CIA/PB 131632-97

DECEMBER 18 1959

UNCLASSIFIED- INFORMATION ON SOVIET
BLOC INTERNATIONAL GEOPHYSICAL COOPERATION
-1959

(22)

PB 131632-97

PB-97

INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION - 1959

December 18, 1959

U. S. DEPARTMENT OF COMMERCE
Business and Defense Services Administration
Office of Technical Services
Washington 25, D. C.

Published Weekly
Subscription Price $12.00 for the Series

Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget, October 28, 1959

NOTICE TO SUBSCRIBERS

INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION will continue publication through 1960.

If you wish to subscribe for the 1960 series, request PB 131632 Information On Soviet Bloc International Geophysical Cooperation - 1960 and enclose check or money order for $12 ($4 additional for foreign mailing). Mail your order to OTS, U. S. Department of Commerce, Washington 25, D. C.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM -- SOVIET-BLOC ACTIVITIES

(First Photographs of the Far Side of the Moon)

Table of Contents

[Translator's Note: The first official publication on the preliminary processing of photographs of the far side of the Moon obtained by the automatic interplanetary station was issued by the Publishing House of the Academy of Sciences USSR on 10 November 1959. A translation of the 34-page booklet, Pervyye Fotografii Obratnoy Storony Luny (First Photographs of the Far Side of the Moon), with an introduction by Academician A. N. Nesmeyanov, President of the Academy of Sciences USSR, follows]

Foreword

The direct experimental study of the cosmos is continuing. On 4 October 1959, the Soviet Union successfully launched the third cosmic rocket, the goal of which was the solution of a series of problems of cosmic space and the photographing of the far side of the Moon and its peripheral areas. In precise conformity with calculations, the automatic interplanetary station, specially equipped for photographing the far side of the Moon, flew past at a short distance from the Moon, turned on its course and, in accordance with a given program, took photographs of the side of the Moon which is not visible from the Earth. With the aid of a television apparatus on board the interplanetary station, the image of the Moon was transmitted, on command from the Earth, from distances of several hundreds of thousands of kilometers.

A new era has begun in the history of astronomy. It has been proved that not only is it possible to study the physical parameters of cosmic space and various emissions of celestial bodies without hindrance, but also it is possible to obtain close-up photographs of the planets. The astronomer will not have to wait 15-17 years for the great opposition of Mars, when the distance between it and the Earth will be reduced by 50-60 million kilometers. Now it is possible, in principle, to send vehicles to within close distances of the planets in order to photograph their surfaces.

Man is no longer chained to the Earth. The Soviet people have made our generation contemporaries of interplanetary flights.

At the Third Session of the Supreme Soviet USSR, N. S. Khrushchev said, regarding this unprecedented accomplishment of Soviet science, "How happy we are, how proud we are of the accomplishments of the Soviet people, such as the successful launching, within one year, 1959, of three cosmic rockets, evoking the delight of all mankind. The entire Soviet nation honors the people of science and labor who paved the way into the cosmos."

Since the time of Galileo and Newton, who founded contemporary natural science, science has scored many an outstanding victory. Among these were the prediction of the existence and the discovery of new planets in the solar system, Neptune and Pluto. But not until our time were the first artificial celestial bodies, those of the Earth and of the Sun, created by the labor of the Soviet people, representing the first time in the history of mankind that a flight was made from one celestial body to another, bringing remarkable investigations of the study of cosmic space. Already the launching of the first Soviet artificial satellites of the Earth and cosmic rockets has brought to science a number of discoveries of universal value: the outer radiation belt and the extraionospheric ring of current around the Earth were discovered; a living organism was sent into flight in cosmic space; new data were obtained on the structure of the magnetic field of the Earth; it was established that the Moon lacks an appreciable magnetic field and has no radiation belt surrounding it; the density of interplanetary gas was determined; and the first photographs of the far side of the Moon were obtained.

The current publications of the Academy of Sciences USSR contain the first published results of the preliminary study of the photographs of the far side of the Moon, taken on board the automatic interplanetary station. The study of these data is being continued, and in a short time, the Academy of Sciences USSR will publish scientific works containing the obtained photographs, a description of the formations on the far side of the Moon, and a description of the method used in determining the nature of these formations, as well as other data.

Scientists of the Soviet Union are hopeful that the publication of the data on the photographing of the far side of the moon will contribute to the further progress of science on the road to the conquering of the universe. -- Academician A. N. Nesmeyanov, President of the Academy of Sciences USSR

INTRODUCTION

On 4 October 1959, the Soviet Union successfully launched the third cosmic rocket. The goal of this launching was the solution of a series of problems of cosmic research. The most important of these was the photographing of the surface of the Moon. There was particular scientific interest in obtaining photographs of that part of the lunar surface which, because of the nature of the motion of the Moon, is not directly visible from the Earth, as well as that part of the surface which is viewed at such an acute angle that it cannot be studied accurately.

An automatic interplanetary station, put into orbit around the Moon by means of a multistage rocket, was built to provide a detailed study of cosmic space and to obtain photographic recordings of the Moon. In precise conformity with calculations, the automatic interplanetary station passed the Moon at a distance of several thousand kilometers and, as a result of the attraction of the Moon, changed the direction of its motion and moved into a trajectory which was convenient both for photographing the side of the Moon which is not visible from Earth and for transmitting scientific information back to Earth.

The accomplishment of the launching of the third cosmic rocket and the placing of the automatic interplanetary station into a given orbit required the solution of a number of new scientific and technical problems. The interplanetary station was launched by a powerful multistage rocket, characterized by a high design perfection, provided with powerful engines which operate on high-caloricity fuel. The realization of a given characteristic motion of the rocket at the end of the accelerated portion of its flight was guaranteed by a precise system of control.

I. Equipment on the Automatic Interplanetary Station

The automatic interplanetary station is a cosmic flying device equipped with a complicated array of radio engineering, phototelevision, and scientific apparatus, a special orientation system, devices for the programmed control of operations of the station's equipment, a system for the automatic control of temperature within the station, and power sources.

By means of a radio engineering device located in the station, it was possible to make measurements of the orbital parameters of the station, to transmit television and telemetric information to Earth, and to transmit commands from Earth for control of the station-borne apparatus.

The station's phototelevision apparatus made it possible to automatically photograph the far side of the Moon, process the film, and prepare it for transmission of the image to Earth.

The complex of scientific equipment in the automatic interplanetary station was designed for the further study of cosmic space and space in the vicinity of the Moon begun by the first two cosmic rockets.

