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IN-LINE COLOUR MEASUREMENT OF SUGAR IN IU_{420} UNITS.

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ABSTRACT

According to ICUMSA Method 4 sugar colour (IU_{420}) is measured as extinction in a filtered sugar solution. The measurement is made in the laboratory with a spectrophotometer. The time needed for sample preparation and measurement is incompatible with the requirements of process control.

The instrument (ColourQ 800) described here can take measurements in the process, without sample preparation. The result is delivered within seconds, and with a good correlation to the measurements in the laboratory. This is based on a unique (and patented) optical system, and new calculation methods.

More than 30 systems have been installed in sugar factories for process or quality control. The applications are for dry and wet sugar, and on band, screw or hopper conveyors.

Some aspects of the function of the system are discussed, together with installation, initial calibration, precision, and tests of the system.

INTRODUCTION

The need for a fast, reliable, and precise system to check the function of centrifugals led to contact between Danisco Sugar (then DDS) and Neltec. The first tests of a new system for colour measurement were made in the 1987 campaign. Since then the system has been modified to be able to measure in IU_{420} units. This has been confirmed in production tests by the Zuckerinstitut in Brunswick (1), by Südzucker (1), and by other sugar factories using the system.

The benefits to the users include:

1. The risks of bad sugar in the drier or the silo are eliminated, as is the risk of inadvertently delivering sugar with too high a colour value.

2. Better control of centrifugals. Malfunctioning is reported immediately. As it is possible to trace, which centrifugal is not working properly, reaction can follow without delay. Stops in the production due to centrifugal problems can be avoided or the consequences can be greatly reduced.

3. Trimming of washing times. The fast feed-back on changes in washing times for each centrifugal makes trimming easy. With continuous monitoring of the quality, the security distance to the quality limit can be reduced, leading to energy savings.

4. Speed. The results are presented in 1 to 5 seconds depending on the application.

5. No sample preparation is required. The measurements are taken directly in the production stream. The frequency of the laboratory tests can be reduced.

6. The quality is improved. More uniform quality is better quality.

THE MEASUREMENT SYSTEM

The basic measurement unit is working on a very simple principle (Figure 1). An illuminator sends out short pulses of white light. A detector collects some of the reflected light and separates it in spectral components. Both units have housings of stainless steel, and are placed at a distance of about 1 meter from the sugar. Therefore they can resist the environmental conditions, and are not contaminated by the sugar.

Information about the reflected light is sent from the detector to a PC, where the colour is calculated and presented to the user. Two graphs are used, a short term graph showing colour during the last 30 minutes (Figure 2), and a long term graph to show the last 24 hours (Figure 3). Under the short term graph is shown information about which centrifugal(s) has delivered sugar to the measurement position at the time of measurement (Figure 4). In this way the operator is able to identify centrifugals with unsatisfactory function.

INSTALLATION

The system has been installed for measurement of wet sugar after the centrifugals, and for measurement of dry sugar before the silo or on a conveyor between the silo and loading point. Two typical installations are shown (Figures 5a, 5b, and 6).

CALIBRATION

The system must go through two calibrations, one initial and one at regular intervals. The initial calibration is made after the installation on site. A number of samples are taken from the normal production stream. Their colours are determined in the laboratory of the sugar factory. These results are combined with the measure-ments from the system to give a calibration curve. This is then implemented in the system. Later during normal operation calibration is needed to compensate for drift in the instrument. This is made by measuring a white tile at regular intervals.

PRECISION

The system is guaranteed to have a precision better than the following:

$$\sqrt{\left(\sum_{i=1}^{N}\left(COLOUR_{IU\,420,LAB} - COLOUR_{IU\,420,NELTEC}\right)^2\right) / N} < 5IU_{420}$$

The limit of 5 IU_{420} applies to measurements in a screw conveyor. For measurements on a hopper conveyor the limit is reduced to 4 IU_{420}, and for measurements of dry sugar on a band conveyor the limit is 3 IU_{420}. Most users experience a precision well below these limits.
The report from the Zuckerinstitut (1) shows a deviation of 2.23 IU_{420} by measurements at a hopper conveyor.

