ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN — POLONIA
VOL. XVII, 1 SECTIO AA 1962

Z Katedry Fizyki Doświadczalnej Wydziału Mat.-Fiz.-Chem. UMCS
Kierownik: prof. dr Włodzimierz Żuk

Mieczysław SUBOTOWICZ, Jan KURANC,
Edward KRUPA

A Galvanometric System for the High Precision Stabilization of the Current in the Thin Lens Beta-Ray Magnetic Spectrometer

Układ galwanometryczny do stabilizacji prądu z dużą dokładnością w spektrometrze do promieniowania beta z cienką soczewką magnetyczną

Гальванометрическая система для стабилизации тока с большой точностью в спектрометре бета — излучения с тонкой магнитной линзой

The beta-ray magnetic spectrometer built in the Department of Experimental Physics at Lublin University was described elsewhere [4]. The spectrometer focusing the electrons of maximal energy about 2.5 MeV should be supplied with the current up to 7 Amps from the d. c. current generator (with external or internal excitation). Because the current in the coils and the power consumption (about 1.5 kW) are comparatively small, we could realize the effective stabilization without directly affecting the excitation circuit. Our automatic electronic system supplying suitable amount of current to the coils of the spectrometer according to the value established in the reference system with a standard cell and standard resistor in thermostate ($\pm$ 0.5°C) can keep the current in the spectrometer coils on the required level with a precision better than $1 : 10^{-4}$.

For similar purposes there were built the stabilization systems using a slightly modified Brown electronic null indicator [2], Pye galvanometer [3] or chopper amplifiers [1]. In our system there was used the galvanometer with photocells and an electronic system. The block diagram is shown in Fig. 1. A standard resistor R_w is connected in series with the coils of the spectrometer S_c. The voltage taken from this resistor is compared with the reference voltage using precise potentiometer P. Any changes of the voltage in the main circuit due to the current generator instabilities or thermal drift are amplified in the d. c. amplifier (A_1, Figs. 1 and 2); its output controls current compensator A_2 supplying the main coils with additional current. For the

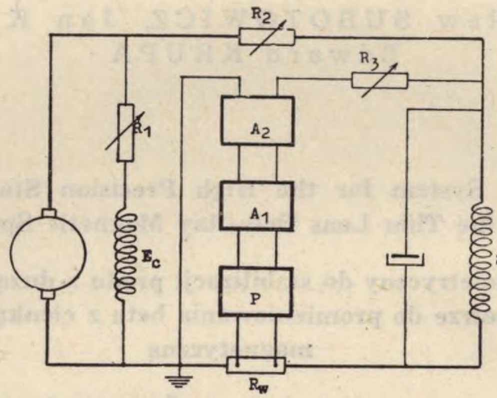

Fig. 1. Block diagram of the stabilizing system
E_c — excitation coil of the d. c. generator
S_c — spectrometer coil
P — precise potentiometer
A_1 — d. c. amplifier with the mirror galvanometer and two photoelectric cells (for details see Fig. 2)
A_2 — current compensator (for details see Fig. 3)
R_w — standard resistor.

required current in the spectrometer coils there is settled a particular current delivered by the current compensator (A_2, Figs. 1 and 2).

Our modified d. c. amplifier, Fig. 2 (type SKBy-02, Energopomiar, Poland) has five voltage and current ranges. They are for input voltages from 100 μV to 2000 μV. The voltage amplification changes from $5.5 \cdot 10^{-4}$ for 100 μV range to $5 \cdot 10^{-3}$ for 2000 μV range. The d. c. amplifier is that of a mirror galvanometer type, coupled with two photoelectric cells, controlling the grids of the valves of the amplifier. There is strong negative feedback. A part of the output voltage is given to the input of the amplifier. This is necessary for a partly compensation of the input voltage to keep the deflection of the galvanometer as small as possible.

During the normal work of the stabilizing system the output voltage of the d. c. amplifier changes on the average from ± 0.4 V to ± 1.0 V.

