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East Europe Report

SCIENTIFIC AFFAIRS

(FOUO 1/82)

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EAST EUROPE REPORT

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INTERNATIONAL AFFAIRS

CZECHOSLOVAKIA

AUTOMATIC STABILIZED PLATFORM FOR INTERKOSMOS SOLAR PROGRAM DESCRIBED

Prague AUTOMATIZACE in Czech No 11, 1981 pp 274-282

[Article by Eng Frantisek Rubes, Eng Jiri Ruzicka and Eng Jiri Recek, Research Institutes Development and Operations Base, Prague-Bechovice: "An Automatic Stabilized Platform in the Interkosmos Program"]

[Text] This article describes the main characteristics of the equipment in the ASP-SKAN automatic stabilized platform, which was developed for the new AUOS-S satellites to be used in the Interkosmos program for the study of solar radiation. The ASP-SKAN is an electromechanical system for precise orientation of high-resolution astronomical instruments.

1. Introduction

The development of rockets and space flight in the past two decades (1960-1980) has made it possible to transport astronomical measuring instruments (telescopes, spectrometers and the like) outside the earth's atmosphere. The placing of scientific measuring instruments in automatic space stations has increased the possibilities for studying short-wave radiation from bodies in space (e.g., ultraviolet and X-ray radiation from the sun), which is absorbed by the earth's atmosphere. Automatic space stations make it possible to conduct nearly continuous astronomical observation free from the disturbing effects of the earth's atmosphere, thus markedly increasing the effectiveness of astronomical observation.

As part of international cooperation in the Interkosmos program, the Soviet Union has developed the new AUOS-S satellites (Automatic Universal Orbital Station-Sun), which will be used to study the sun from earth orbit. The AUOS-S satellite is capable of triaxial orientation in space. Its longitudinal axis is oriented toward the center of the sun with an accuracy within a few minutes of arc. It is in a nearly circular orbit at an altitude of 500 km, and an active life of 6 months is expected.

Because of the high resolution of the optics in the astronomical measuring instrument (within 10 seconds of arc), the error in stabilization of the optical axis must be within a few seconds of arc. In 1974, specialists of the Space Physics working group in the Interkosmos program issued the specifications for the development of the ASP-SKAN automatic stabilized platform, which will be placed aboard an AUOS-S satellite and will carry astronomical instruments intended for study of X-rays from the sun. The specifications called for resolution of the above-mentioned problem of precisely orienting the optical axes of astronomical instruments toward a specified area of the sun, as well as support of other program functions.

The task of developing and producing the electromechanical system for the ASP-SKAN was assigned to the Research Institutes Development and Operations Base (VPZ) in Bechovice. The requester and principal coordinator of the task on the Czechoslovak side is AsU [Institute of Astronomy] CSAV [Czechoslovak Academy of Sciences] in Ondrejov. The Space Research Institute (IKI) of the USSR Academy of Sciences in Moscow was designated manager and coordinator of technical design on the Soviet side. An economic specification for the design was that Czechoslovak or CEMA components must be used. Microprocessors could not be used in the design because none with high reliability were available during the development and testing stage. An attempt was made to assure maximum equipment reliability from the very beginning of development work. Material and design tests carried out during development affected the design of the final working model. But these matters, as well as a description of the simulation of the weightless state, are outside the scope of the present article.

2. Characteristics of the ASP-SKAN Equipment

The ASP-SKAN, which carries two devices for studying solar activity, performs the following functions:

a. Automatic compensation of errors in the orientation of the orbital station and definition of the relative coordinate system for measurement of the motions described in points b through d;

b. Orientation of the optical axes of the astronomical instruments to a specific point on the solar disk;

c. Line scanning of the image of the solar disk by mechanical movement, i.e., "coarse scan";

d. Line scanning of a selected section of the solar disk by mechanical movement, i.e., "fine scan";

e. Automatic organization of functions under points b through d into a selected program mode;

f. Provision of the necessary information on equipment operation to the telemetric system.

Functions a and f are carried out independently, while functions b through e are chosen by external command. The external commands also specify the coordinate values, in the relative system, which are required for the activities in points b and d.

3. Technical Description

The ASP-SKAN equipment consists of mechanical and electronic sections connected by cables (see Fig. 3.0).

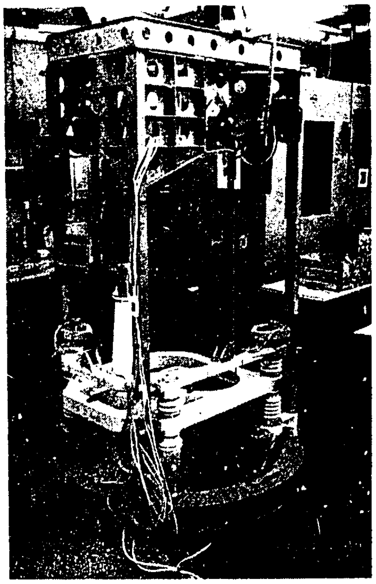


Fig. 3.0. ASP-SKAN platform with mockup of scientific instrument and auxiliary test frame holding a solar simulator and equipment for simulating weightlessness.

The mechanical section, which is the functional part of the system, is designed to operate in open space (vacuum, weightless condition and the like).

The electronic section provides power to the mechanical section and controls its operation. With the exception of the position sensor, the electronic section is contained in the electronics unit, which is intended for operation in the climate-controlled environment of the sealed part of the satellite.

3.1 Description of the Mechanical Section

The kinematic organization of the platform's mechanical design is shown in Fig. 3.1.

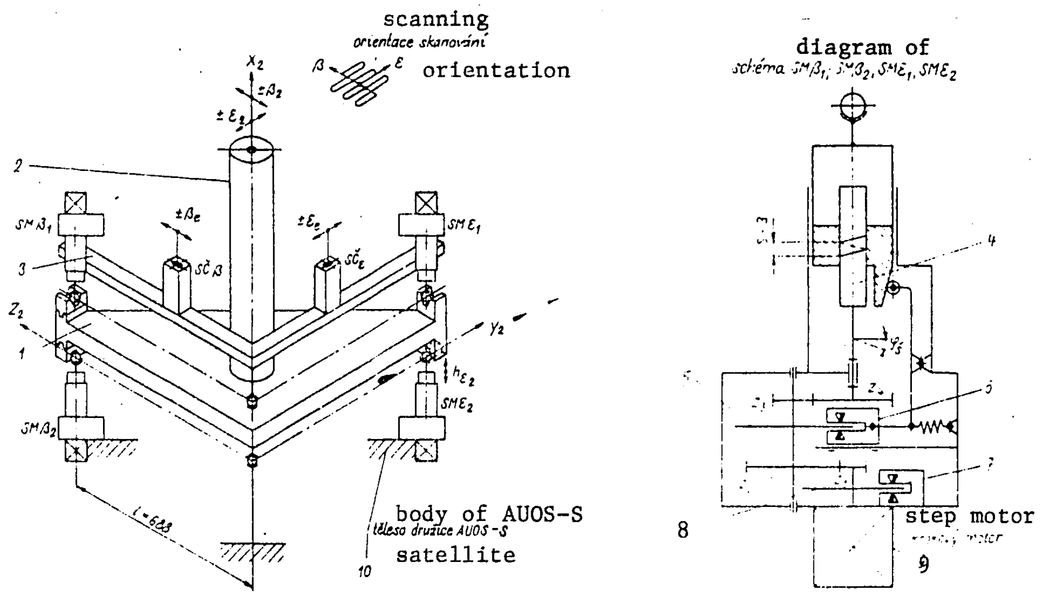


Fig. 3.1. Kinematic diagram of ASP-SKAN.

Key:

1. Measuring instrument frame
2. Measuring instrument
3. Arm for solar sensors
4. Ball circulating screw
5. Disk mask for sensing of middle and end positions
6. Photoelectric sensors
7. Photoelectric sensors
8. Disk mask for sensing motor steps
9. Step motor
10. Body of AUOS satellite

SC. Solar sensor
SM. Adjustment servomechanism
ℓ. Length of swinging arm

The bodies of the two lower adjustment servomechanisms $SM\varepsilon_2$ and $SM\beta_2$ are fixed to the body 10 of the satellite. The extensible part of adjustment servomechanism $SM\varepsilon_2$ ends in a ball-and-socket joint with radial expansion, while the extensible part of adjustment servomechanism $SM\beta_2$ ends in a ball-and-socket joint with crosswise expansion. The upper part of the fixed leg of the platform ends in a ball-and-socket joint located at the origin of the three-dimensional rectangular coordinate system x_2, y_2, z_2.