APPLICATIONS IN A SUGAR FACTORY

5 different locations for installation of ColourQ 800 are relevant in the part of the factory after the centrifugals (Figure 7).

Before the drier(s) the two qualities can be monitored, to detect when a centrifugal is not working properly. Bad sugar can be sent back for remelt. The drier is protected against contamination with bad sugar. The measurements can also be used to justify mixing of the two streams into one.

After the drier the system works as a quality control instrument. The measurement conditions are very good, so here the best precision is obtained. The quality is confirmed before the sugar reaches the silo. If you want to mix the two streams here, the mixing ratio can be controlled.

The final quality check can be made on the conveyor taking the sugar from the silo to the loading point.

FACTORY INSTALLATIONS

More than 30 factory installations have been made in Europe.

SUMMARY AND CONCLUSIONS

The Neltec instrument, ColourQ 800, is able to measure sugar colour in the production process without any sample preparation. The unit has speed and precision to be used in process and quality control.

REFERENCES

1. Buchholz, K., and Bruhns, M. (1995). The 1994/95 campaign in Germany and new technological developments. (In German) Zuckerindustrie 120, 1995 (May), pp. 357-358.

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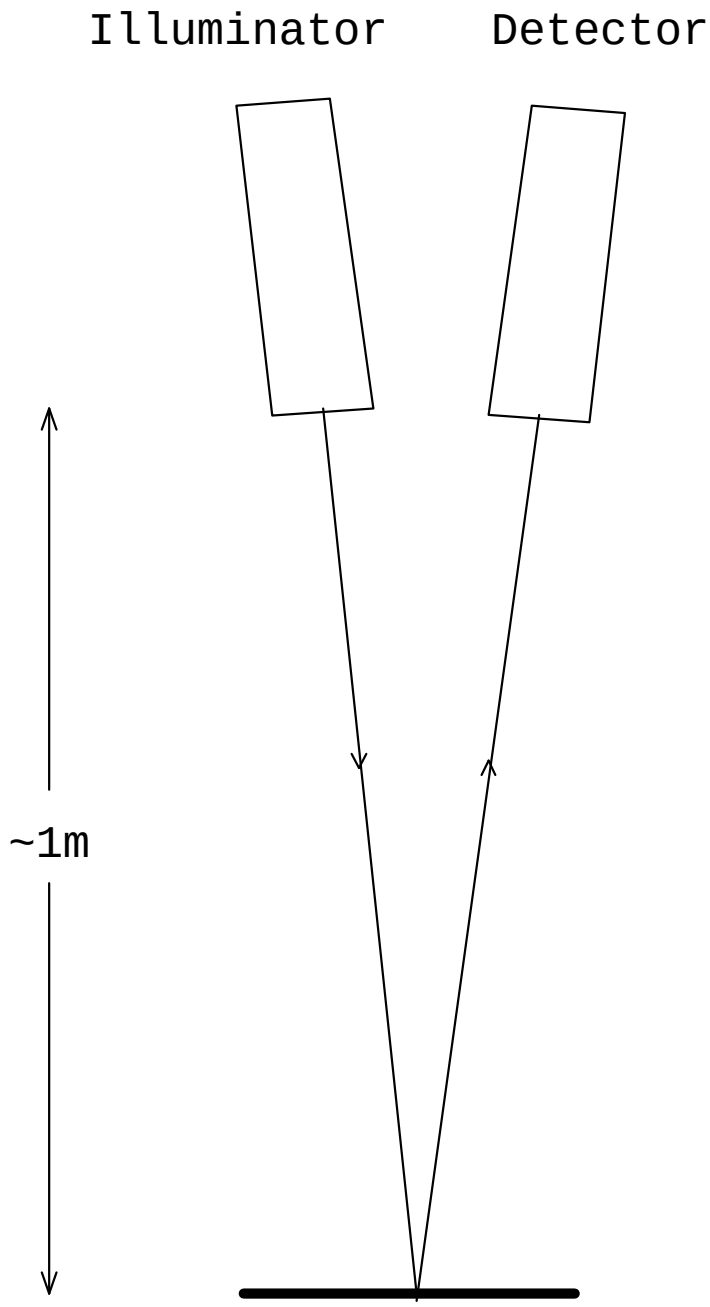

