UNION OF THE SOVIET SOCIALIST REPUBLICS
THE USSR CENTRAL AERO CLUB
V. P. TCHKALOV

RECORDS FILE

ON THE FIRST SPACE FLIGHT BY THE USSR CITIZEN

YURI ALEXEYEVICH GAGARIN

Made on April 12, 1961

ON SPACESHIP-SPUTNIK "VOSTOK"

MOSCOW
1961

THE TCHKALOV CENTRAL AERO CLUB OF THE USSR

CARD OF GENERAL DATA

1. Records: flight duration, flight altitude and weight lifted.
2. Pilot: Yuri Alexeyevich Gagarin, sports certificate No. 525/5, dated December 16, 1955.
3. Citizenship: citizen of the USSR.
4. Type of vehicle: rocket.
5. Trade-mark of vehicle: "VOSTOK".
6. Brief characteristics of vehicle: the vehicle consists of a carrier-rocket and a spaceship-sputnik. The spaceship-sputnik contains a pilot's compartment with hatches and portholes to be used by the pilot and his outfit and an instrumentation compartment to place the control and communication gear, and brake power unit.
7. Identifying marks (brief description): "USSR-VOSTOK".
8. Number and date of spaceship book: Book No. 3, dated March 25, 1961.
9. Engines of vehicle:
    a) Type: liquid-propellant rocket power plant.
    b) Trade-mark: "VOSTOK".
    c) Power characteristics: total maximum useful power of all the stages is 20,000,000 h. p.
    d) Number of motors: 6

V. A. Plaxin,
I. G. Borisenko,
sports commissars
of the Tchkalov Central
Aero Club of the USSR

THE TCHKALOV CENTRAL AERO CLUB OF THE USSR

STATEMENT

of weighing of spaceship-sputnik "VOSTOK"

On the 10th of April, 1961, we, the undersigned Vladymir Alexeyevich Plaxin and Ivan Grigorievich Borisenko, sports commissars of the Tchkalov Central Aero Club of the USSR, Vladymir Ivanovich Bodrikov and Valentin Michailovich Stolnikov, calculating engineers, drew up a statement to the following effect:

On the 10th of April, 1961, we weighed the payload of 4,725 kilogrammes mounted on the space rocket "VOSTOK."

The payload consisted of a spaceship-sputnik with the pilot-cosmonaut Yuri Alexeyevich Gagarin in his full space flight outfit to be put in orbit around the Earth. The payload weight did not include the weight of the final carrier rocket stage.

V. A. Plaxin,
I. G. Borisenko,
sports commissars
of the Tchkalov Central Aero Club
of the USSR

V. I. Bodrikov,
V. M. Stolnikov,
calculating engineers

THE TCHKALOV CENTRAL AERO CLUB OF THE USSR

STATEMENT

of launching of rocket with spaceship-sputnik "VOSTOK"

On the 12th of April, 1961, I, the undersigned Vladymir Alexeyevich Plaxin, sports commissar of the Tchkalov Central Aero Club of the USSR, bear witness to the launching of the rocket carrying the spaceship-sputnik "VOSTOK"with the identifying marks of "USSR-VOSTOK", controlled by the pilot-cosmonaut Yuri Alexeyevich Gagarin. The launching was made at 9.07 Moscow time from a cosmodrome in the vicinity of the station of Baikonur.

The left-off of the rocket took place at 9.07 Moscow time.

The geographical coordinates of the place of launching are in the latitude of 47° North and the longitude of 65° East.

V. A. Plaxin,
sports commissar
of the Tchkalov Central Aero Club
of the USSR

THE USSR TCHKALOV CENTRAL AEROCLUB

STATEMENT
of landing of VOSTOK spaceship

On the 12th of April, 1961, I, the undersigned Ivan Grigorievich Borisenko, sports commissar of the USSR Tchkalov Central Aeroclub, bear witness to the fact that at 10.55 a.m. Moscow time on the 12th of April, 1961, in the vicinity of the village of Smelovka, Ternovka district, Saratov region, the USSR, the pilot-cosmonaut Yuri Alexeyevich Gagarin landed with the "Vostok" spaceship which had the identifying marks of "USSR—Vostok".

The geographical coordinates of the place of landing are in the latitude of 51°16′ North,

the longitude of 45°59′ East.

