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THE CENTRAL AEROCLUB
Union of Soviet Socialist Republics

In Honor of V.P. Tchkalovff

The additional materials in reference to the record of Soviet Flier-Cosmonaut H.C. Titov

Moscow 1962

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Union of Soviet Socialist Republics
in Honor of V. P. Tchkalovff

PROGRAM OF FLIGHT

1. The start of ship at 6 o'clock according to the Greenwich time 6 August 1961.

2. The flight for 17 orbits around the earth with the landing in the beginning of the 18th orbit on the territory of the USSR on 51° Northern Latitude. In case of the normal flight the landing is being conducted with the use of automatic system of orientation.

3. In case of bad feelings of the cosmonaut or abnormalities in the work of the apparàtus on board the ship, the landing can be accomplished earlier with the use of manual control or automatic system of orientation. Decision about such earlier landing with the use of manual control is being adopted after consultation with the Earth. In case of absence of contact, decision and landing may be adopted independently.

4. During the flight cosmonaut conducts radio broadcast and accepts the news from Earth on HF and UHF channels.

   UHF - the contact is sustained in zone of action UHF - stations.

   HF - Transmissions are conducted through one-half hour each at 0 and 30 minutes of Moscow Greenwich time each hour except the time assigned for the rest and sleep;

   - He conducts a journal board (log) and the record of his impressions on magnetophone;

   - He controls the operation of the ship systems on the board;

   - According to the instructions from Earth, he corrects the clock on the board and the indicator of his position in space and of the landing.

   - During the first and seventh orbit he practices the manual control of the ship. At this time he evaluates convenience of this manual control work, also the effectiveness of the system and expanse of the working body.

   - He conducts photographs from the ship's board and observation through the illuminators with the use of the optical device and without it.

   - The choice of places for photograph and observation are conducted independently;

   - He conducts self observation and physical exercises.

   - He takes food and water.

21 - He evaluates possiblity of finding out when he would come in and come out of the earth's shadow

- After depreciation of the apparatus for moving and the brakes, he conveys the message to earth about the work of such apparatus;

- After applying the ship's brakes in bad layers of atmosphere (while descending from the orbit) at the height of 6.5 KM, he conducts catapult from the cabin with the following landing on a parachute.

The ship is landing without pilot. After the landing, the ship informs about the landing. In case of system's refusal to catapult the cosmonaut is landing in the cabin of the ship.

22 Temporary Description of Landing - Greenwich Time

1. At 6:27 from the automatization of landing, a contact has been conducted into the system of ship orientation.

2. At 6:52 - 20.4 seconds from automatization of landing contact moving and braking of system is done.

3. At 7:11 from automatization of landing, the hatch has been blown out from catapult. After two seconds, the system for parachuting of the cosmonaut automatically has been introduced.

At the time of blowing off of the hatch of the catapult opening, the height of the flight was 7 KM.

4. At 7:11 minutes 15 seconds from automatization of landing, the system of landing of ship itself was conducted.

5. At 7:18 the landing took place.

26 <u>Telemetry Information of the Ship "Vostok 2"</u>

Telemetric measurement of the ship "Vostok 2" presupposed:

The medical control of the Cosmonaut's condition;

Control of the climatic conditions in the cabin of the ship Sputnik;

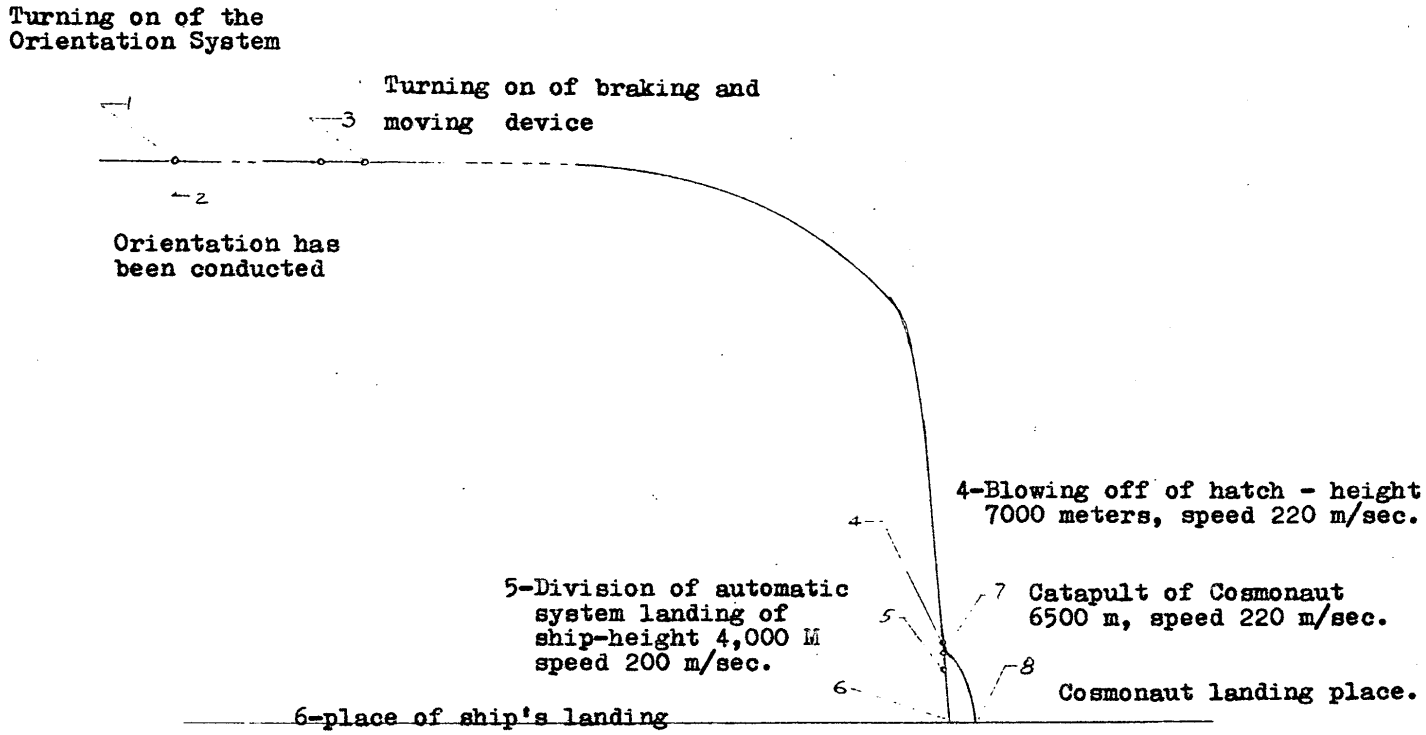
Control systems work in the area of verbal contact;

Control of the manual operation;

- When it is necessary he is using the sanitary facilities.

- He evaluates the different modes of eating food and also convenience of using the sanitary facilities.

SCHEME OF DESCENT



26 Cont'd Control of working of different systems apparatus and elements of the ship.

Information of ship's transmitters and instruments were conveyed radio telemetric systems and were received on Earth by the registering stations.

Under section of descent, landing information or data were registered by the board's automatic and remembering devices.

As a result of the telemeasurements and information has been received for about 10 minutes on land during each seance of contact and also in full while applying the brakes of descent and landing.

The medical control in regard to the cosmonauts condition during the period of telemetric seance and contact was realized according to the data of electrocardiograph and pneumograph. Besides this with the assistance of special conveyor, the frequency of cosmonaut's pulse was constantly controlled.

A copy of the cardiograph is attached.

