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A BRIEF DESCRIPTION OF THE BRAZILIAN SATELLITES

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14. Abstract/Notes

This paper describes the first Brazilian experimental satellites, based on the results of the preliminary studies phase. The satellites will have environmental data restransmission and remote sensing as applications, and are scheduled for launch in 1989-1992.

15. Remarks

Presented at the Regional Meeting of Latin American Users of Remote Sensing Satellites, São José dos Campos, November 30 - December 2, 1981.

RESUMO

Este relatório descreve os primeiros satélites experimentais brasileiros, baseado nos resultados da fase de estudos preliminares. Os satélites terão como aplicações a retransmissão de dados ambientes e o sensoriamento remoto, e estão programados para lançamentos em 1989-1992.

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1. INTRODUCTION

This paper contains a brief description of the first four Brazilian experimental satellites, based on the results of the preliminary studies phase. The satellites will have environmental data retransmission and remote sensing as applications, and are scheduled for launch in 1989-1992. Although the missions were defined on the basis of Brazilian needs and priorities, it is clear that use of the satellites in the framework of international cooperative programs presents interesting possibilities. Technical requirements for operation beyond the minimum Brazilian coverage (such as additional on-board power generation and storage) must be analyzed in each case, but are not likely to present insurmountable difficulties.

2. THE ENVIRONMENTAL DATA COLLECTING SATELLITES

The first two satellites will have a relatively simple mission, namely retransmiting to Earth environmental data collected and transmitted to the satellites by automatic data-collecting platforms (DCPs) similar to those used in the ARGOS system. The applications envisaged for this mission are mainly in meteorology and hydrology. Each satellite will carry a transponder capable of receiving data packets in UHF and retransmitting them in S-band to one or two earth stations. On-board storage and processing of the data are not contemplated in the present design. In order to obtain good recurrent coverage of Brazil, an approximately circular orbit at 700-800 km altitude, with 20-25 degrees of inclination, has been specified for this mission.

The satellites have the shape of an octogonal prism (Figure 1), with solar cell arrays covering the sides and most of the top base (not shown in Figure 1). The cylindrical UHF and S-band antennas protrude from the base of the spacecraft which remains pointed towards the earth. Sufficient attitude stabilization for telecommunication purposes is obtained by the action of the gravity gradient on the pair formed by the satellite proper and a small mass placed at the tip of an extendable boom (deployed in orbit), which tends to remain aligned with the vertical. Figure 2 shows the spacecraft mounted on the rocket, prior do launch.

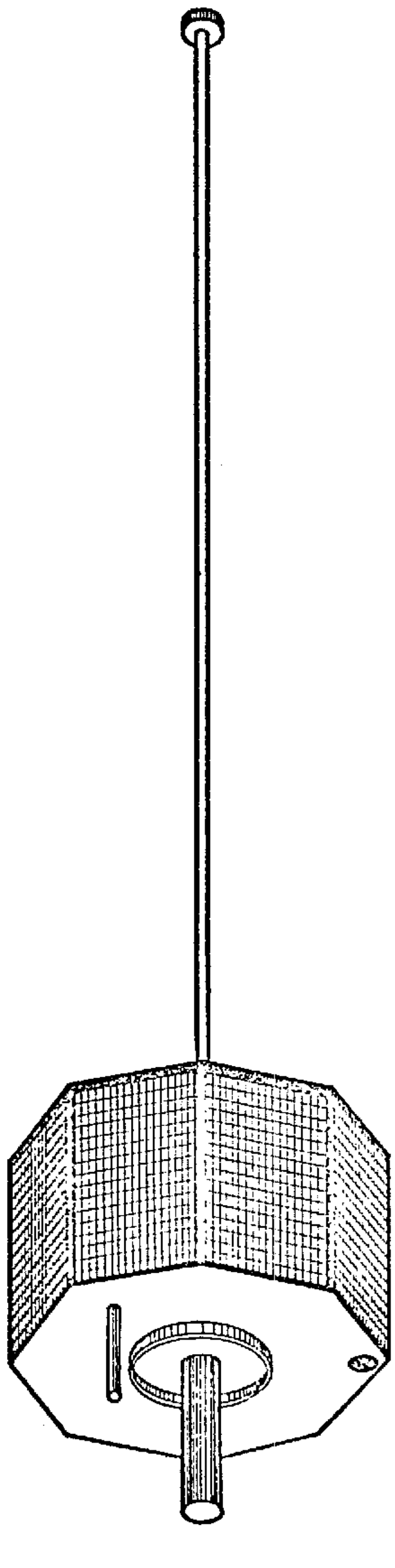

Fig. 1 - The Environmental Data Collecting Satellite in orbit.

