

High-quality tape recording for electromyographic applications

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Tape recording is an effective means of storing EEG, ECG and EMG signals in their original form. However, previously available tape recorders have either been impractical to use or have been too poor to allow a detailed laboratory analysis of physiological signals. Bulky and heavy stationary machines have traditionally provided the means of recording and reproducing necessary to fully utilize present day analysis equipment. Only small cassette recorders have offered the portability necessary to record the signals when and where required.

The B & K Portable Instrumentation Tape Recorders solve this problem. In a number of research projects, these tape recorders are being used as a highly reliable means of acquiring, exchanging and reproducing EMG signals.

In one example, clinics in Scandinavia have developed automatic analysis equipment to facilitate EMG interpretation. The purpose of the project is to compare the analysis results obtained from one centre with that of another, thus ensuring that the slightly different methods of analysis are compatible. Although no special need for portability existed, the Portable Instrumentation Tape Recorders from Brüel & Kjær were chosen for this purpose because of their high performance. They have minimal wow and flutter, very good phase and frequency responses (overall DC to 60 kHz) and are simple to operate.

Follow that postman

Another research project, however, did take advantage of the portability of the B & K tape recorders.

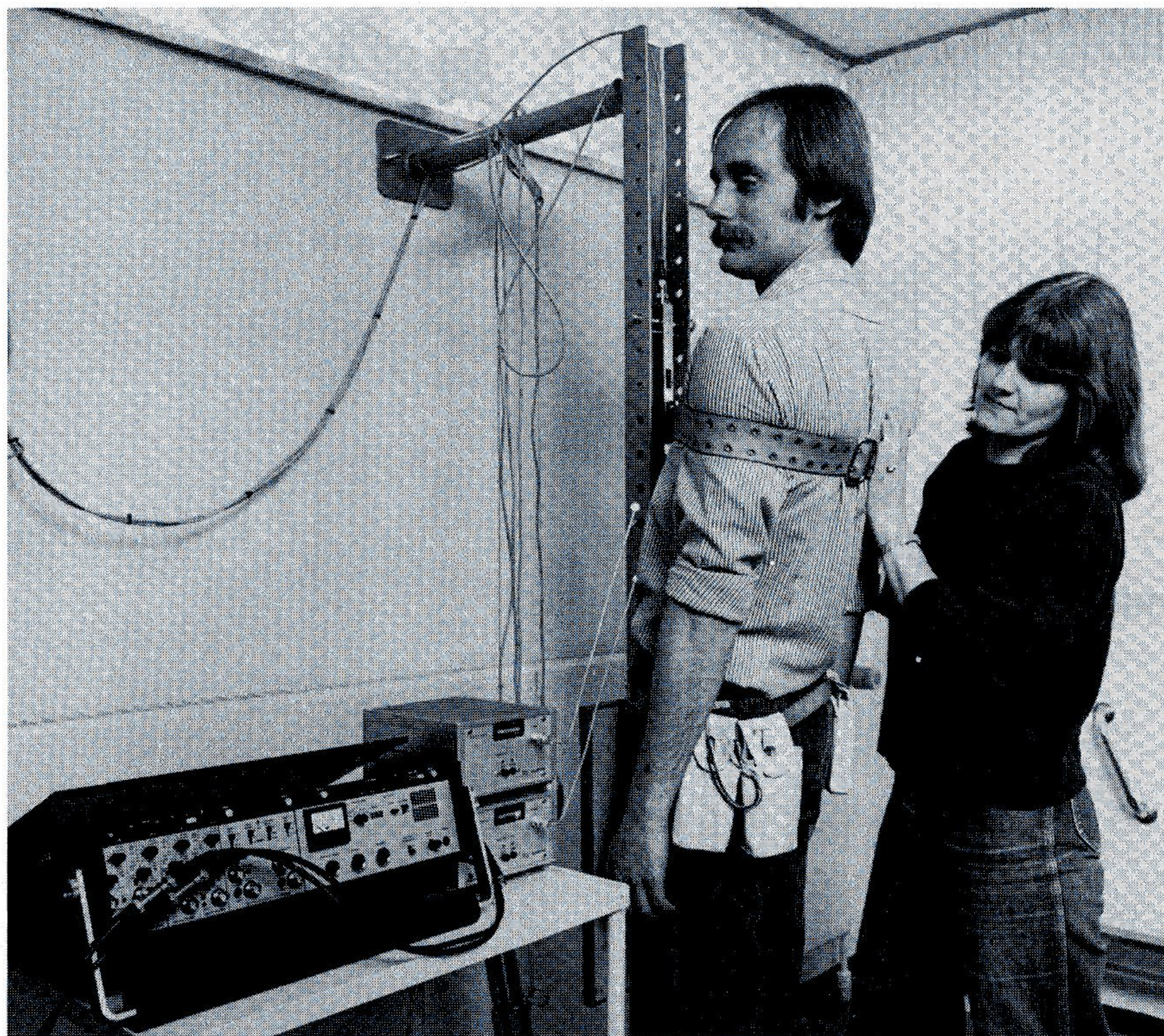


Fig. 1. Before each series of measurements, calibration was carried out under laboratory conditions for subsequent comparison with the results from the field.

In autumn 1977, an agreement was made between the Danish Post Office, the Union of Postal Workers and the Union of General Workers. It was decided that a study should be made of the physiological stresses experienced by workers in the postal delivery service. The study was carried out by the August Krogh Institute of the University of Copenhagen.

The object of the exercise was to determine the individual power output and load during delivery in representative districts. This parameter was related to age, sex and working capacity of each individual. The various districts chosen included those

consisting primarily of blocks of flats or bungalows and combinations of these.

EMG measurements

The project involved field EMG-measurements of potentials from the back and the knee using ordinary surface electrodes. Studies were made on 31 postmen and a control group of 10 students. The measurements were carried out in two stages; firstly in the summer and secondly in the winter. All studies were supplemented by a general health examination. Interviews were used to assess the subjective experience of possible stress and pain.