All control of the functioning of the station's apparatus was accomplished by means of radio links from points on Earth and also by means of independently programmed station-borne devices. Such a combined system makes it possible to more easily control the conduct of scientific experiments and to receive information from any sector of the orbit within the range of radio visibility from ground observation points.

An automatic temperature control system operates continuously to maintain a given temperature in the station. With this system, the heat given off by the instruments is lead out through the radiation surface into the surrounding cosmic space.

Heat emission is controlled by means of shutters on the exterior of the satellite which open the radiation surface when temperature within the station reaches $+25^{\circ}$.

The power supply system comprises individual units of chemical sources of current for supplying the short-term operating equipment and also a centralized reserve chemical battery. Solar current sources compensate for expended energy from the reserve battery. Supply of the station equipment is maintained through converter and stabilizing devices.

The automatic interplanetary station is a thin-walled hermetically sealed capsule having a cylindrical shape with spherical ends within which are located the equipment and chemical power supplies. Some of the scientific instruments, the antennas, and sections of the solar battery are on the exterior of the station. In the upper end is an illuminator with a cover which automatically opens before photographing begins. Under the illuminator are the camera lenses and a pick-up for orientation with the moon. In the upper and lower ends are small illuminators for the solar pick-ups of the orientation system. In the lower end are the control motors for this system.

The maximum diameter of the station is 1,200 millimeters, and the length is 1,300 millimeters (without antennas).

For photographing the moon, it was found to be more expedient to point the photographic equipment by rotating the entire automatic interplanetary station. The orientation system rotated and maintained the automatic interplanetary station in the required direction.

The orientation system was turned on after approaching the moon, at the moment when the station was located approximately in a straight line between the Earth and Moon. At this time, the Earth was located to one side of a line between the Sun and Moon. The distance to the Moon at the moment the orientation system was turned on was, in accordance with computations, 60,000-70,000 kilometers. The possibility of realizing the necessary position of the station during its orientation was accomplished by a specially selected trajectory. This position permitted the station to be oriented with respect to the Moon under conditions of illumination from three bright celestial bodies -- the Sun, Moon, and Earth.

At the beginning of operation of the orientation system, the components of which included optical and gyroscopic units, electronic logic devices, and control motors, it was necessary to stop the arbitrary rotation of the automatic interplanetary station around its center of gravity which had begun at the moment of separation of the station from the last stage of the launching rocket.

After rotation had ceased, the lower end of the station was directed toward the Sun by means of solar pick-ups. In this position, the optical axes of the camera were directed toward one side of the Moon.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

Then, the appropriate optical device, in the field of vision of which neither the Earth nor Sun could then appear, turned off the pick-up orienting on the Sun and directed the photographic apparatus precisely at the Moon. From the optical device, the incoming "presence" signal from the Moon initiated the photographing process automatically. During the entire photographing operation, the orientation system continually directed the automatic interplanetary station at the Moon.

After exposure of all the frames, the orientation system was shut off. At this moment, the system imparted to the automatic interplanetary station a well-regulated rotation with such a specific angular velocity that, first, the temperature regime would improve and, second, the effect of rotation on functioning of the scientific equipment would be excluded.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

II. Flight of the Interplanetary Station

Problems concerning orientation and radio communication with the automatic interplanetary station impose special requirements on the flight trajectory.

An initial requirement for the normal operation of the orientation system is that the Moon, the station, and the Sun be in approximately a single, straight line at the instant the system begins to function, since at this time the station would be within the distance range indicated in the preceding section.

In connection with the large volume of information to be transmitted from the interplanetary station to earth, the flight trajectory must permit the receiving points throughout the territory of the USSR to obtain the maximum amount of information on the first orbit, particularly at distances close to the surface of the earth.

It was also very desirable for purposes of scientific research to obtain a trajectory which would ensure that the station continued in flight for a sufficiently long period of time.

Investigations showed that these requirements could be most fully satisfied by using the gravitation of the Moon in the formation of the orbit. To obtain an orbit with the required characteristics, it was necessary that this effect be fully determined as to magnitude and direction. The Moon can exert a considerable effect on the motion of the satellite only if the Moon's attraction is sufficiently great. To achieve this, the station must pass close to the Moon. For a directional change in the orbit characteristics, the station must pass alongside the fully determined side of the Moon. More exactly, the direction of the Moon's effect is determined by the inclination of the station's orbit to the plane of the Moon's orbit in its selenocentric motion.

The firing velocity for flight around the Moon with return to Earth must be several times less than the so-called second cosmic (or parabolic) velocity, which is equal to 11.2 kilometers per second at the surface of the Earth. Flight around the moon may be accomplished with various types of trajectories.

If the flight trajectory passes at distances of several tens of thousands of kilometers from the Moon, the effect of the Moon is comparatively slight, and motion relative to the Earth will occur in a trajectory which is close to an ellipse with focus at the center of the Earth. Circumlunar trajectories which pass at several tens of thousands of kilometers from the Moon have many great disadvantages. It is impossible in a flight at great distances from the Moon to make a direct investigation of the cosmic space in the neighborhood of the Moon. If a

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

rocket is launched in the northern hemisphere of the Earth, the return to Earth is toward the southern hemisphere. Motion close to the Earth on the return is outside the limits of visibility from the northern hemisphere, and, therefore, radio communication close to the Earth is impossible. In returning to Earth, the rocket enters the dense layers of the atmosphere and burns; the flight is ended after the first turn.

The use of the directional action of the lunar attraction at close proximity to the Moon to form the orbit of the automatic interplanetary station made it possible to obtain an orbit which did not have the disadvantages common to trajectories which circle the Moon at great distances.

The flight trajectory of the automatic interplanetary station passed at a distance of 7,900 kilometers from the center of the Moon and was calculated to be south of the Moon at the time of closest approach. Due to the attraction of the Moon, the trajectory of the automatic station is deflected to the north in accordance with the calculations. This deflection is so considerable that the return to Earth is toward the northern hemisphere. After approaching the Moon, the greatest height of the station above the horizon increases daily for the various observation points throughout the northern hemisphere. There was a corresponding increase in the time intervals within which direct communication with the station was possible. During the approach to Earth, the automatic station could be observed in the northern hemisphere as a nonsetting star.

In returning to Earth on the first orbit, the station did not enter the atmosphere and did not burn. It passed at a distance of 47,500 kilometers from the center of the Earth, moving in an elongated orbit, almost an ellipse. The greatest distance of the station from the Earth was 480,000 kilometers.