Figure 1. Position of illuminator and detector

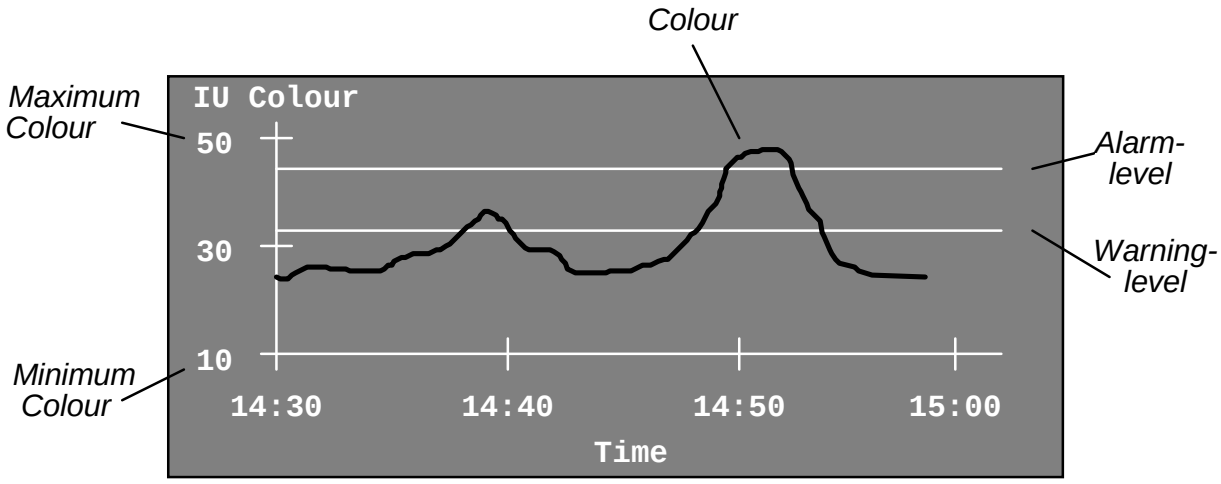

Figure 2. Short term graphics

