The Dauphinee-Mooser Measuring Circuit Extended to Lower Values of Resistance and Hall Voltage

J. H. FERMOR, A. KJEKSHUS and M. LEIN

Kjemisk Institutt A, Universitetet i Oslo, Blindern, Oslo 3, Norway

In using the Dauphinee-Mooser [1] (see also Dauphinee [2] and v.d. Pauw [3]) chopper comparator circuit for resistivity and Hall coefficient determinations at this Institute, it has frequently been of interest to measure resistance values into the metallic range and also low values of Hall voltage.

The required extension of the range of the apparatus has been very conveniently achieved by the use of a differential amplifier.

The measuring circuit. Fig. 1 shows the measuring circuit [1] in a modified form where a further chopper has been added in order to obtain greater sensitivity. The capacitors C_1 and C_2 are alternately charged to the specimen voltage E_S which is then compared with the voltage E_W across the variable standard resistor W.

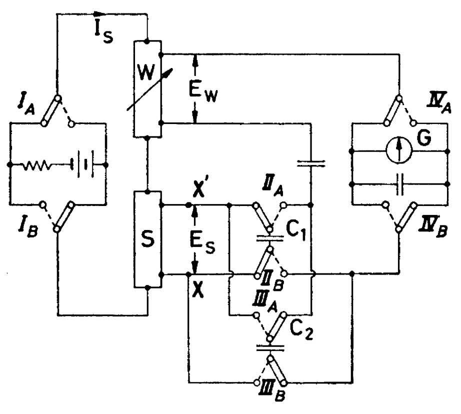

Fig. 1. Modified Dauphinee-Mooser [1] chopper comparator circuit shown in the resistance connection.

All the choppers are driven from a common shaft. Chopper *IV* makes contact after *II* (*III*) and breaks before *II* (*III*), allowing a galvanometer current to flow which is proportional to $E_W - E_S$ and therefore to $R_W - R_S$ since $I_W = I_S$.

With this arrangement, the lowest measurable value of R_S at a given experimental accuracy, is determined by the following factors:

a) Maximum allowable value of I_S
b) Galvanometer sensitivity
c) Capacitor values
d) Chopper and galvanometer circuit noise
e) Calibration of decade resistance W

These factors are not easily controlled with a view to using the method at lower levels and in practice, the lowest decade may be 10^{-2} Ω/step (2 % accuracy) with a further 10^{-2} Ω shunted by a helical potentiometer to give an extra decade. For these last figures to be accurate to within 5 %, extra switching must be used for the potential contacts of W in order to avoid the inclusion of the connecting wire and switch contact resistances of the higher decades in R_W.

The insertion of a differential amplifier having a voltage gain of 10^2, at the points X X', enables a specimen resistance R_S to be balanced at a value of $W = 10^2 R_S$, thus extending the measuring range by two orders of magnitude. This modification may be very easily made to existing apparatus. It is preferable to the alternative of defined attenuation of E_W, in that the voltage levels are maintained high.

The amplifier. The gain of the amplifier should be well stabilized by the use of negative feedback. It is convenient to be able to adjust the gain within fine limits and to set this control by balancing a standard 1 Ω resistor at a W setting of 100 Ω.

The amplifier should show a substantial degree of common mode rejection. This is facilitated by the use of the chassis ground connection shown in Fig. 2. R, which is adjusted for minimum common mode voltage, should not be so low as to disturb I_S appreciably, while at the same time the requirement $CR \ll (2n)^{-1}$ must be satisfied. Here n is the chopper frequency and C the stray capacitance to ground.

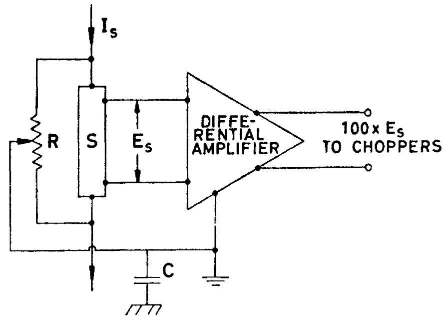

Fig. 2. Connection of differential amplifier for high common mode rejection.

With $n = 35$ c/s, an amplifier pass band of 20 c/s — 20 Kc/s is suitable, while the output impedance must satisfy the requirement $C_1 R_{out} \ll (2n)^{-1}$. ($C_1 = C_2$).

In evaluating the signal to noise ratio from the amplifier, only those noise voltages lying in the response range of the galvanometer (0 — 5 c/s approx.) need to be considered and many commercial amplifiers give satisfactory results.

A fairly high input impedance is indicated for the amplifier when Hall voltages are to be measured on specimens of higher resistance.

Acknowledgments. The authors wish to thank *Norges almenvitenskapelige forsknings-råd* for financial support and Professor H. Haraldsen for the provision of experimental facilities.

1. Dauphinee, T. M. and Mooser, E. *Rev. Sci. Instr.* **26** (1955) 660.
2. Dauphinee, T. M. *Can. J. Phys.* **31** (1953) 577.
3. v.d. Pauw, L. J. *Rev. Sci. Instr.* **31** (1960) 1189.

Received February 23, 1965.

The Reaction of β-Fructosidase with the Monogalactosylsucroses Extracted from Plants

RANDI SØMME and ALF WICKSTRØM

Department of Chemistry, Agricultural College, Vollebekk, Norway

It is generally accepted that β-fructosidase is unable to hydrolyse sucrose derivatives in which one of the hydroxyl groups of the fructose moiety is substituted. Thus, naturally occurring galactosyl-sucroses having the galactopyranosyl group linked to fructose at position 6 (planteose), position 1 (lychnose series), or position 3 (isolychnose series) are not at all attacked by yeast invertase (review articles [1-3]). This is consistent with the view that the specific role of the enzyme is to detach a fructofuranosyl group, and complete resistance towards invertase of any sucrose-containing oligosaccharide has so far been accepted as a proof of the absence of a terminal fructofuranosyl residue.

It has however been suggested [4] that also the hydroxyl group on C_2 of the glucose moiety is possibly essential for the formation of the enzyme-substrate complex between sucrose and β-fructosidase. A natural galactosyl-sucrose in which this hydroxyl group is blocked by substitution was later found (umbelliferose), and this trisaccharide proved to be extremely resistent to hydrolysis by invertase.[5] From experiments by one of us (A. W., unpublished), using umbelliferose preparations which had been carefully purified for any contamination of sucrose, it emerged that umbelliferose is not at all attacked by yeast invertase. These results are confirmed by the present work (Fig. 1).

Since a galactopyranosyl group on C_2 of the glucose moiety protects the sucrose linkage from hydrolysis by β-fructosidase, it seemed of interest to examine how much a galactosyl group on the adjacent C_3 might influence the hydrolysis rate. A natural galactosyl-sucrose of the required structure (Formula I) was detected in 1958 [6] as a constituent of the seeds of some grass species (*Festuca* and *Lolium*).

The position of the galactosyl group of this new sugar was originally studied [6] by examining the electrophoretic mobility