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BRÜEL & KJÆR application notes

Noise control investigation using sound intensity measurements

by K.B.Ginn & M.Brock

Description of the noise problem

A preliminary noise control investigation was performed in a workshop after the ten full-time workers had complained of excessive noise. The noise levels generally lay between 75 dBA and 90 dBA for most of the working day. The workshop had a floor area of 330 m^2 and contained one “large” and sixteen “small” automatic lathes (Fig.1). The lathes were fed with metal bars of up to 5 m in length and of various cross-sections. The long feed-tubes which contain these bars are indicated on the workshop plan (Fig.1). The greatest amount of noise was produced when the lathes operated on bars of hexagonal cross section. The tool heads of the lathes could hold up to eight tools at a time, enabling a complex unit to be produced. The operators frequently checked the tolerances of the units produced and re-adjusted the tools if necessary.

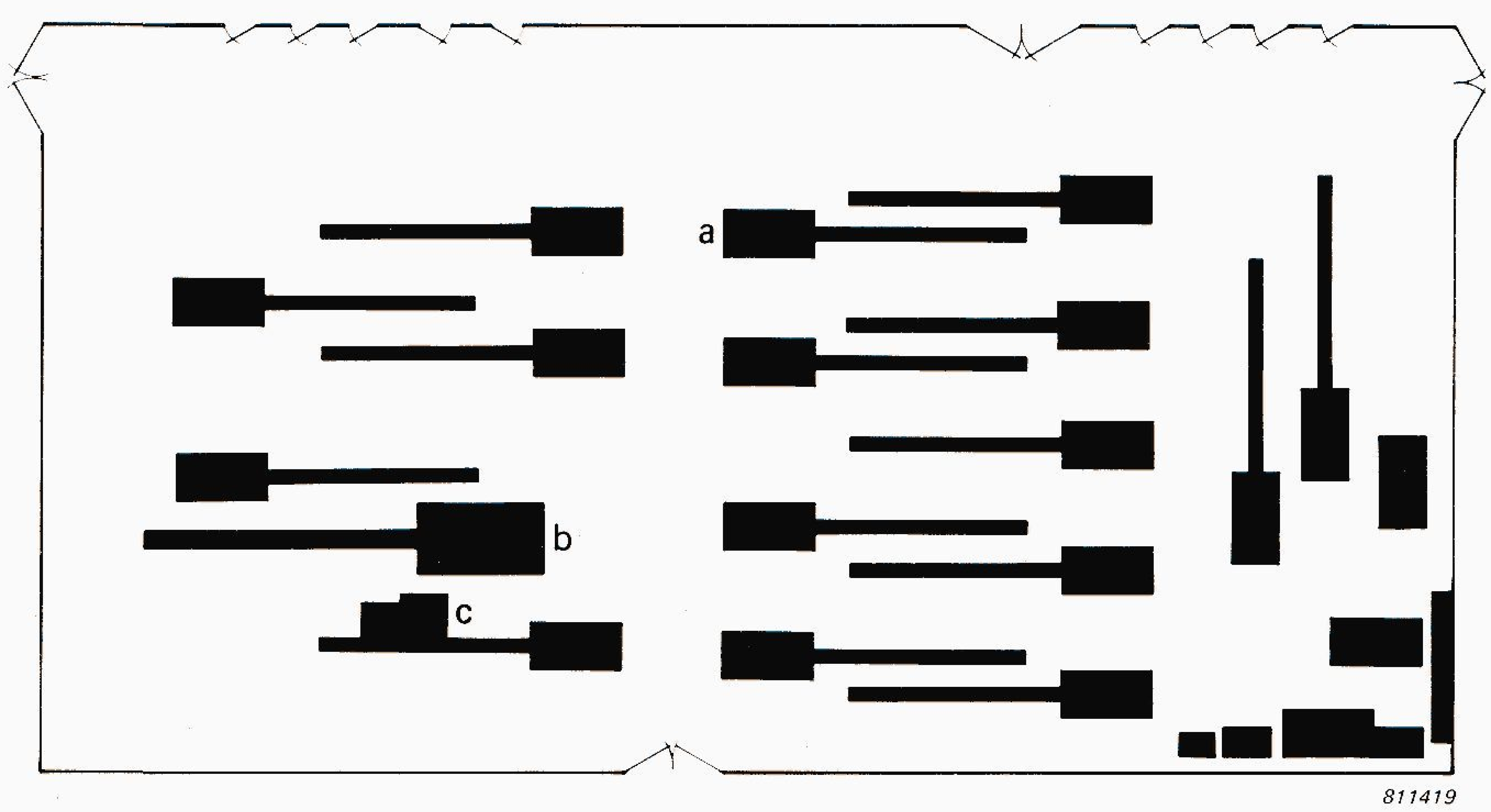


Fig. 1. Plan of workshop showing the positions of the automatic lathes and feedtubes.
a) small lathe
b) large lathe
c) quality control bench

Method

The Sound Intensity Analyzing System Type 3360 was employed for the investigation which enabled preliminary measurements to be performed without interrupting production as sound intensity measurements are not influenced by continuous background noise. Three kinds of measurement were performed:

1. Background sound pressure level (Fig.2)
2. Source location
3. Intensity spectrograms

An X-Y Recorder Type 2308 was used to record the results. Measurements were performed on the large lathe and on one of the small lathes.