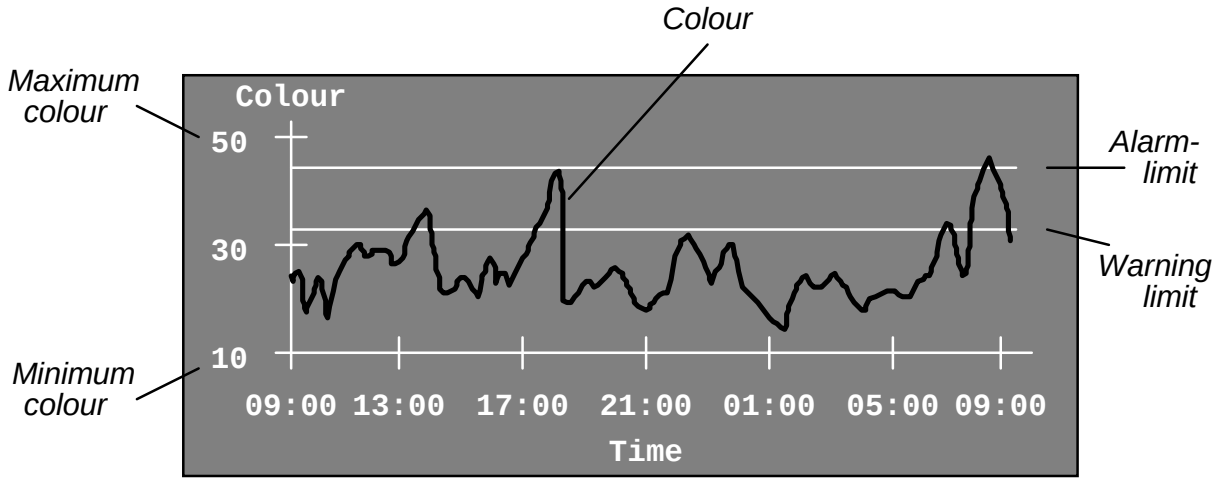

Figure 3. Long term graphics

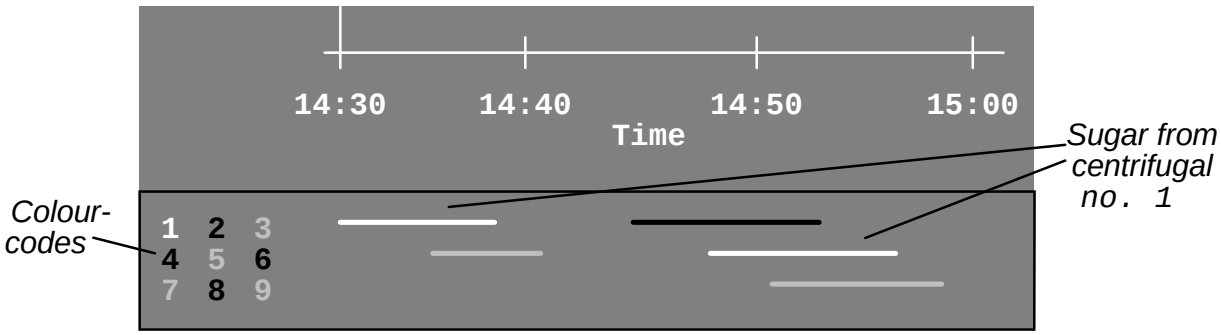

