Differential quasi-isothermal microcalorimeter with a digital output. II. Output unit for the punching machine

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The function and concept solution of an output unit for the punching machine are described in this paper. This unit processes the output voltage of the bridge of the microcalorimeter for the input system of the tape punching machine and the subsequent processing of experimental data on the computer. This unit consists of a digital voltmeter NR 20 and the tape punching machine ZJŠ 332.5. The output unit described consists of the code converter and the control unit for the punching machine. Its solution enables the use of different types of digital voltmeters, punching machines, and various input and output codes.

Описываются назначение и концепция выходного блока для перфорирующего устройства, обрабатывающего выходное напряжение с мостика микрокалориметра для входа в перфоратор ленты и последующей обработки экспериментальных данных на ЭВМ. Блок работает в составе цифрового вольтметра NR 20 и перфоратора ленты ZJŠ 332.5. Приводимый выходной блок состоит из преобразователя кода и управляющего блока перфоратора. Его конструкция позволяет использование цифровых вольтметров и перфораторов различного типа, и также различных кодов на выходе и входе.

The application of the experimental data processing by means of computers is a typical feature of the present experimental technique.

For the heat-flow calorimeters with the stable zero line, it is relatively easy to determine the equivalent of the value of released or consumed heat by a simple electronic integration of the signal corresponding to the area under recording line. As to other calorimeters, mostly isoperibolic, the finding of the equivalent of heat

change in the system is more complicated because of necessary corrections for heat transfer between the calorimeter and its environment. Therefore it appears serviceable to record the temperature progress in the initial, main, and final phase of experiment on a punched or magnetic tape and evaluate the corrected heat effect by computers according to the given computing programmes.

In this paper, the output unit consisting of a code converter and a control unit for punching machine, the punched tape code used and its storage in the computer memory is described.

Block diagram of the experimental system

The block diagram of the experimental system is presented in Fig. 1. The output signal from the disbalanced bridge is taken from the differential quasi-isothermal microcalorimeter [1] and after amplification in the electronic control unit of the calorimeter, it is processed by a digital voltmeter which is switched by an adjustable timing unit built in the control unit of the calorimeter. The output from the digital voltmeter is led to the output unit for punching machine and recorded on the punched tape. In this study, we were concerned with the principle and function of the device which is marked by dash line in Fig. 1.

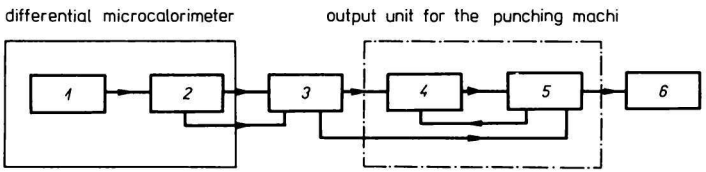

Fig. 1. Block diagram of the experimental device.
1. Bridge; *2.* electronic control unit; *3.* digital voltmeter; *4.* code converter; *5.* control unit for the punching machine; *6.* punching machine.

Output unit for the punching machine

The reading and processing of signals from measuring instruments are frequently performed in commercially available data loggers which are considerably expensive and in most cases dependent on a given input and output code, type of digital voltmeter and punching machine. For this reason, the particular components of the logger are not replaceable and for the most part suited to single purpose.

According to the basic literature [2—4] the described device was originally also developed as a single-purpose component of a measuring apparatus in which it had only to ensure the transfer and decoding of the data from a data logger Solartron to a punching machine of the ZJŠ 332.3 type.

During the development, it appeared that a similar device could be used in a great number of workplaces. Therefore all requirements were considered and respected by developing this unit. In spite of relative simplicity and low purchase cost, this system fulfils the needs of maximum universality. Thus the output unit for the punching machine was constructed the block diagram of which for the digital voltmeter Metra NR 20 and the tape punching machine ZJŠ 332.5 is given in Fig. 2.

The output unit for the punching machine is a device for collecting data from different digital apparatuses and for recording these data on a punched tape by means of a punching machine. It consists of two parts (Fig. 2), *i. e.* a code converter and a control unit for the punching machine. In the code converter, an input information is transformed into the required output code. The control unit is a logical system which controls the function of the code converter and the punching machine.