The flight of the station in the vicinity of the Earth was at such great distances from its surface that there was no braking from atmospheric resistance. Therefore, if the motion were only a result of the gravitational force of the Earth, the automatic station would be a satellite of the Earth with an infinitely long lifetime.

Actually, however, the duration of the station is limited. As a result of the perturbing effect of the attraction of the Sun, the closest distance from the orbit to the Earth (the height of the perigee of the orbit) is constantly decreasing. Therefore, after having completed a certain number of revolutions, the station, in returning to Earth, will enter the dense layers of the atmosphere and cease to exist.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

The magnitude of the decrease in the height of the perigee in one revolution depends on the dimensions of the orbit and, in particular, on the height of the apogee, the greatest distance from the orbit to the earth. The height of the perigee rises sharply with an increase in the height of the apogee. Therefore, in choosing the trajectory of the interplanetary station, it was necessary to approximate the situation in which the height of the apogee is as small as possible and does not much exceed the distance from the Earth to the Moon. It is also necessary that the height of the perigee on the first orbit be as great as possible. The number of rotations of the automatic station around the Earth and its lifetime depend on the degree to which both these requirements are fulfilled.

The effect of the Moon is not limited to the effect which it exerts during the first approach. Perturbations in the station orbit caused by the Moon's attraction do not have the same regularity as those caused by the Sun's attraction and depend greatly on the period of rotation of the station around the Earth. The Moon may have a substantial effect if the trajectory of the station again approaches sufficiently close to the Moon on one of the subsequent rotations. In this case, the approach of the station and the Moon would occur at approximately the same point in the lunar orbit as the first time. The character of the motion of the station may change substantially. If the interplanetary station passes around the Moon from the south side, i.e., if the approach is the same as the first, then there will be a sharp increase in the number of rotations and the lifetime of the station, and the main property of its trajectory, approach to Earth from the northern hemisphere, will be preserved. If it goes around from the north side, the height of the perigee will decrease, and if the perturbation is sufficiently strong, a collision with the Earth may occur on the next return.

On those turns of the orbit where a sufficiently close approach to the Moon does not occur, the Moon, nevertheless, exerts a considerable effect on the motion of the station. Although the Moon's attraction in this case is very small, over a considerable number of turns of the trajectory, the Moon's attraction exerts a considerable effect on the motion of the automatic station and causes a decrease in the height of the perigee and the lifetime of the station in orbit.

The picture of the motion of the automatic station under the simultaneous gravitational effects of the Earth, Moon, and Sun is very complex. The character of the passage near the Moon on the first approach is the determining factor for the further motion of the interplanetary station.

Since there is no correction in the motion of the interplanetary station in flight, its whole flight is determined, in the final analysis, by the parameters of the motion at the end of launching segment, (basically, the magnitude and direction of the velocity.) It is clear then that it is possible to obtain the trajectory described above only with an extremely accurate system for controlling the flight of the launching rocket in the launching segment.

It may be imagined that through the center of the Moon perpendicular to the Earth-Moon line, there is a plane, which we shall call the mapping plane. The trajectory relative to the Moon may be characterized by the position of the point of intersection of the trajectory with the mapping plane.

Calculations show that a deviation of the point of intersection of the trajectory with the mapping plane from the intended position by 1,000 kilometers changes the minimum distance of the station from the Earth at the end of the first revolution by 5,000-10,000 kilometers and the time of return to Earth by 10-14 hours. Such a substantial change in the values of the trajectory parameters close to the Earth is connected mainly with a difference in the effect of the Moon on the motion of the station in the cases of the calculated and deviated trajectories.

Although satisfaction of all the conditions imposed on the circling trajectory admits of greater deviations from the calculated position of the point of intersection of the trajectory with the mapping plane than there could be in the case of impact with the Moon, realized with the second Soviet cosmic rocket, the accuracy required in the launching segment remains as high as in the case of impact. This is mainly because errors in the magnitude of the velocity at the end of the launching segment in the case of elliptical circling trajectories cause deviations in the point of intersection of the trajectory with the mapping plane which are 3-4 times greater than in the case of hyperbolic trajectories, which are convenient to use for impact.

In addition, for good radio communication between the interplanetary station and observation points on earth, it is necessary to know with sufficient accuracy the change in the characteristics of the motion of the station with time. This is necessary in order that the measuring points can carry out calculations on the target with the required accuracy and determine the times for switching on the transmitting devices on board. This requires systematic measurement of the trajectory of the interplanetary station, analysis of the data, and correction of the characteristics of the motion of the station, both during its approach to the Moon and after its flight around the Moon. The effect of the Sun and Moon on the evolution of the orbit of the interplanetary station in the process of its further flight also requires constant measurement and correction of the characteristics of the motion of the station.

These conditions impose great demands on the automatic Earth complex intended to measure the parameters of the trajectory of the interplanetary station, calculate a prediction of its motion, calculate targets by measuring and observation points, and calculate the times for switching on the transmitting devices on board the interplanetary station throughout its flight around the Earth.

The Earth complex includes a radio-technical station for measuring the distance, angular parameters, and radial velocity of the motion of the object; a station for receiving telemetering information; and automatic lines connecting the measuring points with the corrdinating-computing center, which, in turn, is connected with Earth points for giving commands to switch on the transmitting devices on board the automatic interplanetary station.

The command radio line made it possible to switch on the radio-technical communication devices at definite time intervals corresponding to favorable conditions for radio communication between the apparatus on board and the Earth points throughout the territory of the Soviet Union. Selection of the duration and time for switching on radio communication with the station was determined by operating conditions of the apparatus on board, the need for conducting trajectory measurements to correct characteristics and predict the motion of the interplanetary station, and conditions of the rated power supply of the devices on board.

Data established through analysis of trajectory measurements on the position of the interplanetary station at the time of the photographing, necessary for tying in the observed objects on the invisible side of the Moon to the selenographic net of coordinates, are presented in the table.

				Selenographic Projection AIS*	
	Date	Time (Moscow)	Distance From Center of Moon (km)	Latitude	Longitude
Beginning of photographing	7 Oct 59	0630	65,200	16.9°	117.6°
Completion of photographing	7 Oct 59	0710	68,400	17.3°	117.1°

*Automatic Interplanetary Station

A preliminary processing of the trajectory measurements on the first turn of the orbit made it possible to establish that the automatic interplanetary station will continue in orbit up to the end of March 1960 and will complete 11 revolutions around the Earth.