Figure 4. Identification of centrifugals

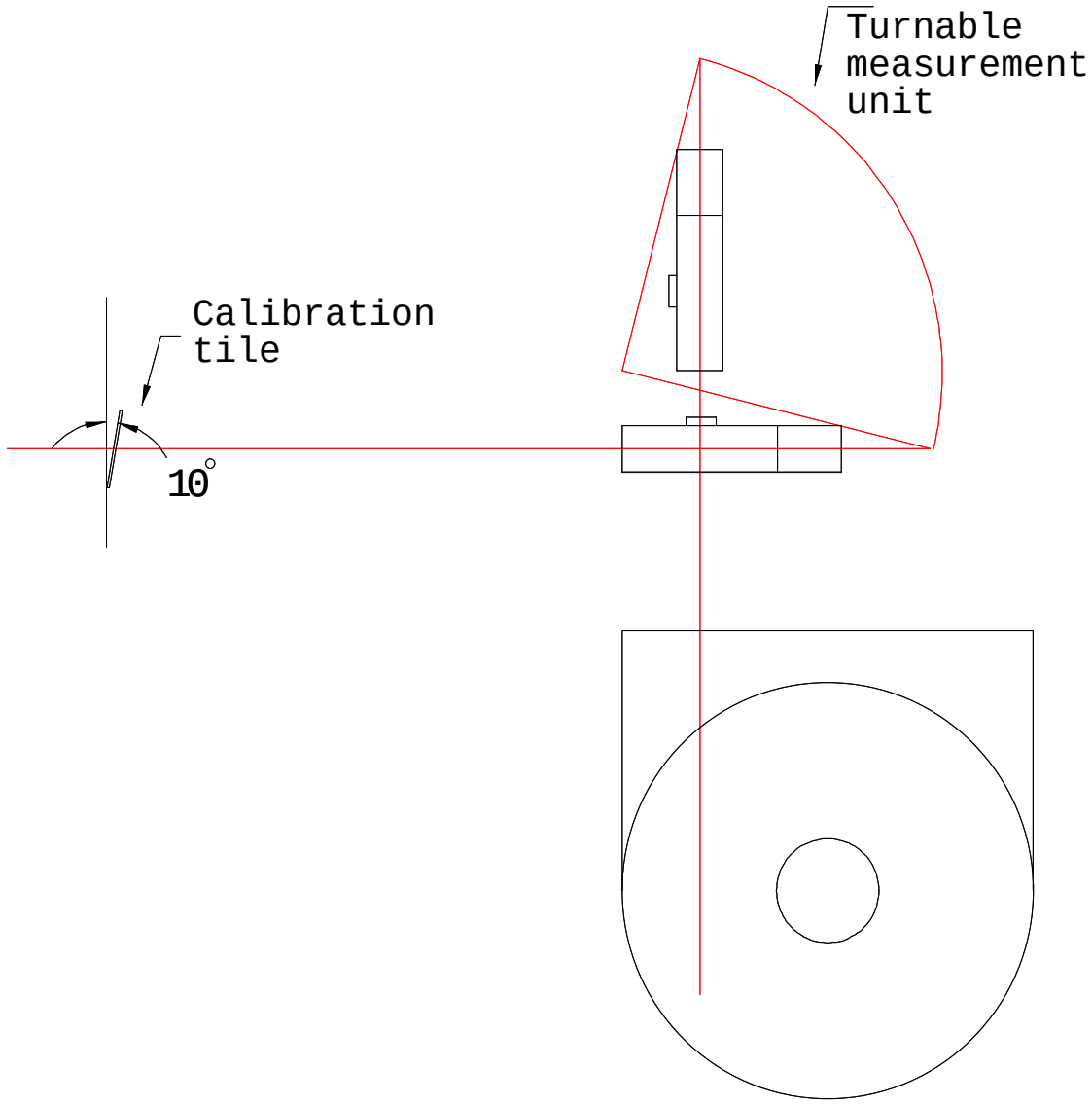

Figure 5a. Measurement in a screw conveyor

