NASA TECHNICAL TRANSLATION

BRIEF DESCRIPTION OF DOCKING DEVICE OF "SOYUZ"-TYPE SPACECRAFT (WITH INTERNAL PASSAGEWAY)

Translation of "Kratkoye Opisaniye Stykovochnogo Ustroystva Kosmicheskikh Korabley Tipa "Soyuz" (S Vnyutrennim Perekhodom)."

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ABSTRACT. The system for docking two "Soyuz"-type spacecraft and establishing an airtight connection between them is described. The latching, sealing and undocking mechanisms are outlined in detail.

Purpose and Structure of Docking Device

The docking device is intended for multiple docking and undocking of /1* spacecraft in flight, with formation of an internal hatch-manhole to allow astronauts to move from one craft to another and transfer cargo. The device allows coupling of the craft at the last stage of docking after maneuvering and rendezvous, allowing the craft to approach one another at a set speed and in mutual positions such that the pin of the docking mechanism enters the receiving cone of the passive craft and connects with its socket after several impacts, forming the initial link between the craft.

The device consists of the "active" and "passive" docking units mounted on the docking craft; these units are made in the form of structurally and technically complete units, made and tested independently, and capable of being installed on various spacecraft. The active and passive units are made in the form of two similar designs, planned to allow possibility of their modification for docking active or passive units with one another. The docking process can be accomplished either completely automatically or with the participation of the pilots of both craft. Since there are identical sets of mechanisms on both units, some of which duplicate each other, and it is possible for the astronauts to perform some of the operations manually, the dependability of the device is increased and its range of possible uses is widened.

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*Numbers in the margin indicate pagination in the foreign text.

Each unit consists of the following basic assemblies: the housing for the unit (1), with docking collar, forming a hatch for the passageway and closed by a hatch cover; the docking mechanism (2), mounted on the hatch cover of the active unit (the hatch cover of the passive unit is a cone with a socket at its apex); mechanisms for opening and sealing the hatch cover (4); mechanisms (5) for tightening and sealing the hatch cover, located inside the docking collar; control unit (6) for automatic control of the mechanisms; systems for checking the seal (7). /2

The docking mechanism ensures damping of the impact of the craft in all possible directions of relative velocity, coupling, synchronization around all three mutually perpendicular axes and drawing together until all joints are fully tight. After the peripheral latches have been shut, sealing and locking the joints, a test is made for airtightness, the connection for the docking mechanism is broken and the hatch cover of the active unit with the docking mechanism and the hatch cover of the passive unit are opened, exposing the hatch-manhole.

Matching the joints connects the electrical lines which allow electrical communication to be established between the different systems of the craft, and especially to control the mechanisms of the docking device from the other spacecraft; two hydraulic lines are also hooked up.

Undocking is accomplished (after closing the hatch cover of the hatch-manhole) by unlocking the peripheral latches. Opening of these latches is ensured by explosive charges. A similar backup system is provided for breaking the connection in the docking mechanism.

Design (See Figures 1, 2, 3). The housing for the units is built of all-metal construction, using an aluminum alloy, and provides a flange on one side for attachment to the craft and a docking collar on the other. Inside the docking collar are mechanisms for sealing the joint. The housing contains mechanisms for opening and sealing the hatch cover. The hatch formed by the docking collar is sealed by hatch covers that are opened from inside the spacecraft.

The docking mechanism consists of a rod with a head which is inserted into the socket of the receiving cone of the passive assembly, where it is coupled on by means of two catches on the head, and an electrical drive mechanism that draws in the rod by means of a circulating-ball drive. The rod is moved gradually by the control drive; in conjunction with the movement of the rod, a lever mechanism is activated to ensure alignment around the transverse axes. The levers are linked kinematically and spread by a cam-type mechanism. Alignment around the longitudinal axes is accomplished by tightening the latches inside the service slots of the socket in the receiving cone.

The rod with its drive and guide tube is mounted in a ball joint at the /3
base of the mechanism. The ball joint allows oscillation of the drive with the rod around the transverse axes, with the system being held in the central position by means of two spring-loaded mechanisms; oscillation is also damped by two electro-mechanical shock absorbers. The shock absorber and spring-loaded mechanisms form a system of block damping that absorbs shocks in the transverse direction as well as in the relative turning of the craft after hookup. Damping is achieved by pressing the rod inward, simultaneously rotating the nut of the circulating-ball drive, compressing the coil spring and rotating the brake on the electro-mechanical shock absorber, developing the required stress during the impacts against the cone before entering the socket. After entering the socket, the principal energy of the central impact is absorbed when the rod is pressed in by sliding over a self-regulating frictional brake that exerts a regulated force on the rod. The frictional brake simultaneously serves to protect the drive mechanism.