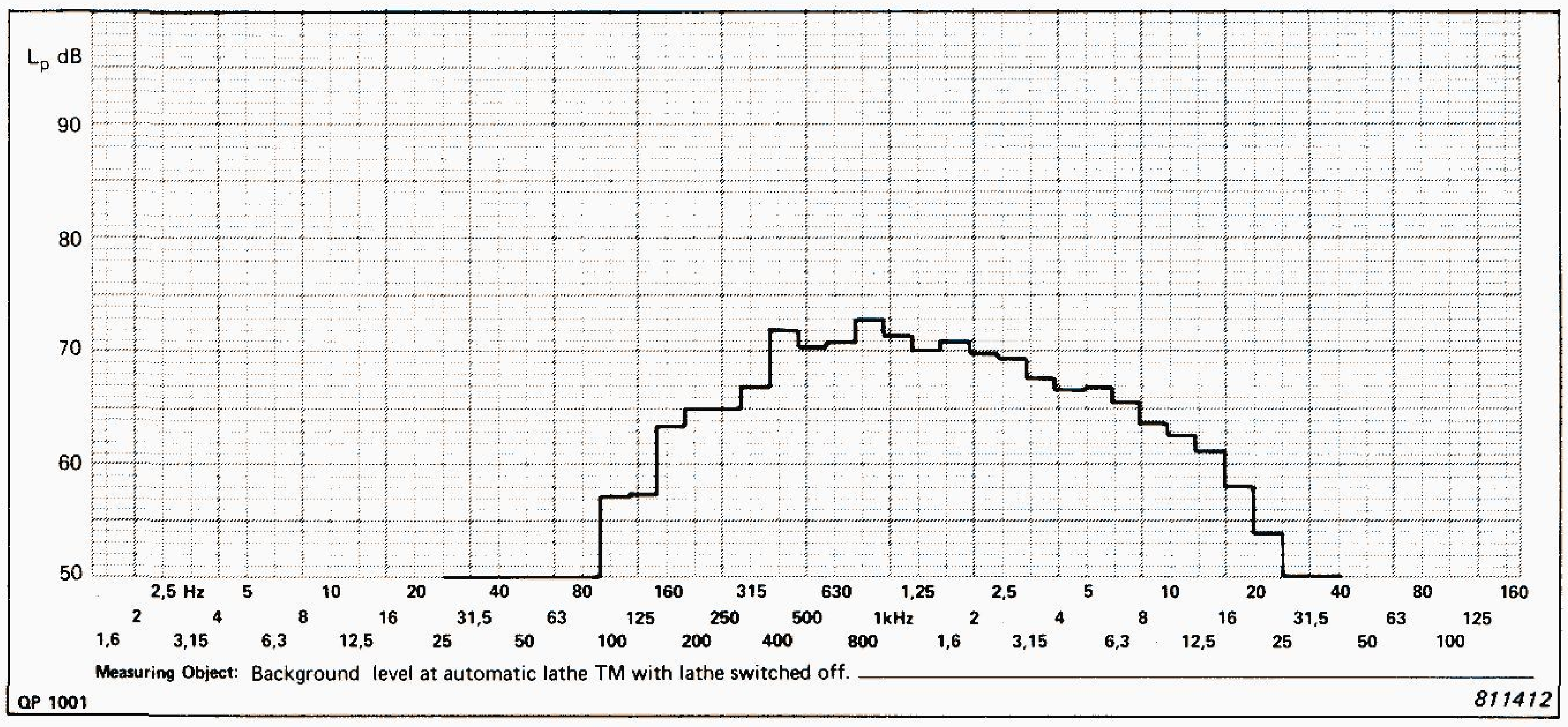


Fig. 2. Background sound pressure levels in the workshop

Source location

The method of locating sources using the 3360 System is shown in Fig.3 and illustrated in Fig.4. The probe is parallel to the machine under investigation and is steadily moved in a line while the display unit is observed. When the display indicates a sudden change of the intensity's direction, one knows that the noise source lies on the plane which passes perpendicularly through the centre of the probe's spacer. This continuous sweep procedure is repeated along a line at right-angles to the first. The noise source is then situated at the point of intersection of the two planes.

Measurement results for the small automatic lathe

A continuous sweep with the probe along the axis of the lathe revealed several major sources which are ranked here in order of importance:

1. the aperture of approximately 5 cm by 5 cm in the top of the pulley and gear housing
2. the "flag" which is dragged down the feed-tube thus pushing the bar into the lathe
3. the feed-tube itself

The intensity spectrograms of these sources are shown in Figs.5, 6 & 7 respectively. It seems reasonable that a metal lap over the hole in the pulley and gear housing would considerably reduce the noise from that source.

Measurement results for the large automatic lathe

The principal sources were found to be:

1. the motor chamber
2. the feed-mechanism
3. the tool/workpiece area

The intensity spectrograms for probe positions near to these sources were measured with and without various acoustic shielding (Figs.9, 10 & 11).