Average meanings of cosmonaut's pulse frequencies during different sections of the flight are presented in this description:

SECTION OF THE FLIGHT	FREQUENCY OF PULSE BEAT PER MINUTE
<u>Period Before the Start</u>	
Before taking place in the ship	69
5 Minutes Before Start	106
<u>Section of Coming Out of Orbit</u>	
In The Beginning	119
At the End	104
27 10 Minutes of Orbital Flight	100
3rd Orbit	95
7th Orbit	82
14th Orbit	76
Section of Applying Brakes	104

As a result of the analysis of the telemetric information, it was concluded that the basic physiological indicators which characterized the condition of the system of breathing and blood circulation of the said cosmonaut on all sections

27 Cont'd of the flight, they were in the limits of meaning, which has been registered during the preparation on Earth.

Climatic conditions inside of the cabin provided possiblity of normal conduct of cosmonaut"s duties.

Radiotelemetric systems have registered the information of indicators:

Temperature inside of the ship"s cabin;

Pressure, humidity and composition of air and air condition inside of the ship's cabin also the indicators of the apparatus control system and termoregulation conditioning and air's regeneration.

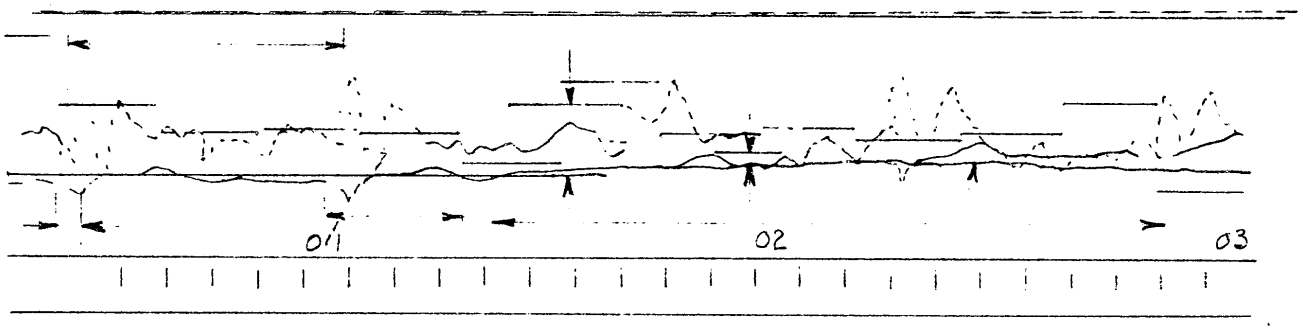
29 Below the data of telemeasurement is given:

No. of Paragraphs	Description of Parameters	Figure of Measurement	Meaning of Paramter and the Section Before Start Coming Out	Orbital Flight
1	The Pressure of Air Inside the Cabin	MM RT ST	750	750-740
2	The Pressure in Suit	MM RT ST	770	750-740
3	Temperature of Air Inside the Cabin	^{0}C	25	25-12
4	Composition of Air Outside the Cabin			
	Hydrogen	%	24	24-27
	Nitrogen	%	0.4	0.4- 0.25
5	Condition of Air Humidity in the Cabin	%	55	55

The measured figures of the parameter were conducted with accuracy.

Temperature	± 1° C
Pressure	± 10 mm RT ST
Humidity	± 5%
Quantity of Oxygen in the Air	± 2%
Quantity of Nitrogen in the Air	± 0.1%

Common accuracy of telemetric system -1% of measured diapason.



ELECTROCARDIOGRAM

30 The summing of indicators was conducted under the conditions of factories and at the time of pre-start tests in the complex with the radio telemetric systems. Below is sample of characteristics of separate indicators which are given.

33 Brief description of measuring apparatus, of accuracy and its measurement and calibration curve.

The measurements were conducted from the measurement points, placed on the tracing of Sputnik flight on the territory of the Soviet Union.

The measuring points had their own radio location stations working under the power of active answer from the Sputnik's board. In this measuring system have been included the apogee and perigee from measuring points (EP) to Sputnik A_1, Azimuth of lines of vision (EP) Sputnik D_1 and the angles of lines place γ.

The measurements of apogee and perigee was conducted by the method of ascertaining of temporgry intervals between the moments of giving and receiving of signals with the transformation of it into a dual code.

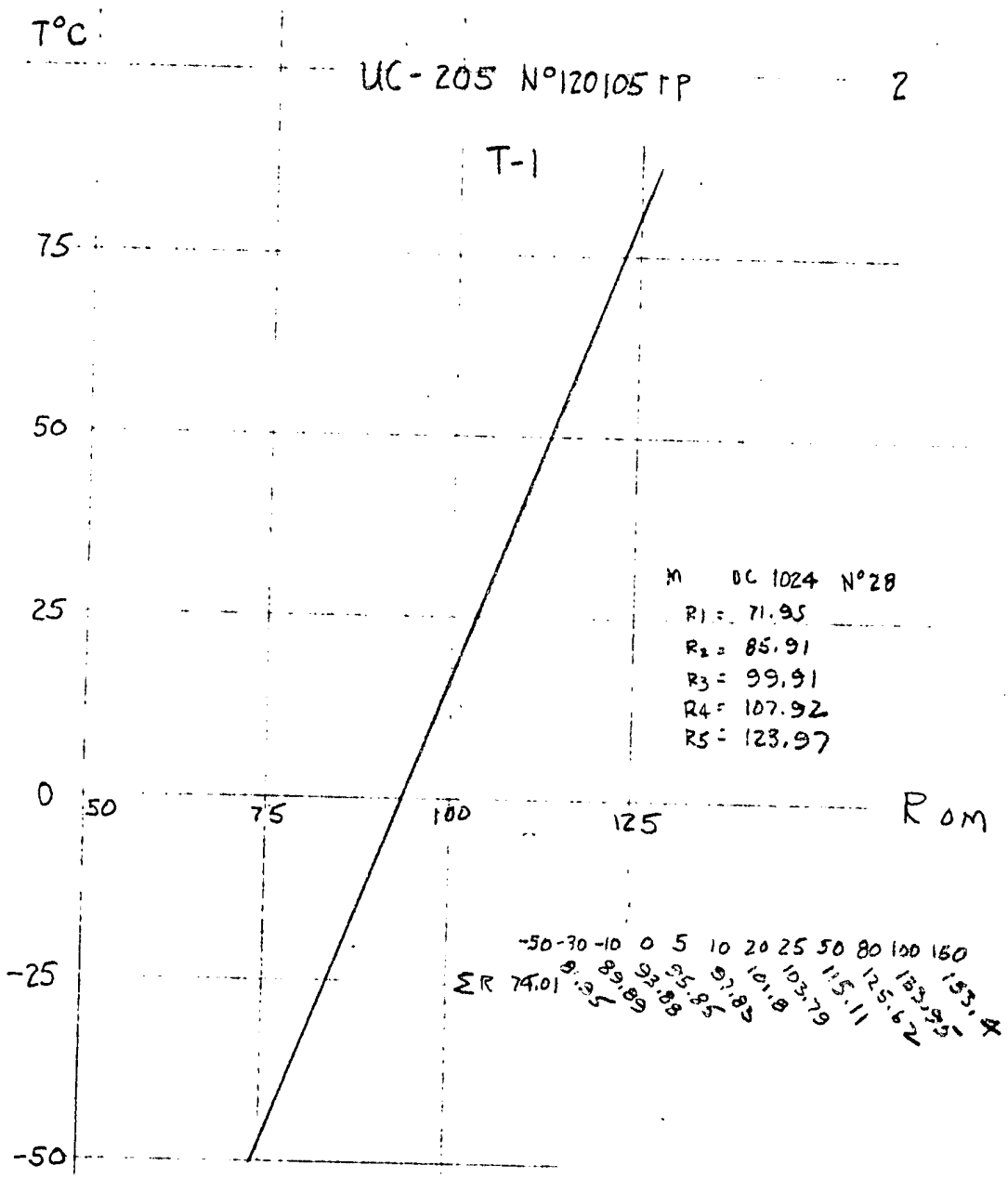
During the measurements, the corrections were taken into account at the time of signal obstruction in the earth and board apparatuses. Ascertainment of corrections was conducted with the help of special calibration apparatus at the time of prestart preparation (See Attached).