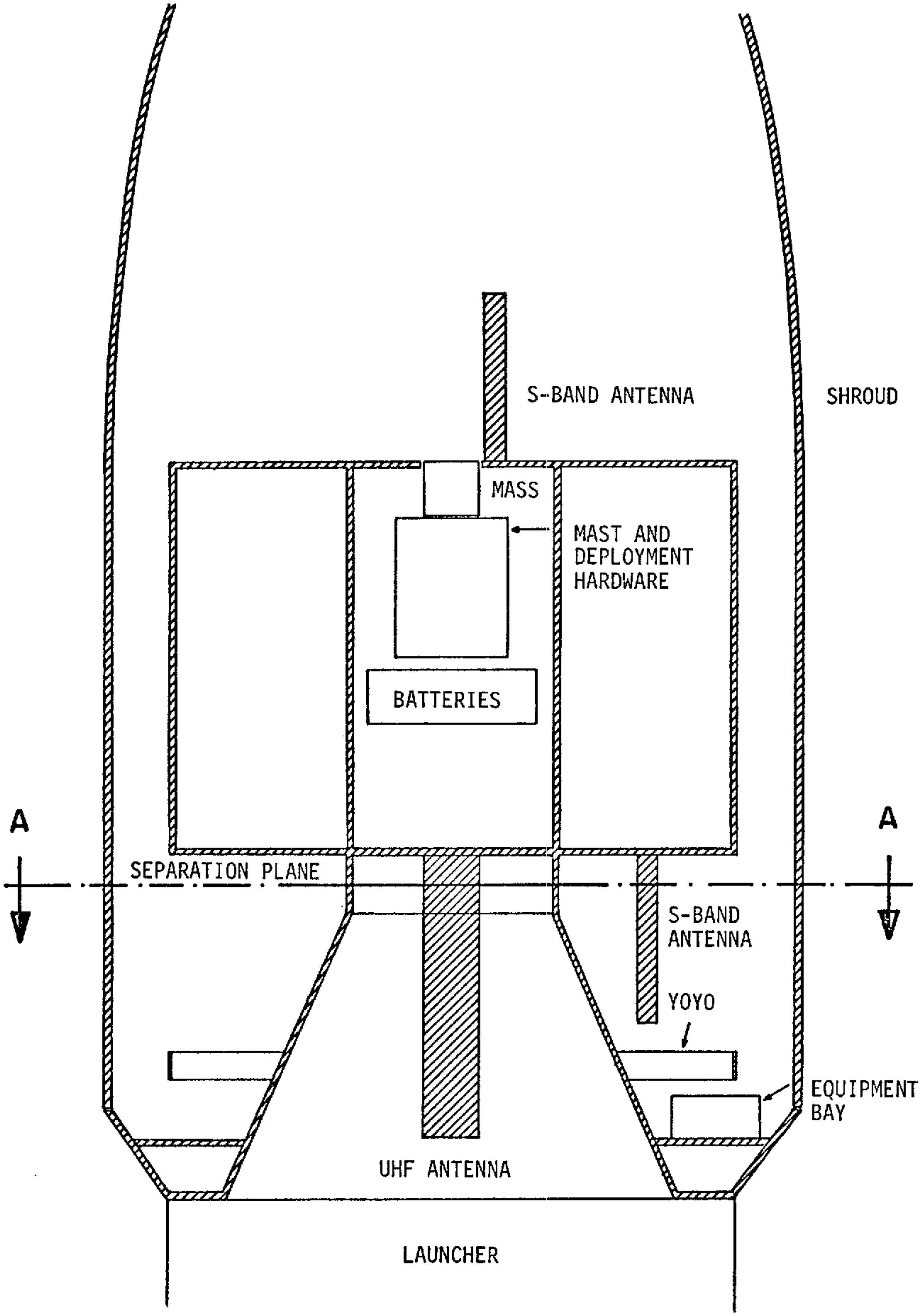

Fig. 2 - The Environmental Data Collecting Satellite ready for launch

The exploded view of the structure of the environmental data collecting satellite (Figure 3) shows the five internal panels (four plates and one cylinder) that support all the equipment boxes and hold the spacecraft together. The side panels and the top and bottom surfaces are more fragile elements supporting only solar cells and attitude-sensing devices.

A block diagram of the satellite, showing the subsystems that carry out housekeeping and mission-related functions, is presented in Figure 4.

3. THE REMOTE SENSING SATELLITES

The Brazilian space program has plans for placing two remote sensing satellites in orbit approximately two years after the launch of the environmental data collecting satellites. The remote sensing satellites will have roughly the same size and shape as their predecessors, with more mass. Their technological complexity is much greater, inasmuch as sophisticated optics, sensors, and data handling electronics, as well as accurate attitude and orbit control, are required for the remote sensing mission. Although most subsystems will have greater capacity than in the first two satellites, the functional block diagram remains similar to the one shown in Figure 4, with the remote sensing payload replacing the DCP transponder, and the new propulsion and control subsystem replacing the gravity-gradient stabilizer.