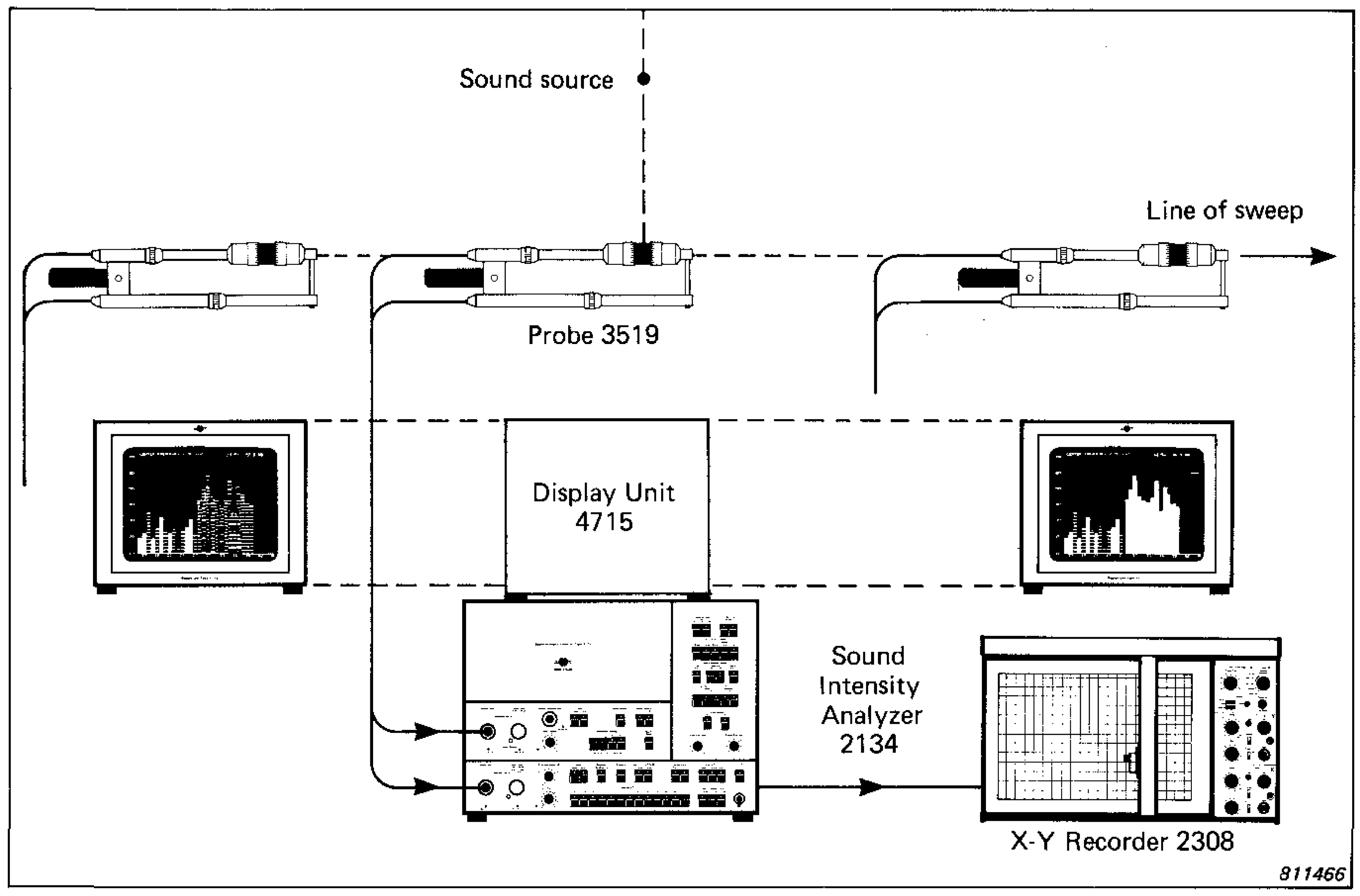


Fig. 3. Continuous sweep method for locating sources using the Sound Intensity Analyzer Type 3360. As the median plane of the probe (i.e. the plane parallel to the microphone diaphragms and and passing through the midpoint bwteen the two diaphragms) is swept passed the source, the intensity spectrum shown on the display changes in brightness indicating that the intensity is now incident from the rear hemisphere of the probe and not the front hemisphere

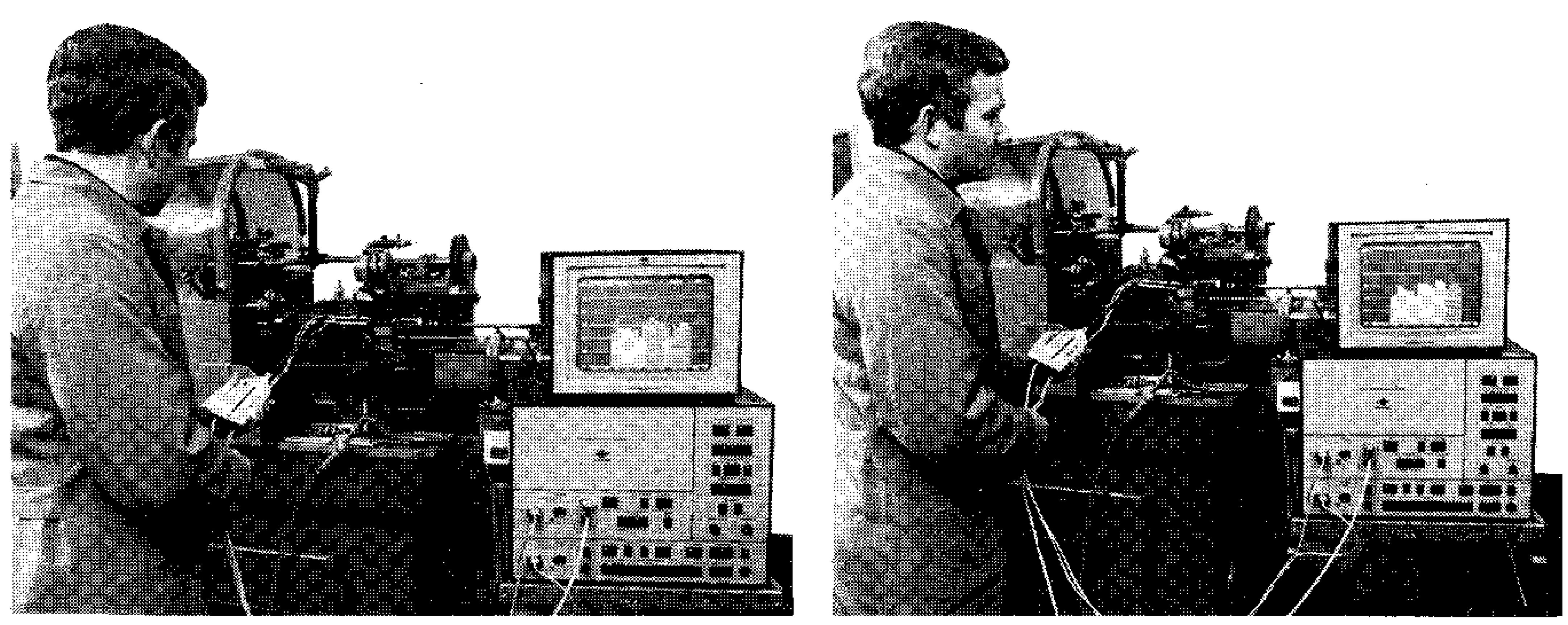


Fig. 4. Continuous sweep method for locating sound sources on a small lathe. As the median plane of the probe is swept passed the source i.e. the pulley and gear housing, the mid-frequencies of the displayed intensity spectrum change in brightness