Ascertainment of correction of earth radio located apparatuses also was conducted in the period of time between the seances of contact with the Sputnik.

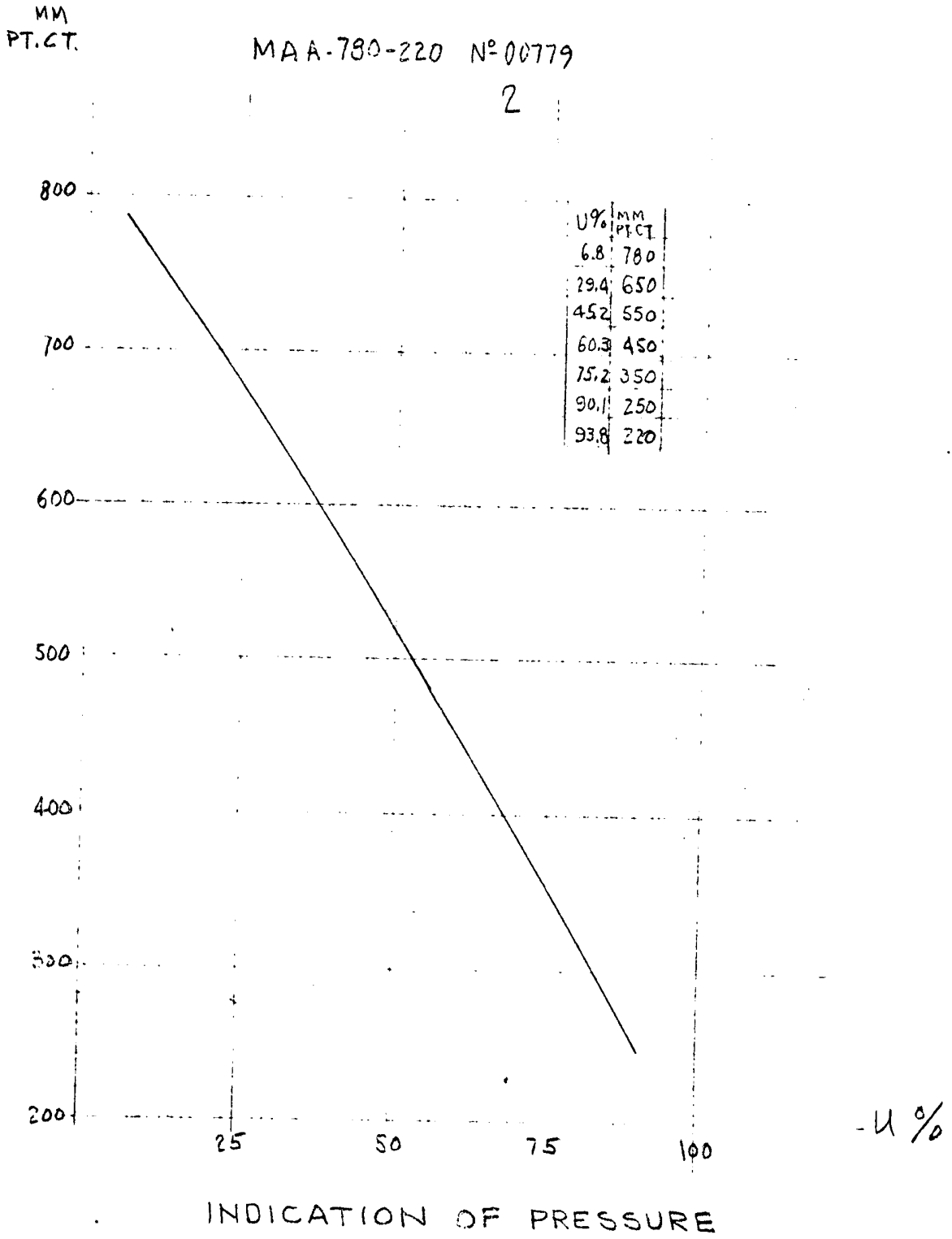
Azimuth A_1 and the angle of place γ, were ascertained with the help of watching aerials and transformers summing figures in dual code. Board's apparatus provided simultaneous work in the governing of active answer with several Earth watching points. γ, Inclusion of Board's apparatus for the purposes of measurement was conducted for the time during the flight of Sputnik over the territory of the Soviet Union in the regions where measuring points were located. (EP).

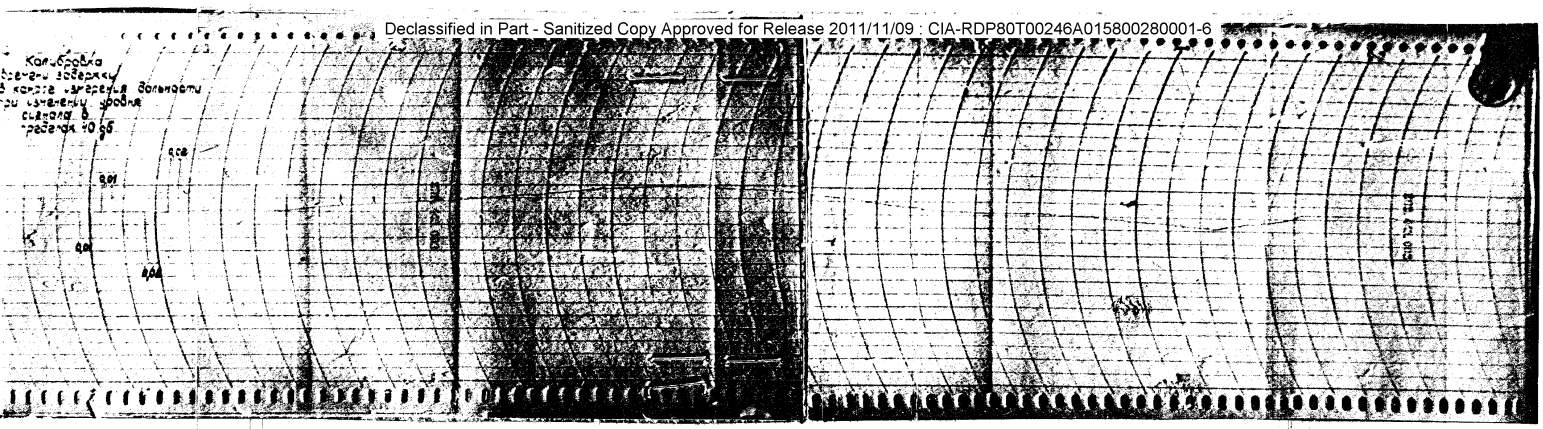
Attachment of the results of said measurements at the same time was conducted with the help of highly stabilized generators conducted by the radio lines with accuracy to 1^0 of the phase.

34 The accuracy of temporary attachment of said measuring results on all measuring points was not worse than 10^{-3} seconds. From all measuring points, the results were automatically transmitted on the lines of contact to the coordinating and calculation center and were surrendered to common analysis and the electronic computing machines - Model M-20 and Arrow.



INDICATION OF TEMPERATURE





as much as these errors during the measurement of ship Sputnik Vostok 2 were not taken into consideration it deemed necessary that the greatness of these errors were not sufficiently small, it was necessary that these errors would be insignificant for this purpose. Coresponding calibration were conducted proving insignificance of said mentioned errors. Calibration was conducted by the way of registration of the time of signals delay during changes of intenseness of signal. According to this scheme on the calibration chart, the results of registration of time variation and delay of signal is indicated in the apparatuses during the change from intenseness of signal (by Power) in the limits of 40 decibels.