III. PHOTOGRAPHING AND TRANSMISSION OF PICTURES

In developing the complex means for photographing and transmitting a picture of the invisible side of the Moon from on board the automatic interplanetary station, the problem of producing a phototelevision system which would make it possible to obtain sufficiently clear half-tone pictures and transmit them at distances measured in hundreds of thousands of kilometers was solved.

The phototelevision apparatus, installed in the interplanetary stations, contained the following principal devices: a camera with two objectives, a small-scale device for automatically developing and fixing the photographic film, a miniature cathode ray tube, a highly stable photoelectric amplifier, an electron circuit containing amplifiers and scanning devices, and a system for automation and programming.

The design of the phototelevision apparatus ensured its reliability under the complex conditions of cosmic flight; the safety of the photographic materials from the harmful action of cosmic radiation and the normal functioning of the unit for processing the photomaterials and the other units of the apparatus in conditions of weightlessness were ensured.

For the exceptionally long-range transmission of pictures with a very low-power radio transmitter, an image transmission speed tens of thousands of times slower than the transmission speed of the standard television transmission centers was used.

In the first photographing of the reverse side of the Moon, it was expedient to photograph as large a portion of its unknown surface as possible. This led to the necessity of photographing the fully illuminated disk whose contrastivity is always considerably lower [at this time] than during lateral illumination which creates shadows from the details of the relief. Automatic contrast control of the transmitted image was applied for best transmission of the low-contrast picture by the phototelevision apparatus.

The camera was equipped with two objectives with focal lengths of 200 and 500 millimeters and apertures of 1:5.6 and 1:9.5, respectively.

The objective with a focal length of 200 millimeters gave a picture of the disk of the Moon fully entered in the frame. The objective with a focal length of 500 millimeters gave a large-scale picture of part of the lunar surface.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

Photographing was made on special 35-millimeter photographic film which can be processed under high temperature.

Photographing was conducted with automatic exposure change for different frames to obtain negatives with the best densities and lasted about 40 minutes, during which time the reverse side of the Moon was photographed repeatedly.

The entire photographing process and film processing was done automatically, according to a fixed program.

For preventing fogging of the film under the action of cosmic radiation, a special safeguard was provided which was selected on the basis of investigations conducted with the aid of the Soviet artificial satellites and cosmic rockets.

Upon completion of photographing, the film moved into a miniature device for automatic processing, where it was developed, fixed, and dried. Then the film moved into a special holder for transmission of the image.

Transmission of images of the Moon was performed by commands from the Earth which switched on the power supply of the station television apparatus, started the transport of photographic film, switched in the television apparatus to the transmitter on board.

Coordination and regulation of the operation of all members, including the electronic circuits and the optical, mechanical, and photochemical apparatus, were accomplished by a system of automation and programming.

The method of "transillumination" was used to transform the image contained on the film negative into electrical signals. This method is analogous to the one employed by television centers in transmission of motion-picture film. A small cathode ray tube of high resolving power produced a bright spot which was projected onto photographic film by means of an optical system. The light which passed through the photographic film fell upon a photoelectric multiplier which transformed the light signal into an electric one.

The light spot on the screen of the cathode ray tube was displaced in relation to the controlling electric signals produced by a special scanning circuit. The image of the light spot on the photograph was uniformly displaced across the photograph from one side to the other, after which it quickly returned to the initial position and again continued with steady movement across the film. This provided "line" scanning of the image. The photographic film itself was pulled slowly past the cathode ray tube, permitting "frame" scanning.

Intensity of the light which passed from the cathode ray tube through the film to the photoelectric multiplier is determined by the density of the negative at the point at which the light spot is located. In movement of the spot over the negative, the amount of current in the photoelectric multiplier changed in relation to the change in density of the image along the line; thus, an electric "image signal" was formed at the output of the photoelectric multiplier, repeating the change in density of the negative along the scanned line.

Amplification and shaping of the image signals were accomplished by a specially developed, stabilized, narrow-band amplifier.

Since the average density of the negative and image contrast were not known exactly beforehand, a device was incorporated in the amplifier for automatic regulation of compensation to counteract the effect of variation in the average density of the negative on the output signal. Automatic brightness regulation of the illuminating tube, to compensate for changes in contrast, was also provided.

Test sings were exposed on the film, a part of which were developed while still on the Earth, and the other part of the sings were developed aboard the station in the course of processing the exposed frames with the back image of the Moon. These signs were transmitted to the Earth, permitting control of the process of photographing, processing, and transmitting the image.

Transmission of the image was possible in two variants: at a slower rate of transmission at great distances and at a faster rate of transmission at closer ranges, i.e., during the satellite approach to the Earth.

The number of lines into which the image was broken up could be varied, depending on the variant selected for the transmission. The maximum number of lines would reach 1,000 per frame.

A method assuring high-noise immunity and reliability of performance of equipment was used to synchronize the transmitting and receiving scanning devices.

The radio-communication line provided a two-way transmission of radio signals. In the "Automatic Interplanetary Station-Earth" direction were transmitted television signals, the signals of scientific instrument readings, and the signals for measuring the parameters of motion of the satellite station. Powerful radio transmitters, high-sensitivity receivers, and recording instruments, as well as the receiving and transmitting antenna assemblies, were part of the ground installation. Transmitting, receiving, and antenna equipment, as well as the command and programming radio-engineering devices, were part of the automatic interplanetary radio station.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

The Moon-image was transmitted from the automatic interplanetary station via the line of radio communication, which also served to measure the parameters of the station motion.

The transmission of the Moon-image, and all other functions of the line in radio communication with the station, were carried out with the aid of continuous radiation of radio waves (as contrasted with pulsed radiation). Such a combination of functions in a single line of radio communication utilizing continuous radiation was tried out for the first time and provided reliable radio communication up to the maximum distances with the lowest power consumption from the power sources on board.

All of the radio-communication line equipment, both aboard the interplanetary station and on the ground posts, was provided in duplicate to improve the reliability of communications. In case of failure of one of the radio instruments aboard the station or upon reaching the limits of its usefulness, it can be replaced by a reserve instrument by transmitting an appropriate command from the ground control post.

The total volume of scientific information transmitted via the radio communication line, including the frames of the Moon-image, considerably exceeded the volume of information transmitted from the first and second Soviet cosmic rockets. This required the application of more efficient methods to secure photographs and to transmit the signals via the radio communication line. These methods assured lowest power consumption from the power sources.