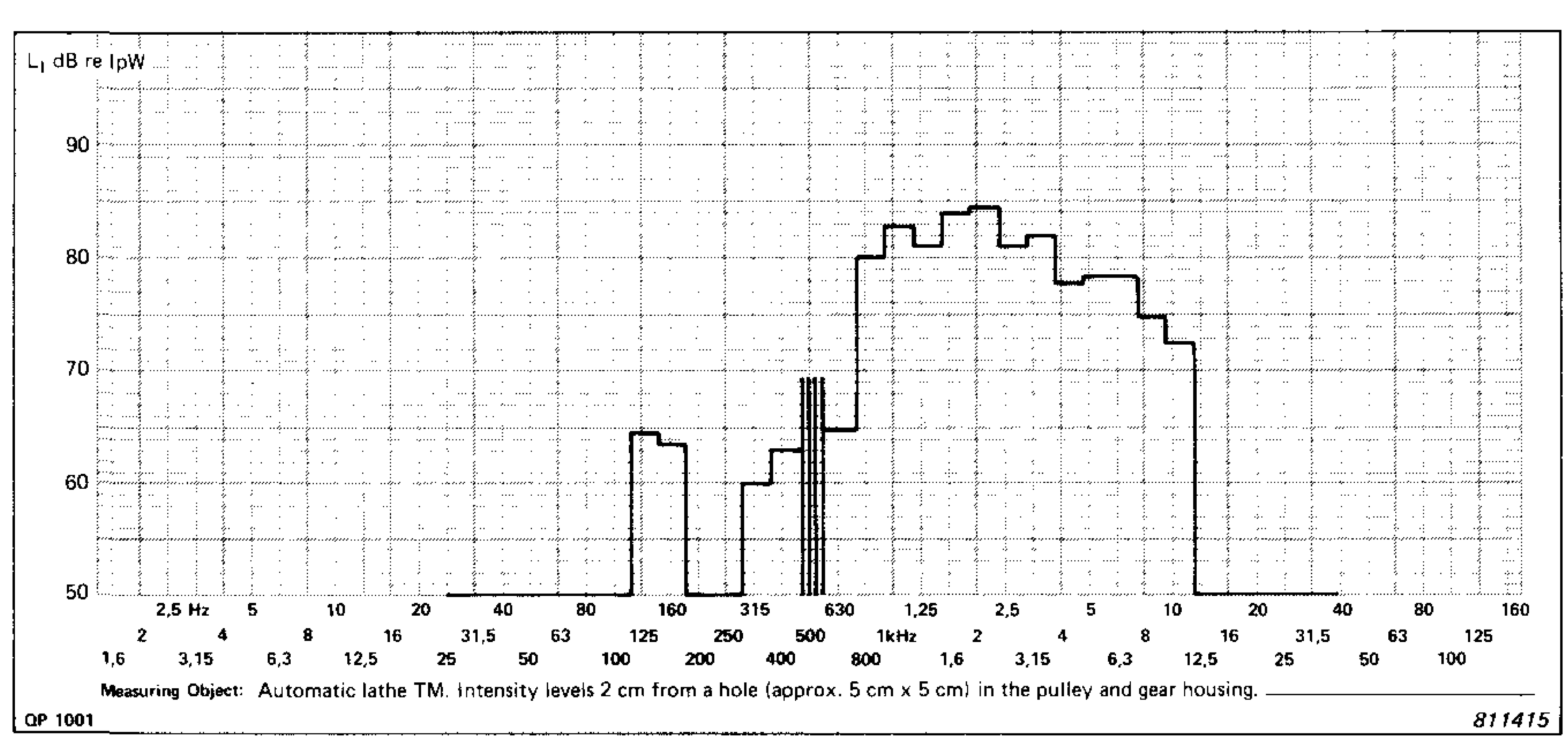


Fig. 5. Small lathe. Intensity spectrogram flush with the aperture in the gear and pulley housing. Note that this is note the same spectrogram a is shown in Fig.4. because in Fig.4. the probe was held parallel to the axis of the lathe an din Fig.5 the probe was held perpendicular to the axis of the lathe

Effect of an acoustic screen

Fig. 9 shows the effect of placing an acoustic screen over the motor chamber opening. The measurement position was 5 cm from the plane of the screen. The screen consisted of 3 cm thick mineral wool on a hardboard backing mounted in a frame of approximately 1 m^2. The hatched and unhatched parts of the curves indicate that the measured sound intensity is incident from the rear and from the front of the probe respectively. This means that in the 3,15 kHz third octave band for example the screen not only blocks the noise from the motor but also absorbs at these frequencies noise which is generated elsewhere in the workshop.

Effect of an acoustic hood

Fig. 10 shows the effect of covering the hydraulically powered, feed-mechanism with an acoustic hood. The measurement position was 5 cm from the surface of the hood. The hood consisted of a massive box, open on two sides so that it could sit close up to the body of the lathe. The box was lined with 3 cm of mineral wool.

Effect of an acoustic barrier

Fig. 11 shows the effect of placing an acoustic barrier between the lathe and the operator's quality control bench. The barrier was 2,2 m high and 1,5 m wide and consisted of a 3 cm thick blanket of mineral wool, backed by a thin sheet of lead. The whole barrier was enclosed in heavy, perforated plastic and supported in a tubular metal frame. The measurements were averaged spatially and temporally by sweeping the probe back and forth over an area of 30 cm by 30 cm and using a 4 second linear average.