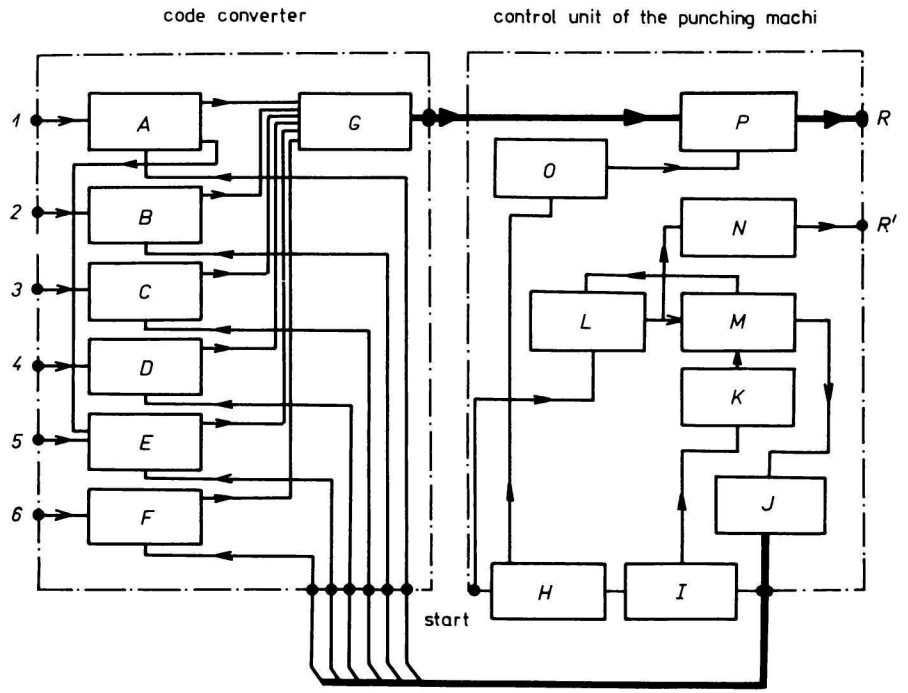

Fig. 2. Block diagram of the output unit for the punching machine.
1—4. Place; *5.* polarity; *6.* range.
A—F. Converter; *G.* output circuits; *H, I.* manual choice; *J.* circuits for converter control; *K.* preselection of step number; *L.* timing circuits; *M.* step counter; *N.* switching circuit of clutch; *O.* internal code; *P.* switching circuit of dies; *R, R'.* into the punching machine.

*Code converter**

The function of the code converter is given in Fig. 3 representing the block diagram of one converter from the code of a digital voltmeter Metra NR 20 (BCD) into the modified BCD code with uneven parity for one digit.

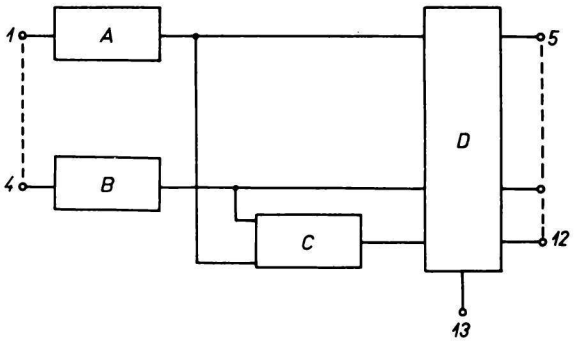

Fig. 3. Block diagram of the code converter.
1—4. Inputs for one digit (BCD code, 0... + 5.5 V, I... − 6 V) from a digital voltmeter Metra NR 20; *5—12.* eight outputs corresponding to 8 tracks on a punched tape; *13.* input for opening the gate of the converter.
A, B. Adaptation of input levels; *C.* generator of parity bit; *D.* output gate.

*Control unit of the punching machine**

The connection of circuits for controlling the punching machine dies is represented in Fig. 4. An external code is led from the converter unit to one octal input set (*e.g. 1A* to *8A*). If we use two converter units, we engage the second octal set (*e.g. 1B* to *8B*) as well. All free octal sets are connected with the potential of 0 V.

Log 1 on any input into octal set brings the corresponding thyristor into conductive state. Thus the circuit of the corresponding punching machine die is connected.