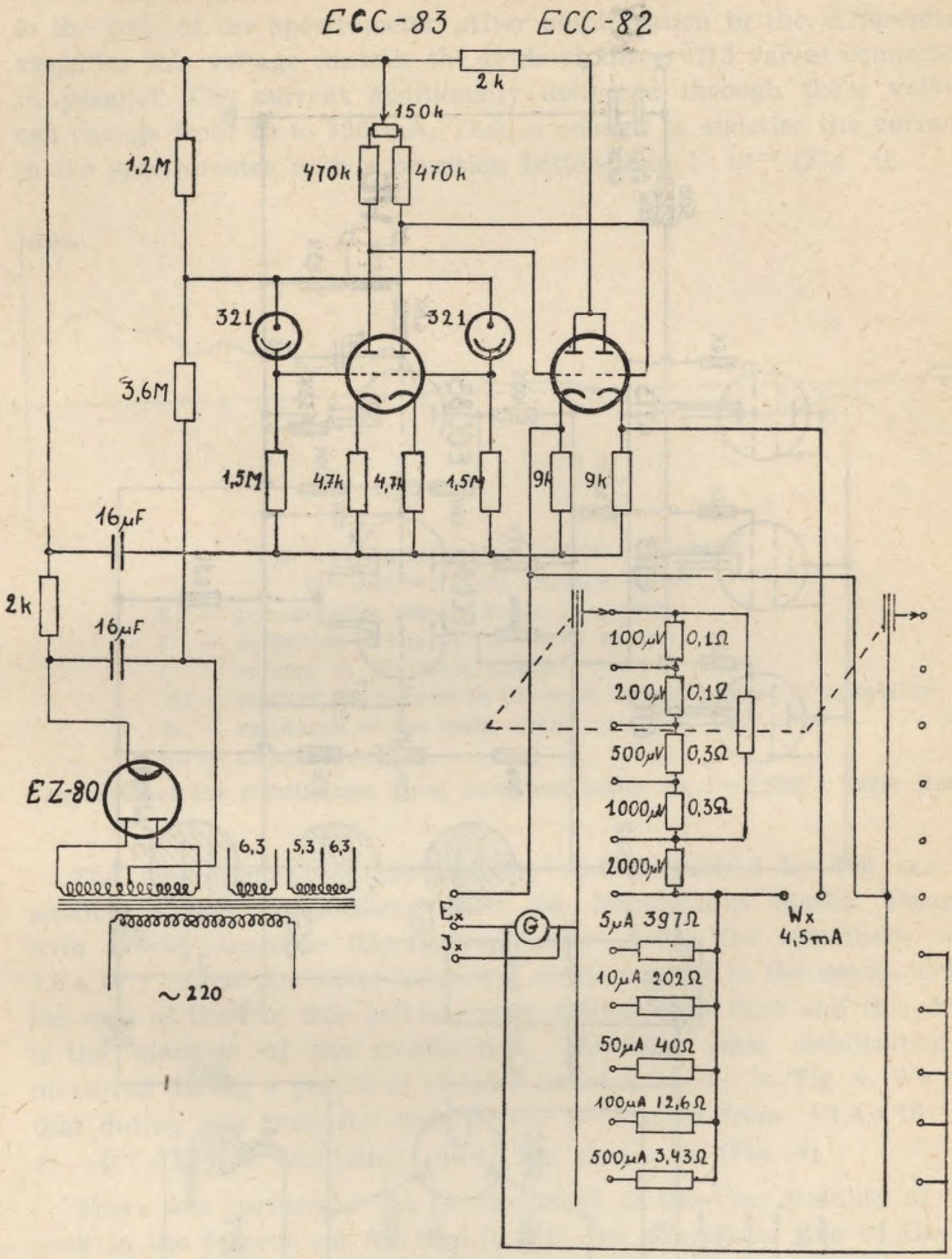

Fig. 2. Scheme of the d. c. amplifier, the mirror galvanometer (G) and two photoelectric cells (321)