The lower part of instrument frame 1 is attached to the joints described above. Arm 3 for the solar sensors is attached to the upper part of instrument frame 1 in similar fashion by upper adjustment servomechanisms $SM\varepsilon_1$ and $SM\beta_1$, the bodies of which are fixed to the arm. The one-coordinate solar sensors SC_ε and SC_β are fixed at the midpoints of the solar sensor arm. The scientific measuring instrument (or instruments) 2 is fixed to instrument frame 1 with its optical axis perpendicular to the y_2-z_2 plane. The x_2 axis is parallel to the longitudinal axis of the AUOS-S satellite, which is approximately oriented toward the center of the sun, with an error of several minutes of arc, by a separate stabilizing system.

The origin of the two-coordinate relative system ε, β is the center of the solar disk, to which the system is oriented; it is determined by using the two one-coordinate solar sensors SC_{ε} and SC_{β}. Lower servomechanism $SM\varepsilon_2$ is electrically connected to directional sensor SC_{ε}, and the pair $SM\beta_2$ and SC_{β} are similarly connected. The directional error recorded by the solar sensors SC is electromechanically compensated by displacement of the movable parts of lower servomechanisms $SM\varepsilon_2$ and $SM\beta_2$. This linkage assures continuous stabilization of the platform. The optical axis of measuring instrument 2 is shifted to a specified point on the image of the solar disk by simultaneous specification of the required displacement to a pair of opposing adjustment servomechanisms, either $SM\varepsilon_2$ and $SM\varepsilon_1$ or $SM\beta_2$ and $SM\beta_1$, with the direction of displacement of the upper servomechanism having the opposite sign from that of the lower.

With this linkage, angular displacement of instrument frame 1 does not disturb the orientations of the optical axes of solar sensors SC, so that the stabilization of the platform described above is not affected. Scanning is analogous to the shifting of the optical axis to a specified point, since the process involves a program-controlled succession of coordinate shifts.

For illustration purposes, we present some kinematic parameters of the ASP-SKAN equipment for a maximum motor stepping frequency of 200 Hz in the coarse scan mode:

--step motor speed	300 rpm
--rotary speed of ball circulating screw	20 rpm
--translational speed of nut of ball circulating screw	1 mm/sec
--angular speed ratio, motor/platform	$21.6 \cdot 10^3$
--angular velocity $\dot{\varepsilon}$, $\dot{\beta}$ of platform	$1.45 \cdot 10^{-3}$ rad/sec
--angular acceleration $\ddot{\varepsilon}$, $\ddot{\beta}$ of platform	$5.81 \cdot 10^{-4}$ rad/sec^2
--operating displacement of screw drive for platform shift of ±60' of arc	±12 mm
--maximum mechanical displacement of screw drive	±15 mm
--screw drive displacement to achieve platform shift of 1" of arc	0.0033 mm
--moment of inertia of instrument frame and instrument (calculated max value)	25 kg-m^2

Most of the parts of the ASP-SKAN system are made of light aluminum alloys. Conventional machine materials (stainless steel, bronze, brass and the like) are used for the most important moving parts. The structural members and drive assemblies of the servomechanisms, which perform the precision adjustments, are prestressed to limit play. Since operation takes place in the deep vacuum of space, parts in sliding contact are lubricated with a microlayer of solid MoS_2 (molybdenum sulfide) lubricant.

The servomechanisms contain a set of optoelectronic sensors which sense:

a. The end positions of servomechanism displacements;
b. The sign of the deviation from the central position;
c. Motor stepping.

The mechanical part of the ASP-SKAN is protected against overload and vibration during launch of the carrier rocket by an arresting device which is released by pyrotechnical means when in orbit (not shown in Fig. 3.1).

3.2 Description of Electrical Part

The organization of the set of electrical components, as shown in Fig. 3.2, strongly resembles a microprocessor system. The electronic section contains the following principal components: voltage transformer, control logic, working counter, working memory, servo control unit and buffer memory. Because the principle that data must change during equipment operation only by increments of 1 was consistently adhered to, a three-decade reversible counter is used to handle the data.

The equipment responds to commands which have been checked by the command receiver unit. The purpose of this unit is to provide a certain degree of noise immunity by testing the command's length. After checking, the commands are executed in order of priority by the control logic unit. Another type of incoming signal is the "point coordinate designations," which are the data required for displacement of the platform in order to orient the optical axes of the astronomical instruments toward a selected point on the solar disk for fine scanning to be performed. The data are stored for subsequent use in the coordinate register, consisting of nonvolatile memory which need not be refreshed after each passage through the earth's shadow, when the power is off. The final types of signal to which the instrument responds are those from the solar sensors, the end position markers, the markers of the mechanical midpoints of the platform movement range, and servomotor steps. The mechanical midpoint markers allow calibration of the coordinate system relative to the center of the sun.

The internal operation of the movement control can best be explained using Fig. 3.3. The curve for platform position is shown in the figure in a coordinate system whose origin is oriented toward the center of the solar disk by means of the signals from the solar sensors. In this coordinate system, the platform and its scientific instruments are controlled by servomotors with a digital link. The position of the platform is read off in incremental form and the direction of motion is determined by step disks located on the motors, which are controlled by the servo control unit; the position is expressed in step increments. The columns on the figure represent the division of the platform's position into motor steps; above and below the curve and at the bottom of the figure are shown the changes in the states of the memories for "difference," "path" and "absolute magnitude" respectively which result from stepping in the directions shown. The figure shows a step with the designation CENTER, covered by the mechanical center marker, which during calibration initializes all of the memories described to the specified coordinates. In sections A, C, and D the dotted line shows a displacement by +4 steps of the motor in the required path, while B and E show a displacement of -4 steps.

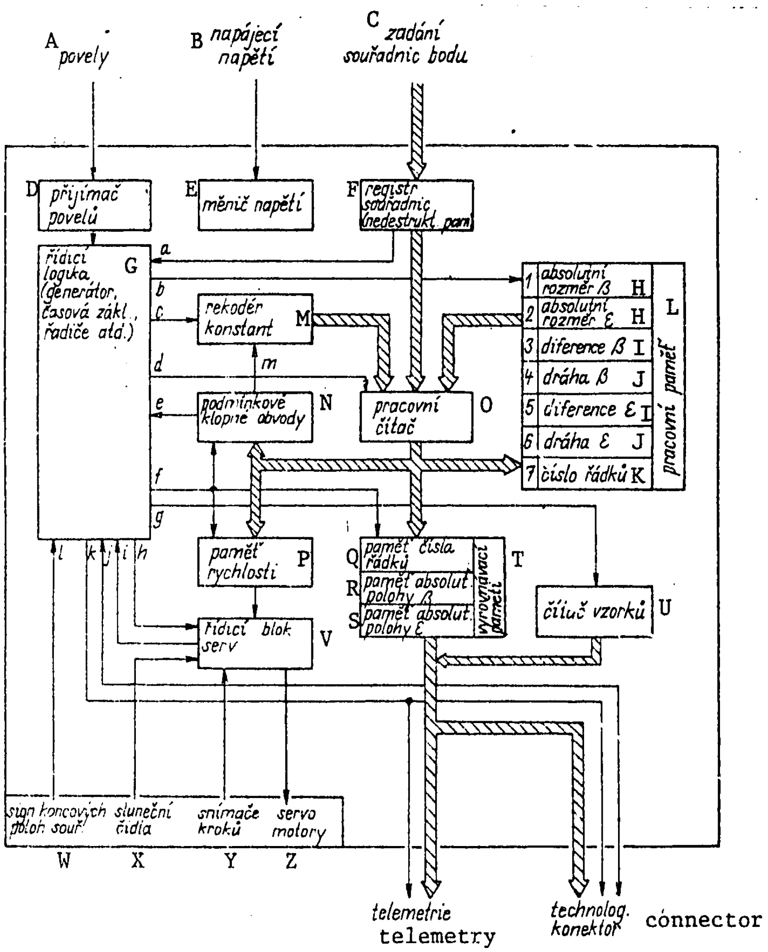


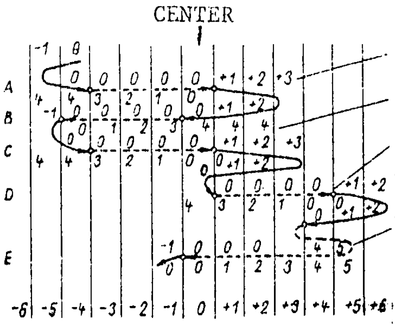
Fig. 3.2. Block diagram of ASP-SKAN equipment.