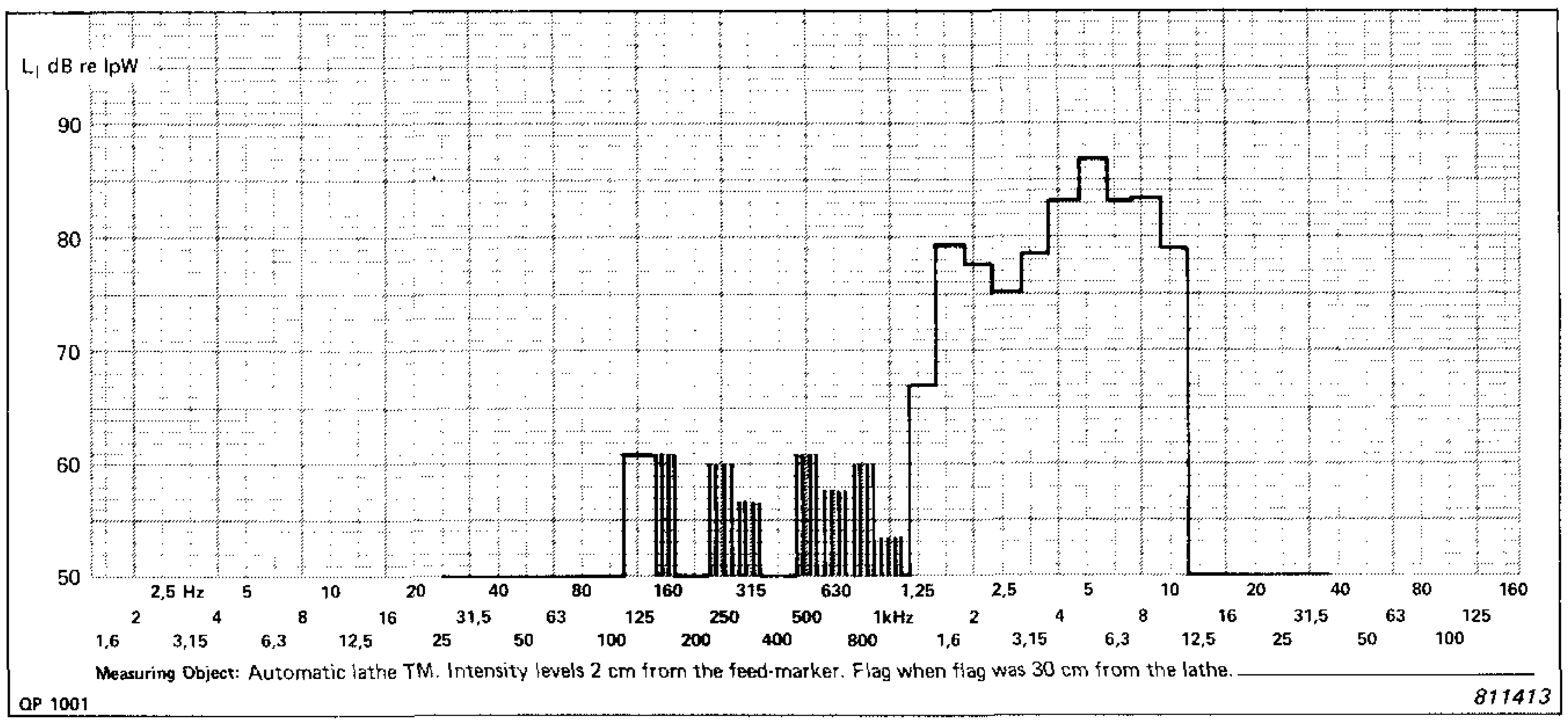


Fig. 6. Small lathe. Intensity spectrogram at a position 2 cm from the metal "flag" which pushes the bar into the lathe. At the time of measurement 30 cm of the bar remained