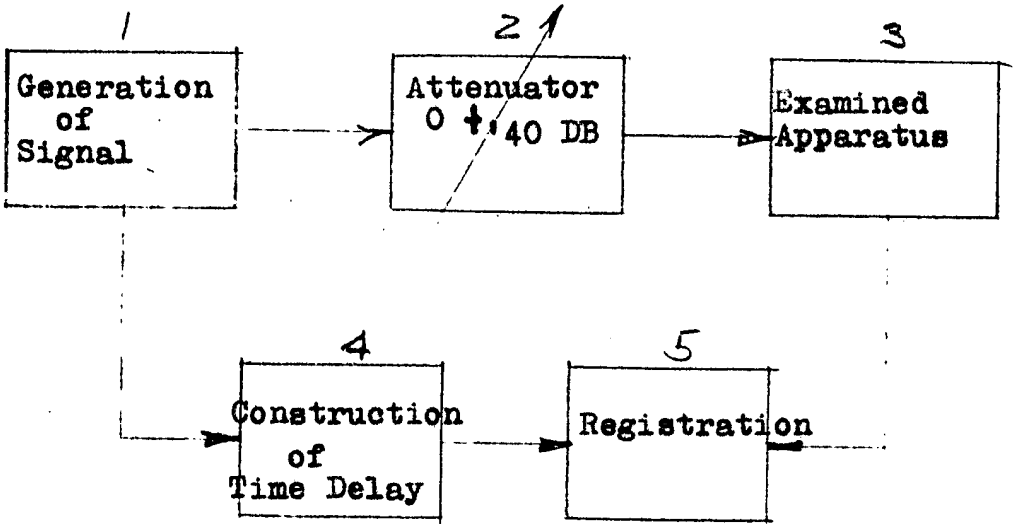
Under vertical axis the change of time cause of delay of average meaning is put aside, on the horizontal axis the change of signals intenseness.

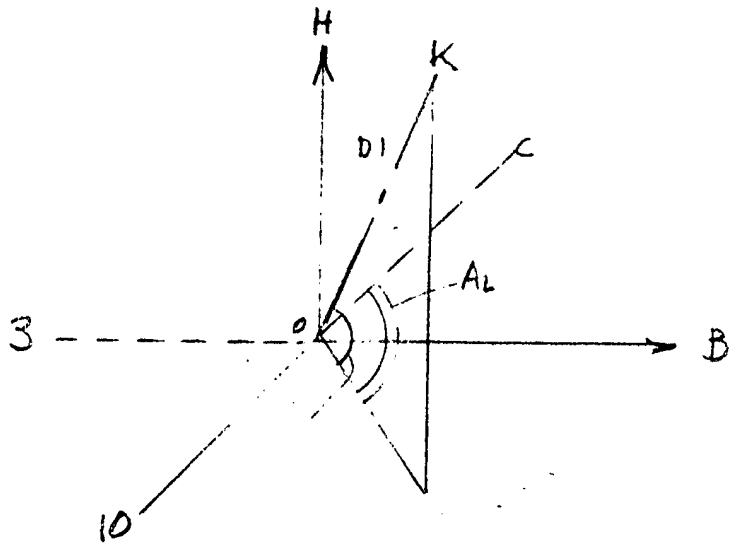
In the beginning of the chart, the calibrating levels of delay in micro seconds are given (+0,0I; -0,0i; +0,02; -0,02).

Calibration proved possibility of neglect for the errors on account of instability of time delay signals in the channel.of distance measurement.

The maximum error was not more than ±0.01 MK/sec (± I,5 meter)

SCHEME OF CALIBRATION AND DELAY





Technical Data of Apparatus Used

The earth radio location station of centimetered diapason the accuracy of apogee and perigee measurement (D_1) 25 M without taking into consideration of frequency non-stabilization reproduction of electro magnetic vibrations.

The accuracy of measurement of the angle coordinating was not worse than I 5'.

Greatness of transgression given account of calibrating mistakes. In reference to distances not more than 3 meters, in reference to the angle coordinator 10".

METHODS OF CALIBRATING

A) Earth Stations

Comparison radio locating distances with the geodesic distances which was measured with accuracy up to 2 M

B) Board Construction

Comparison of radio locating distance former place of radio location station to board antenna of Sputnik, which at the time of starting position with geodesic distance between these objects taking into consideration and deducted for apparatus hindrances of the radio location stations were measured according to the point (A) C) (Russian V) Calibration of the time of hindrances in the channel of distance measurement.

Change of signal level causes variation of hindrances time of the signall[illegible]apparatus; this causes the errors of distance measurement.

37 Data in reference to trajectory of flight of the Cosmic Ship Vostok 2

1. The minimum height of the flight over the surface of the earth

   H min = 178280 meters

   Geodesic coordinators at the point with the minimum height

   φ = 38° 29' 37" , 6 Northern Latitude

   λ = 34° 18' 12" Eastern Longitude

2. The maximum hhight of the flight over the surface of the earth

   H max = 246270 meters

Geodesic coordinator of the point with the maximum height

= 63° 08' 37", 6 Northern Latitude

= 114° 36' 36" Western Longitude

Geodesic Coordinator time (Moscow) and the height of the flight over the surface of earth during the second orbit for two points:

φ_1 = 45°,5 Northern Latitude	φ_2 = 50°,8 Northern Latitude
λ_1 = 400,4 Western Longitude	λ_2 = 153°, 2 Western Longitude
H_1 = 180 km	H_2 = 192 km
T_1 = 10 hrs. 33 minutes	T_2 = 10 hours 50 minutes

4 Elements of Orbit:

Large Half of Axis

$$a = 6583060 \text{ meters}$$

Eccentricity

$$e = 0.00522$$

Incline of orbit towards the equator's level

$$i = 64° 58' 01", 6$$

38 Angles condition of perigee

$$\omega = 63° 14'24",6$$

Length of Orbit's Ascending Angle

$$\Omega = 80° 02"32"$$

Time of Passing Through Perigee

$$\tau = 10 \text{ hrs. } 35.79 \text{ min.}$$

Time of Passing Through Ascending Knot

$$t = 10 \text{ hrs. } 20.38 \text{ min.}$$

Time of Orbitting

$$T = 88.458 \text{ min.}$$

4 An account of the construction of cosmic ship Sputnik Vostok 2 and its special contents.

The cosmic ship Sputnik Vostok 2 presents self directing rocket apparatus. Its control can be realized automatically as well as manually by the cosmonaut. The ship consists of hermetic cabin in which the Cosmonaut is found; panel with instruments and apparatuses and the brakes and the instruments for movement which could be used by the cosmonaut himself. The pilot*s cabin from the outside has a special heat insulation which protects the capsule from the influence of high temperature during the section of landing. The cabin has two hatches that can be opened quickly. In the shell of the cabin there are three illuminators through which cosmonaut can conduct his observations. The said illuminators are equipped with heat proof glass, calculated on the influence of high temperature which appears on the surface of the cabin during the entrance into the thick layers of atmosphere.

All illuminators are equipped with shades which can be opened and closed automatically as well as by the hand of the Cosmonaut.