For an internal code, there is the logical zero at input *I*, which is a condition for conductive state of all eight thyristors. By selecting the potentials at inputs *01*

* A detailed electronic documentation is available in the Institute of Nuclear Physics, Czechoslovak Academy of Sciences, Řež near Prague, under designation E 183 A [5] and E 184 A [6].

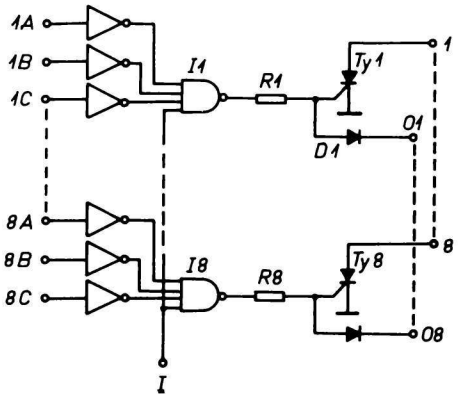

Fig. 4. Circuits for the control of dies.
R1—150, *I1—18* — MH7420, *D1—D8* — GA204, *Ty1—Ty8* — KT502, *I* — choice of external or internal code; *01—08* — inputs of internal code for particular dies; *1A—8A, 1B—8B,* or *1C—8C* — set of eight inputs; *1—8* — outputs for controlling the dies of the punching machine.

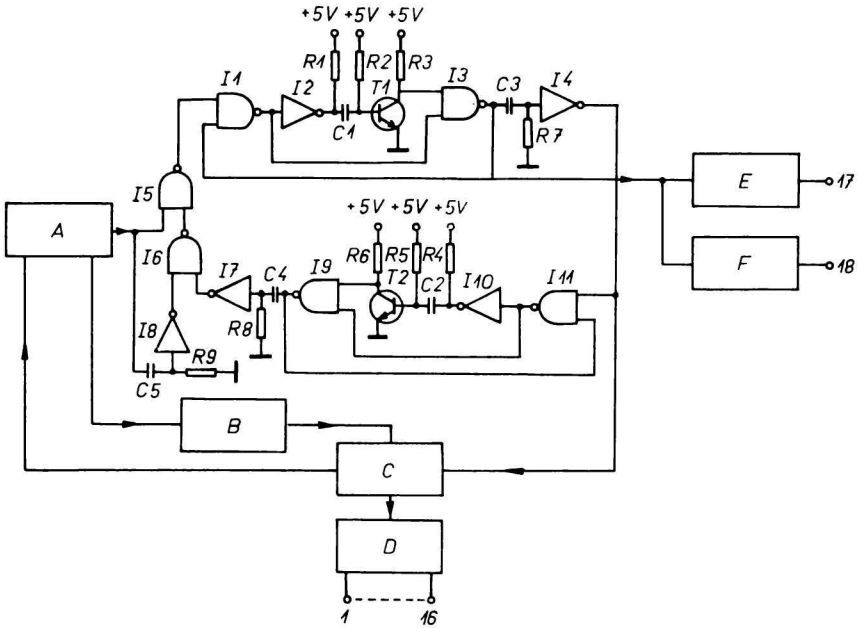

Fig. 5. Timing circuits.
R1, R4 — 680; *R2, R5*— 56K; *R3, R6* — 10K; *R7, R8, R9* — 470; *C1* — M47; *C2* — 1M; *C3* — 1K2; *C4, C5* — 4K7; *I1, I3, I5, 16, 19, I11* — MH7400; *12, 14, 17, 18, I10* — MH7404.
1—16. Outputs for controlling the gates of converters; *17.* output for switching the clutch of the punching machine; *18.* output for switching the circuits of the dies of the punching machine.
A. Control logic; *B.* preselection of step number; *C.* step counter; *D.* circuits for converter control; *E.* switching circuit of clutch; *F.* switching circuit of dies.

to *08* (by the knobs on the panel), a combination of holes on the tape may be made. The diagram of timing circuits is presented in Fig. 5.

The starting signal of the control logic (jumps from log 0 to log 1) opens gate *I5*. The impulse derived from the front edge of this jump passes to the input *I1* and starts monostable toggle circuit *1* (further MTC1). The output impulse of this circuit approximately of the length of 22 ms switches the circuit of the clutch of the punching machine. The combination given by the state of thyristors *Ty1* to *Ty8* (Fig. 4) corresponding to an output combination of the converter opened during this step (outputs *1* to *16*) is recorded on a punched tape. The impulse from MTC1 finished, the clutch circuit and anodic circuits *Ty1* to *Ty8* are switched off. The anodic circuits pass in a nonconductive state. The punching machine achieves the punching cycle and stops.