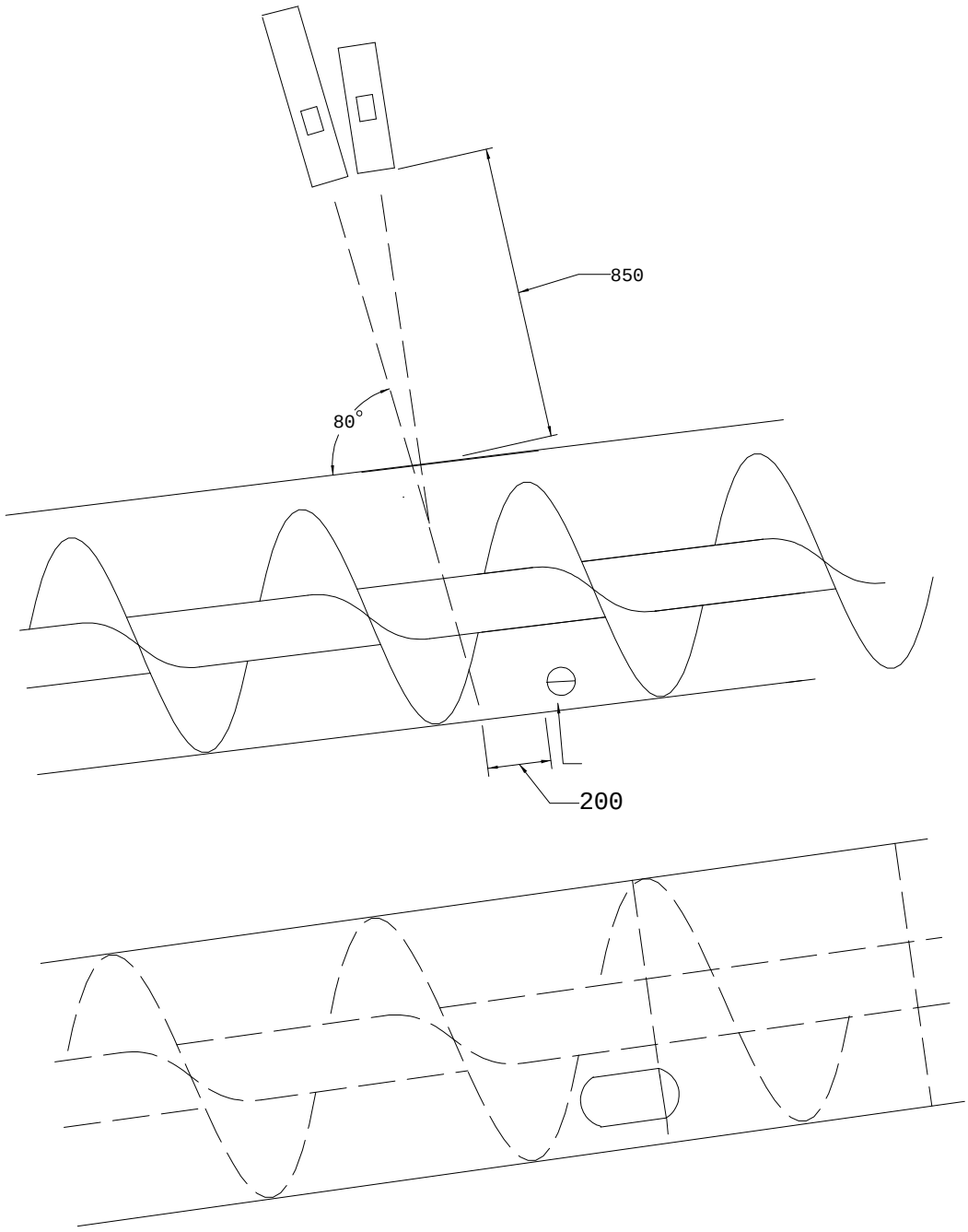

Figure 5b. Measurement in a screw conveyor

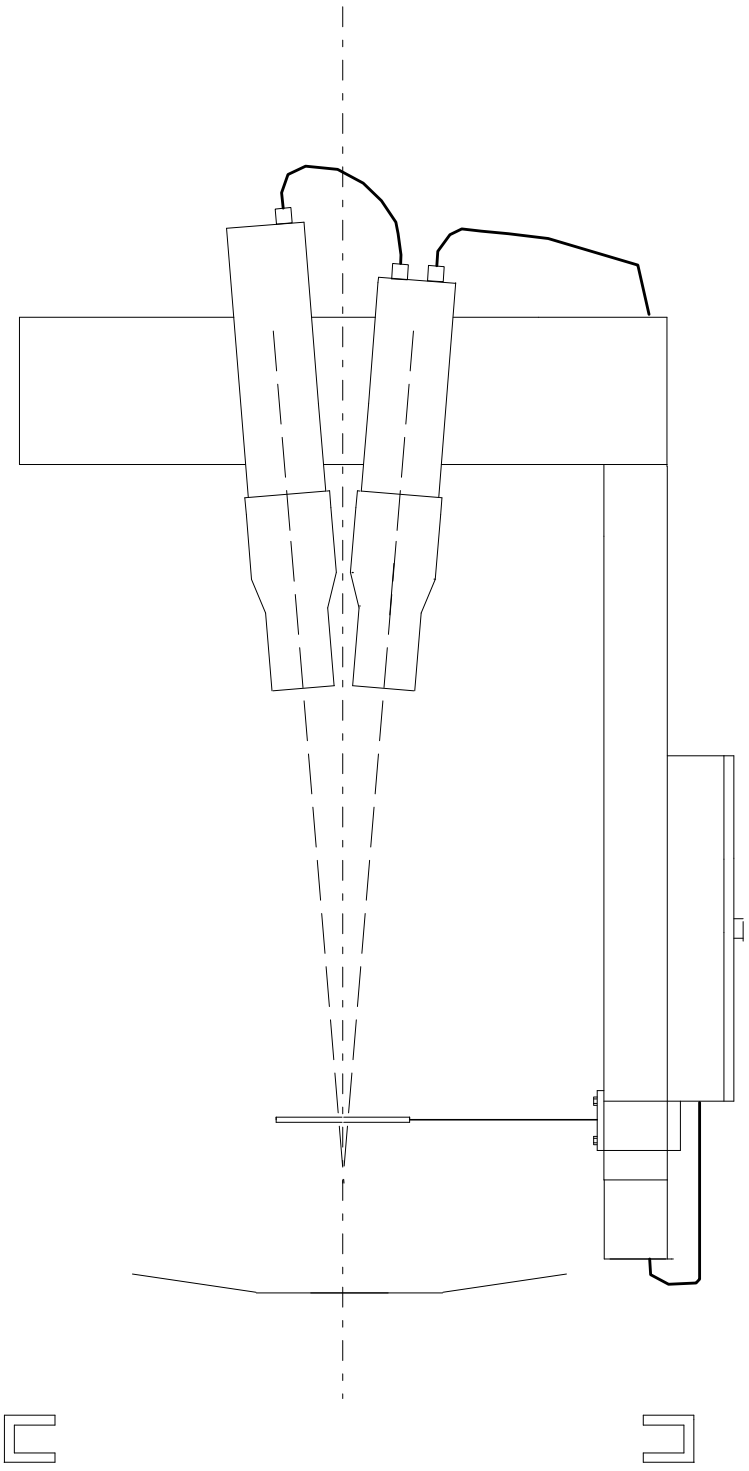