Semiconductors, ferrites, and other modern components and materials were used in the radio equipment on board. Special attention was given to securing the least space for and weight of the instruments, which, in turn, permitted the increase of the weight and space assigned to the electric power sources.

To conserve electric power, the power radiated by the satellite radio transmitter was set at several watts.

The difficulties of maintaining a reliable radio contact with an interplanetary automatic station can be realized if we calculate what fraction of the power radiated by the satellite radio transmitter will reach the receiving ground installation.

In order that the radio contract with the satellite station would not be interrupted during its rotation, the station antennas had to radiate the radio signals uniformly in all directions, so that the radiation power per unit of area would be approximately equal at all the points of an imaginary sphere, at the center of which is located the satellite station.

The fraction of radiated power reaching the ground receiving antenna is determined by the ratio of the effective area of the receiving antenna to that of the surface of a sphere with radius equal to the distance from the satellite station to the receiving ground post. Large receiving antennas are used to increase the effective area of such antennas for efficient reception of signals from the satellite station.

However, even under the above-mentioned conditions, in the case of the greatest distance from the Earth to the satellite station, the intercepted radiation signal from the satellite transmitter will be 100 million times smaller than the average power received by a conventional television receiver. The perception of such a weak signal can be accomplished only by a very sensitive receiving installation with a very low level of set noises.

The set noises at the output of the ground receiving installation were reduced to a minimum with the aid of special measures.

In accordance with the postulates of information theory and the theory of noise immunity, the reception of rather weak signals with a noise background can be secured by lowering the rate of information transmission. The degree of lowering of rate of information transmission depends on the selected method of transmission and reception of radio signals.

In the radio-communication line, such methods of processing and transmission of signals at the satellite station and at the ground receiving post were used which, to an utmost degree, have lowered the noise level and, at the same time, maintained a satisfactory rate of transmission.

Economic utilization of power sources on the satellite station, availability of radio communication line with continuous radiation and performing several functions, use of special receiving antennas at the ground post, use of highly sensitive receiving installations, and utilization of special methods for processing and transmission of signals -- all contributed toward the maintenance of reliable radio communication with the automatic interplanetary station, an uninterrupted operation of command radio line, and planned photographing of the Moon and telemetered information.

The reception of Moon-image signals on the ground was carried out with special devices for registering the television images on a film, with magnetic recording devices having very uniform speed of the magnetic tape with skiatrons (long persistance cathode-ray tubes), and with open-recording devices where the image is recorded on an electro-chemical paper. The data thus secured from all kinds of recording were used to study the far side of the Moon.

The transmission of images was carried out for various distances up to 470,000 kilometers with the aid of radio-television equipment installed on the automatic interplanetary station. Thus, the possibility of transmission in cosmic space over extra-great distances of the half-tone images with high resolution and without appreciable distortions in the course of radiowave propagation was confirmed experimentally.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

IV. INVISIBLE SIDE OF THE MOON

The period of rotation of the Moon about its own axis coincides with the period of its revolution about the Earth, and for that reason, one and the same side of the Moon is always turned toward the earth. In the distant past, millions of years ago, the Moon rotated about its own axis faster than now, completing one rotation in a few hours.

The forces of affluent friction, arising by the attraction of the Sun and Earth, braked the Moon, lengthening the period of its rotation about its axis to 27.32 hours.

During the course of 350 years of telescopic observations, maps were made of the side of the Moon turned to us. Beginning with the first representations of the lunar surface, these maps continually became more exact and were supplemented according to the degree of existing means and methods of observation. At the present time, maps exist on which are plotted tens of thousands of circular mountains which are craters, numerous mountain ridges, dark regions of lunar soil called seas, apparent fissures, and many other details of the lunar surface.

The occurrence of the so-called librations of the Moon that is, the periodic oscillations of the Moon about its center, permits the terrestrial observer to investigate and plot 59 percent of the lunar surface on a map. Certain lunar forms situated on the very edge of the visual disc become visible only during appropriate librations of the Moon. The drifting of all these circular regions on maps is caused by perspective distortions.

The selection of the time for photographing by the automatic interplanetary station enables us to obtain photographs of the extensive portion of the lunar surface not visible from the Earth and of a smaller region with already known formations. During this time, almost the entire Sun-illuminated-disk of the Moon was rotated toward the station. In similar conditions of illumination of the lunar surface, its formations do not give shadows, and several details are made less conspicuous. The presence on the photographs of part of the never-before-studied portion of the Moon permitted objects located on the far side of the moon to be tied into already known formations and, in this manner, a determination of their selenographic coordinates. On the photographs, the boundary between visual and nonvisual portions of the Moon from the Earth is designated by a dotted line.

Among the objects photographed from the rim of the interplanetary station and visible from the Earth are the Humboldt Sea, the Sea of Crises, the Marginal Sea, the Smyth Sea, a portion of the Southern Sea, and others.

These seas, distributed on the very edge of the Moon and visible from the Earth, appear long and narrow to us as a result of perspective distortion. Their actual form has not yet been determined. These seas are located far from the visual edge of the Moon on the photographs obtained from the rim of the interplanetary station, and their form is insignificantly affected by perspective distortion.

On the basis of a preliminary study, of the photographs obtained, it is possible to report that there are few mountainous regions and seas similar to the seas of the visual portion on the far side of the Moon. Abruptly, there appear crater seas lying in the southern and priequatorial regions.

Regarding the seas located close to the edge of the visible portion, the Humboldt, Marginal, Smyth, and Southern seas are clearly discernible almost without distortion. It was found that the Southern Sea, for the most part, is located on the far side of the Moon and that its boundaries have nonstraight, meandering form.

The Smyth Sea, in comparison with the Southern Sea, has a more circular form, and its southern side is notched by a mountainous region. The Smyth Sea, for the most part, is also located on the nonvisible side of the Moon. The Marginal Sea has a drawn-out form with an indentation in a direction opposite from the Sea of Crises. The Smyth Sea also continues on the far side of the Moon. The Humboldt Sea has a peculiar pear-shaped form.

The entire region adjoining the western edge of the far side of the Moon is characterized by a reflecting power intermediate between those of mountainous regions and seas. According to reflecting power, it is analogous to the region of the Moon located between the craters of Tycho and Petavius and the Nectaris Sea.

