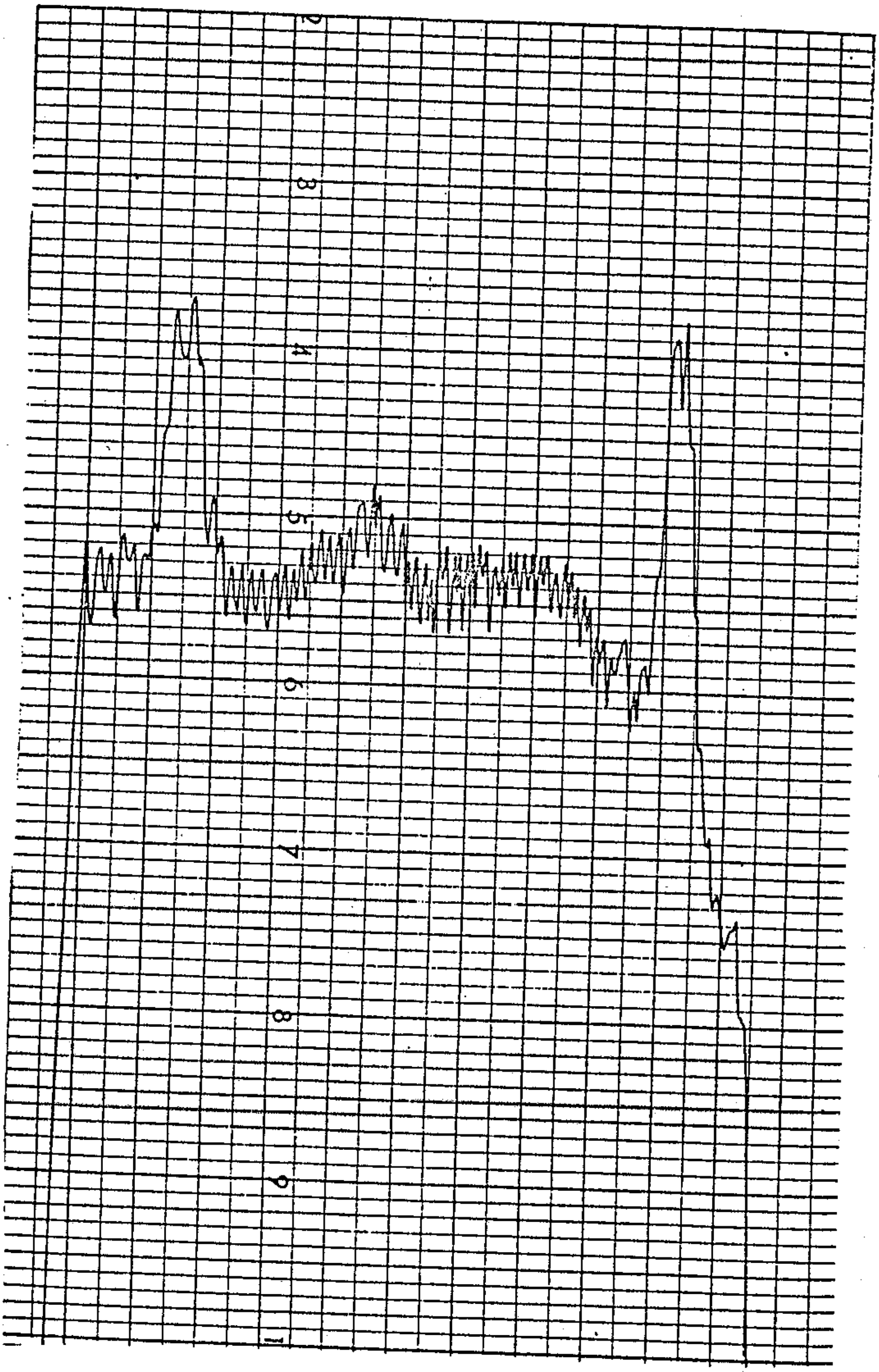
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