The basic structure of the remote sensing spacecraft is shown in Figure 5. The solar panels are deployed in orbit. During the launch phase they are folded onto the sides of the satellite (also see Figure 6). After deployment the solar panels can be turned toward the sun around the axis perpendicular to the plane of the orbit, so as to generate more power than would be obtainable from fixed solar panels. Figure 7 shows the motion of the solar panels at the equinoxes (late March and September).

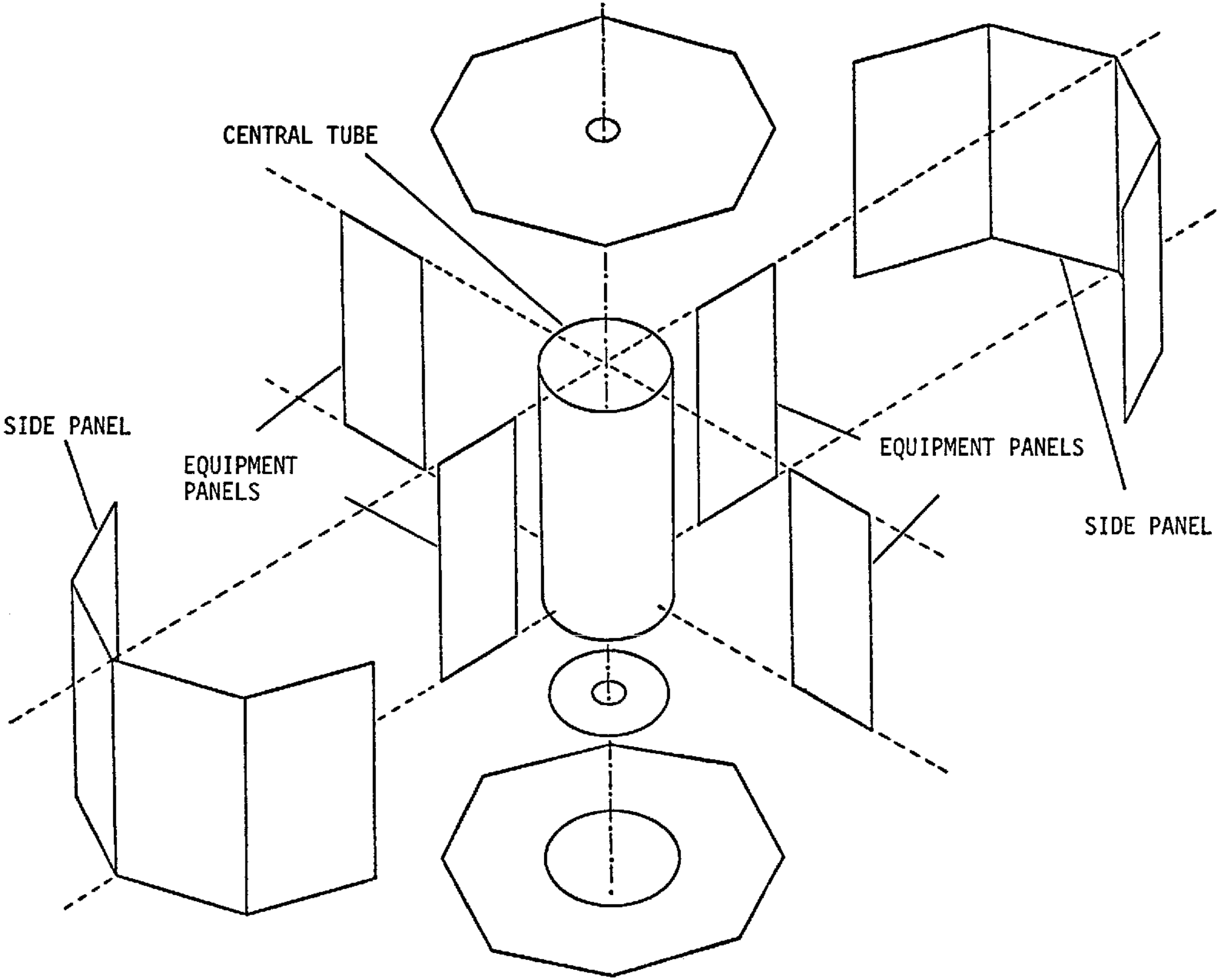

Fig. 3 - Exploded view of the structure of the Environmental Data Collecting Satellite