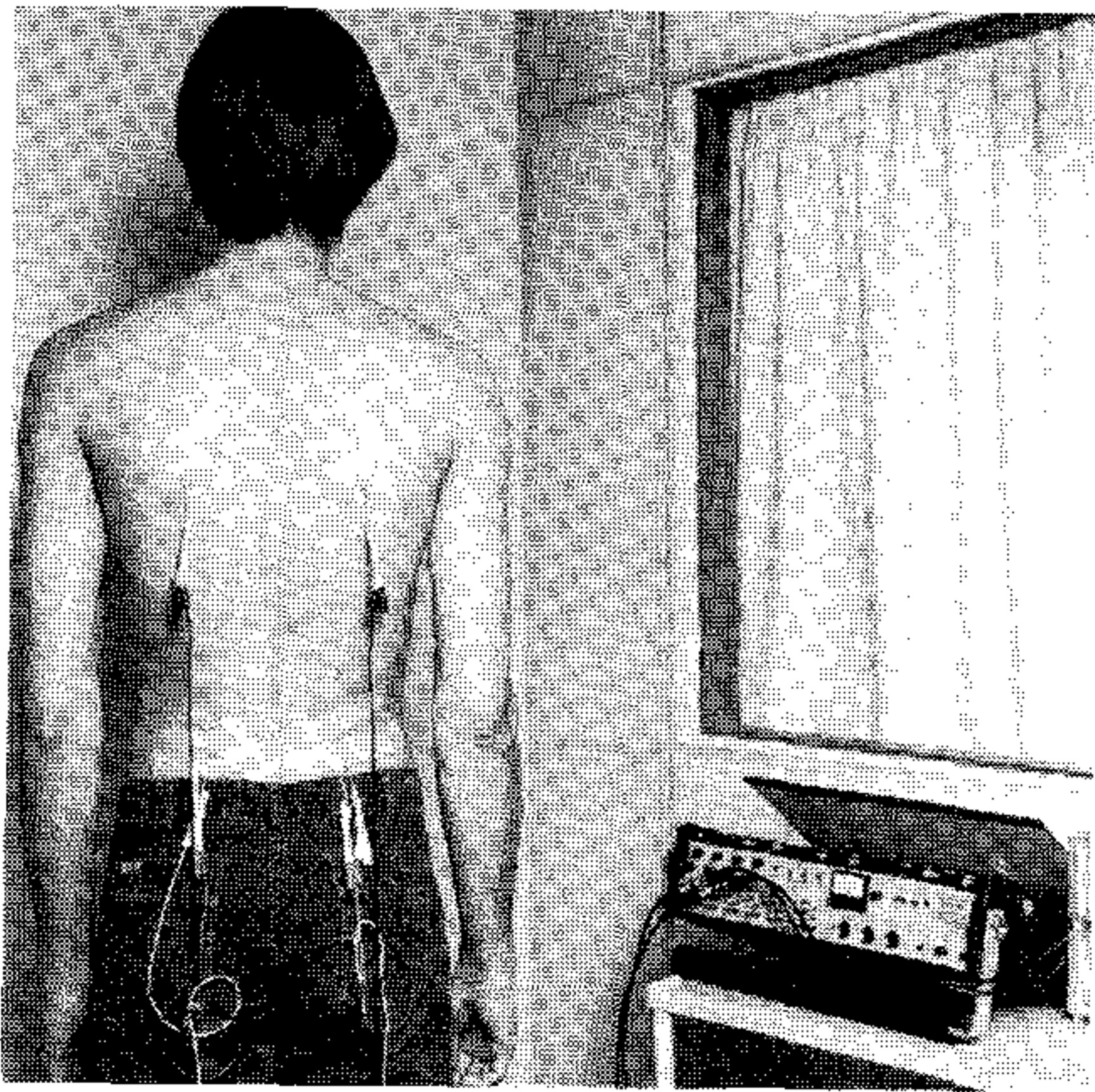


Fig. 2. EMG analyses under actual working conditions in the Danish postal service have rendered valuable information in a study performed to determine, and possibly reduce, fatigue.

The electromyogram (EMG), as measured with surface electrodes, reflects the activity of active muscles under the skin surface. Since the muscles are situated some distance from the electrodes, it is not possible to determine precisely from which type and from how many motor units the potentials originate. Needle electrodes, which are normally used for detailed studies, can only be employed under laboratory conditions.

Under constant non-maximum loads, the amplitude of the EMG increases with time. This reflects muscle fatigue. Frequency analyses of muscle activity show that the energy of the EMG from a fatigued muscle predominates in the low-frequency part of the EMG spectrum.

Frequency analysis is useful for evaluating the degree of fatigue because it does not depend significantly on the actual level of tension. The results of some researchers, however, indicate that the combined effect of heat, arising from the muscle's metabolism, and fatigue may give rise to misleading or inaccurate results.

Recording and analysis

A normal postman's route was divided into two delivery rounds. Mea-

surements were made immediately at the start of the first round, just before the rest at the end of the first round and at the end of the second round.

The EMG activity was measured with disposable surface electrodes connected to three sets of telemetry transmitters. An extra transmitter, using a 1 kHz tone burst, was used to identify the exact time the postman bent down to deliver a letter. The channel used for this tone burst served also as a microphone channel for comments about the postman's work to the tape recorder. The quality of transmission was monitored using a portable oscilloscope, and the EMG signal was fed to the B&K tape recorder together with a 200 μ V telemetry amplitude reference signal.