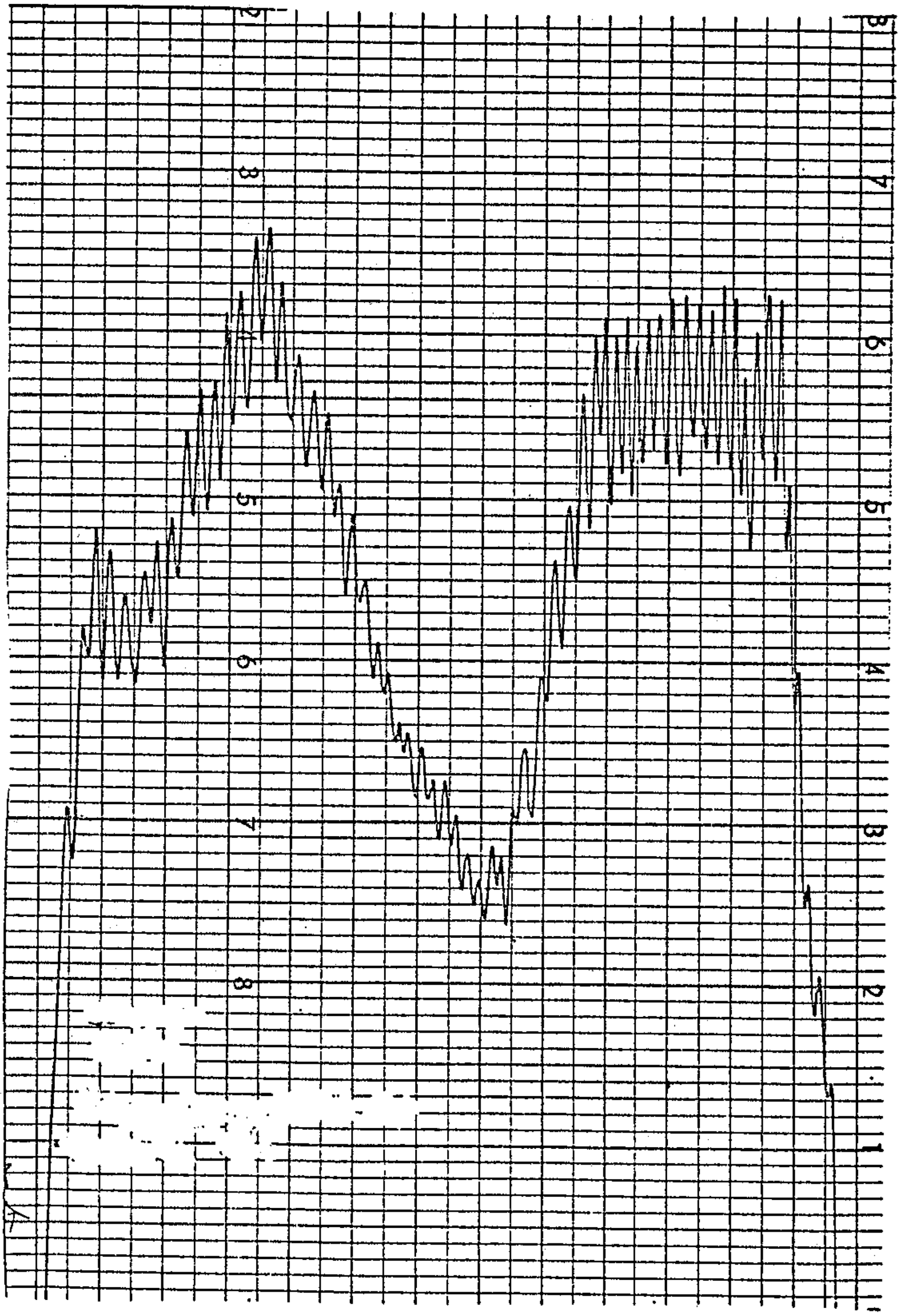

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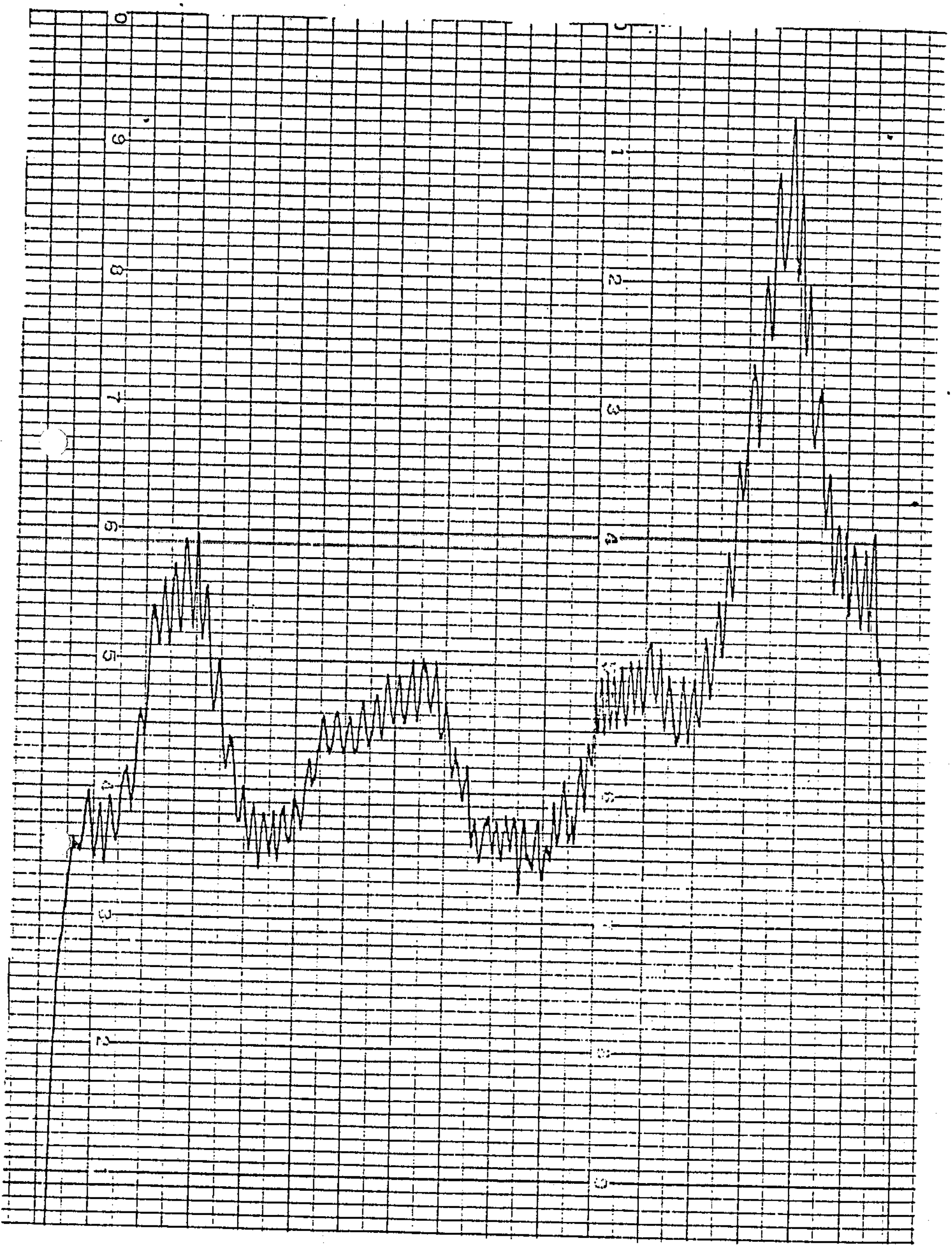