I. G. Borisenko,
sports commissar of the USSR
Tchkalov Central Aeroclub.

ИГБо

THE TCHKALOV CENTRAL AERO CLUB OF THE USSR

STATEMENT
of defining of flight duration of spaceship-sputnik VOSTOK with pilot-cosmonaut Yuri Alexeyevich Gagarin, April 12, 1961

We, the undersigned Vladymir Alexeyevich Plaxin and Ivan Grigorievich Borisenko, sports commissars of the Tchkalov Central Aero Club of the USSR, have drawn up the following statement:

On the basis of the statements of the launching of the rocket with the spaceship-sputnik VOSTOK and of the landing of the spaceship with its pilot-cosmonaut we have established the following:

The total flight duration of the pilot-cosmonaut Y. A. Gagarin, from the moment of launching the rocket with the spaceship-sputnik VOSTOK to the moment of the spaceship landing, is 108 minutes.

V. A. Plaxin,
I. G. Borisenko,
sports commissars
of the Tchkalov Central Aero Club
of the USSR

THE TCHKALOV CENTRAL AERO CLUB OF THE USSR

STATEMENT

of defining of maximum flight altitude of spaceship-sputnik "VOSTOK" with pilot-cosmonaut Yuri Alexeyevich Gagarin, April 12, 1961

We, the undersigned Vladymir Alexeyevich Plaxin and Ivan Grigorievich Borisenko, sports commissars of the Tchkalov Central Aero Club of the USSR, and Alexandra Ivanovna Sragovich, department chief of the Coordinating Computation Centre, have drawn up the following statement:

On the basis of studying the results of data processing of the measurements taken during the spaceship-sputnik "VOSTOK" flight by the Coordinating Computation Centre we have established the following:

The maximum altitude reached by the pilot-cosmonaut Yuri Alexeyevich Gagarin in his earth-satellite orbital flight on the spaceship-sputnik "VOSTOK" amounts to 327 km.

V. A. Plaxin,
I. G. Borisenko,
sports commissars
of the Tchkalov Central Aero Club
of the USSR

A. I. Sragovich,
department chief
of the Coordinating Computation Centre

THE COORDINATING COMPUTATION CENTRE

"MOSCOW – COSMOS"

Results of data processing of orbital measurements taken during the spaceship-sputnik "VOSTOK" flight, April 12, 1961

The data processing of the orbital measurements taken during the spaceship-sputnik "VOSTOK" flight on the 12th of April, 1961, by electronic computers M-20 and "Strela" in accordance with the technique given in an appendix, has made it possible to establish the following:

1. The spaceship-sputnik "VOSTOK" was put in an earth-satellite orbit with a period of revolution of 89:34 minutes.

2. The maximum altitude reached by the spaceship-sputnik "VOSTOK" during its flight in an earth-satellite orbit (the apogee distance from the Earth's surface) was 327 km.

3. The minimum altitude of the orbit of the spaceship-sputnik "VOSTOK" was 181 km.

4. The evaluation of the above parameters accuracy shows that the errors are between +2 and –2 km for the maximum altitude and between +1 and –1 km for the minimum altitude.

Note: The technique of defining the elements of the spaceship-sputnik "VOSTOK" orbit is given in an appendix.

Срагович *A. I. Sragovich,*
department chief
of the Coordinating Computation Centre

Technique of orbit elements determination of spaceship-sputnik "VOSTOK"

In the determination of the spaceship-sputnik orbit the following assumptions of its movement were made:

— Sputnik was considered as a material point moving under the effect of the Earth attraction force and air resistance force.

— In the expansion of the attraction force acceleration potentials of the spherical functions two addends were taken into account, namely, the homogenous sphere potential and the term accounting for Earth compression; field anomalies of the gravitational forces were neglected in the computations.

— Acceleration of the air resistance force was calculated according to the following formula:

$$\alpha = s\rho v^2 \tag{1}$$

where

v**—sputnik relative velocity vector modulus.**

ρ**—air density at a given altitude.**

s**—ballistic coefficient, the magnitude of which is defined by sputnik weight and aerodynamic characteristics.**

Sputnik movement was considered in the rectangular coordinates system O_{xyz} fixed to the rotating Earth. The original of the coordinates system coincides with the centre of the Earth, O_z axis passes through the North pole, O_x axis passes through the Greenwich meridian and O_y axis is directed eastward.