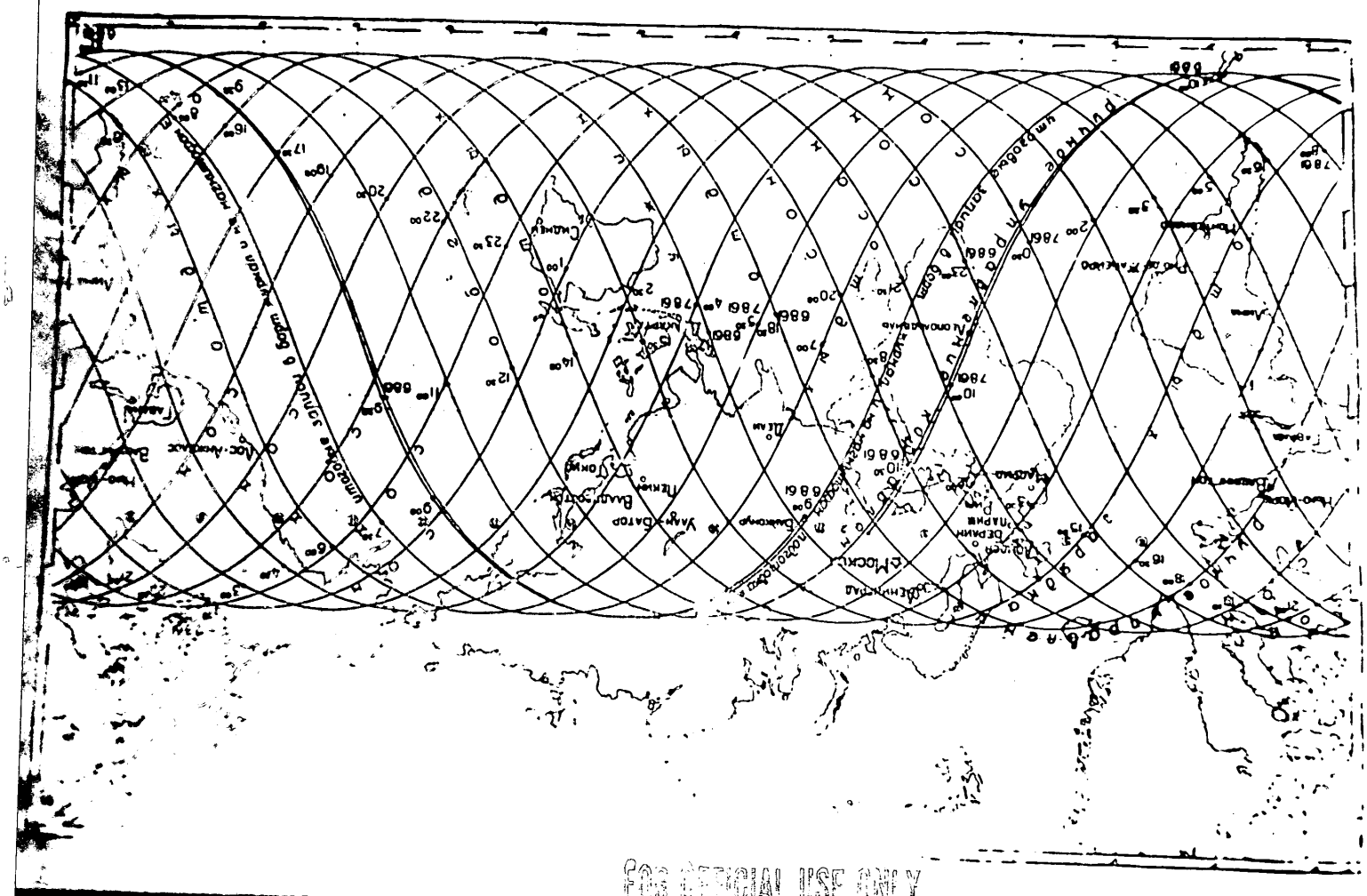
In the cabin of the ship the protection system for the Cosmonaut's activities is placed; also part of radio instruments; optic device for observations by cosmonaut through illuminators; also television camera.

On the said panel board are placed radio equipped apparatus for control; also the system of termo regulation of the ship.

During the flight cosmonaut had its place in catapult chair, which was the place for his work and also served as the medium of quitting the cabin before landing. The surface of the chair was laid with soft plastic pillows fitting the forms of the parts of the cosmonaut*s body, when he occupies this chair. In this chair are found system for parachuting, providing for cosmonaut's possibility of landing.

5 In case of landing on water, Cosmonaut can use inflated boat which opens up automatically. Should the Cosmonaut be unable to use the boat after landing on water, then the special construction of the Cosmonaut*s suit helps him on water in a position when he lies in it on his back.

During the orbital flight, cosmonaut's ventilation of suit is being achieved by the air in the cabin. In case the cabin is unsealed, automatic hermetic sealing takes place in the suit. Cosmonaut's supply of oxygen and ventilaton of the suit in such a case is provided by the extra supply of preserved compressed oxygen and air which are found on board ship. Oxygen and air are guaranteed for cosmonaut in case of cabin unsealing (accidentally) indicating contact with Earth and choosing the place for landing thus realizing descent. Apparatus on flight manual control and descending of ship permits Cosmonaut



5 Cont'd to conduct manual control of ship's orientation in space and to achieve ship's landing in chosen area. The pilot can with assistance of organs of control ____? achieve regulation of temperature under humidity and condition of atmosphere in the cabin.

Besides these apparatuses and the ship Sputnik Vostok 2, the following systems are placed:

1. The system of orientation which provides a definite space position of ship before making a contact for braking provisions.

Functionally system of orientation is being divided into manual and automatic.

2. Optical orientation of which Cosmonaut has a use for definition of flight direction and local vertical.

Optical orientation is placed on one of the illuminators in the pilot's cabin.

3. Braking-Moving device with a system of control is designated for change of greatness and direction of speed's vector on the ship with the purpose of leading it from the orbital Earth sputnik on the trajectory of descent. Plug-in of braking and moving device is being done automatically as well as according to the desire of the pilot with the help of the organs of control of launching on the ____?

4. Apparatus of flight control providing automatic control by the instruments aboard the ship according to the given program.

5. Radio apparatus for 2-side contact of Cosmonaut with the points on earth during pre-start preparation, on the section of leaving the atmosphere and during the flight orbit. On the ship there were placed two receivers and two transmitters.

HF/diapason; the receiver and transmitter UHF diapason, magnetophone, loudspeaker receiver, electro acoustic provision.

The shortwave and HF transmitters and receivers worked on the common antennas through special dividing filters. Frequencies of transmitters aboard the ship as follows: 15,715; 20,000 — ? and 143,625 megahertz. The choice of radio contacts mode was achieved by the pilot by the use of this or that channel.

Turning on of magnetophone was conducted automatically when cosmonaut gave voice signal transmission to earth of magnetophone record was conducted over the radio quickly after a word from Earth while the ship was flying over the receiving stations.

6. Radio apparatus of orbit control designed for measurement of parameters of ship movement on the section of leaving the atmosphere and in orbit and would consist of receiving and transmitting and formulating apparatus for antenna ____? feeder systems.

7 The television system was placed for the observation of the cosmonaut and receiving of objective data about his well-being, conduct and coordination of movements during conducting of his several tasks.

8. Apparatus of control and regulation of his physiological fundations during the flight.

Frequency pulse, breathing, etc. permitted constant observation of cosmonaut's condition.

9. Radio telemetric apparatus system of autonomous registration and indicative apparatus providing control and registration of work of the apparatus aboard the ship during the flight.

On the ship there was placed radio system called "signal" and operated on the frequency of 19,999 megahertz

10/ The system of security for conditions providing human life and activity.

For sustaining of basic parameters of micro climate of the cabin in the limitation area near to normal, this being done by use of the system of conditioning providing elimination of nitrogen and humidity and also discharge of necessary quantity of oxygen for the cosmonaut's breathing. Quantity of oxygen discharged by the system was regulated automatically.

The system of conditioning was also provided for the destruction of harmful mixtures which appeared as a result of activity of human body and work apparatuses.

For sustaining of normal pressure in the cabin a system was installed for regulation of said pressure. Under the system of nourishment and provision of water, provided the pilot with the food, produce and water during the whole orbital flight. The food and water were taken three times during the 24 hours.

For the need of elimination under the condition of weightlessness, special sanitary device was used designated for such needs.

11. For the sustaining of ship's temperature in given limits aboard the ship was placed automatic system of termo regulation. The system consists of two contours - aerial open into space of the pilot cabin and that of liquid one, connected with radiational reflector of heat, which was placed on the panel board.

By contours are connected in aerial-liquid heat circulation placed in the cabin of the cosmic ship. Such a system provides sustaining and regulation of temperature inside of the ship in the limits of +10 + +25°C.

12. The system of cabin lighting includes a watching and working light. The control of lighting is connected with the ? and can be plugged in and out. The said lighting provides the lighting from 5 to 70 LUKC (?).

13. The system for circulating . . . . .

14. The instrument for definition by pilot of ship's posttion in orbit and geographic coordinator of expected point of landing has been executed in a form of a globe 1:100000000.