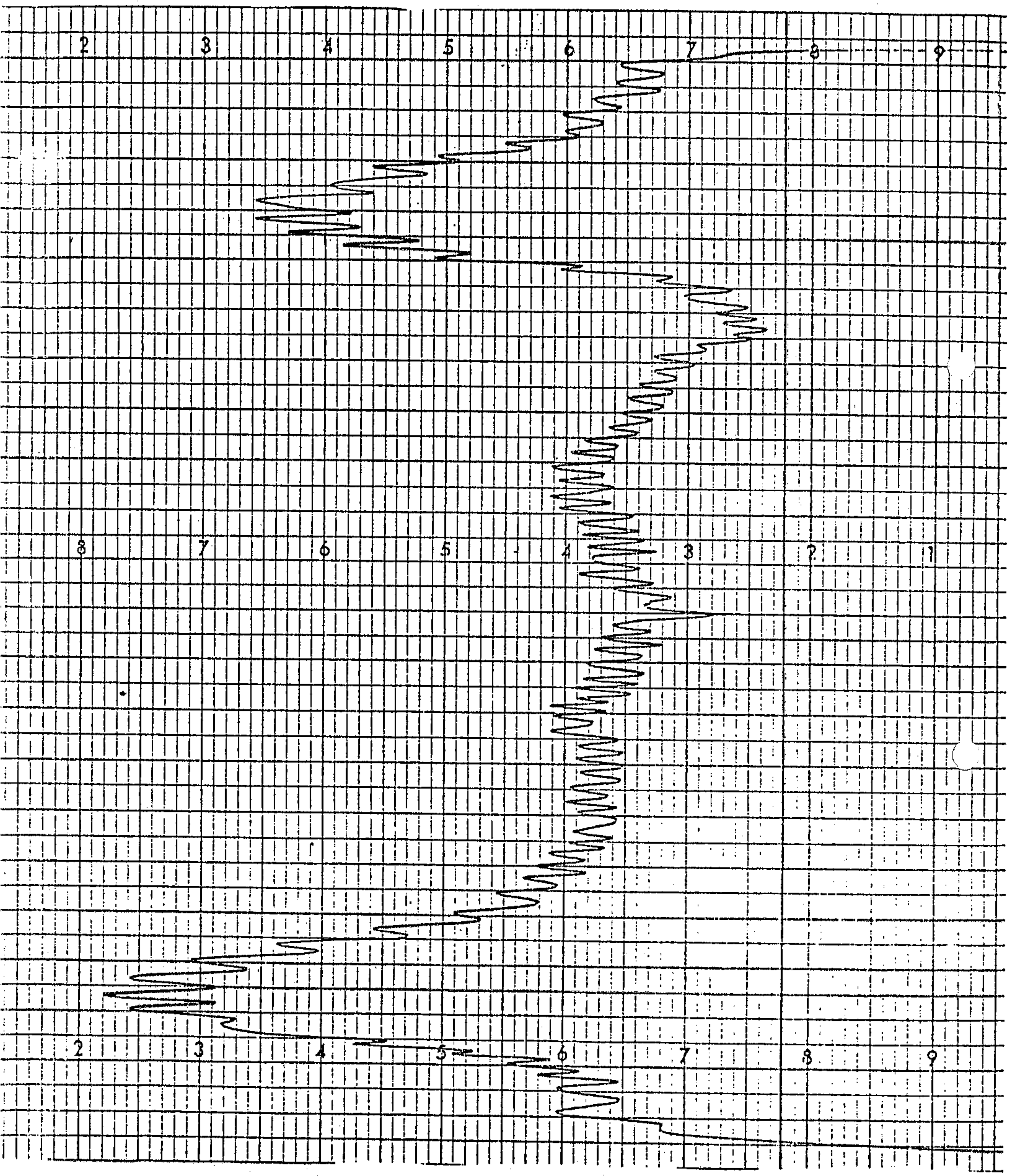
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