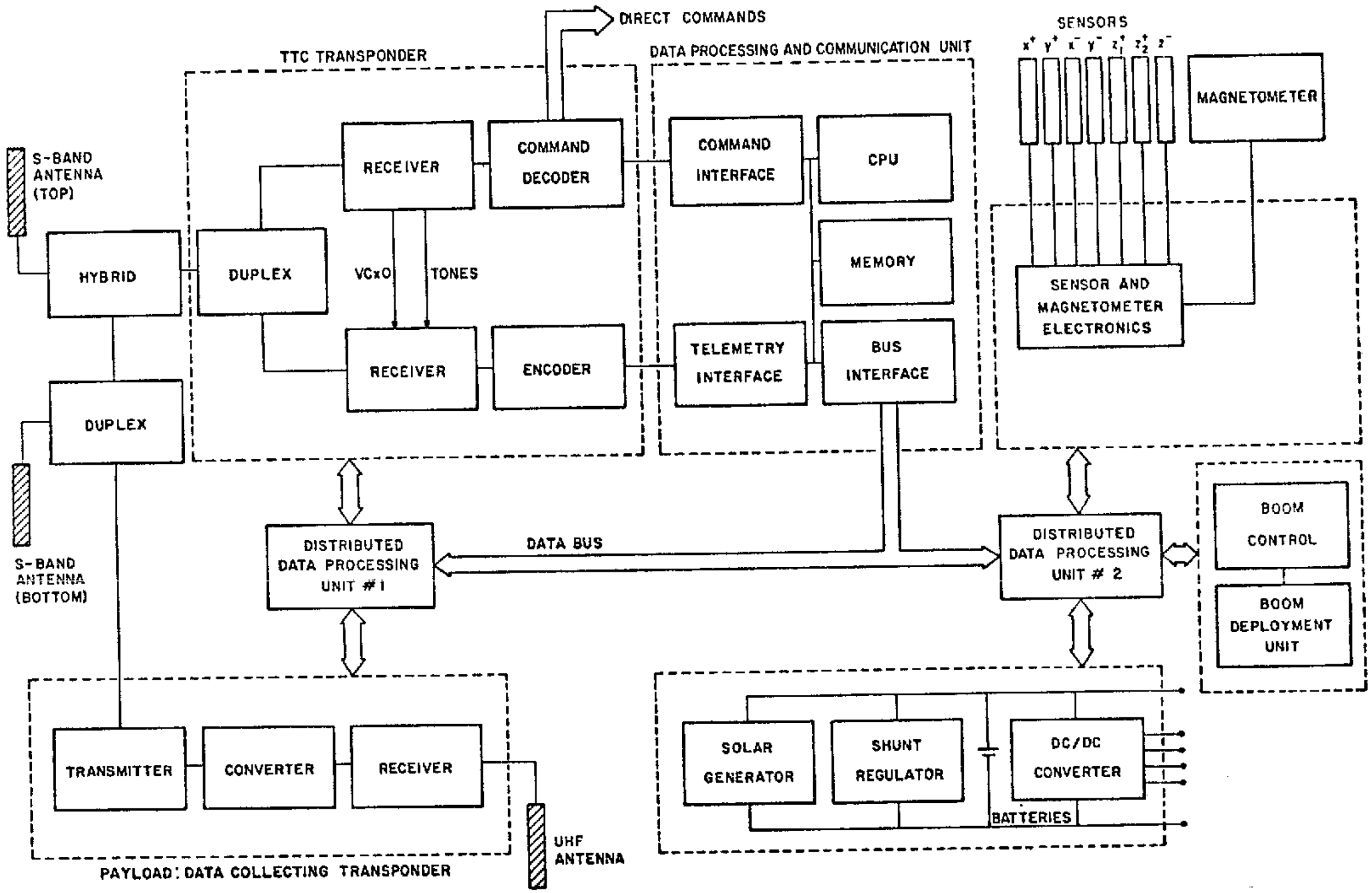

Fig. 4 - Functional block diagram of the Environmental Data Collecting Satellite