Figure 6. Measurement of
dry sugar
on conveyor

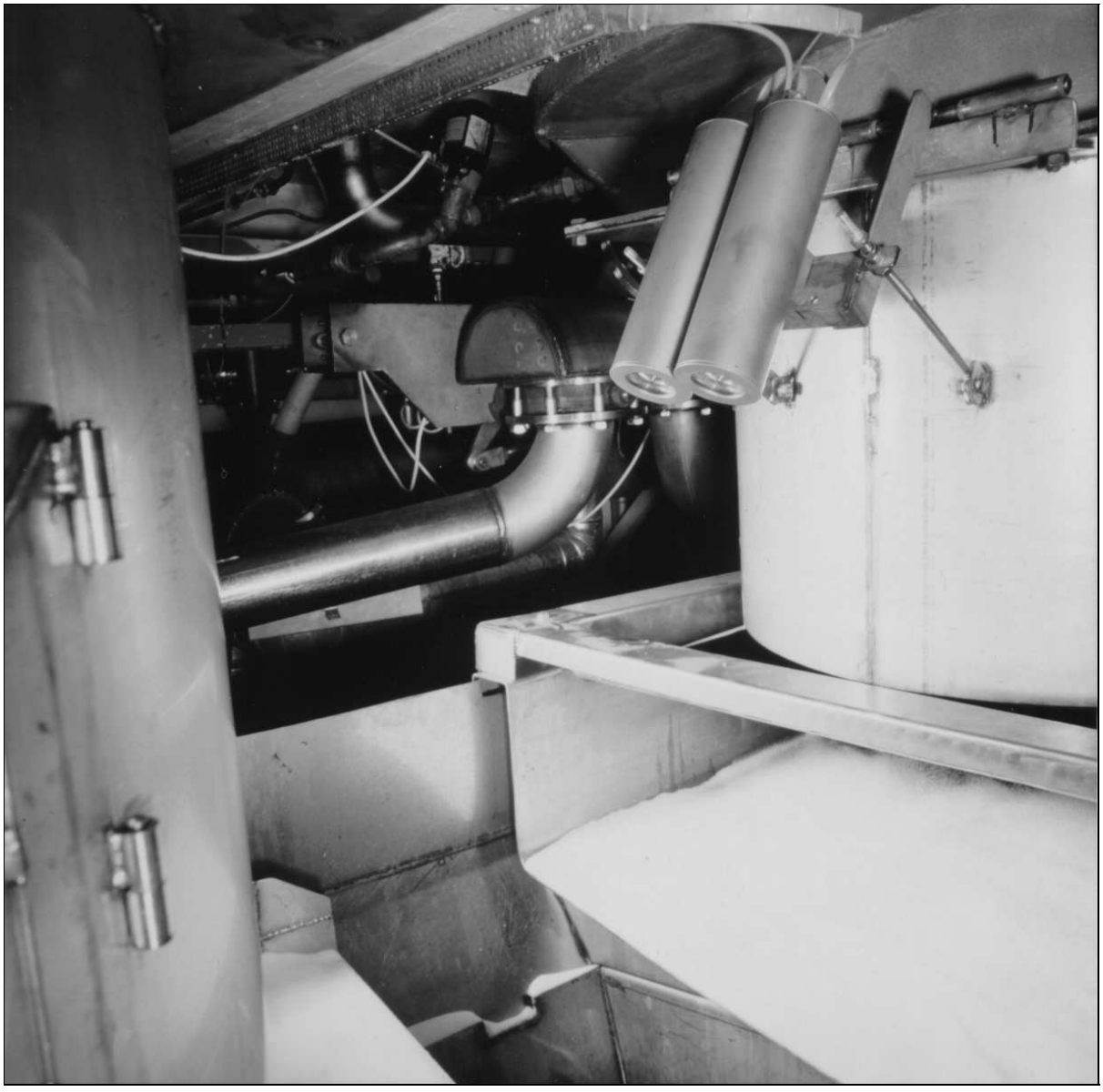

Figure 7. Measurement of sugar