Key:

a. Sign of point coordinates
b. Address and setting for memory readout or entry
c. COARSE SCAN or FINE SCAN performed
d. Clearing, entry and up or down counting
e. Information on zero value, odd number, etc.
f. Memory entry
g. Samples within line, clearing of counter

[Key continued on following page]

h. Correction, timing and required direction of motion
i. Motor steps
j. Control of multiplexer for monitoring equipment operation
k. Signaling on operation, synchronization of peripherals
l. Signal of passage through extreme and central positions of coordinates
m. 0.40, 0.41, odd and even lines
n. Required servo speed
A. Commands
B. Power
C. Specification of point coordinates
D. Command receiver
E. Voltage transformer
F. Coordinate register (nonvolatile memory)
G. Control logic (time base generator, controllers, etc.)
H. "Absolute magnitude" of β or ε
I. "Difference" for β or ε
J. "Path" for β or ε
K. Line number
L. Working memory
M. Constant recoder
N. Condition flip-flops
O. Working counter
P. Speed memory
Q. Line number memory
R. Absolute position of β (memory)
S. Absolute position of ε (memory)
T. Buffer memory
U. Sample counter
V. Servo control unit
W. Coordinate extreme position signals
X. Solar sensors
Y. Step sensors
Z. Servomotors



"Difference," above the curve

"Path," below the curve

Changeover from "path" to "difference" and vice versa

Possible burst during "path"

"Absolute magnitude"

—— Stabilization of position

----- Required path, four motor steps long

Fig. 3.3. Recording of state in working memory.

The activity described above is performed by the other units shown in Fig. 3.2. The working memory holds the independent addresses for each coordinate and for the line number, which designates the length and direction of the path during scanning by means of the constant recoder unit. Permanent functions always include suitable entry of data into the working counter (from the working memory, coordinate register and constant recoder), loading of the working counter (clearing, incrementing or decrementing by 1 or by 0), and entry of the condition of the working counter into working memory and into the other units.

This activity cycles through all addresses of working memory.

The buffer memory unit is intended for asynchronous parallel transmission of data from the electronic unit to the telemetry unit, which transmits it in suitable form to the ground receiving station. This method is used to transmit information on the absolute position of the platform, the number of the line being scanned, and the sample number within the scan line (from the sample counter). In addition, information on the activity currently being performed (scan, line, correction and the like) is transmitted.

The transmission of test parameters is a completely independent operation controlled from the test apparatus. For this purpose, after the test equipment is plugged into the connector, the buffer memory and multiplex circuits are operated on in such a way that the instantaneous state of the circuits in question is shown on the test equipment panel. The circuits which are used only for testing are powered by the test equipment, and only during tests.

3.3 The Servosystem

Since the kinematic arrangement of the platform which is used allows us to consider it as independently controlled in each dimension, the servosystem is divided into two independent associated channels, β and ε. Each channel performs two independent tasks: stabilizing the position of the platform relative to the center of the sun, and moving the platform in response to commands from the logical unit. This is done by having the servosystem independently control the mutual deviation between the two frames of the platform and the deviation of this pair of frames from the front surface of the station. Fig. 3.4 illustrates the situation in channel ε and also shows the significance of the angular designations ε_1, ε_2 and ε_S used below. A block diagram of channel ε is shown in Fig. 3.5a.

The position is stabilized by a regulating circuit which includes solar sensor SC, preamplifier PZ, correction circuit KO, servoamplifier SZ2, motor M2, mechanical drive P2, element D2 representing the dynamic properties of the design, and kinematic sum element KS.

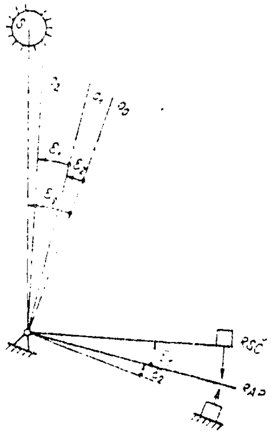


Fig. 3.4. Geometric relations: S, center of solar disk; RSC, solar sensor arm; RAP, astronomical instrument frame; $o_{[2]}$, station axis; o_1, optical axis of astronomical instrument, o_0, optical axis of solar sensor.

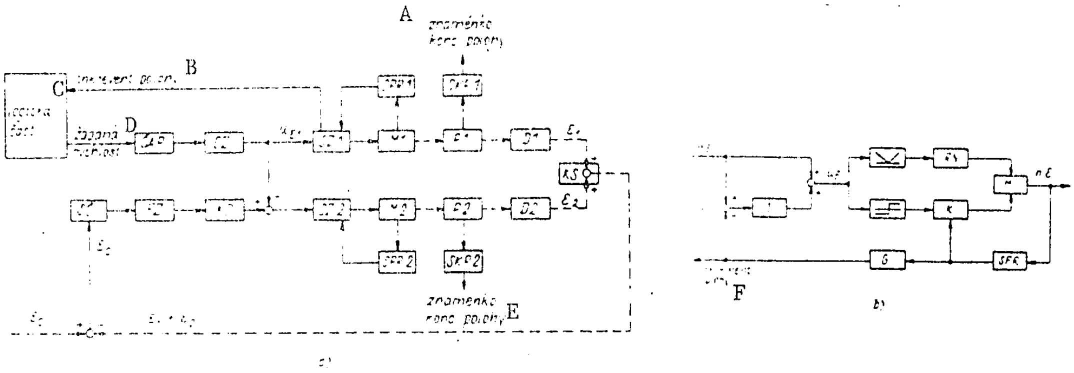


Fig. 3.5. Block diagram of servosystem. (Note: Adjustment = increment of position)

Key:

A. Sign of extreme position
B. Position increment
C. Logic section
D. Required speed
E. Sign of extreme position
F. Position increment

The solar sensor measures the regulating error ε_0 of the position stabilizing circuit and converts it into an analog electrical signal. A Cassegrainian optical system projects the solar disk on the image plane, in which is located a diaphragm with a pair of parallel slits. The slits pass light from opposing parts of the image of the solar disk onto two silicon photodiodes connected in antiparallel. The pair of photodiodes feed to the low-input resistance preamplifiers a current proportional to the difference between the incident light fluxes and relatively independent of the temperature. Since the difference between the light fluxes depends on the transverse displacement of the image of the solar disk relative to the slits, the sensor output current is an odd function of the error ε_0. The preamplifier both acts as a current-to-voltage converter and, by means of linear feedback, adjusts the transfer characteristic of the sensor to a form approximating the hyperbolic arcsine. This assures that the beginning of the curve is sufficiently steep and also that it is monotone over a wide range of regulating departures. The correction circuit is of a proportional integrating type with a non-minimal phase element to assure stability of the loop, which is disturbed principally by element D2. The integrating component assures precise tracking even when the station is turning at constant velocity.

The servoamplifier-motor system constitutes an astatic velocity-type servomechanism whose design is shown in detail in Fig. 3.5b. To the axle of motor M is attached the photoelectric rotor position sensor SPR, using a 2-bit Gray code. The change in the sensor output resulting from turning of the rotor produces in pulse generator GI a pulse of constant width and amplitude whose polarity depends on the direction of rotation. The average value of the pulse gives the actual rotation speed, while the required speed is specified by input voltage u_ε. The difference between these two voltages, i.e., the speed error, is processed by integrator I, the output voltage from which thus expresses the deviation in the servomechanism's position. The sum of the integrator output voltage and the input voltage u_ε, which is designated u_r, controls the speed of the motor. Because of the unavailability of a suitable DC commutatorless motor, we used an SMR 300-300 step motor with active rotor, which allows such operation as a result of its relatively small stall torque. The motor is fed a voltage proportional to the absolute value of voltage u_r by the controlled switching voltage regulator RN. Commutation of the windings is performed electronically by commutator K according to the sign of the voltage u_r and the output of sensor SPR, whose divisions match the organization of the stator fields.

Mechanical drive P2 converts the rotation of the motor into changes in the angle ε_2 between the optical axes of the astronomical instruments and the longitudinal axis of the station. Term D2 represents the effect of the inertial masses and the pliability of the construction and exerts an effect in the higher frequencies, where it is partially compensated by correction circuit KO. Kinematic element KS assigns to angle ε_2 an angle ε_1 determined by the other branch of the servosystem; the resulting angle expresses the deviation of the optical axis of the solar sensor from the longitudinal axis of the station. The solar sensor balances this deviation against the deviation of the center of the solar disk from the station axis and processes the regulating error ε_0 by the method described.