The revolving of the globe is being achieved simultaneously relative to the two axes.

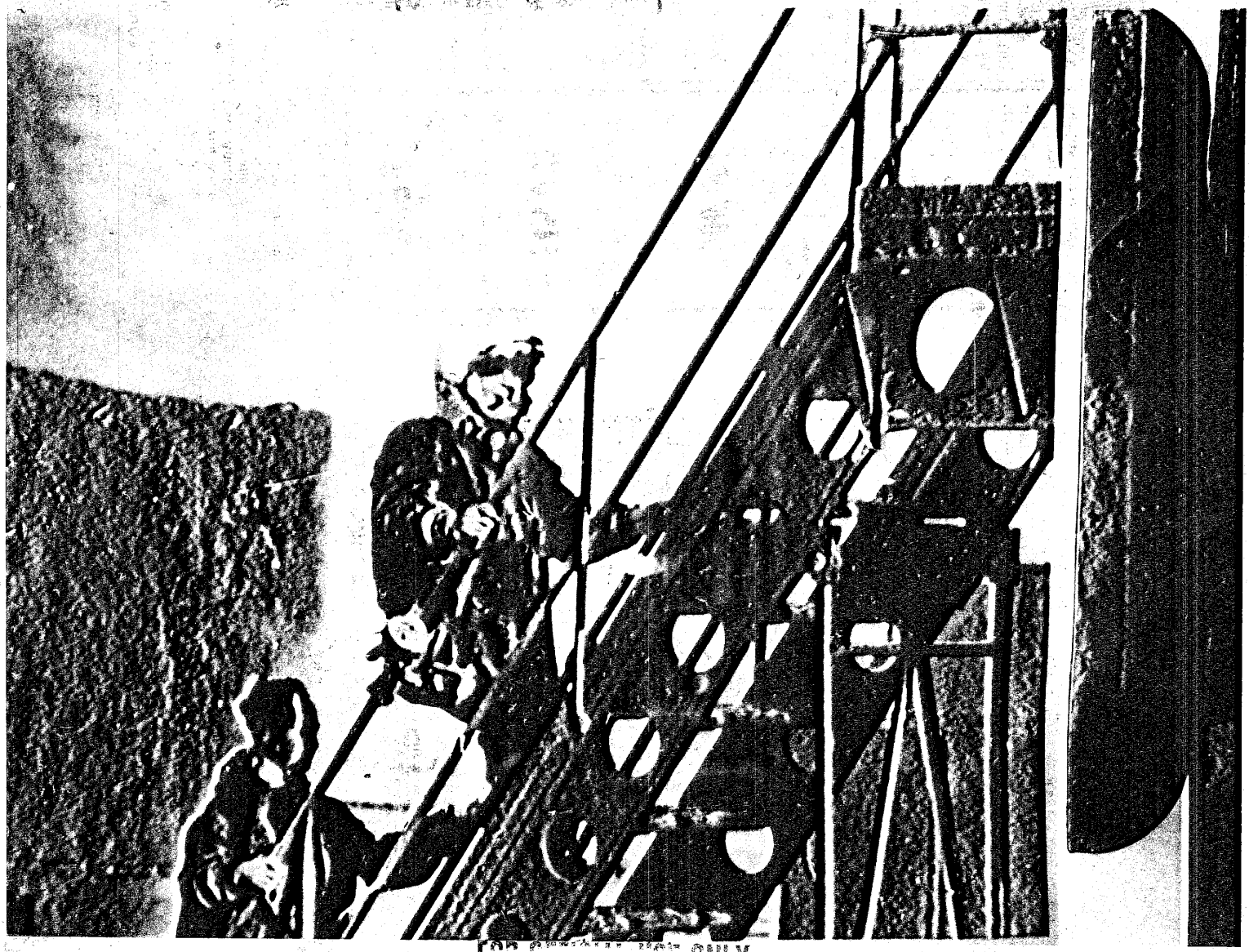
Revolving relative to the first axis cofresponds to revolving of earth around its own axis. With the taking into consideration of correction of the precision of ship sputnik's orbit.

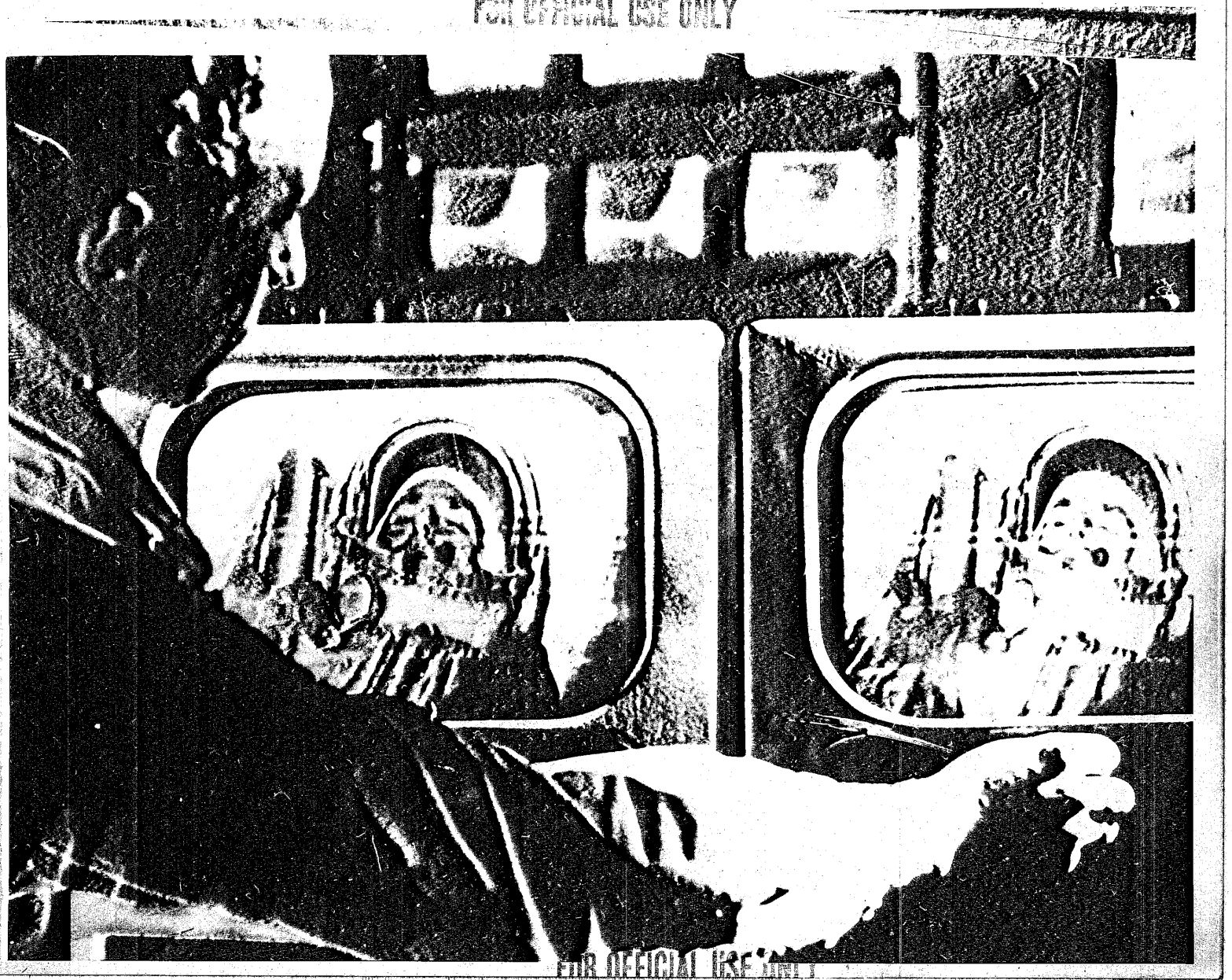
Revolving relative to the second axis corresponds to the movement of ship Sputnik in orbit.