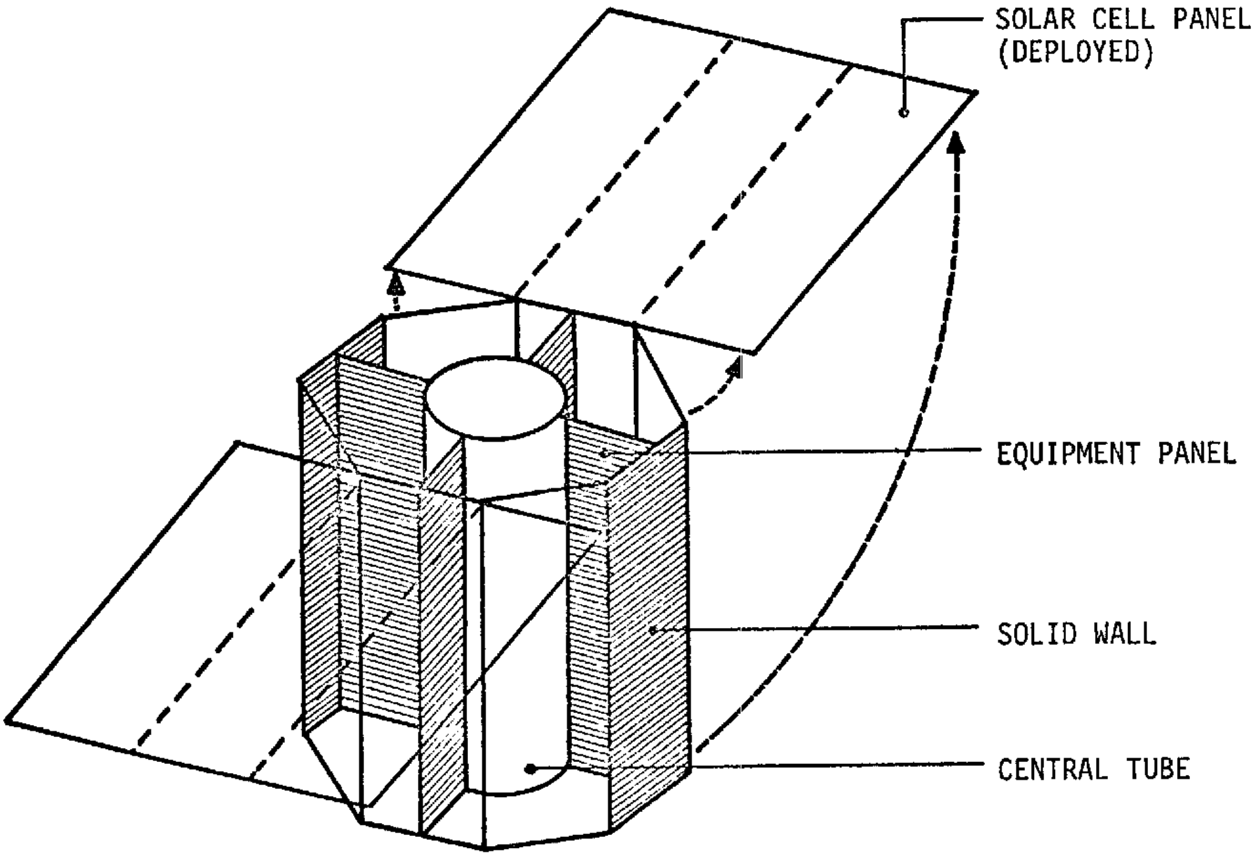

Fig. 5 - Structure of the Remote Sensing Satellite.