Sputnik orbit elements were defined on the basis of measurements data processing by means of the boundary problem solving for the following system of differential equations of movement:

$$\begin{aligned}
\dot{V}_x &= -S\rho V V_x - g_r \frac{x}{r} + g_m \frac{z}{r} \cdot \frac{x}{r_1} + 2\Omega_3 V_y, \\
\dot{V}_y &= -S\rho V V_y - g_r \frac{y}{r} + g_m \frac{z}{r} \cdot \frac{y}{r_1} - 2\Omega_3 V_x, \\
\dot{V}_z &= -S\rho V V_z - g_r \frac{z}{r} - g_m \frac{r_1}{r}, \\
\dot{X} &= V_x, \\
\dot{Y} &= V_y, \\
\dot{Z} &= V_z
\end{aligned} \tag{2}$$

where

$$r = \sqrt{x^2 + y^2 + z^2}, \quad r_1 = \sqrt{x^2 + y^2}, \quad V = \sqrt{V_x^2 + V_y^2 + V_z^2},$$

g_r **and** g_m**—radial and meridianal components of the gravitational force acceleration, respectively (positive directions of count** g_r**—to the** centre of the Earth, g_m—to the South), $\Omega_з$—angular velocity of the Earth rotation.

The initial data for the boundary problem solution were the results of the measurements t_i, r_i $(t_i \leqslant t_{i+1}, i = 1, 2, ..., N$, where N is the total number of measurements) and the calculated values of the initial movement conditions $q_j^{(0)}$ (j = 1, 2,..., 6) related to the moment of beginning of the spaceship orbital flight $t_o \leqslant t_1$.

The measurement system t_i, r_i included slant distances from the measurement station to the sputnik D_i, line-of-sight asymuths measurement station—"Sputnik" A_i and elevation angles of the line γ_i. The measurements were carried out from the stations of measuring complex located in the USSR territory. Measurement stations were equipped with radio stations operating on the principle of active response from the spaceship and provided for the required precision of measurements and at the same time for a precise reduction of all measurement stations data to uniform time.

The calculations of the corrections to the initial movement conditions $\delta q_j^{(o)}$, were carried out by the method of least squares, permitting to determine the orbit elements with maximum possible precision.

For not equally precise measurements of the parameters D_i, A_i and γ_i the following relations were accepted as conditional equations:

$$\sum_{j=1}^{6} \frac{\partial r_i}{\partial q_j^{(0)}} p_i \, \delta q_j^{(0)} = \Delta r_i p_i \, , \; (i = 1, 2, \ldots, N_1) \tag{3}$$

where

$\frac{\partial r_i}{\partial q_j^{(0)}}$—partial derivatives of the measured parameters by the initial conditions of movement, $p_i = \frac{1}{\sigma (r_i)}$—"weight" of i-th measurement, N_1—member of measurements used in the given iteration (from the total number N), $\Delta r_i = r_{i\,meas.} - r_{i\,calc.}$

On the basis of the given system of conditional equations normal equations are derived according to the well-known rules:

$$\sum_{n=1}^{6} Q_{mn} \, \delta q_n^{(0)} = \theta_m \, , \; (m = 1, \, 2, \ldots, 6) \tag{4}$$

The solution of these equations results in the determination of the corrections $\delta q_j^{(o)}$ (j = 1,2,..., 6) to the initial conditions of movement.

The boundary problem solution is made by the iteration method. As a result more precise initial conditions are determined in the moment of time t_o by means of the following formulae:

$$q_{jl}^{(0)} = \tilde{q}_j^{(0)} + \sum_{i=1}^{l} \delta q_{ji}^{(0)} \, , \; (j = 1,2, \ldots, 6), \tag{5}$$

where l is the number of iterations to the complete convergence of the iteration process.

More precise initial conditions of movement t_o, V_{xo}, V_{yo},..., Z_o were taken as the reference data for the spaceship-sputnik "VOSTOK" movement forecasting by means of numerical integration of movement equations (2) up to the moment when the command was given to switch on the brake power unit and also by means of numerical integration of movement equation taking into consideration the brake power unit operation which begins from that moment.

The boundary problem solution and the spaceship "VOSTOK" movement forecasting were carried out on electronic computers "M-20" and "Strela" during the spaceship orbital flight.

Later more precise determinations of the orbit elements were made from complete processing of data from all the stations of the complex and the evaluation was made of the precision of the determination of the fundamental orbit elements.

Сраговин *A. I. Sragovich,*
department chief
of the Coordinating Computation Centre

REPORT

on the arrangement of the spaceship-sputnik VOSTOK and its special equipment

The spaceship is a guided rocket vehicle. It carried the following major systems and units:

1. Manual spaceship flight and descent control systems. By means of these systems the cosmonaut can determine his position relative to the Earth surface, manually control the spaceship attitude, and fire the retrorocket.