South-southeast from the Humboldt Sea, on the boundary of the indicated region, a mountain chain with an extent of more than 2,000 kilometers passes over the equator and reaches into the southern hemisphere. Beyond the mountain chain stretches, apparently, a continental shelf with a higher reflecting power.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

A crater sea with a diameter of approximately 300 kilometers is located in the region bounded by coordinates of +20 and +30 degrees latitude and plus 140 and plus 160 degrees longitude. The southern portion of this sea terminates in a gulf. A large crater with a diameter of more than 100 kilometers, having a dark bottom and bright central peak, encircled by an extensive light embankment, is located in the southern hemisphere, in the region having minus 30 degrees latitude and plus 130 degrees longitude.

A group of four craters of medium dimensions is located in the proximity of the above-mentioned chain in the direction of the Marginal Sea at plus 30 degrees north latitude. The largest of these craters has a diameter of approximately 70 kilometers. A detached crater of circular form is located close to this group in the region with coordinates plus 10 degrees latitude and plus 110 degrees longitude. Two regions with a sharply reduced reflecting power are located in the southern hemisphere at the edge of the disk.

In addition, individual regions with a slightly increased and reduced reflecting power and numerous minute details are to be found on the photographs. The nature of these details, their forms and dimensions, will be established after a more complete study of these photographs.

Thus the fact that it was possible for the first time to televise pictures of the nonvisible portion of the lunar surface from on board the interplanetary station opens wide possibilities for study of the planets of our solar system.

[Figures and Figure Captions Follow:]

[Figure 1 (photograph) not reproduced here.]

Figure 1. The automatic Interplanetary Station on Assembly Stand.

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

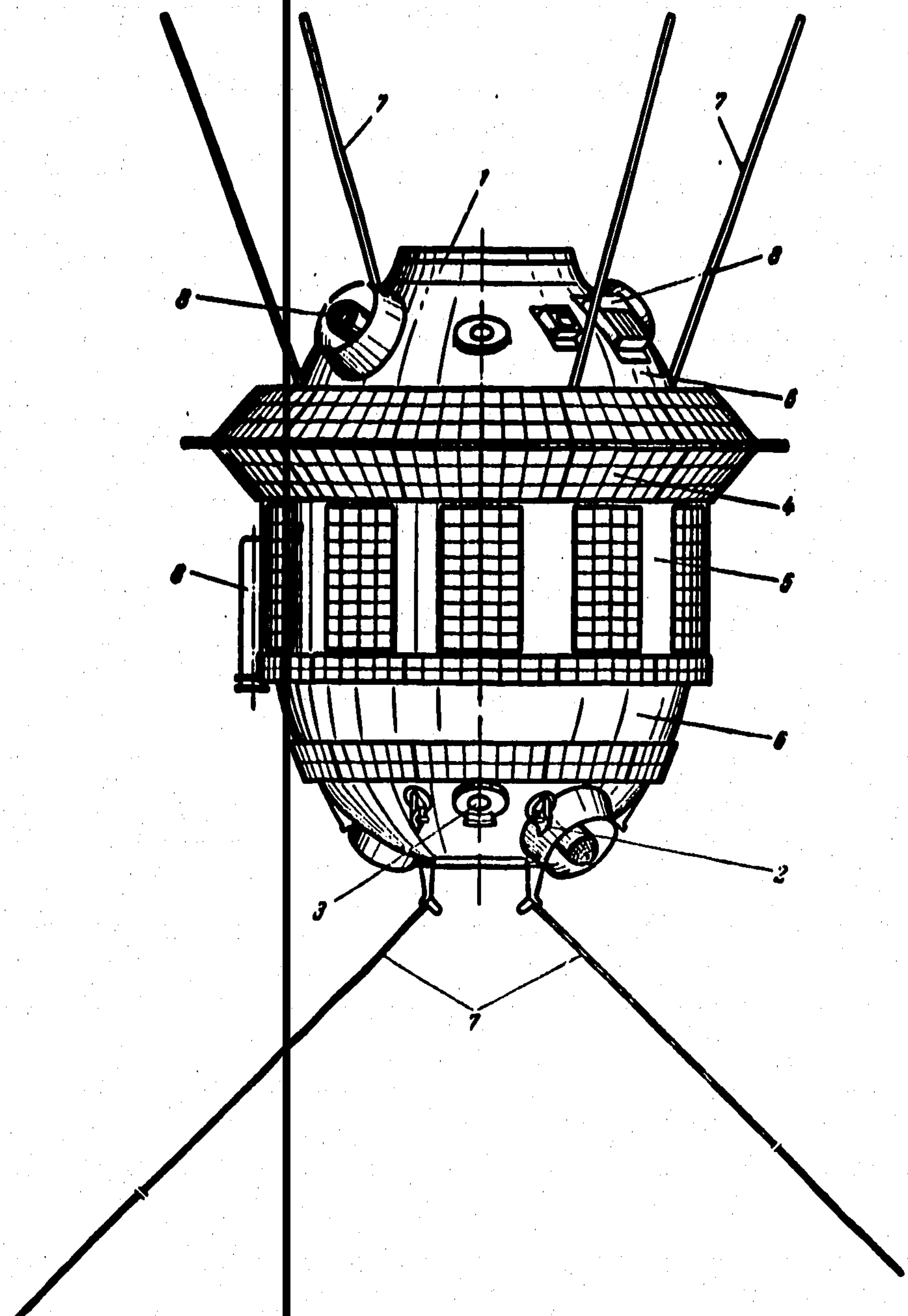

Figure 2. General View of the Automatic Interplanetary Station (diagram) (1) illuminator for photographic equipment; (2) motor of the orientation system; (3) solar transducer; (4) solar battery sections; (5) jalousies of the heat regulation system; (6) thermal shields; (7) antennas; and (8) instruments for scientific investigations.