The docking mechanism allows the spacecraft to be drawn together so that the joints match exactly; in the last stage of drawing the craft together, final alignment is performed with the aid of guide pins, the electrical connections are made, and the spring-loaded push rods used in undocking are compressed.

To undock using the docking mechanism (to make it possible to open the hatch covers next), the catches on the head are opened by drawing in their stops with a special electrical drive located in the tail of the control tube. This undocking process is backed up by withdrawing the stops in the socket

of the receiving cone, also accomplished by an electrical drive.

Mechanism for drawing together and sealing the joint. This consists of 8 locks activated by one electric drive by means of a closed flexible connector. Each lock consists of an active and passive holding device. The active holding device has an eccentric mechanism by means of which the active holding devices of one craft pull on the holding devices of the second craft, compressing two concentric rubber rings for sealing the joint and pulling together the joint halves with regulated force.

The regulated force is provided by previously compressed springs, which are each fitted with a passive holding device and which ensure compensation for irregularities in the compression of the individual locks to allow drawing them together with the aid of a single drive.

The active holding devices are in the open (not combined with the passive holding devices) position initially, before they are closed; they are held open by a stop on an eccentric shaft. When the craft begin to draw together, the stop on the eccentric shaft is pulled out and the active holding device interlocks with the passive one by means of a spring. /4

Undocking is accomplished by rotating the eccentric shaft in the opposite direction, so that the stops simultaneously disconnect all the active holding devices from the passive ones.

Explosive devices provide a backup in the undocking process.

Mechanism for opening and sealing hatch covers. This consists of a system of bolts connected by rods and operated by an electric drive, and an electric drive for opening the hatch cover, which operates the arm on which the hatch cover is mounted.

The hatch cover can be sealed and opened manually; for the purpose, the electric drives are fitted with sockets that allow them to be moved when in the inoperative state. The hatch covers can be sealed and unsealed both from inside the craft or from the other craft (i.e., from outside -- Translator's Note).

Control of all mechanisms can be accomplished either completely automatically with the aid of the automatic system located on the docking unit or on command from the astronaut's control panel. To allow automatic control and monitoring of telemetric information and to transmit the signals required for operation of the combined systems, all of the mechanisms of the units are equipped with a system of sensors that monitor the completion of all operations. Means have been provided for controlling the mechanisms of the passive unit from the active craft (using some of the electrical connections that are made when the two craft dock), as well as for the transmission of commands to perform individual operations via command radio links to both the active and passive craft.

The system for testing the air-tightness of the seal consists in checking the seal formed in the chamber after docking by measuring the pressure during the time required for determining the permissible degree of decrease in its value due to lack of a proper seal.