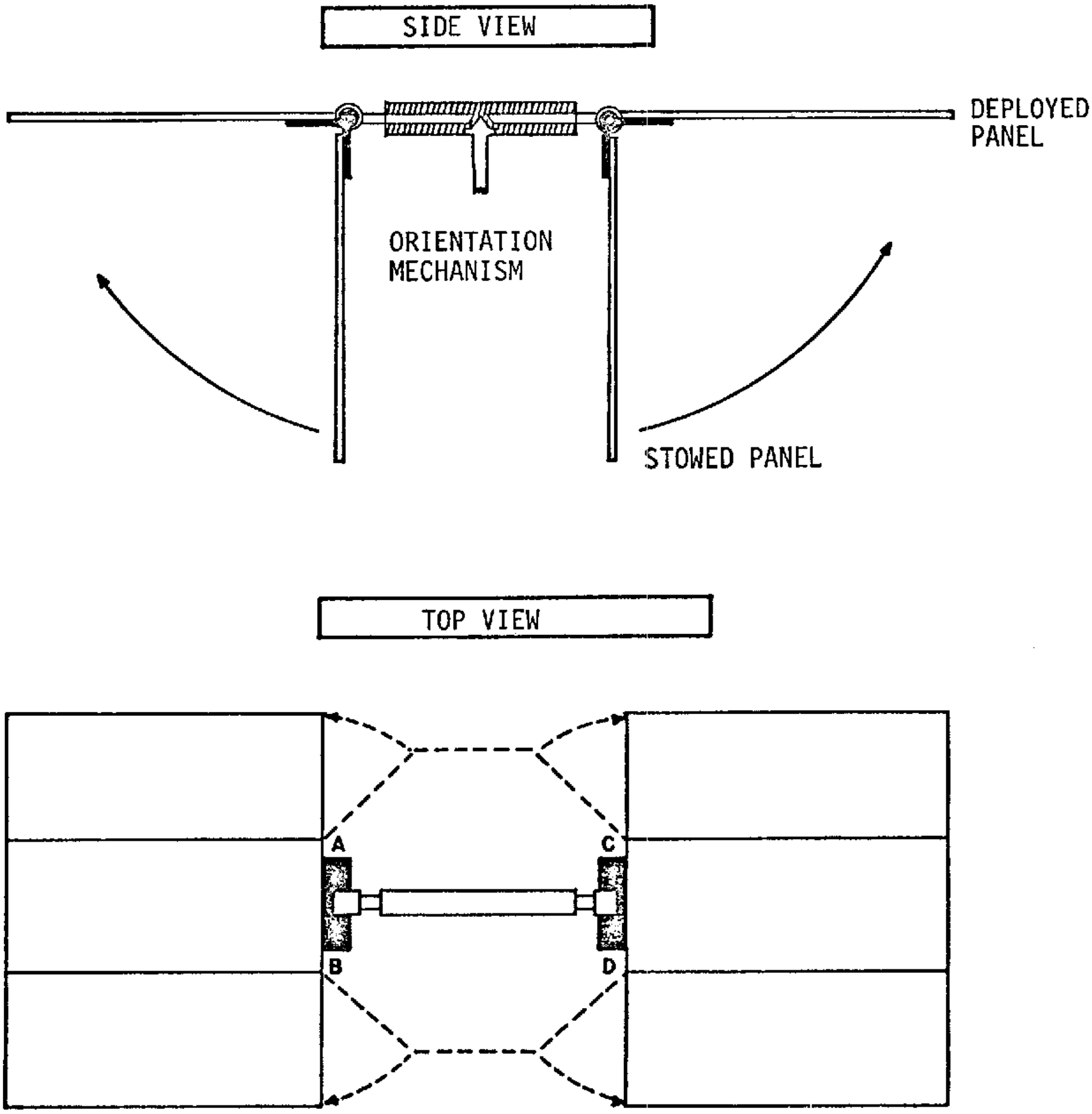

Fig. 6 - Deployable panels for solar cells.