Controllers are provided which allow the cosmonaut to vary the cabin humidity and temperature.

2. Optical orienting unit used by the cosmonaut to determine the local horizon and the direction of flight.

3. Automatic attitude control system which provides when used the alignment of the retrorocket axis on the Sun (prior to the firing of the retrorocket).

4. Flight control system that provides automatic control of the systems on board, their switching and changing of work regimes, etc.

5. Retrorocket used for changing the value and direction of the spaceship velocity vector to start reentry.

6. Radio equipment for the communication of the cosmonaut with the Earth on HF and UHF.

7. Padio equipment to control the spaceship orbit.

8. TV-system for observing the state of the cosmonaut from Earth.

9. Instruments for monitoring and recording the physiological functions of the cosmonaut in flight.

10. Radiotelemetering equipment, self-contained recording system and sensors which provide control and registration of functioning the spaceship-borne systems in flight.

11. Life support system (air conditioning system, cabin pressure-control system, food and water supply system and a system for the removal of the products of body activity).

12. Spaceship thermocontrol system providing the maintenance of the desired thermal regime in the spaceship compartments.

13. Landing system.

14. Cosmonaut seat.

15. Electropower sources.

16. TL antennas of the spaceship radio systems.

The cosmonaut is placed in a special seat in the cabin of the spaceship. This seat provides the most favourable conditions for the cosmonaut under accelerations.

If necessary, the cosmonaut can leave the spaceship using this seat.

There are three portholes in the cabin, through which it is possible to observe the surrounding space. One of the portholes carries an optical orienting unit. All the portholes possess shutters with actuators which are closed by the cosmonaut when the Sun rays fall on his face.

The cosmonaut is dressed in a special space suit which protects him and permits him to work even in case of cabin decompression.

Engineer Константинов *(N. F. Konstantinov)*

REPORT

by Major Yuri Alexeyevich Gagarin, Pilot-Cosmonaut of the USSR,

on flight on spaceship-sputnik "VOSTOK" April 12, 1961.

On the 12th of April, 1961, the Soviet spaceship-sputnik "VOSTOK" was put in orbit around the Earth with me on board.

In preparation for the flight I had completed a special training programme worked out by our scientists. I had studied well the technical equipment and was well prepared for a space flight.

Before the flight I felt fine and was absolutely sure of a successful outcome. The spaceship and its equipment was very good and reliable and all my comrades — scientists, engineers, technicians and I had no doubt as to the success of the space flight.

During the flight I also felt fine.

In the course of the powered flight, in the ascent period, g-loads and vibrations had no depressing effect on me and I could fruitfully work in accordance with a predetermined programme.

The spaceship put in orbit and the carrier-rocket separated, weightlessness set in. At first the sensation was to some extent unusual, although I had experienced weightlessness of short duration before. But soon I adapted myself to the condition of weightlessness, got used to it and could continue fulfilling my programme. My subjective opinion is that weightlessness does not affect work capacity or physiological functions.

During the whole period of flight I was carrying out fruitful work under the programme. I ate anddrank and maintained continuous radio communication with the Earth on different channels by telephone and telegraph. I controlled the operation of the spaceship equipment, sent reports to the Earth and recorded my observations in the logbook and on a magnetophone. During the whole period of weightlessness my work capacity was fully preserved, and I felt fine. Then in conformity with the flight programme at a definite time a command was given to descend, the brake power unit was switched on and the spaceship acquired a velocity necessary for landing. The landing predetermined by the flight programme was effected and I was back on the Earth happy to see my dear Soviet people. The landing took place in a prescribed area.

Now I want to describe in short my observations while in space.

From the height of 175-327 km there was a very good view of the Earth. Its surface had approximately the same appearance as when you look at it from a jet-plane flying at a high altitude. I could clearly distinguish big mountain ranges, big rivers, large forests, coastlines and islands. I had a good view of the clouds covering the Earth's surface and of the shadow they cast on the Earth. The sky was jet-black. The stars were somewhat brighter and clearer seen against that black background. The Earth had a very distinct and pretty blue halo. This halo could be clearly seen when looking at the horizon. It had a smooth transition from pale blue to blue, dark blue, violet and absolutely black. It was a magnificent picture.