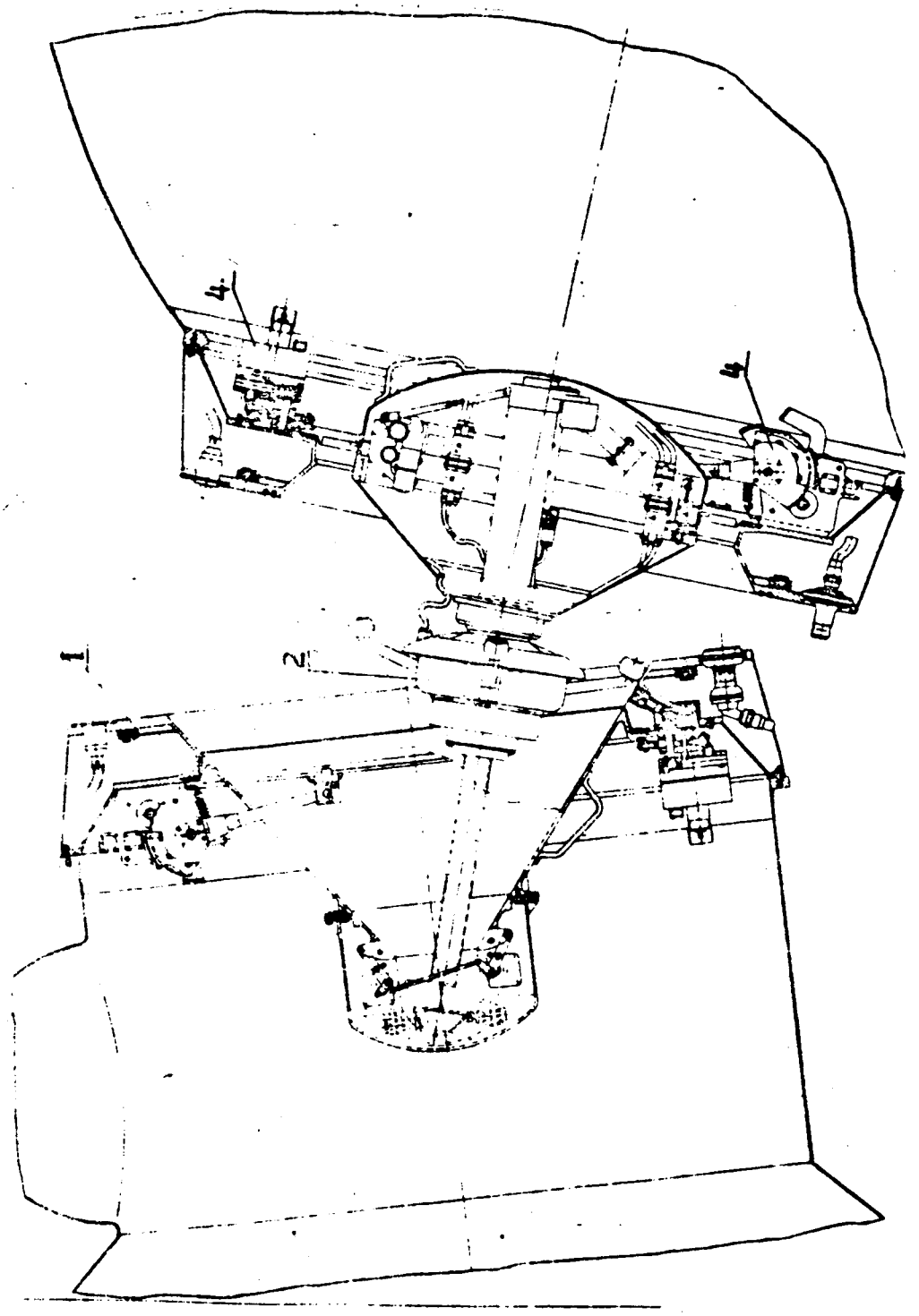

Figure 1.