Since the position stabilization circuit constantly makes the optical axis of the solar sensor track the center of the solar disk, the task of the program position control is to control the deviation of the instrument frame from the solar sensor frame, i.e., angle ε_1. This is performed by a hybrid regulating circuit with a digital measuring element contained in the logical part of the control system. This element compares the required displacement value with the constantly changing value ε_1, which is measured incrementally using information provided by sensor SPR1. It uses the comparison results, in accordance with the programmed function of the platform, to specify the speed and direction of movement. Digital analog converter CAP converts this information, in the form of parts of a constant time function, to an analog voltage. Since the platform and astronomical instruments have considerable moments of inertia, the reaction moments resulting from abrupt movement could have a negative effect on the stability of the station. Accordingly, an acceleration limiter OZ is placed between the digital-analog converter and the servoamplifier to assure a smooth transition between the discrete speed values, using constant acceleration of an acceptable magnitude.

To prevent changes in the angle ε_1 from disrupting the activity of the stabilization circuit, angle ε_2 is simultaneously controlled in the reverse direction in the same manner, providing a difference term in the input of servoamplifier SZ2. For correct operation the servomechanisms controlling angles ε_1 and ε_2 must have the same transfer characteristics. This is the reason for their relatively great complexity.

4. Operation and Functions of the ASP-SKAN Equipment

4.1 Release and Correction

The first operation in orbit is release of the system on command from earth (one-time action); in this operation, the mechanical part of the equipment, which was secured against overload, is released. After each passage out of the earth's shadow, the ASP-SKAN equipment always carries out automatic calibration of the coordinate system, by means of a correction procedure, after the power is turned on. In the initial part of the correction, the frames are held in the central positions of their ranges of movement for a period of about 4.5 minutes after the power is turned on. After the end of this period, which is reserved for stabilizing the position of the orbital station, the platform orients itself by means of the solar sensors. Following this correction, which is also performed if some servomechanism reaches its extreme position, the platform is ready to operate in any chosen mode.

4.2 Platform Working Modes

The operation of the platform is summarized in Table 4.1, which is organized in terms of the commands received from the station control unit (BUS). Mode 1 is used in case of low solar activity and mode 2 in case of medium or high solar activity. The programmed activity ends with the reception of a new command of the same or higher priority or with shutting off of the power. A request for a single coarse scan or fine scan has a higher priority than commands calling for modes 1-4. A request to record an eruption is produced by the command ZAP 2, which has the highest priority.

Table 4.1. Survey of Activities of ASP-SKAN System
[C. SCAN = coarse scan; F. SCAN = fine scan]

	POVEL command	equipment activity ČINNOST ZAŘÍZENÍ
	REŽIM 1 Mode 1	→ STŘED → VEL. SKAN → ČAS. PRODL. (CENTER → C. SCAN → DELAY) → OBLAST → MALÝ SKAN → ČAS. PRODL. (AREA → F. SCAN → DELAY)
	REŽIM 2 Mode 2	→ STŘED → OBLAST → MALÝ SKAN → ČaAS. PRODL. (CENTER → AREA → F. SCAN → DELAY)
	REŽIM 3 Mode 3	STŘED → OBLAST → STABIL. PLOHY (CENTER → AREA → POS. STABILIZATION)
	REŽIM Mode 4	STŘED → STABIL. POLOHY (CENTER → POS. STABILIZATION)
	C. SCAN VELKÝ SKAN	STŘED → VELKÝ SKAN → * (CENTER → C. SCAN → *)
	F. SCAN MALÝ SKAN	STŘED → OBLAST → MALÝ SKAN → * (CENTER → AREA → F. SCAN → *)
ERUPCE eruption	ZAP 2	STŘED → OBLAST → (CENTER → AREA →) MALÝ SKAN * F. SCAN
	RF 10-ZAP 1	→ MALÝ SKAN * F. SCAN
	cancellation ZRUŠENÍ: ZAP 3 + DRP	→ F. SCAN

* SPUŠTĚNÍ POSLEDNĚ ZADANÉHO REŽIMU 1 ÷ 4 start of last-specified mode (1-4)

The names of the operations presented in the table are:

CENTER--orientation of the platform to the center of the solar disk and stabilization on this point;

AREA--transfer to the central point of a chosen area of the solar disk and stabilization on this point; the coordinates of this point are supplied to the ASP-SKAN equipment in advance;

COARSE SCAN, FINE SCAN--controlled movement as described below;

TIME DELAY--point stabilization for a period of about 4.5 minutes.

In case of an eruption, the command ZAP 2 is executed after performance of the operations CENTER and AREA. Release from the performance of FINE SCAN requires reception of the command RF10-ZAP 1 and completion of the AREA operation. Termination of the FINE SCAN operation requires simultaneous reception of commands ZAP 3 and DRP. The durations of the individual operations are shown in Table 4.2.

Table 4.2. Durations of Individual Operations

ÚKON operation	CENTER STŘED	AREA OBLAST	C. SCAN V. SKAN	F. SCAN MALÝ SKAN			DELAY ČASOVÁ PRODL.
				ZAP 1 NP	ZAP 2	ZAP 3	
PRŮMĚRNĚ TRVÁ AVG. DURATION	10 s	10 s	10,5 min	2 min	3 min	10 min	4,5 min

The operations COARSE SCAN and FINE SCAN are shown in Fig. 4.1. FINE SCAN is COARSE SCAN magnified 16 times. As can be seen from the figure, the scans have 39 active lines (numbered 1-39); here they are specified both in minutes of arc and in motor steps. Because of differences in the frequency of sampling of the measurements (within the scan line, by the scientific instruments), different scanning speeds are chosen within the lines; these are called by commands ZAP 1, ZAP 2, ZAP 3 and NP. In addition, in order to prevent disruption of the operation of the satellite's stabilizing system, each scanning line has speedup and braking loops with contact acceleration and deceleration.

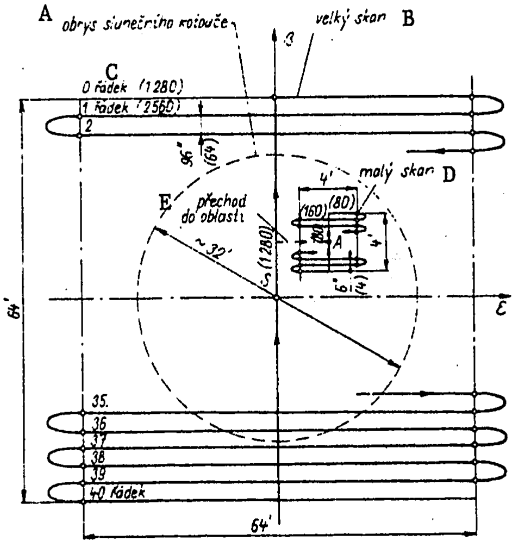


Fig. 4.1. Graph of scanning motion

Key:
- A. Outline of solar disk
- B. Coarse scan
- C. Line
- D. Fine scan
- E. Shift to area

4.3 Description of Functions

The requirements regarding automated stabilization of the ASP-SKAN platform result in routines of differing degrees of complexity. The simplest routine is stabilization of the platform on a point, which in practice is the most frequent activity and whose performance characteristics primarily affect the precision of platform operation. Other routines involve platform functions performed directly [i.e., without the need to organize a program] (centering, transfer to a given area). The most complex routines are those for programmed actions (generation of scanning motions, generation of a sequence of operations during correction and eruption operations and the like). In addition, provision is made for the specification of an arbitrary succession of routines, but the platform must perform them with the predetermined priority. Accordingly, flowcharts were chosen to determine the operation of the ASP-SKAN platform; these can cover the operation of the equipment in any state.

4.3.1. Command Priority Flowchart (Fig. 4.2)

This diagram deals with asynchronous control of the ASP-SKAN platform. The diagram shows clearly the priority of execution of individual commands, as well as their storage in case of deferred execution. For clarification, the flowchart notes only the terms "...REQUIRED?" which cover the state between the arrival of the external command and completion of the required procedure. In practice, commands are ignored only when a coarse or fine scan is being transmitted. When END OF PROGRAM is reached, the platform stabilizes at the last point. The subroutines "...procedure" are outlined in Figs. 4.3 and 4.4.