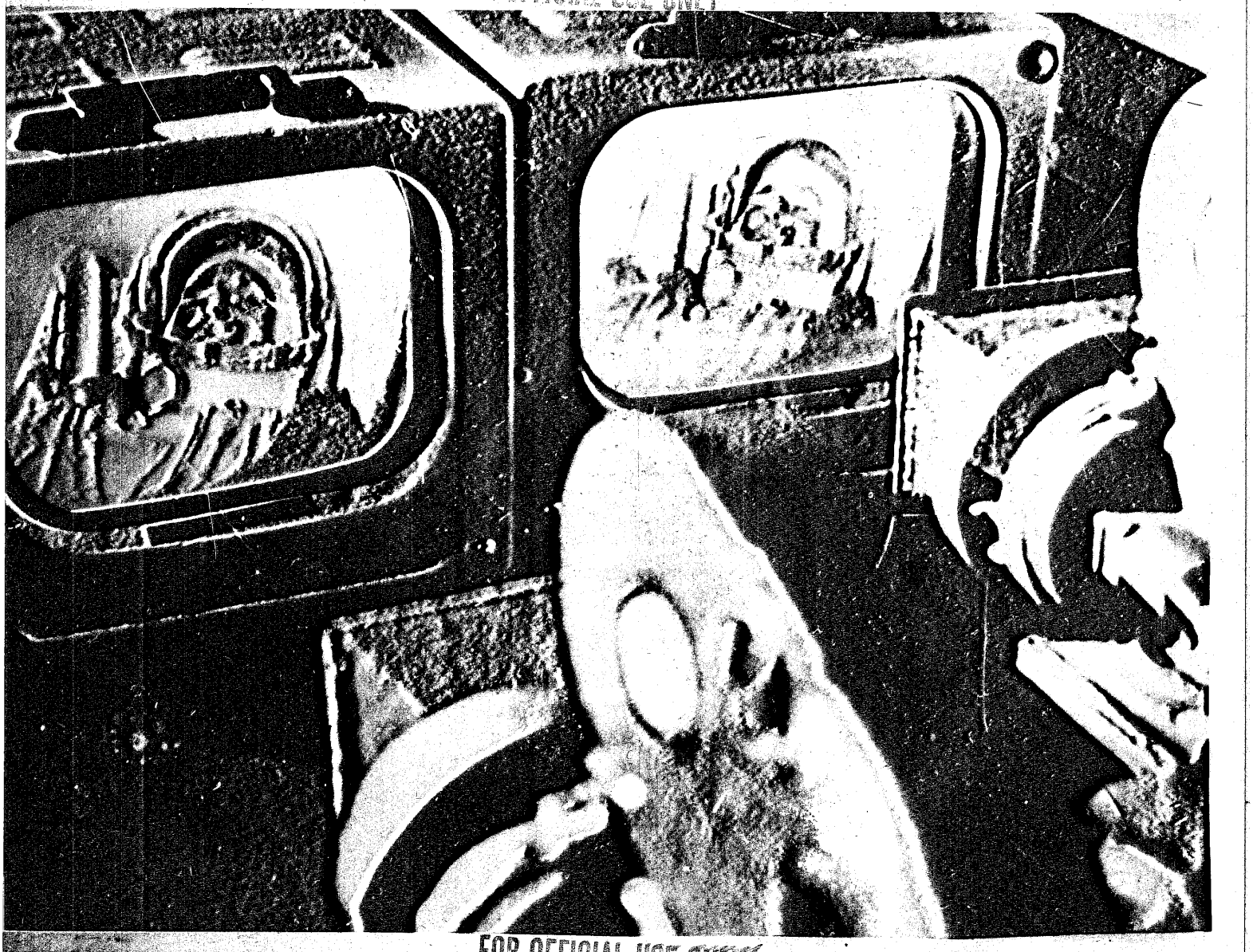
Therefore, under the crosshairs displayed on the face side of instrument glass is each movement appearing in the area of which the Sputnik appears in flight. Indication of expected landing place is achieved by globes turning to the angle of resistance (?) corresponding to the calculated angle of descent; counting from the moment of turning on of braking device up to the place of landing.

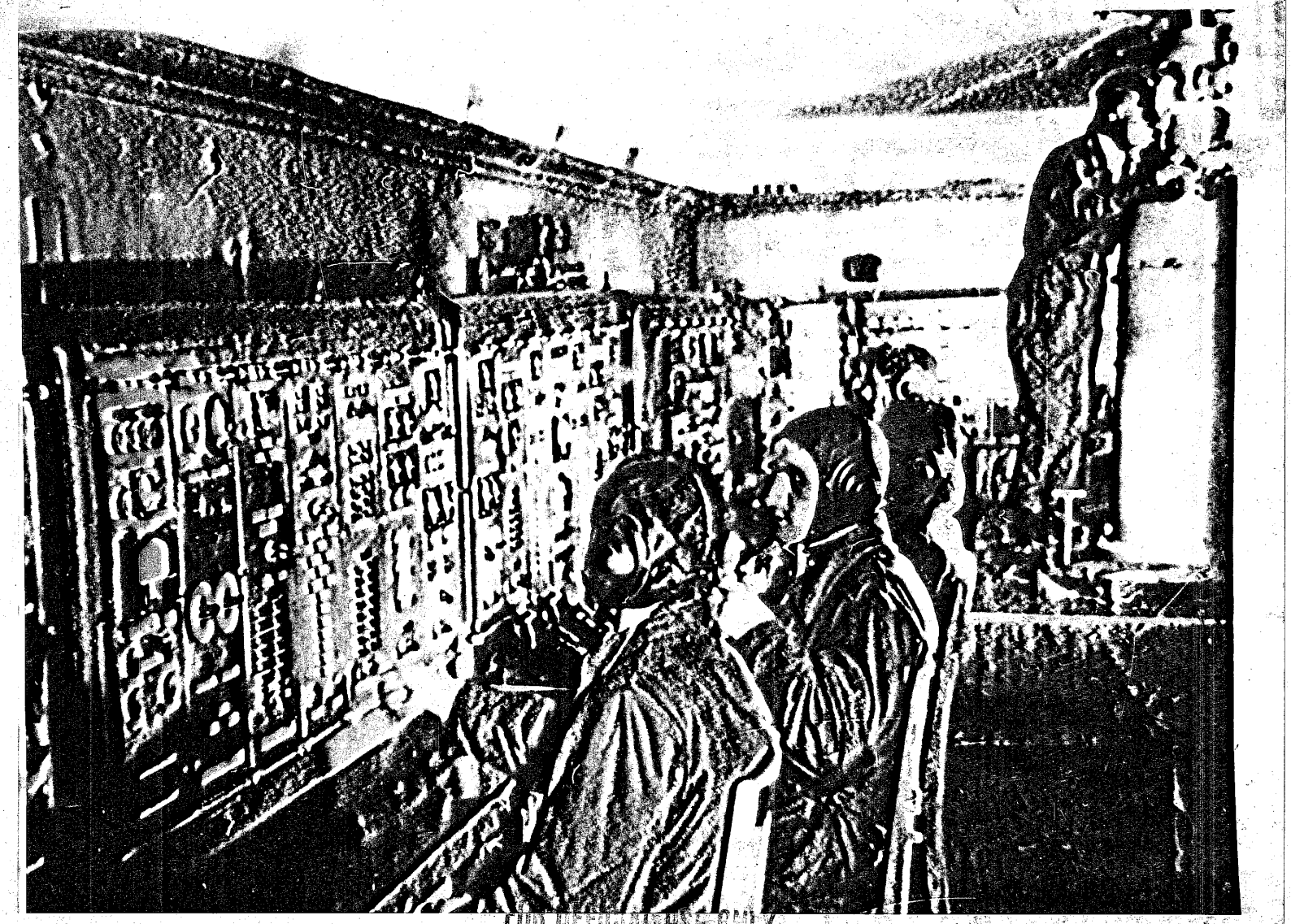
The globe's construction provides possibility of adding necessary corrections into work of instrument according to the results offactual measurements of orbit parameters.