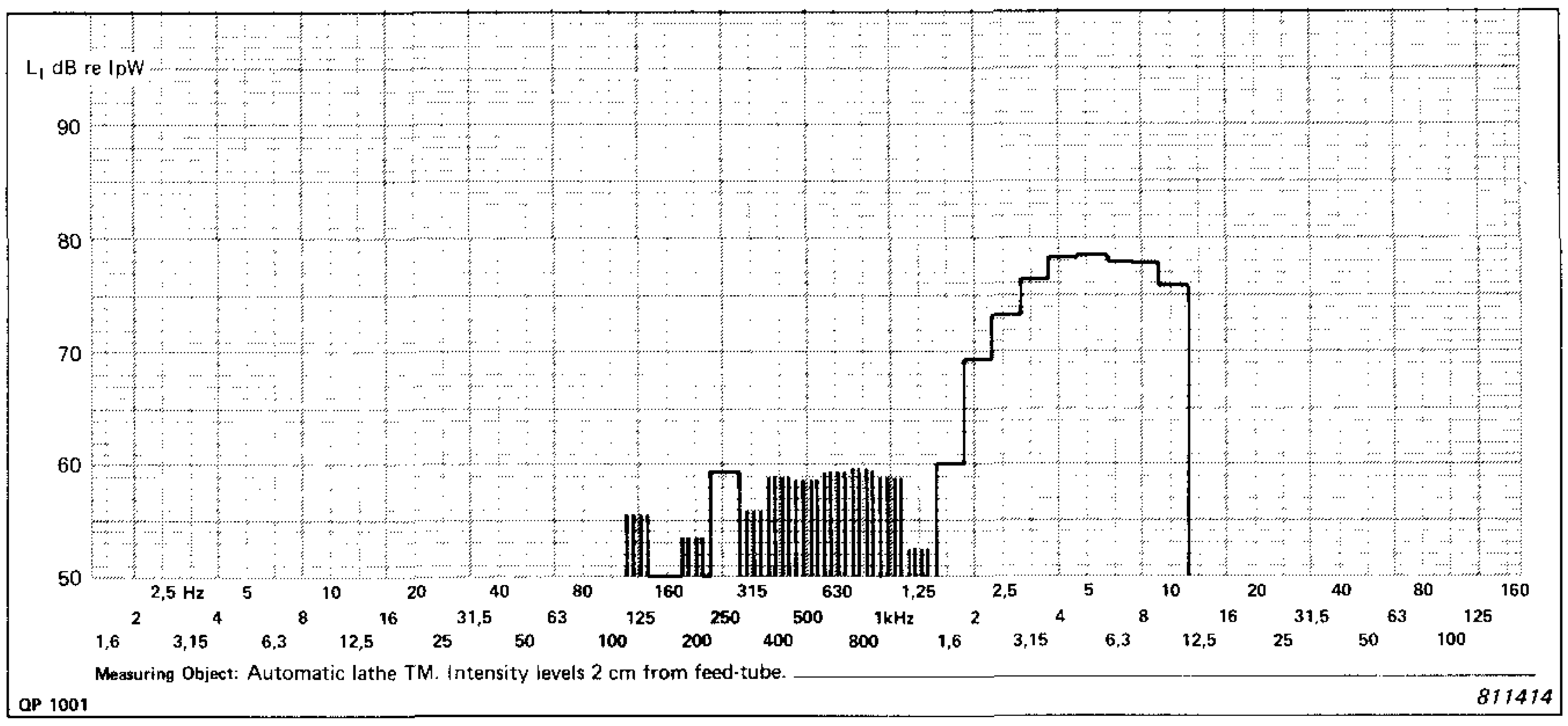
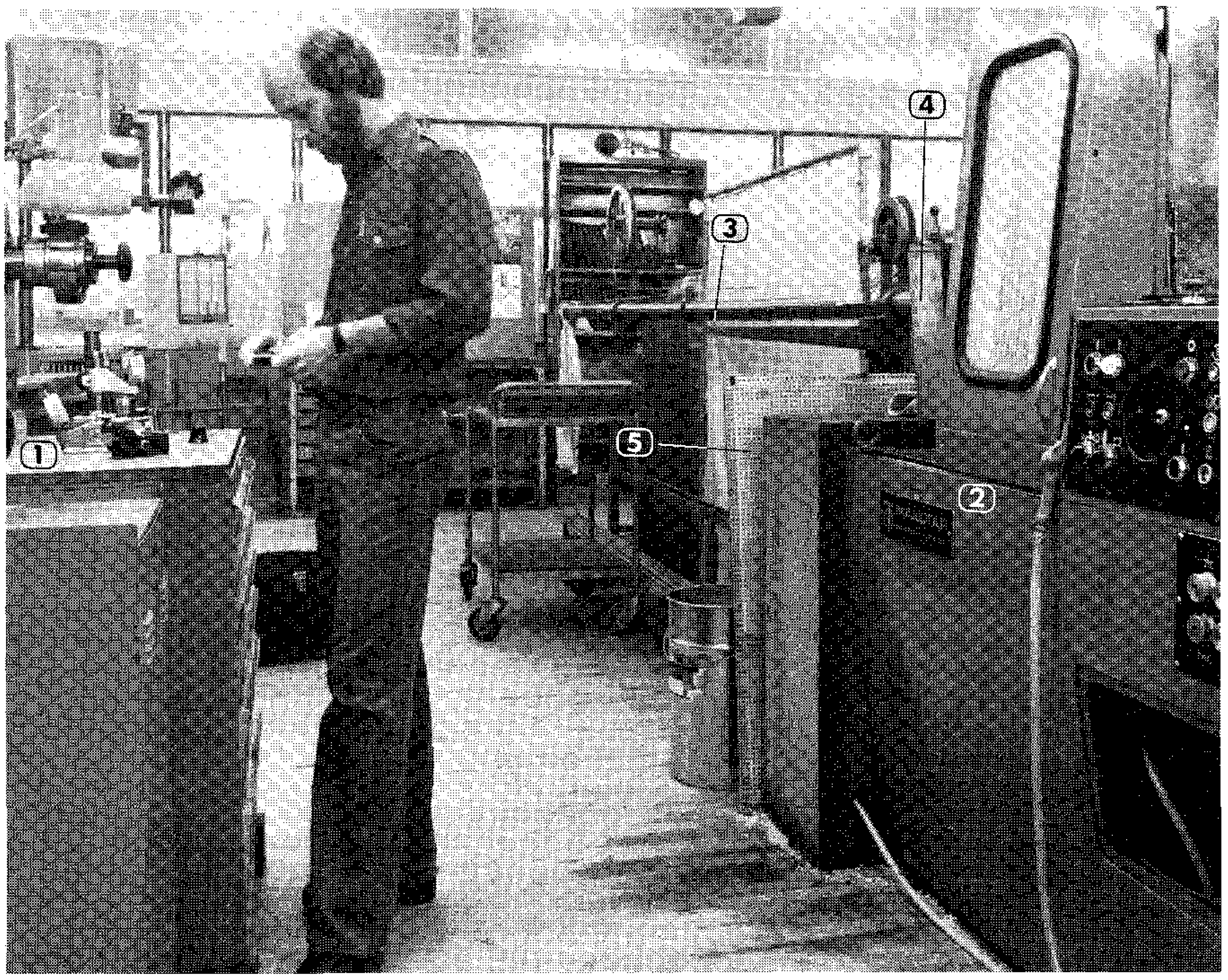


Fig. 7. Small lathe. Intensity spectrogram 2 cm from the feed-tube



① Quality control bench ③ Feed-tube ⑤ Screen
② Lathe ④ Hood

Fig. 8. Large lathe (on the right) showing the proximity of the quality control bench and the positions of the feed-tube, the hood and the screen

Possible ways of reducing noise from the lathes

It appears that by simple means (e.g. minor alterations to the lathes, judicious positioning of acoustic screens) the overall noise level could be considerably reduced. However, several factors - apart from the overruling economic factor - must be borne in mind:

1. If acoustic screens are employed then a sufficient ventilation to the lathe must be maintain to prevent overheating.
2. If acoustic barriers are not positioned with forethought, they might obstruct the operator in his work.
3. Not all noise from the lathe should be muffled as an experienced operator, simply by listening, can tell what stage a particular operation has reached and can also diagnose most of the common faults.