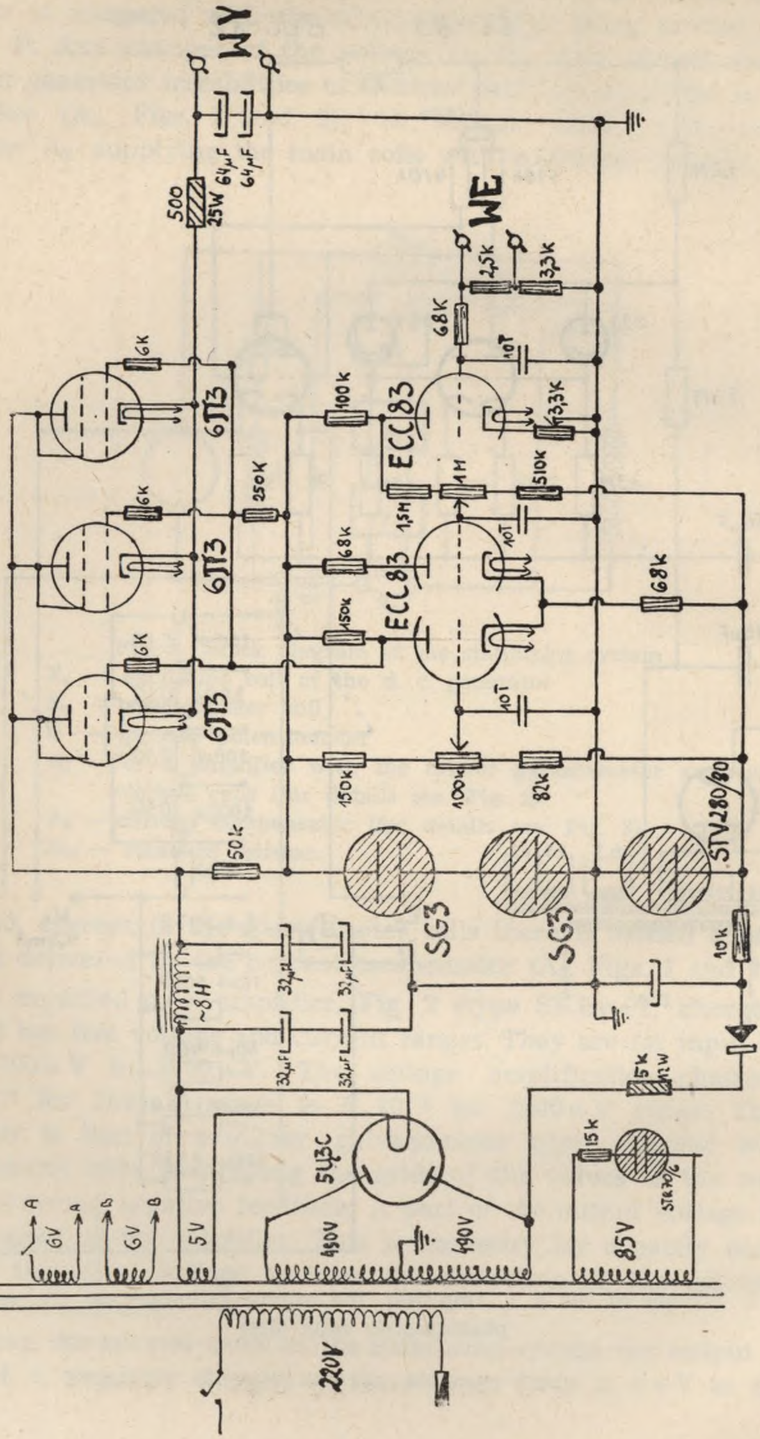

Fig. 3. Current compensator (We — input, Wy — output)

This voltage controls the current compensator (Fig. 3) delivering current to the coils of the spectrometer. After amplification in the differential amplifier this voltage controls the grids of three *6П3* valves connected in parallel. The current additionally delivered through those valves can change from 20 to 350 mA. That is enough to stabilize the current in the spectrometer with a precision better than $1 : 10^{-4}$ (Fig. 4).