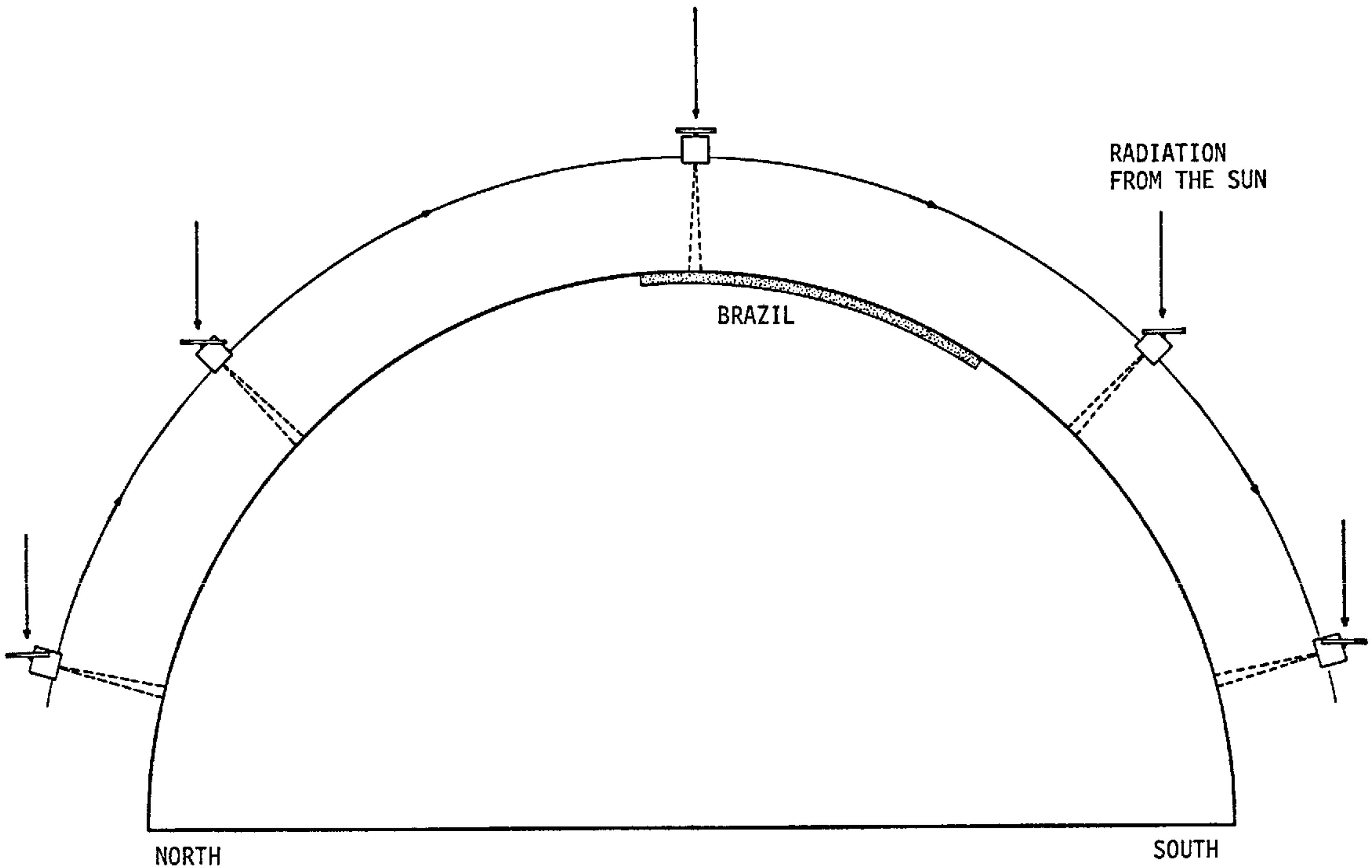

Fig. 7 - Motion of the solar panels (near equinox).

The Brazilian remote sensing satellites will be maintained in near-polar sun-synchronous (retrograde) circular orbits, similar to the orbits of LANDSAT, SPOT, etc. These orbits are also synchronized with a multiple of the period of rotation of the Earth around its own axis - 35 days in the case of the Brazilian satellites - thus ensuring repetition of coverage after that number of days. The relatively long cycle of 35 days was dictated by the narrow width of the swath of ground viewed by the satellite's sensors, which in turn has to do with the low altitude of the orbit selected (641.6 km). Table 1 summarizes the data for this orbit. Low-inclination orbits were briefly considered for the Brazilian remote sensing satellites in the early studies, but they could not provide the desired repetition of lighting conditions in the coverage of the territory.

TABLE 1

DATA FOR THE PRIMARY ORBIT

Radius	7019.76 km
Height above the equator	641.6 km
Inclination	97.95^{o}
Equatorial plane crossing local time	Noon (approx.)
Number of nodal periods per day	$14 + \frac{26}{35}$
Earth coverage repetition cycle	35 days
Time lag between adjacent swath passages	4 days
Separation between consecutive traces:	
- on the equator	2718 km
- at 30^{o} latitude	2354 km
Separation between adjacent traces:	
- on the equator	77.66 km
- at 30^{o} latitude	67.25 km

Two backup sun-synchronous orbits at lower altitudes (632.6 and 614.5 km), both with the coverage cycle of 35 days, have also been selected for use in case the launcher and the spacecraft's orbit transfer system cannot take it up to 641.6 km with an adequate amount of propellant left for attitude control.

The recurrent coverage pattern for the primary orbit is schematically represented in Figure 8. Its long coverage cycle is inconvenient for certain applications requiring more frequent observation of specific areas on the ground. This shortcoming will be circumvented on the Brazilian remote sensing satellites by means of a sensor-directing mechanism (actually a mirror) capable of slanted viewing up to a certain angle from the vertical, as illustrated in Figure 9. This expedient, which is used in the French satellite SPOT, will permit observation of selected targets with intervals not exceeding four days - naturally to the detriment of observations of other nearby areas.

The receiving earth station for the Brazilian remote sensing satellites will be located at the site presently used for reception of LANDSAT, near Cuiabá, a central point in South America. Visibility circles for the primary orbit altitude are sketched in Figure 10.