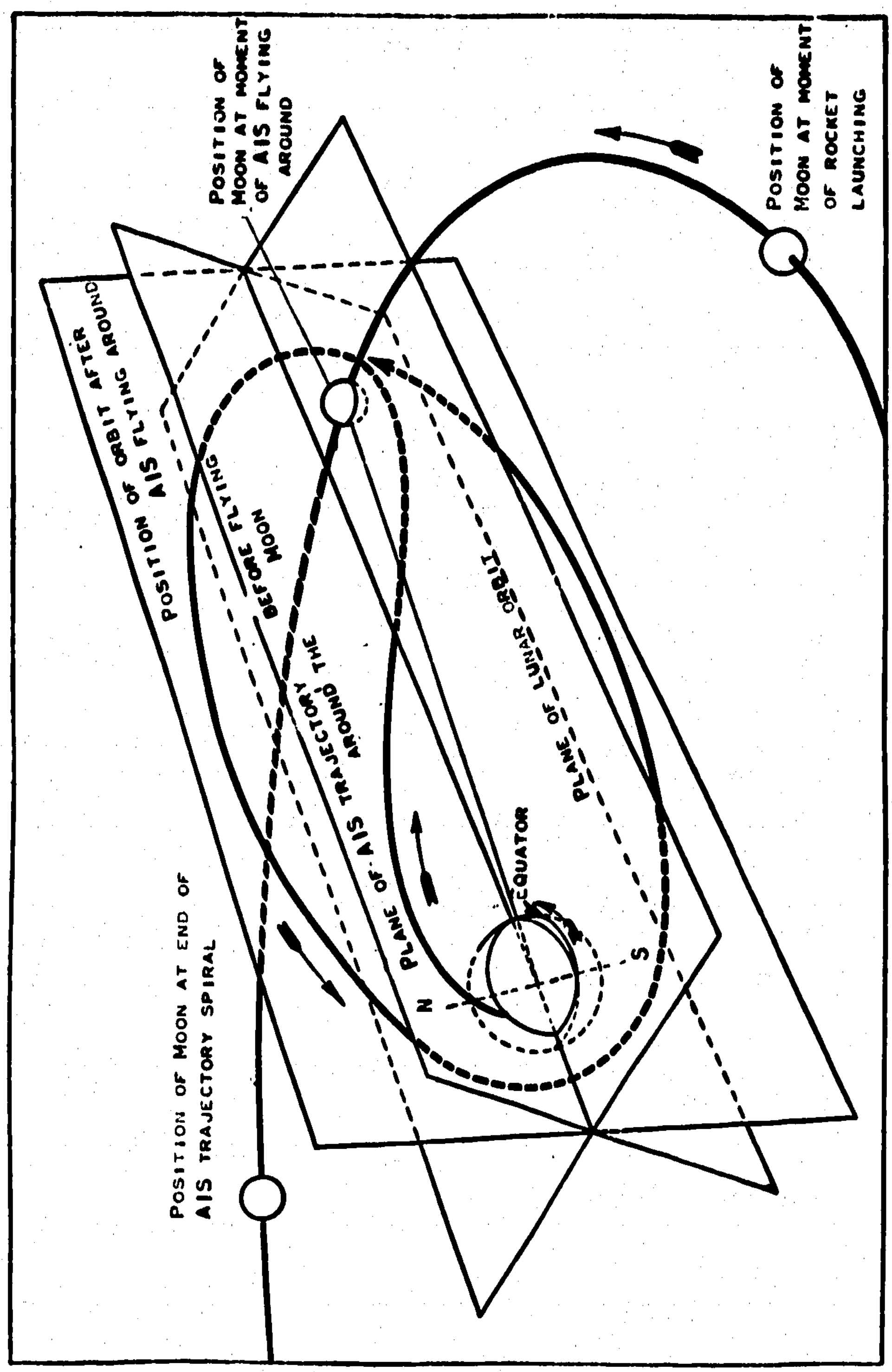

Figure 3. Diagram of the Flight Trajectory of the Automatic Interplanetary Station

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5

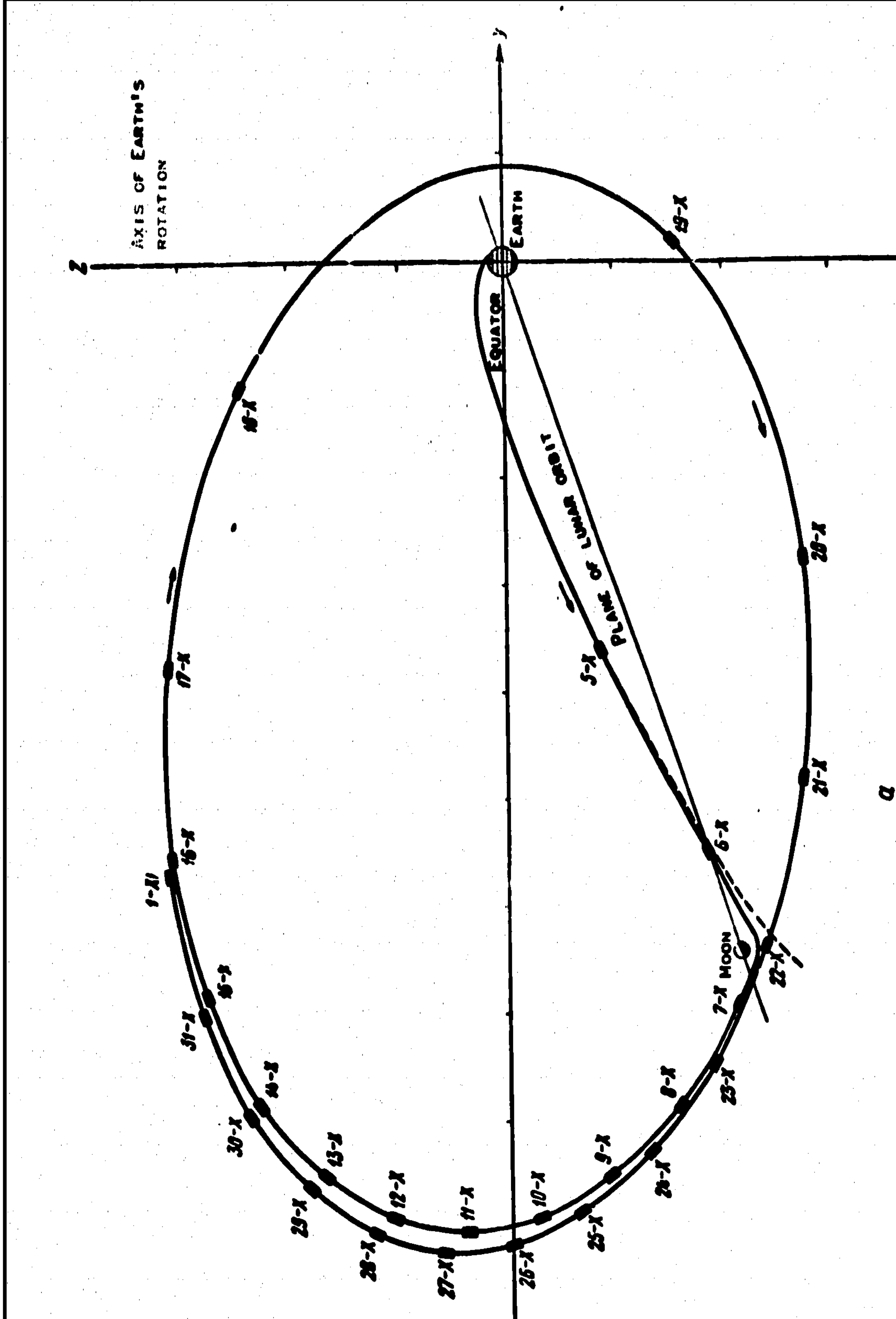

Figure 4. Flight Trajectory of Automatic Interplanetary Station
(a) view from the side of the vernal equinox