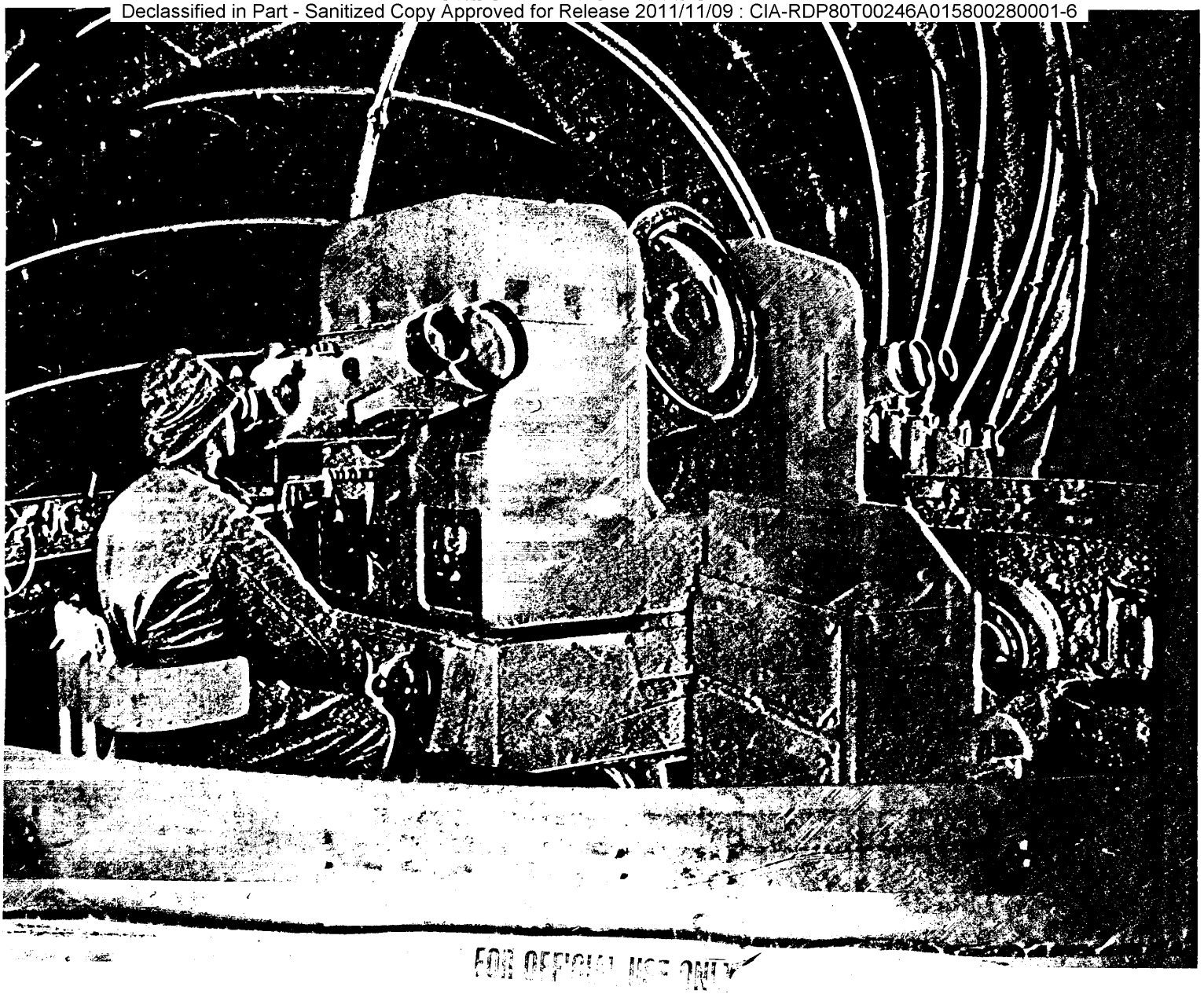
Engineer /s/ Konstantinoff











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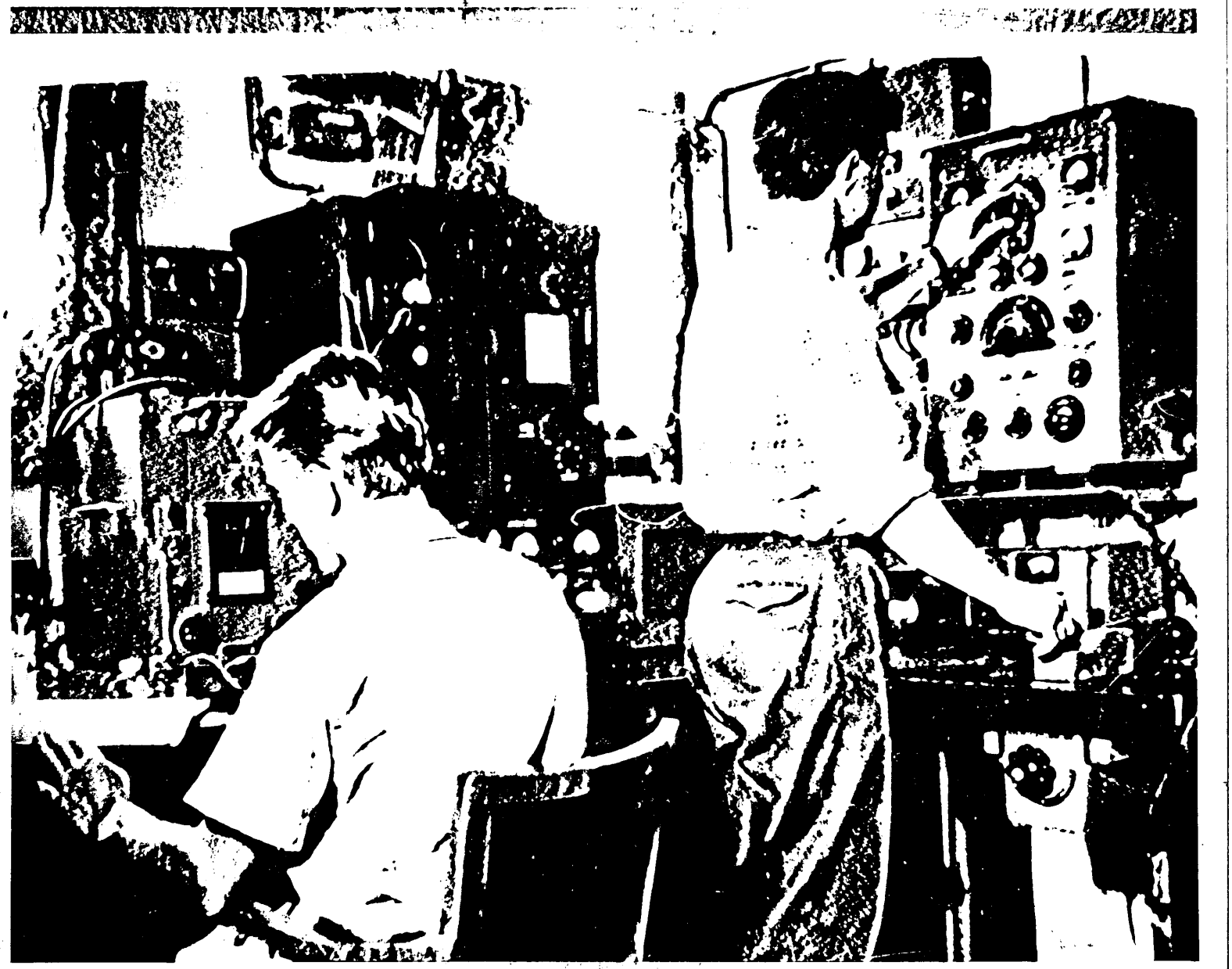

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