When I emerged from the Earth's shadow the sun was shining through the Earth's atmosphere. Here the halo looked somewhat different. On the Earth's surface, at the very horizon, there was a vivid orange band which went through all the colours of the rainbow — pale blue to deep blue, violet and jet-black.

The entry into the Earth's shadow was very rapid. Everything became dark at once. I could see nothing on the Earth's surface, probably because I was over the ocean. Were I passing over big cities, I could very likely have seen their lights.

The stars were clearly visible.Emergence from the Earth's shadow was also very rapid and sudden.

Thanks to a thorough training I experienced no discomfort from the effects of the space-flight factors. At present I feel fine.

Y. A. Gagarin,

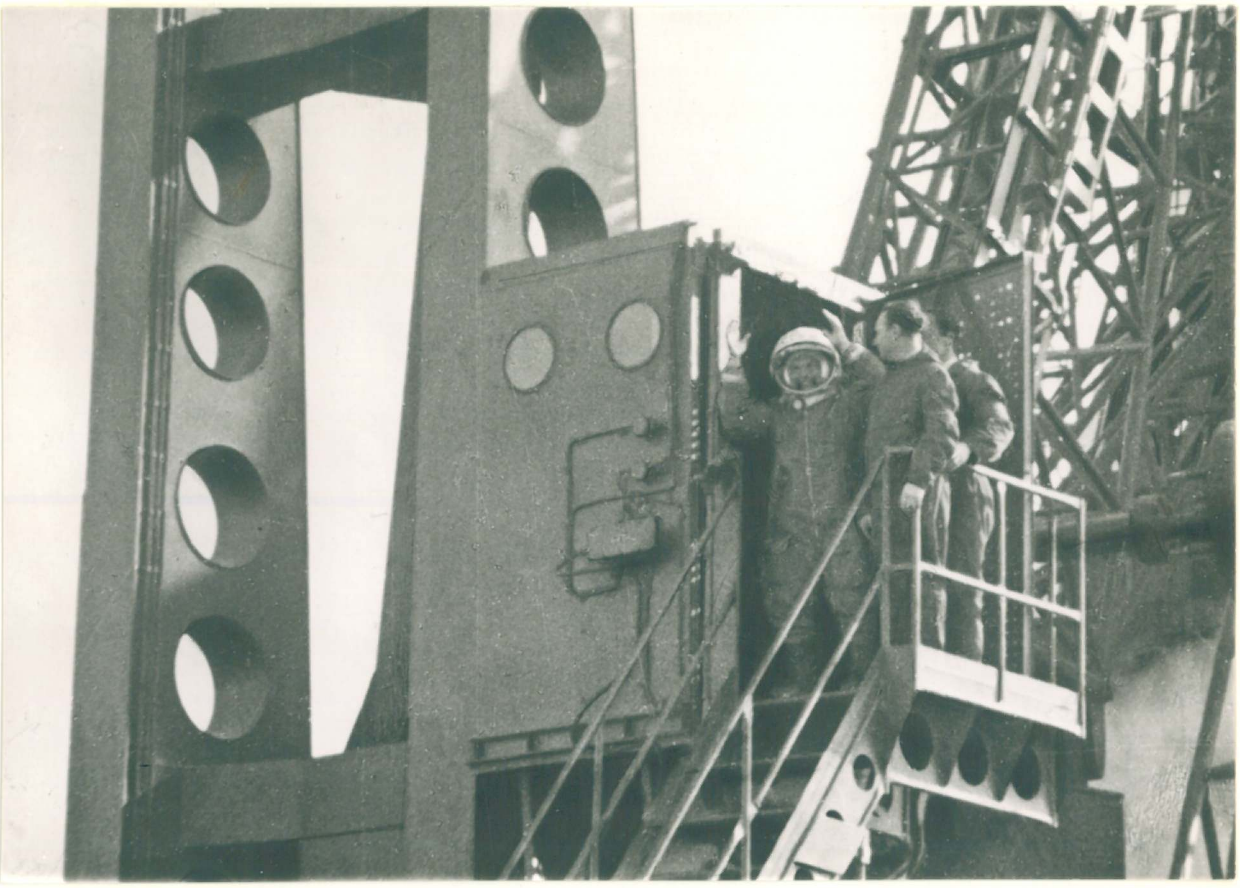
Pilot-Cosmonaut of the USSR

April 15, 1961

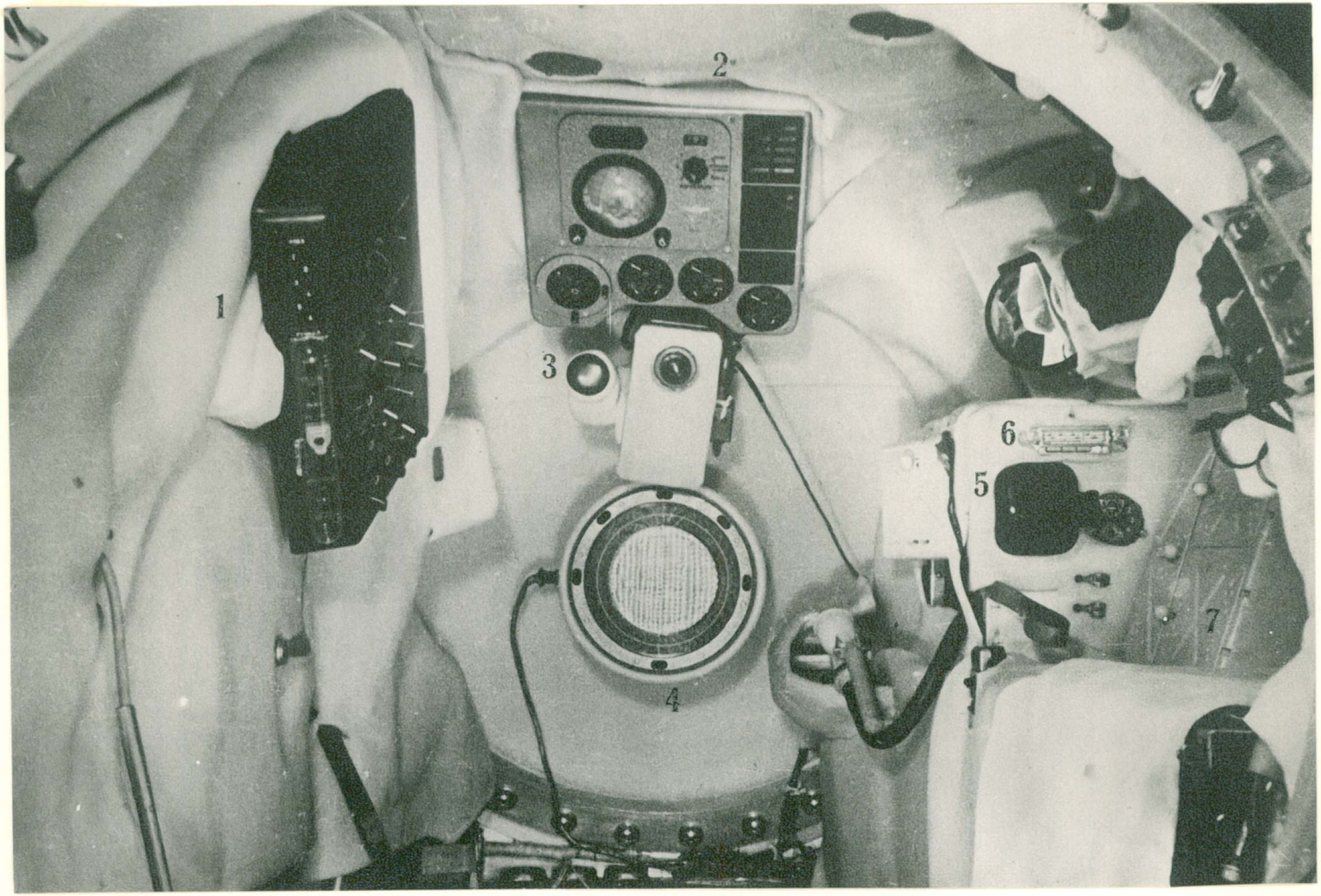
Гагарин

Pilot-cosmonaut of the USSR
major Yuri Alexeyevich Gagarin

Pilot-cosmonaut Y. A. Gagarin in his slight suit



Pilot-cosmonaut Y. A. Gagarin before the entering
the spaceship-sputnic "Vostok"



The inside view of the cosmonaut's compartment of the spaceship-sputnik "Vostok":
1 — pilot's desk; 2 — instrument panel with the globe; 3 — television camera; 4 — porthole with an optical orientation system; 5 — control handle of the spaceship orientation; 6 — radio receiver; 7 — food container

Pilot-cosmonaut Y. A. Gagarin directly after the landing is reporting by telephone to the Head of the USSR Government N. S. Khrushchov of the successful fulfilment of the first manned flight into space