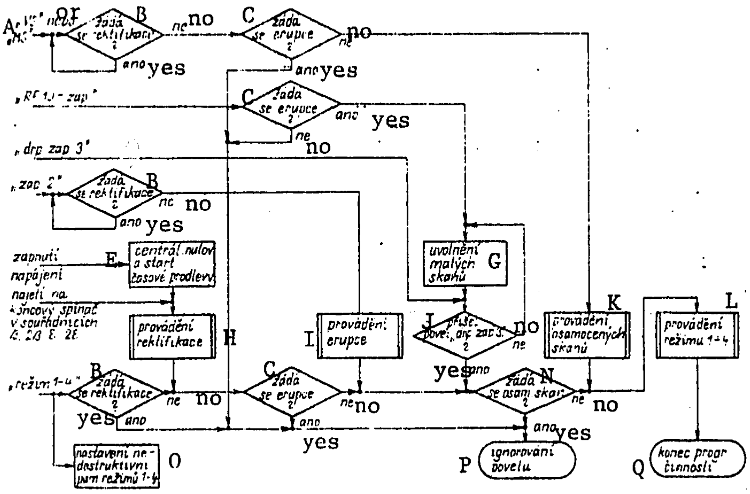


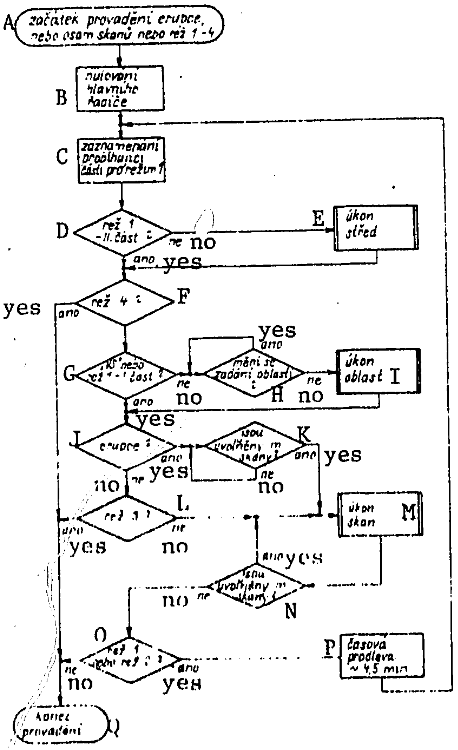
Fig. 4.2. Command priority flowchart

Key:

A. COARSE SCAN or FINE SCAN
B. Correction required?
C. ERUPTION subroutine required?
D. Power turned on
E. Center, clear and start time delay
F. Arrival at end switch of coordinate
G. Enable fine scans
H. Execute CORRECTION subroutine
I. Execute ERUPTION subroutine
J. Command DNP ZAP 3 received?
K. Execute isolated scans
L. Execute modes 1-4
M. MODE 1-4
N. Isolated scan required"
O. Setting of nonvolatile memory for modes 1-4
P. Command ignored
Q. End of program

4.3.2. Flowchart for Main Controller (Fig. 4.3)

This diagram gives a detailed description of the generation of individual operations. The equipment operates asynchronously and, when necessary, cyclically, and accordingly operation is interrupted by initializing the main controller every time "Begin ...procedure" occurs. Calibration of the coordinate system is initiated by the fact that every procedure begins with the CENTER operation, which, as can be seen from Fig. 4.4, compares the contents of the memories. The flowchart shows that the generated activity is stopped only in case of the decision elements "CHANGE IN AREA SPECIFIED?" and "FINE SCAN SELECTED?". This means that economical utilization of the equipment requires that the relevant commands arrive the right time. The "Operation" subroutines are diagrammed in Figs. 4.4 and 4.5.



Key:

A. Begin ERUPTION, isolated scan, or modes 1-4
B. Main controller initialized
C. Designation of area for mode 1
D. Mode 1: second part?
E. CENTER operation
F. Mode 4?
G. COARSE SCAN or mode 1, part 1?
H. Specification of area changed?
I. AREA operation
J. ERUPTION?
K. Fine scans enabled?
L. Mode 3?
M. SCAN operation
N. Fine scans enabled?
O. Mode 1 or 2?
P. Time delay, about 4.5 minutes
Q. END

Fig. 4.3. Flowchart for main controller

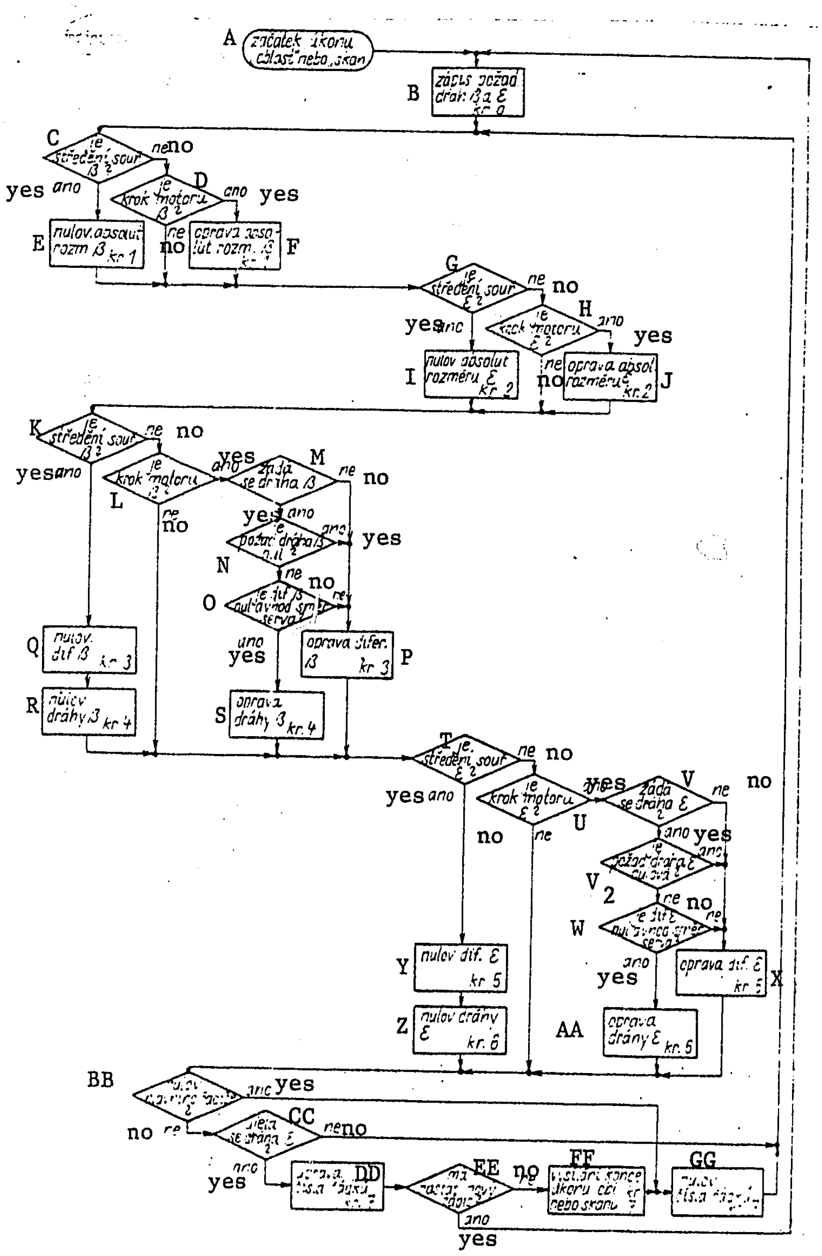


Fig. 4.4. Flowchart for auxiliary circuits

Key:

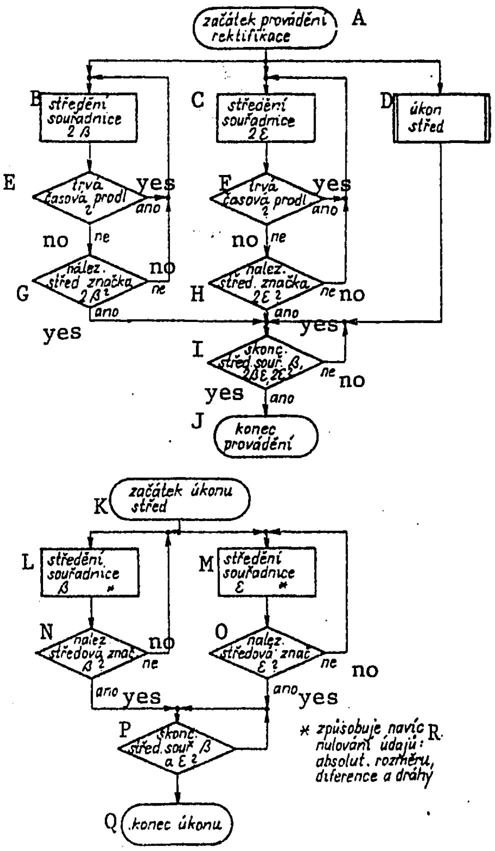
A. Begin AREA or SCAN operation
B. Enter required path for β and ε; step KR.0
C. Centering of β coordinate?