Conclusion

The possibilites of reducing the general noise level in an automatic lathe workshop were investigated without interrupting production by employing the Sound Intensity Analysing System Type 3360. Despite high levels of background noise, the 3360 System could locate the principal noise sources in a manner of minutes. Several possible acoustic remedies were tried on the noisiest lathe in the workshop. The total time taken for this preliminary investigation was 2 hours.

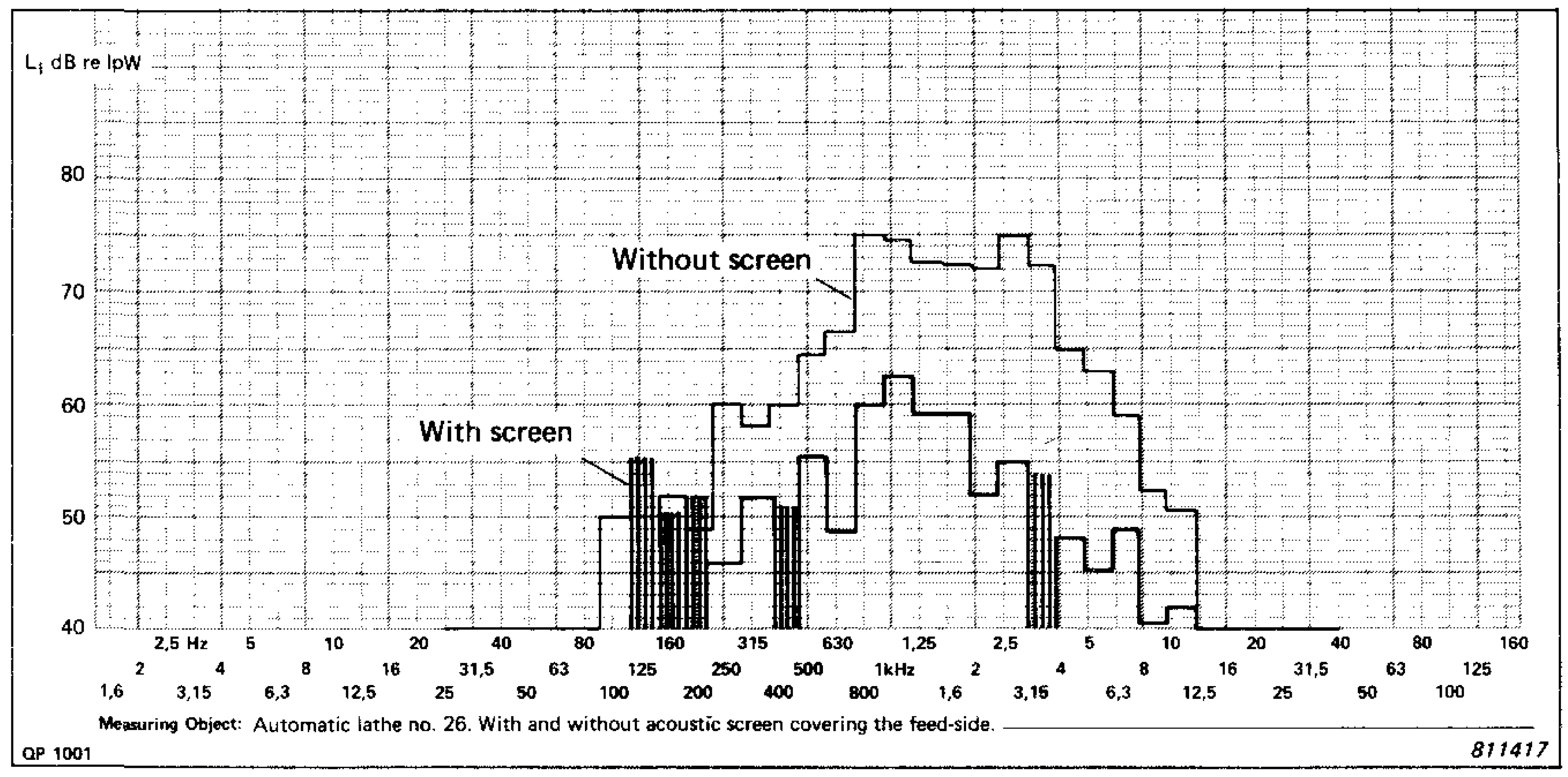


Fig. 9. Large lathe. Intensity spectrogram measured on the feed side close to the motor chamber, with and without an acoustic screen