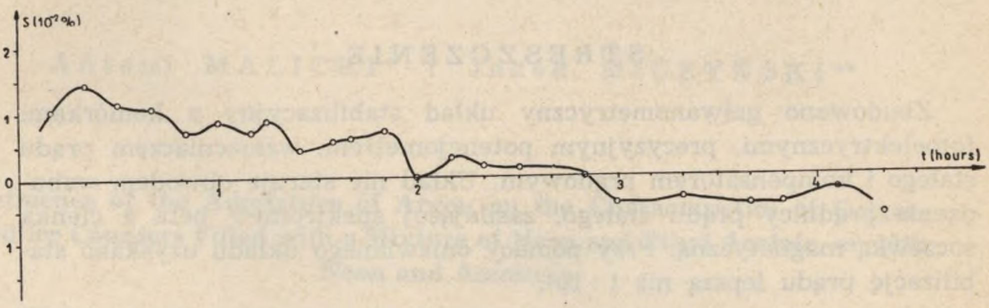

Fig. 4. Long term stabilization S diagram;
$S = \triangle i/i = (l.\, S_g/i).\ (R_z/R_w)$, where
S_g — galvanometer sensitivity in Amps/mm
l — deflection of the galvanometer in mm
i — current in the main circuit
$\triangle i$ — drift of the current in the main circuit because of instability
R_z — resistance of the main circuit
R_w — standard resistor.
The curve of the stabilization given here was taken for $i = 2.5355 \pm 0.0001$ Amps

The measurement of the stability was performed by the use of another voltage compensator (KFs—88, Politechnika Śląska, Poland) with a very sensitive Kipp-galvanometer A-52. The sensitivity was 1.0×10^{-9} Amps/mm. After balancing of the current in the spectrometer the spot of light of this galvanometer drifted with time and this drift is the measure of the stabilization. The long term stabilization S measured during a period of about 5 hours is shown in Fig. 4. We see that during this time the stabilization S changed from $+1.4 \times 10^{-2}$ % to -0.7×10^{-2} % oscillating round the time axis (Fig. 4).

There was performed the measurement of the time stability of the peak in the β-spectrum for Cs-137. For the conversion line of Cs-137 and the current in the spectrometer coils $i = 2.5355 \pm 0.0001$ Amps the probable error of the counting rate of the electrons, by use of the G—M counter, was ± 0.8 %. The counting rate of the electrons by fixed current was measured during 5 hours at intervals of 10 minutes.

REFERENCES

1. Burzyński Z: Nukleonika, 6, 71, 1961, nr 2.
2. Garwin R. L.: Rev. Sci. Instr., 29, 223, 1958.
3. Martin D. G. E., Vakselj M., Subotowicz M.: in print.
4. Subotowicz M., Kuranc J., Krupa E.: Folia Societatis Scientarium Lublinensis, 2, 110 (1962).

STRESZCZENIE

Zbudowano galwanometryczny układ stabilizacyjny z komórkami fotoelektrycznymi, precyzyjnym potencjometrem, wzmacniaczem prądu stałego i kompensatorem prądowym. Układ nie steruje obwodem wzbudzenia prądnicy prądu stałego, zasilającej spektrometr beta z cienką soczewką magnetyczną. Przy pomocy omawianego układu uzyskano stabilizację prądu lepszą niż $1 : 10^4$.

РЕЗЮМЕ

Построена стабилизационная система, в которой использован гальванометер с фотоэлементами, точный потенциометер, усилитель постоянного тока и компенсатор по току. Система не влияет на возбуждение динамомашины постоянного тока. Эта сравнительно простая стабилизационная система, использованная в бета-спектрометре, дает стабилизацию лучше чем $1 : 10^4$.

Annales UMCS Lublin 1963 Format 70×100 Druku str. 6
Papier druk. sat. III kl. 80 g. Lub. Druk. Pras. Lublin, Unicka 4 Zam. 3001. 24.VIII.63
600 + 75 egz. N-5 Manuskrypt otrzymano 24.VIII.63 Data ukończenia 21.III.64