[Key continued on following page]

D. Stepping of β motor?
E. Set "absolute magnitude" β at zero; step KR.1
F. Adjust "absolute magnitude" β; step KR.1
G. Centering of ε coordinate?
H. Stepping of β motor?
I. Set "absolute magnitude" ε at zero; step KR.2
J. Adjust "absolute magnitude" ε; step KR.2
K. Centering of β coordinate?
L. Stepping of β motor?
M. "Path" for β required?
N. Is "path" for β zero?
O. Is "difference" for β zero and in agreement with servo direction?
P. Adjust "difference" for β; step KR.3
Q. Set "difference" for β at zero; step KR.3
R. Set "path" for β at zero; step KR.4
S. Adjust "path" for β; step KR.4
T. Centering of ε coordinate?
U. Stepping of ε motor?
V. Is "path" for ε required?
V2. Is "path" for ε zero?
W. Is "difference" for ε zero and in agreement with servo direction?
X. Adjust "difference" for ε; step KR.5
Y. Set "difference" for ε at zero; step KR.5
Z. Set "path" for ε at zero; step KR.6
AA. Adjust "path" for ε; step KR.6
BB. Initialize main controller?
CC. "Path" for ε performed?
DD. Adjust line number; step KR.7
EE. Begin new entry?
FF. Emit "End of AREA or SCAN operation"; step KR.7
GG. Set line number at zero; step KR.7

4.3.3. Flowchart for Auxiliary Controller (Fig. 4.5)

This flowchart describes the permanent computation cycle, carried out in eight steps designated KR.0 through KR.7. The computation cycle is modified only on the basis of external conditions, but these must occur before step KR.0 and last at least to the end of step KR.6, which is carried out by the main controller. Between the end of an operation (and forced clearing of the main controller) and the beginning of a new operation, and also between individual motor steps, at least one computation cycle is performed. It is clear from the diagram that each coordinate is controlled separately, that all required paths (including those of scan lines) are entered during step KR.0, and that auxiliary computations (scan line number) and decisions are made during step KR.7.



Key:
A. Begin correction procedure
B. Centering of coordinate 2β
C. Centering of coordinate 2ε
D. CENTER operations
E. Time delay continuing?
F. Time delay continuing?
G. Center marker of 2β found?
H. Center marker of 2ε found?
I. Centering of coordinates β, 2βε, 2ε completed?
J. End of procedure
K. Beginning of CENTER operation
L. Centering of β coordinate
M. Centering of ε coordinate
N. Center marker of β found?
O. Center marker of ε found?
P. Centering of β and ε coordinates completed?
Q. End of operation
R. Also sets "absolute dimension," "difference" and "path" at zero

Fig. 4.5. Flowchart for auxiliary controller

5. Conclusions

In building the apparatus, we used primarily the technological experience of many specialized organizations in Czechoslovakia, thus assuring the requisite quality. For ground testing of the equipment, we used a special test bench to simulate weightlessness and the disruptive influence of the stabilizing motion of the satellite. The measurements themselves were made by position sensing using an LA 3000 interferometer; the measurement data were evaluated with an HP 21MX computer. The measurement results confirmed that the system had the intended properties.

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INTERNATIONAL AFFAIRS

MICROPROCESSOR SYSTEMS, COMPUTER COMPONENT BASE IN CEMA OUTLINED

Prague ELEKTROTECHNICKY OBZOR in Czech No 10, 1981 pp 578-581

[Article by Eng Eduard Schliksbier, CSc, Research Institute of High-Voltage Electrical Engineering, Prague-Bechovice: "Microprocessors and Their Trends"]

[Excerpt] The Component Base in the CEMA Countries

Currently the CEMA countries are devoting considerable attention to developing semiconductor memories and microprocessors. In Czechoslovakia, semiconductor components are developed and produced primarily by Tesla Roznov and Tesla Piestany. Two promising basic sets of components are being developed.

a. The MH 3000 series of Schottky TTL [transistor-transistor logic] bipolar circuits. The basic circuits are the MH 3001 microprogram control circuit, the MH 3002 two-bit processor and the MH 3003 look-ahead carry generator; the MH 3205; MH 3212, MH 3214, MH 3216 and MH 3226 are auxiliary circuits. The demand for all of these types of circuits will be met from 1981 on. To simplify the use of MH 3000 series circuits it is planned to add to the already available development system an emulator module and microprogram memory, including the necessary service software. One advantage of the MH 3000 bit-slice processor system is its high degree of versatility, with arbitrary word length and structure and a user-selectable instruction set. However, constructing a system is complex.

b. The 8080 unipolar microprocessor system. The basis of this system (equivalent to the Intel MCS-80) is the MHB 8080 eight-bit central processor with the MH 8224 clock circuit and MH 8228 system control unit. In addition there are the already-mentioned MH 3205, MH3212, MH 3214, MH 3216 and MH 3226 units and the new MH 8255 parallel interface circuit and MH 8251 USART [universal synchronous-asynchronous receiver-transmitter]. Deliveries of the complete set of components from an experimental production facility are expected to start in 1982.

The standard set of microprocessor systems includes memory circuits, some of which are already available. Bipolar memories include the MH 7489 64-bit RAM, the MH 74S 201 256-bit RAM, the MH 74 188 256-bit EPROM and the MH 74S 287 1024-bit EPROM. The MH 74 S187 1024-bit ROM and the MH 74 S571 2048-bit EPROM are in preparation. For the future, the unipolar memory circuits are oriented toward CMOS and NMOS with silicon or floating gates. Some representative types are the MHB 1902 static RAM and a static RAM equivalent to the I 2102A (both 1,024 bits), a dynamic RAM equivalent to the MK 4116-P4 (16 Kbit), and a REPROM equivalent to the I 8708 (8 Kbit).

In the Soviet Union, microprocessor circuits and memories are designed using S-TTL, I^2L and ECL [Schottley TTL, integrated injection logic, emitter-coupled logic] technology, and for the future an attempt is being made to make them compatible at the level of individual logic and memory modules on boards. The K-589 series, equivalent to the MH 3000 series of bipolar circuits, is in series production. Also available is the fast K-584 IK1 4-bit processor (equivalent to the [Texas Instruments] SBP0400). Production of the 8080 unipolar microprocessor system (designated K-580 IK80) has begun; in until 1980 it was provided in flat-pack form, and since then it has been available in dual in-line packaging. Also available is a series of RAM and PROM units with capacities up to 8 Kbit using various types of bipolar technology. Import of selected components from the Soviet Union is the responsibility of the Tesla OP DIZ [supply and engineering services establishment] in Prague.

East Germany has developed and is currently producing the U-8080D 8-bit microprocessor, which is also available in Czechoslovakia. Also being successfully produced is an equivalent to Zilog's Z80. Bulgaria is concentrating its microprocessor research on an equivalent to the [Motorola] M6800 and its supporting circuits. Bipolar memory units are being developed and produced in Hungary as well, including a PROM with the standard designation TM 622 (2 Kbit) and the TM 624 4-Kbit PROM. Romania is also preparing to develop bipolar S-TTL memory units.

Thus development in the microprocessor field in the socialist countries is being supported with components analogous to tested world standards, in addition to which original-design components compatible with various kinds of circuitry are being developed.

Development Systems and Industrial Microprocessor Systems in Czechoslovakia

Microprocessor equipment allows even less specialized users to design microcomputers. Accordingly, Czechoslovak organizations are preparing auxiliary hardware which will aid in the development of microcomputer hardware and software.

The simplest resident devices include the MDT 1000 16-bit bipolar microprocessor, developed by VUMS [Research Institute of Mathematical Machines] Prague. This is a multiboard microprocessor using SSI and MSI integrated circuits. Of similar design is the TP 8 8-bit processor produced by VUVET [Research Institute of Vacuum Electro-Technology] in Zilina, which is intended primarily for data collection, control of manufacturing processes, and scientific experimentation. The PROMES [expansion unknown] organization in Prague has used the I 8080 microprocessor to build the TEMS-01 single-board microcomputer.