Nodal period: 1/(14 + 26/35) day = 35/516 day

Altitude: 641.605 km

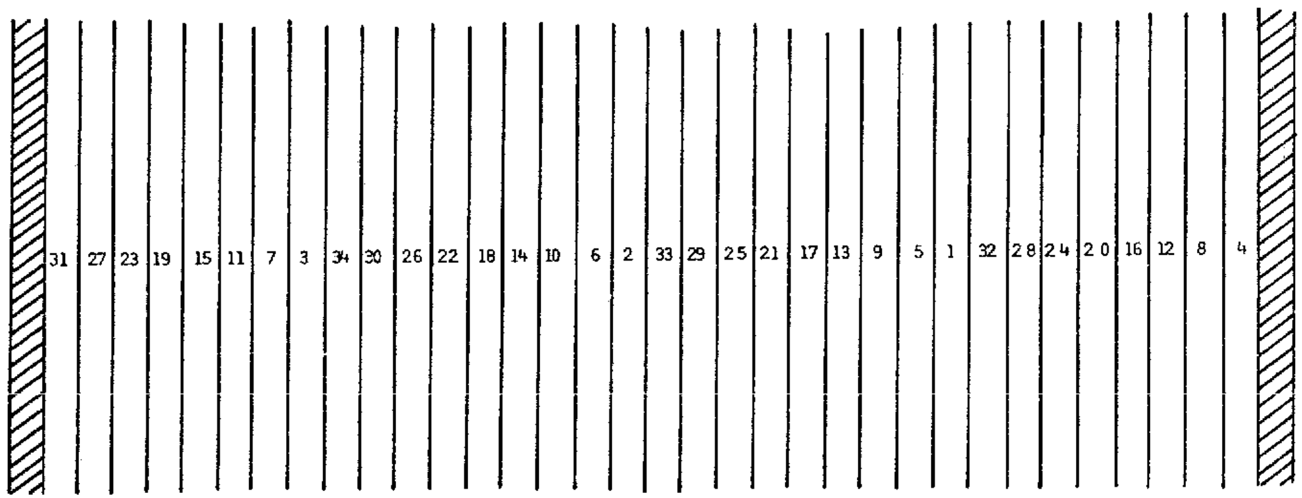

Fig. 8 - Schematic representation of the coverage pattern of the Remote Sensing Satellite.

The shaded swaths are covered on days 0 and 35.

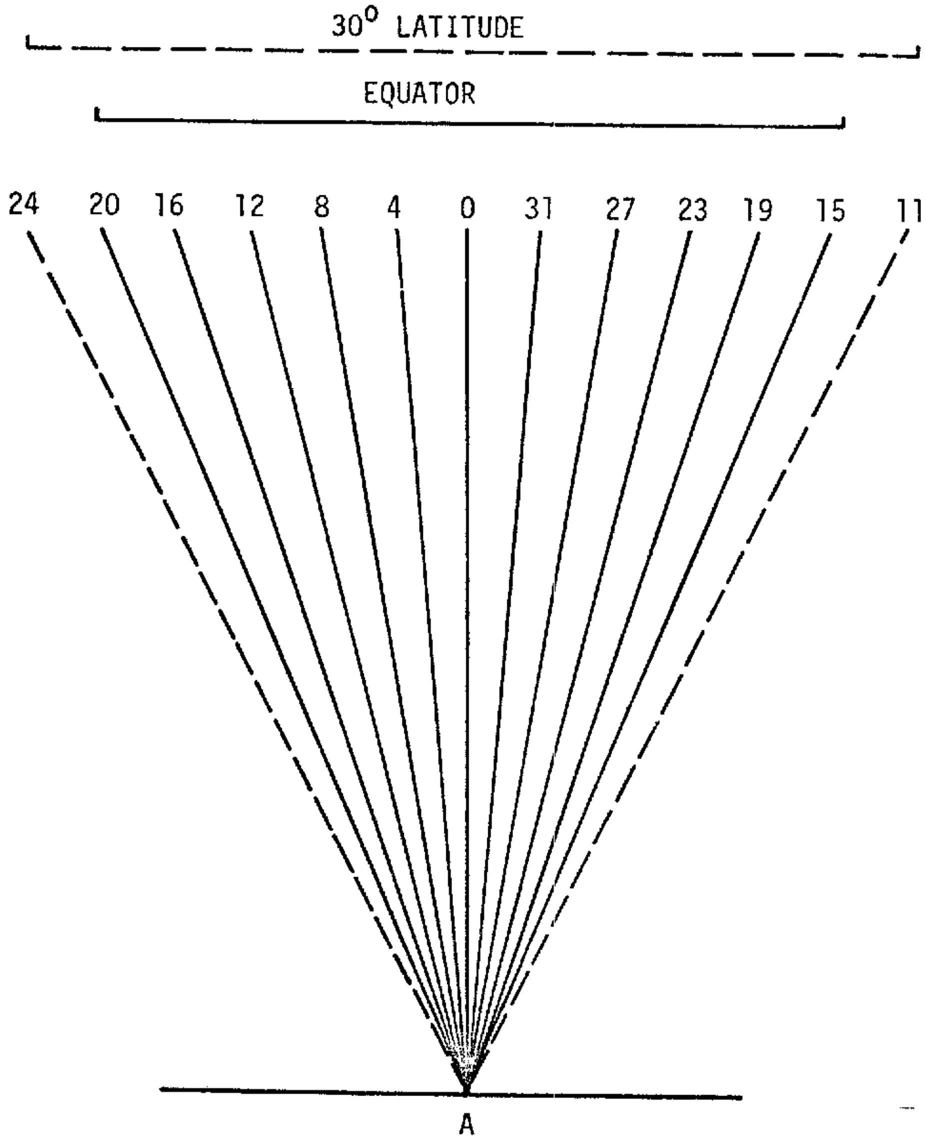

Fig. 9 - Acessibility of a remote sensing target, A, from several orbital passes.

Each pass is labeled by the number of days lapsed after the zenith pass on day 0 (refer to Fig. 8).

Fig. 10 - Visibility circles for the Remote Sensing Satellite from the Cuiabá earth station with minimum elevation angles of 0^{o}, 3^{o}, and 5^{o}.

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