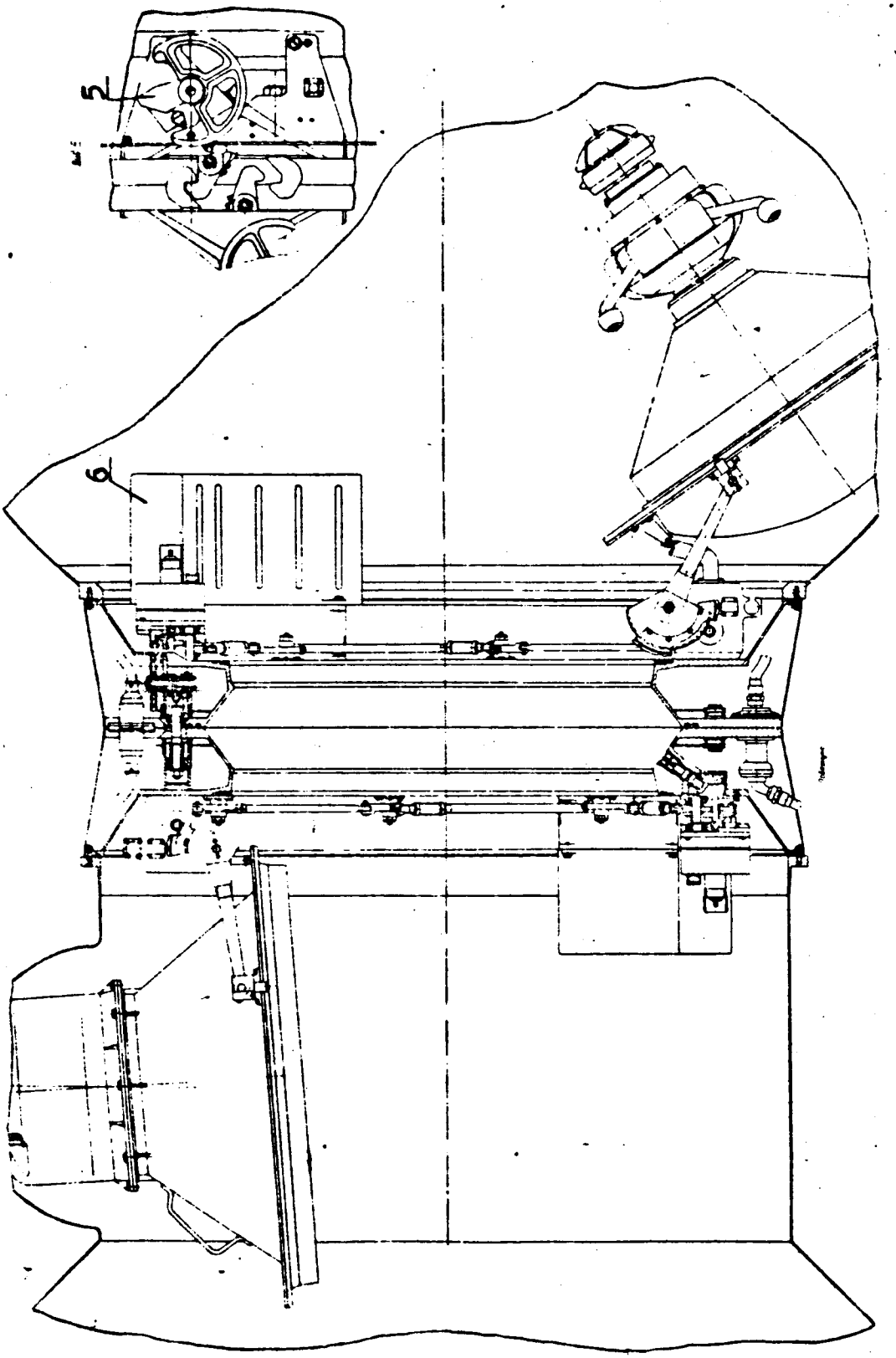

Figure 2.

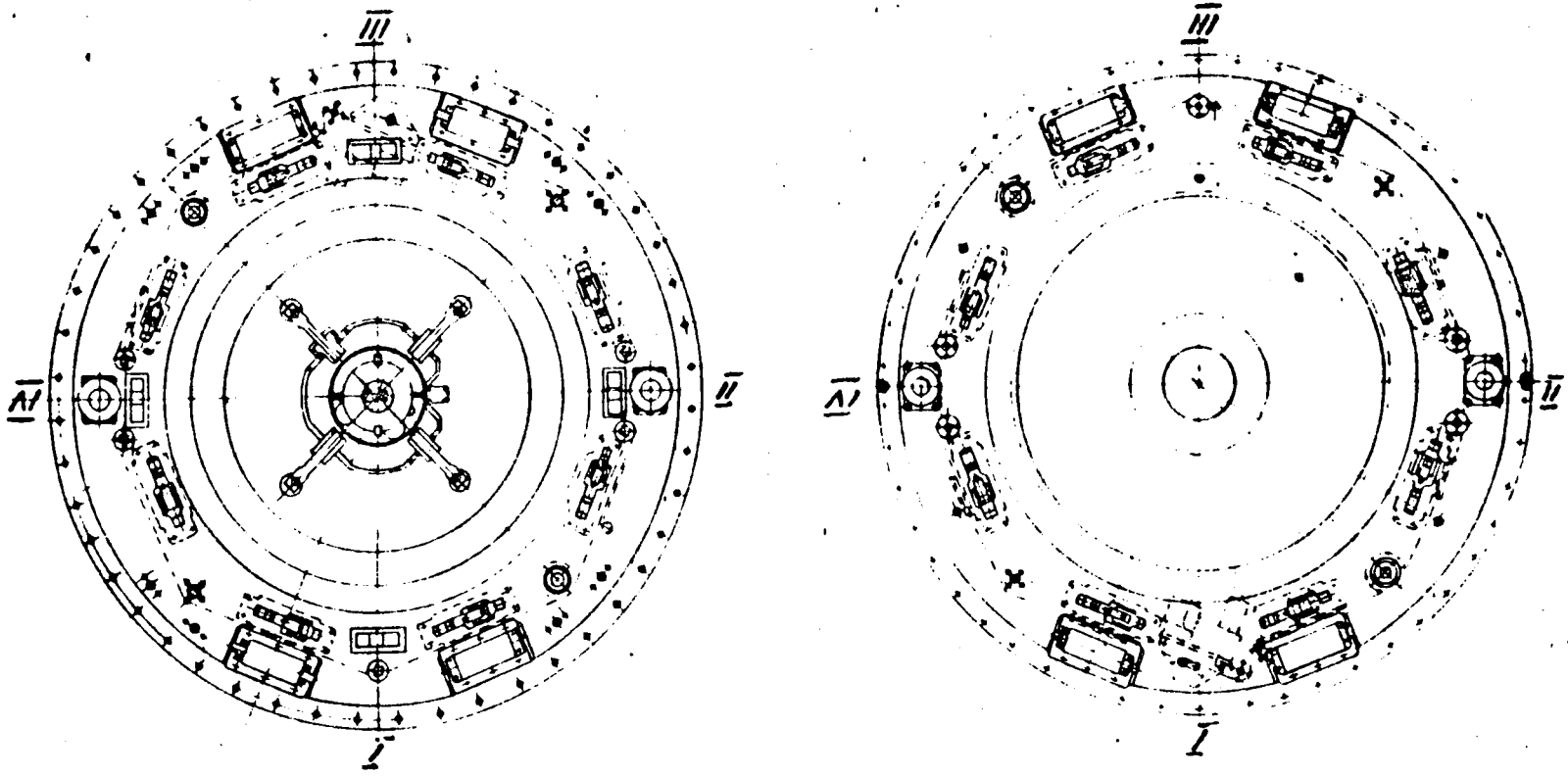

Figure 3.

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