One of the foremost resident systems based on microprocessor development systems is the MVS, already developed by Tesla Kolin. This is intended for the development of the hardware configuration and software of systems using the 8080 microprocessor. It allows entry of programs in a symbolic language, conversion into machine language, program revision in machine-language and source-language form, debugging and testing of peripherals. The MVS system is produced in two varieties, the MVS 800 and MVS 801, which differ in the processor unit. In the MVS 801 this is a three-board unit built from circuits available on the Czechoslovak market. The MVS 300 contains a single-board processor. The DDS-80, another microprocessor modular system, has been developed by VUT [Telecommunications Research Institute] in Prague. It is intended for the development, production and servicing of associated telecommunications measuring equipment. Development systems containing single-board processors have also been perfected by VUVT [Research Institute of Data Processing Technology] in Zilina and VUAP in Prague.

Host systems may also be used for microcomputer program development. VUMS has used the ADT minicomputer as a development system for the 8080 microprocessor. The system software includes the 8080/ADT Cross Assembler program and the 8080/ADT simulation program. HMU [Hydrometeorological Institute] in Prague has a similar development system available.

Modular industrial microprocessor systems include a special unit for interfacing with the environment. These are used to design microprocessor-based control systems. One example is the modular microprocessor system developed by Tesla Kolin national enterprise using the 8080 microprocessor, which is intended for controlling machine tools. The MIKROSAT system of VUAP Prague intended for similar purposes, is in the final stage of development. The DARIS system is intended for control of power-production facilities. The PPC-4 polyprocessor control system has been designed by CKD-Polovodice [Ceskomoravska-Kolben-Danek Semiconductors] in Prague. In 1981, the K 1510 control microprocessor system based on the U808 D microprocessor was imported from East Germany; also in production is the K 1520, based on the Z-80 microprocessor.

Conclusion

Qualitative and quantitative changes in microcomputers result especially from technological progress. Development of auxiliary equipment such as cheap peripherals, analog-digital and digital-analog converters and auxiliary circuits results from microcomputer system development. Thus this technical field is becoming the most important aspect of electronics and data processing in Czechoslovakia, and accordingly the scope of this article makes it impossible to describe in detail all aspects of the current status and development of microprocessor equipment.

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CZECHOSLOVAKIA

MINISTER OUTLINES 1981-1985 METALLURGY TASKS

Prague HUTNICKE LISTY in Czech No 1, 1982 pp 1, 2

[Article by Eng Ladislav Gerle, ScC, deputy premier of the CSSR Government: "Tasks of Metallurgy in the Seventh Five-Year Plan"]

[Text] During the era of the building of socialism extraordinary attention was paid to the development of metallurgy in the CSSR. The growth of our metallurgical production enabled us to develop individual industries and, above all, engineering and construction. The consumption of metallurgical products was rapidly increasing. The CSSR produced 1,000 kg, and consumed more than 7,000 kg of steel per citizen, thus reaching one of the highest levels on the international scale. The high level of consumption of metallurgical products in our national economy also underlines certain shortcomings and problems in production as well as in the area of processing of ferrous metals, such as a low share of high-grade steel and cost-efficient profiles in consumption; the obsolescence of certain technologies in production and processing also exerted a negative effect.

The prolonged trend of continuous growth in the volume of production and consequently, also in the consumption of metals is unacceptable for the CSSR. The 16th CPCZ Congress stipulated that the level achieved in metallurgical production must be maintained in the coming years. Any further growth of engineering production and of all other sectors of our national economy is incumbent on the annual achievement of 4.5 to 5 percent relative savings of metals.

This task cannot be regarded simply as a problem for consumer sectors but also as the main objective of our metallurgy. If in the past we viewed the development of metallurgy as an increase in the volume of production, at present we must consider it as the development of quality and utility value of metallurgical products.

This development in our metallurgy as well as in fuel and energy economy is not unexpected. State goal-oriented programs were adopted for fuel, energy and metal economy toward the end of the Sixth Five-Year Plan. Their approval was preceded by analyses in individual national economic sectors and by comparison with other countries. According to the estimate, we need approximately 30 percent more steel and energy in the CSSR than in comparable industrially advanced countries to create comparable national revenue. This is due to high specific consumption of energy in metallurgical works and to inadequate value added to steel and thus, also energy, in machine engineering. If the volume of metallurgical production is decisive for many branches of our national economy, we may speak equally of sources of energy whose amounts and structure also limit our metallurgical production. For the first time ever this year, a plan for metallurgical production based on the limits of our energy balance was stipulated.

In 1981, our government weighed the main problems of the current situation, the preconditions and trends for the further development of Czechoslovak metallurgical industry. In terms of our national economy, its basic function as the base for machine engineering, electrical engineering, construction and other industries was reemphasized. Questions concerning the quality and the line of metallurgical products manufactured from steel and nonferrous metals appeared conspicuously in the forefront. Especially the development of electrical engineering, consumer industry and power engineering depends totally on the demanded line of products made from nonferrous metals, alloys and high-trade steel.

The standard of metallurgical production is narrowly connected with the conditions prevailing in the base of production and technology. The programs for development organized during the Sixth Five-Year Plan are investment-intensive and only their comprehensive exploitation may bring about the necessary economic efficiency. This concerns above all the so-called pipe and atomic programs and the related new capacities in the Tube Rolling and Iron Works in Chomutov, the State Iron Works in Podbrezova, the Poldi United Steel Works, National Enterprise, in Kladno, and the Iron Works in Veseli nad Moravou and in Vitkovice. The development of converter steel production was organized in the Great October Socialist Revolution Iron Works in Trinec and the production of high-capacity equipment was concentrated in the East Slovakia Iron Works in Kosice and in the New Metallurgical Works of Klement Gottwald in Ostrava. The necessary restriction of investment development programs will also be reflected in our national economy as investment cuts in our metallurgy. More than ever we must focus on repair of metallurgical equipment not only to ensure reliability of production but especially to introduce programs of reconstruction and modernization in order to improve the quality and consumption of power.

Furthermore, the management of scientific and technological development must correspond with the new situation. Its plans must be linked with other parts of the plan, particularly with the plan for production, economy and replacement of capital assets. Relevant are only those solutions whose results may be applied in production to cut the costs, material, power and raw-material inputs and to improve the useful value of production. The tasks of technological development must be dealt with continuously in the following directions:

--in the production of good-quality metallurgical coke from the deteriorating coal charge;

--by reducing specific fuel consumption in production of pig iron, steel and metal shaping;

--by utilizing waste heat and secondary sources of energy;

--by better utilization of metal substances; by controlled processing of metallurgical waste, metallurgical ashes, sludge and dumps;

--by introducing new types of steel, metal alloys and lines of metallurgical products for the machine engineering and electrical engineering industries;

--by improving labor productivity and the working environment, and by decreasing the ecologically harmful effects of metallurgical works.

Toward the end of 1981 the Federal Assembly approved the law on the Seventh Five-Year Plan. Over the coming months it will be specified in the form of detailed plans for the VHJ [economic production units], enterprises and plants. It is imperative to approach our labor with the plan in a creative manner and not with the traditionally specified tasks. The government stresses the plan as a means to fulfill the basic tasks in metallurgical production and in utilization of metals as well as in fuel and energy economy much more emphatically than during the first year of implementation of the regulations contained in the Set of Measures. Over the past 30 years Czechoslovak metallurgy successfully established important economic potentials. Now we must use them efficiently so that they continue to serve as a base and moreover, as a resource for problems facing the Czechoslovak economy.

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CZECHOSLOVAKIA

METAL RECYCLING SAVES ENERGY, HARD CURRENCY

Prague ELEKTROTECHNICKY OBZOR in Czech Dec 81 pp 673-674

[Article by Eng Antonin Radvanovsky: "Waste of Raw Material?"]

[Text] The scrap metal industry (PKO): it does not sound very attractive. It is little known to the public, is underrated, and hitherto has frequently been considered something tolerated somewhere on the outskirts of the advanced Czechoslovak industrial complex.

Even the name "industry" puzzles the layman. The concepts of "industry" and "scrap" are opposed in his logic. What can scrap have in common with the concept of a modern industry? For surely the latter typically has to do with machinery, transport facilities, domestic appliances--in short, useful new products. What has this to do with scrap, useless matter which the ordinary citizen is happy to ignore and is glad to get rid of twice a year on "Iron Week."

The scrap metal industry--a seeming union of opposites. Chance rather than design has bound up the past and the present together in this name. A conflict between the long since unjustified view of secondary raw material which persists in the consciousness of the general public and its extreme importance to the national economy.

To consider this raw material as waste, as is rather common today, is in reality more than an anachronism. The idea is more than a century out of date, because with the introduction of the open-hearth process toward the end of the last century scrap metal ceased to be useless inert matter and became a raw material--at first, to be sure, as a tolerated substitute, but later as a suitable addition to the charge, and today as an essential component. This is something that a well-versed professional would know.