The final edge of the impulse from MTC1 at the input *I11* starts the monostable toggle circuit *2* (MTC2) and simultaneously changes the state of the step counter by a unit. The converter hitherto open is closed and the subsequent one opens. The final edge of the output signal from MTC2 (of the length of about 45 ms) passes through the gate *I5* and the described cycle is repeated up to the moment when the step counter stops counting and closes gate *I5* through the control logic.

The length of the impulses from MTC1 and MTC2 is variable by the magnitude of capacities *C1* and *C2*. The sum of the lengths of both impulses (67 ms) approximately corresponds to the maximum punching rate of a punching machine of the type 332 which amounts to 15 signs per second (according to the information of the producer).

Activity of the output unit for the punching machine

The digital reading (4×4 bits), information about polarity of the measured voltage (1 bit), and information about measuring range (6 bits) as well as the command "start" are transferred from digital voltmeter to inputs of the unit. The command "start" switches the timing circuits (Fig. 2) which open particular converters *A* to *F* through the step counter and circuits for the control of converters. After passing the output circuits and switching circuits of dies, the output information of these converters appears for the time interval given by the timing circuits at input to the punching machine which simultaneously gets a command to punching through switching circuit of the clutch. Each line of the tape record, therefore, corresponds to an output reading of the corresponding converter *A* to *E*.

When the punching cycle, *i.e.* punching of the information from one converter, has been finished, the timing circuits give a command to punching the information from other converters. In this way, the output data from all converters *A* to *F* are

recorded. Then the punching stops and the apparatus waits for the next command "start"

The manual selection of the internal code enables to put arbitrary data on a tape, *e.g.* number and type of the experiment, date, dividing signs for denotation of the stages of the experiment or to give instructions for computer in conformity with the programme of data processing.

The long-term experience with the output unit for the punching machine is satisfactory. Initial difficulties due to the corrosion of silver contacts of the Zeibina type were completely removed by replacing them with gilded contacts exhibiting a high safety of operation.

Modification of the output unit for the punching machine

Besides the use described, the output unit for the punching machine may be employed in many other cases. At present, there are exchange code converters available for digital voltmeters Solartron, voltmeter Metra NR 20, MT 100, French nanovoltmeter Setaram NV 724 N, and for a system of decadic counters.

The input and output code can be of the type BCD, BCD + 3, 1 from 10, hexadecimal and Gier with uneven parity while a relatively easy modification makes possible to apply every other known code.

At present, all types of punching machines of the series ZJŠ 332, Hungarian punching machine Perfomom 30, with small modification Facit 1500 and Facit 1501, and the Polish punching machine DU 10 may be used.

A use of device for the other data sources or other punching machines requires small modifications and/or replacement of the type of converter.

Code of the punched tape and processing of the punched tape on a computer

In our instrumental system, we used a digital voltmeter Metra NR 20 for continuous reading of the output signal from the calorimeter (deflection measurement of the disbalanced bridge with thermistors in differential connection [1]). The switching of the voltmeter in adjustable intervals of 0.5, 1, 2, 4, and 8 s between two starting commands was controlled by the electronic control unit of the calorimeter (Fig. 1).

The output from the code converter described in the preceding part was punched in a modified BCD code by a punching machine ZJŠ 332.5. In punching any measured voltage value, the voltage polarity was also punched together with the 1st digit of the voltage value (only zero or unit) in the first line on the punched tape. The second and as far as fifth line of the digital record on the punched tape contains the pertinent digits of lower orders in the BCD code. The last, *i.e.* the sixth line of the digital record, contains information about the order of digit and simultaneously

the dividing sign for processing on a computer. All signs are punched in uneven parity.

When the measurements were processed on a table computer Hewlett—Packard 9830 A, the punched tape was read sign after sign up to the dividing sign and the set of six lines on the punched tape containing even polarity and information about the digit order was transformed back into decadic form and stored in the memory of the computer. Then the temporal progress of voltage is given by sequence of the digits read.

The computation programme for the processing of output data and evaluation of experimental results will be the topic of the subsequent communication.

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