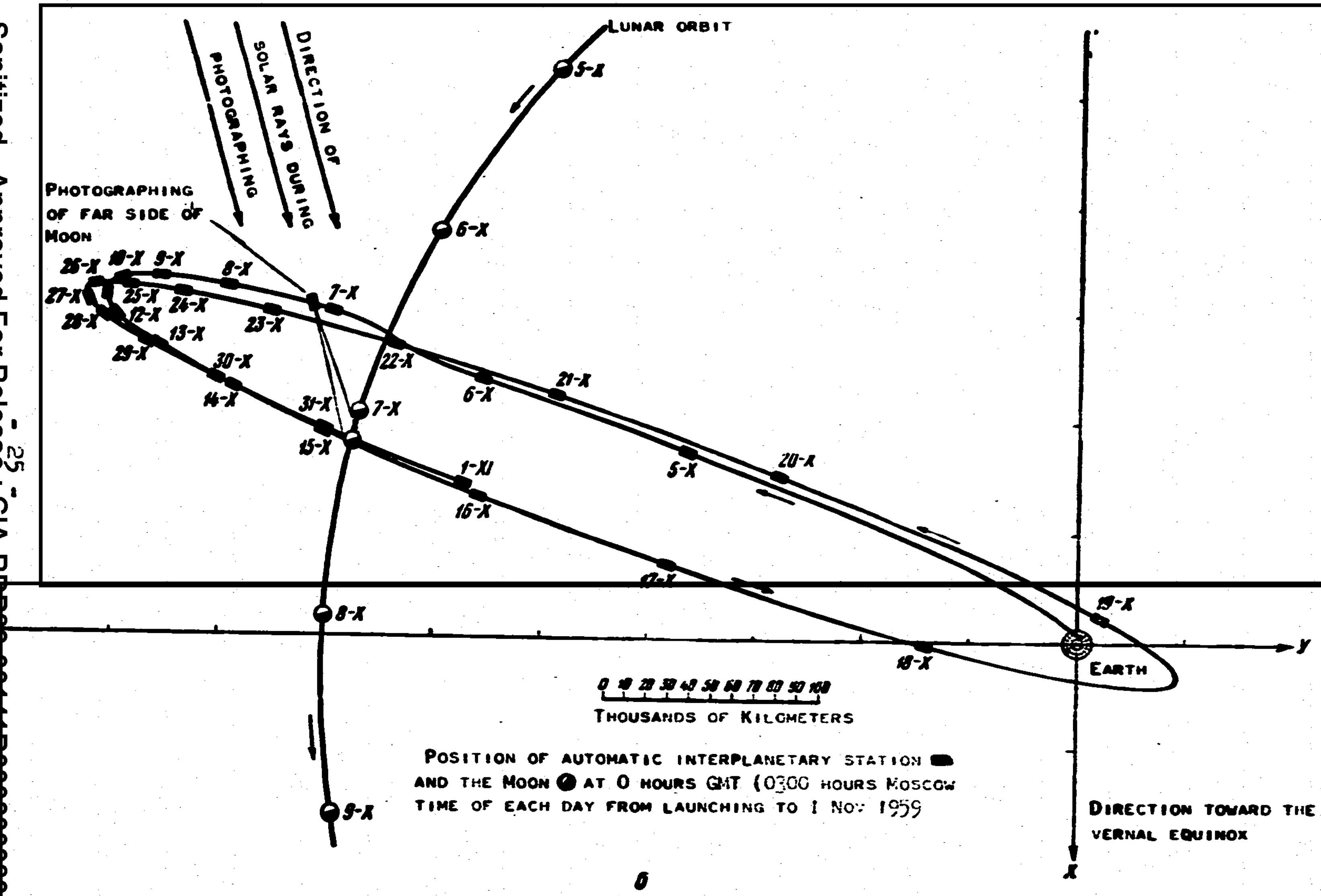

Figure 4. Flight Trajectory of Automatic Interplanetary Station
(b) projection on the plane of the Earth's equator

[Figures 5 (drawing), 6, 7, and 8 (photographs not reproduced here.]

Figure 5. Position of the Automatic Interplanetary Station in Space During Photographing of the Far Side of the Moon (arrows on the right indicate the direction of the Sun's rays).

Figure 6. Photograph of the Far Side of the Moon Taken From on Board the Automatic Interplanetary Station.

Figure 7. Photograph of the Far Side of the Moon Taken From the Automatic Interplanetary Station.

Figure 8. Distribution of objects on the side of the Moon not visible from Earth which appeared in the preliminary processing of photographs taken from on board the automatic interplanetary station.

(1) large crater sea with a diameter of 300 kilometers, Sea of Moscow; (2) Bay of Astronauts in the Sea of Moscow; (3) Continuation of the Southern Sea on the back side of the Moon; (4) crater with central peak, Tsiolkovskiy; (5) crater with central peak, Lomonosov; (6) crater, Juliot Curie; (7) Mountain range, Sovetskiy; (8) Sea of Mechta.

The continuous line intersecting the diagram is the lunar equator; the dotted line is the boundary of the visible and invisible parts of the Moon from the Earth. Objects satisfactorily established during the preliminary processing are connected by an unbroken line; objects requiring better definition of shape are joined by the broken line; objects, the classification of which has been more accurately defined, are surrounded by dots; in the remaining part, further processing of the photomaterials obtained is being made.

Roman numerals denote objects on the visible side of the Moon: (I) Humboldt Sea; (II) Sea of Crises; (III) Marginal Sea, which continues on the invisible part of the Moon; (IV) Sea of Waves; (V) Smyth Sea, which continues on the invisible side of the Moon; (VI) Sea of Fertility; (VII) Southern Sea, which continues on the invisible part of the Moon.

* * *

Sanitized - Approved For Release : CIA-RDP82-00141R000200980001-5