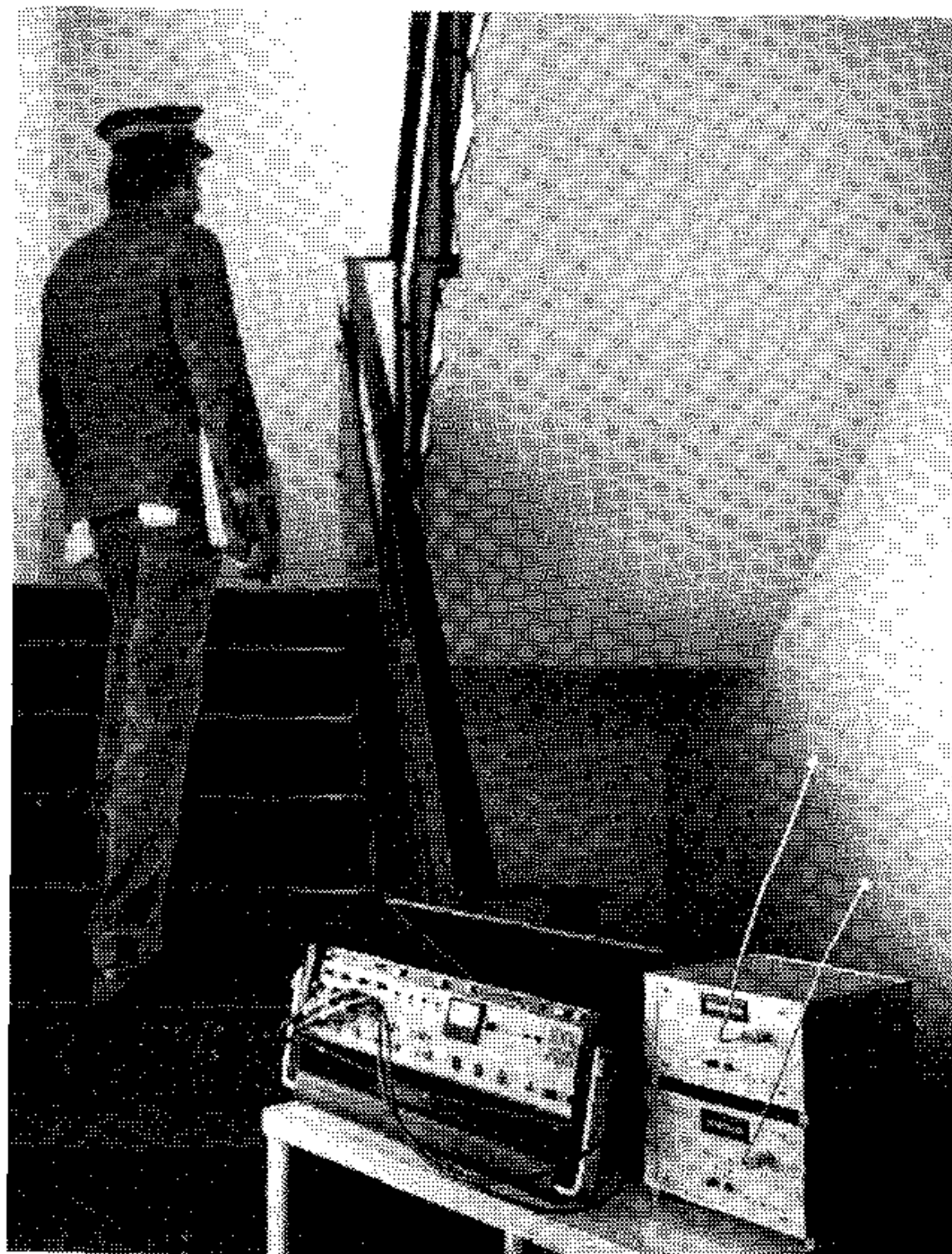


Fig. 3. Telemetry transmitters were employed in the study to relay the EMG from the back muscles to a tape recorder for later analysis.

The tape recorder was either carried over the shoulder, or in a car that drove along the postman's route. In both cases the special vibration-suppression design of the B&K tape recorders secured that now caused by walking and driving would not affect the original quality of the EMG in the play-back signal.

Control measurements were performed in the laboratory using a specially built test door with a letter box adjustable to 5 settings. These control measurements involved 10 students as a standard-population reference.

The signals were finally played back to an EMG strip-chart recorder and a non-parametric statistical analyser with a PDP-11/34 mini-computer.

Conclusions

The studies performed so far have shown that the leg musculature of male postmen is exposed to a very low fatiguing load. Present research indicates that knee load may be a parameter worth evaluating in more detail in forthcoming studies. For postwomen, the present study has revealed excessive loads to the leg and back musculature. This is believed to be caused mainly by the higher ratio, for females, of load to maximum force (the maximum force of the female musculature is approx. 30 % lower than that for male subjects).

The Brüel & Kjær Portable Instrumentation Tape Recorder proved to be an indispensable high-performance aid in gathering the EMG signals needed for the analysis. As a consequence, it has already been decided to apply one of the latest models, the B&K Portable Instrumentation Tape Recorder Type 7005, in the detailed study commencing shortly.

Literature

1. Christensen, H. and Daltorn, E.: Lokalbelastning i ryg og knæ hos brevbærere. Gymnastikteoretisk Laboratorium ved Københavns Universitet, Copenhagen 1981.



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