But even he does not always deal with scrap metal like a good manager. For otherwise it would not be the case that, for example, of the 200,000 tons of alloy steel cuttings which Kovosrot [scrap metal enterprise] receives from mechanical industry suppliers, only 15 percent is unmixed. Some 117,000 tons of alloy steel is mixed with other scrap in machining plants every year, which destroys its value. This loses society at least 1,000 tons of chromium, 500 tons of nickel, 100 tons of molybdenum and considerable quantities of other valuable alloy additives.

The situation is similar as regards conservation of nonferrous metals. Mixtures of copper alloys with tin, zinc, or lead amount to 5,500 tons a year. Because with available technologies we are capable of removing only copper from this mixture, year after year we are poorer by fully 1,000 tons of zinc, 200 tons of lead and 70 tons of tin. The situation is the same with aluminum alloys. If scrap operations were managed responsibly in the machining plants, it would be possible, without additional measures, to increase deliveries of nonferrous scrap to the metallurgical industry by 8.8 percent in the case of zinc and by almost a quarter in the case of tin.

Obviously, our opening statement about the misconceptions regarding scrap metal and its value to society apply rather broadly--not only to housewives and pensioners or other "uninformed" persons, but to certain economic workers as well. The facts presented show that secondary metal-containing raw materials are handled uneconomically and at variance with the interests of society, even where they are the basic materials of the production process and where there would be every reason to expect that every kilogram would be used effectively.

A responsible attitude toward secondary metal-containing raw materials is governed by a simple proportion: the more metal we save, the less we must import--and imports are by no means cheap.

We now import almost a full range of metal ores and pure metals. Their prices on world markets are increasing rapidly. In the 1970's, the prices of iron ores on capitalist markets increased 20 percent, while copper ores increased in price by 56 percent, aluminum ores by 138 percent, zinc ores by 160 percent, and tin ores by fully 390 percent. Even though a substantial part of our imports come from the Soviet Union and other socialist countries at favorable prices, the increase in the price of iron ores alone on non-socialist markets costs us a quarter of a billion more foreign exchange korunas annually than it did in 1970. The rising spiral of prices continues. It is estimated that world supplies of certain metals will last only a few more decades, which supports the supposition that prices will rise further. Accordingly, it is the duty of everyone society gives the right of handling the country's metal supply to use it responsibly, effectively and in the interests of all.

External factors are not the only ones to play a role, even though they are unquestionably important. One of our economy's basic tasks is increasing efficiency. And the use of scrap metals is very promising as regards efficiency. It is a domestically available, easily obtainable and very cheap raw material.

The expenditure on collection, preparation and transport of a ton of scrap iron is less than Kcs 180. To produce the same quantity of pig iron we must expend Kcs 1,717. The processing of a ton of nonferrous metal from scrap costs an average of Kcs 790, while the purchase prices of primary raw materials are many times higher. In 1980 the price was Kcs 35,596 per ton for copper, Kcs 15,821 per ton for lead, Kcs 23,416 per ton for aluminum, and Kcs 269,507 per ton for tin. This speaks clearly in favor of scrap.

But there is another important advantage. The use of scrap metal considerably decreases transport costs. This is because metal content is about 55 percent for iron ores, 5-6 percent for zinc ores, 2-3 percent for lead ores, 0.5-1 percent for copper ores and 0.2-0.6 percent for tin ores: a large amount of dross is transported in the ore.

In contrast, scrap metal contains almost 100 percent metal. If instead of the 3.3 million tons of scrap metal which Kovosrot delivered to the metallurgists in 1980, it were necessary to transport the equivalent quantity of ore, the railroads would have had to load and transport over considerable distances an additional several tens of thousands of railcars.

The use of scrap metals has a favorable effect on the energy balance, which is becoming increasingly important to society. For every ton of iron producted from scrap metal, 0.5 tons of blast furnace coke is saved. A ton of steel produced from scrap yields a saving of 8,500 kWh, a ton of lead 9,000 kWh, a ton of zinc 9,500 kWh, a ton of copper 11,800 kWh and a ton of aluminum 62,000 kWh. If scrap metal deliveries to the metallurgical industry in 1980 had to be replaced by primary raw materials, their processing would have required an increase of 3.2 GW in power consumption. These are real values which cannot be ignored.

The scrap metal industry embarked on the path of socialist development 30 years ago. It has given almost a third of a century of useful service to the development of the national economy. During this time, as the industry's importance for the development of the national economy has increased steadily, its nature has changed substantially. Today the mission, work and processes of the Kovosrot national enterprise are fundamentally different. From an industry which once was fused in the public consciousness with the image of the scrap man with his wagon and his cry of "Rags, leather, iron," the scrap metal industry has changed into an organization which not only collects large quantities of scrap metal, but also processes it using modern industrial techniques and delivers it to the metallurgical industry.

During their existence, Kovosrot's facilities have delivered more than 60 million tons of iron and more than 3 million tons of nonferrous metals to the metallurgical industry. The uninformed public frequently sees Kovosrot's mills through the lens of the Raw Materials Collection Enterprise's purchase points. But this is an image from the remote past of this industry. In 1952 the construction of new, modern facilities began, and in 1958 Kovosrot began an intensive transition to large-scale industrial scrap processing. This was a matter of sheer necessity, for the metallurgical industry's demands for increased deliveries of scrap metals were increasing not by a few percent, but by tens of percent annually. Kovosrot's equipment holdings gradually adapted to this requirement. From 1958, with the beginning of large-scale baling of scrap, through 1980, the volume of industrially processed scrap increased 13-fold. Now baling cutting, breaking, fragmenting and other processes are used to handle almost 2 million tons of scrap steel a year; almost a third of scrap steel delivered to the metallurgical industry comes from baling presses.

The introduction of technology into the operations of the scrap metal industry led to an increase in labor productivity and to higher quality raw materials deliveries. One important benefit of baling was a 10-fold increase in the iron content of processed light scrap, which resulted in a decrease in the number of cars required for transport, but made itself especially felt at the furnaces, where charging time was decreased and melting time was eliminated or decreased. One hydraulic shears for cutting heavy scrap replaced the work of 20 or more gas cutters, and similar effects resulted from the gradual introduction of breakers, rams and other mechanisms. The construction of a modern production-equipment base is unquestionably one of the most important successes in the still-brief history of the scrap metal industry.

But technical progress is forging rapidly ahead. What was modern only yesterday is barely satisfactory today, and tomorrow will be a byword for obsolescence. This applies doubly to the growth industries, of which the scrap metals industry is unquestionably one.

Only further modernization can assure that the industry will fulfill its demanding tasks for the seventh and eighth five-year plans. Trifles are not involved. By 1990, deliveries of ferrous metals must be increased 26 percent and those of nonferrous metals by at least a fifth. A substantially greater increase is expected in the case of the most important nonferrous metals: 130 percent for aluminum, and 146 percent for lead.

Without the installation of new machinery and the introduction of the most modern technologies, the assignments included in the CPCZ's economic policy directives and in the economic plans could not be mastered. One approach is to speed up technical progress. Accordingly, new machines and processes are steadily appearing in the production process. A considerable contribution to the handling of ferrous metals will be the expanded baling of chips and the construction of shredder mills. During the Seventh Five-Year Plan, baling will increase from the current 30,000 tons to roughly 120,000 tons a year. The handling of light obsolete scrap such as auto bodies, refrigerators, washing machines and the like in shredders is to achieve a level of 280,000 tons by the beginning of the Eighth Five-Year Plan. This would mean that the scrap metal industry would be approaching the worldwide peak in this area.

Gravimetric classification in heavy suspensions and hydrometallurgical processes will be introduced in nonferrous metal preparation plants in the future, and it is also planned to introduce classification technologies based on deep cooling.

Thus, without exaggeration, the Seventh Five-Year Plan can be called the five-year plan of new technology. This is a direction which has been fully approved by the highest economic bodies of party and state. Their support is expressed in CSSR Government Decree No 282 of 28 August 1980.

In comparison with previous five-year plans, the volume of investment is to increase more than twofold; it will financially cover all of the main proposed directions of technical development. Thus the government has decided to alleviate the grave situation in the transport of scrap metals, according it the same preferential treatment in railway transport which prior to 1 January 1981 was accorded only to fuels and export goods. The state document also includes several economic, organizational and legislative measures designed to produce a greater incentive for stepping up the intensity of collection both at plants and among the populace. In particular, much is expected from revamping the functions of scrap supervisors at the plants.

The first fruits of these positive approaches are already beginning to be evident, so that the way is clear for the scrap metal industry to fulfill its demanding task for the Seventh Five-Year Plan.

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END