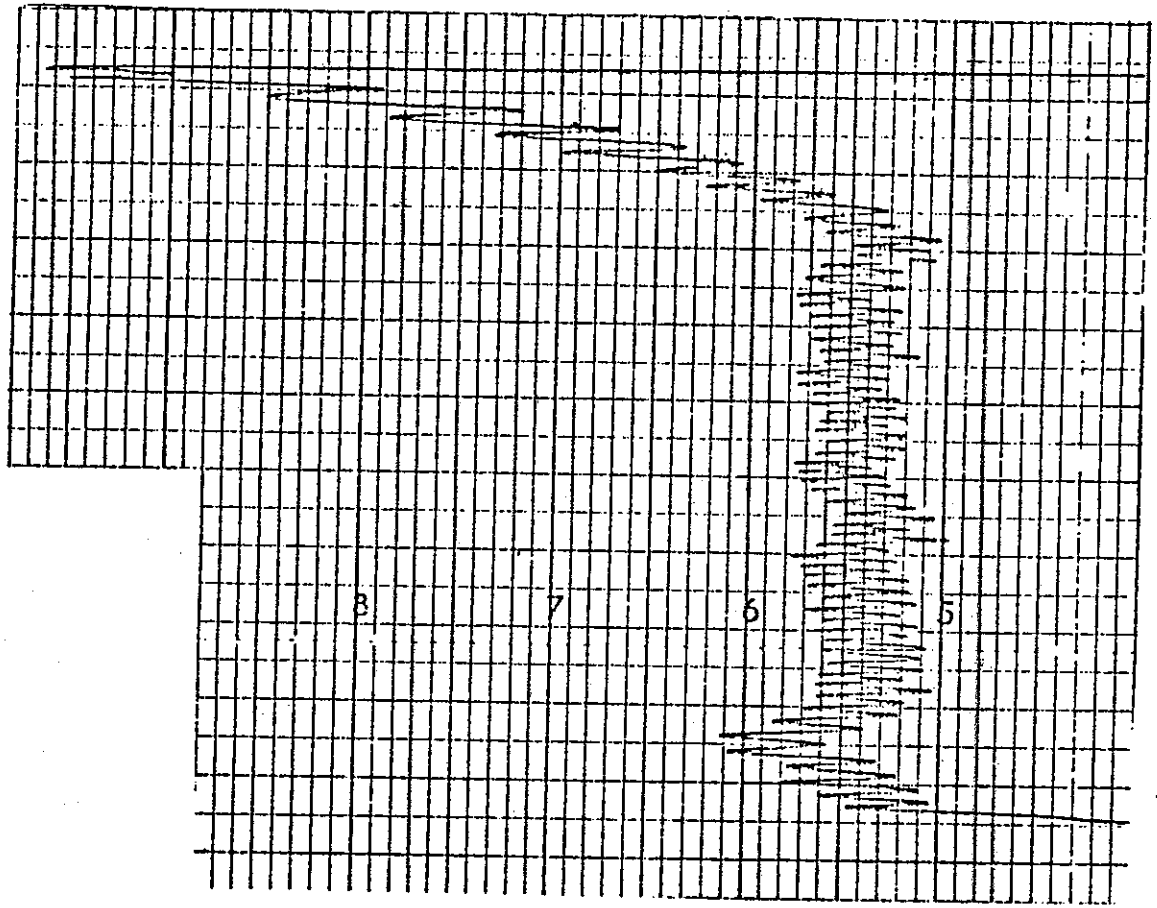

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