on hopper conveyor

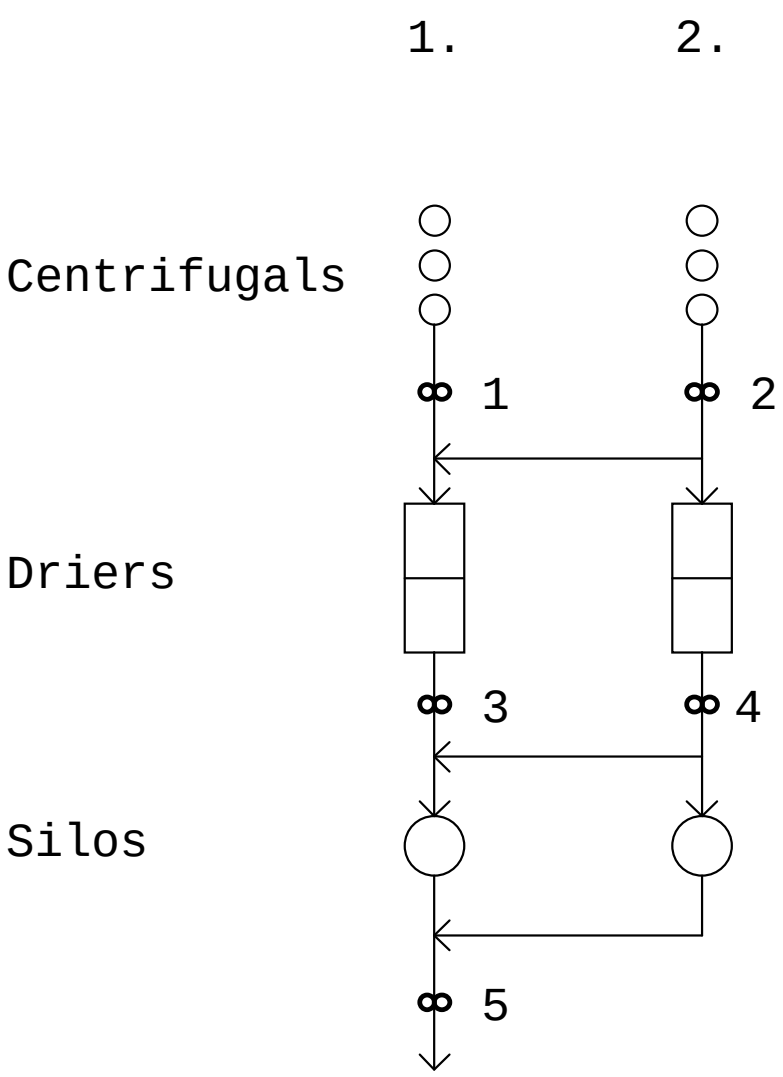

Figure 8. Five positions for measurement of sugar colour.