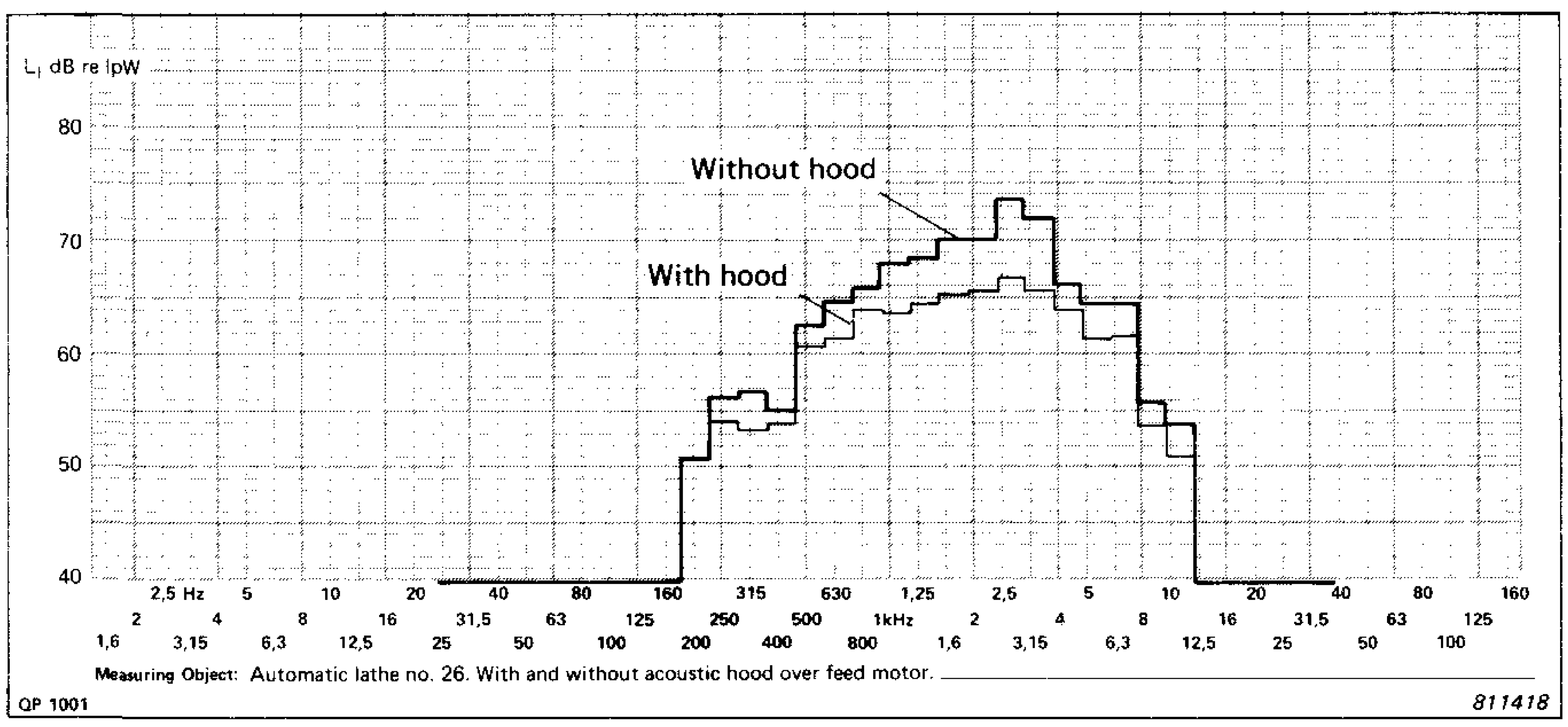


Fig. 10. Large lathe. Intensity spectrogram measured above feed mechanism, with and without hood

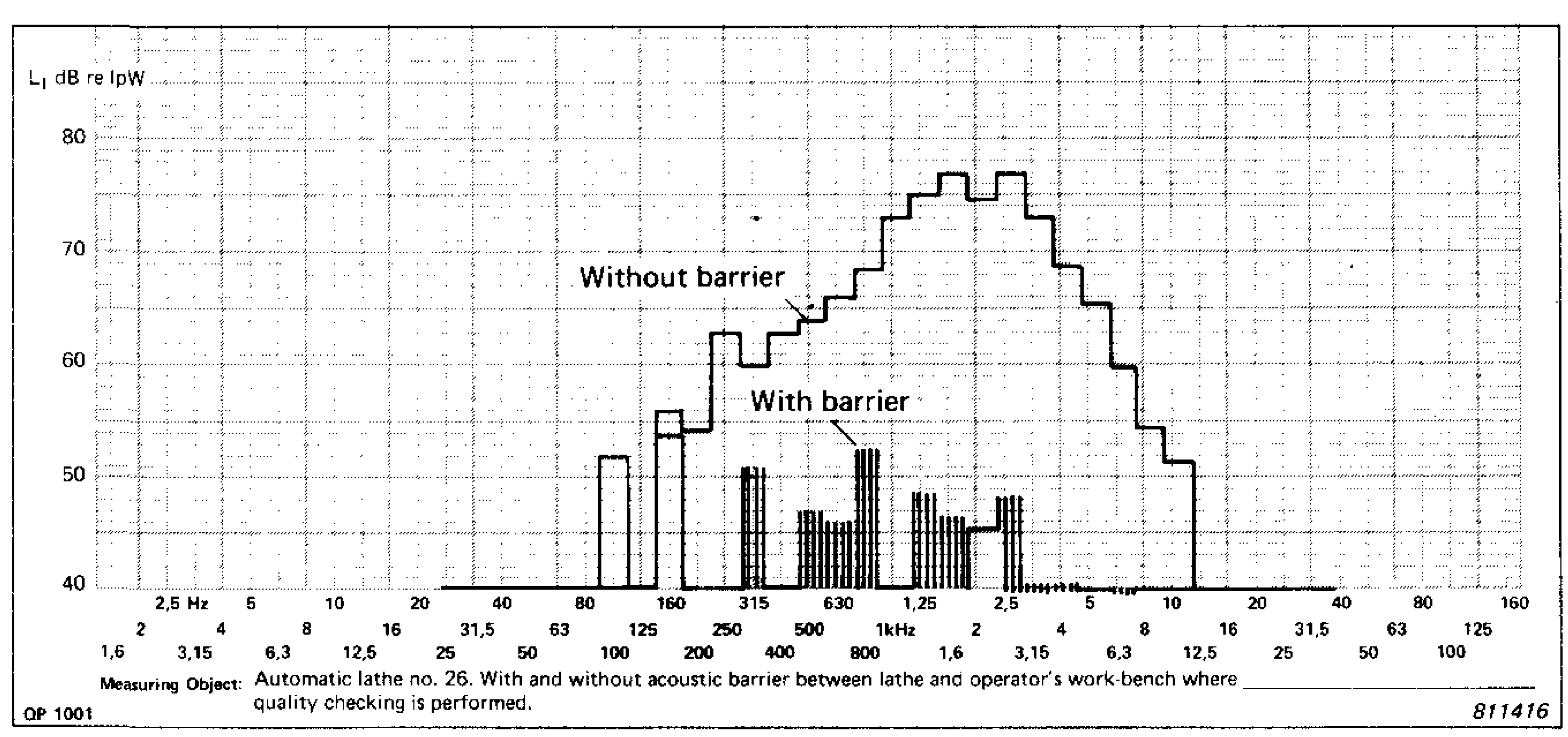


Fig. 11. Large lathe. Intensity spectrogram measured at operator's usual position at his quality control bench, with and without an intervening acoustic barrier

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