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PREPARE THE MAN

STUDENT STUDY GUIDE OBR1821F/3121F-V-1 thru 4
VOLUME I of II

Department of Missile and Space Training

Missile Launch/Missile Officer (LGM-25)

MISSILE SYSTEMS

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SHEPPARD TECHNICAL TRAINING CENTER

pp 101-116 missing
but notes included

Designed For ATC Course Use

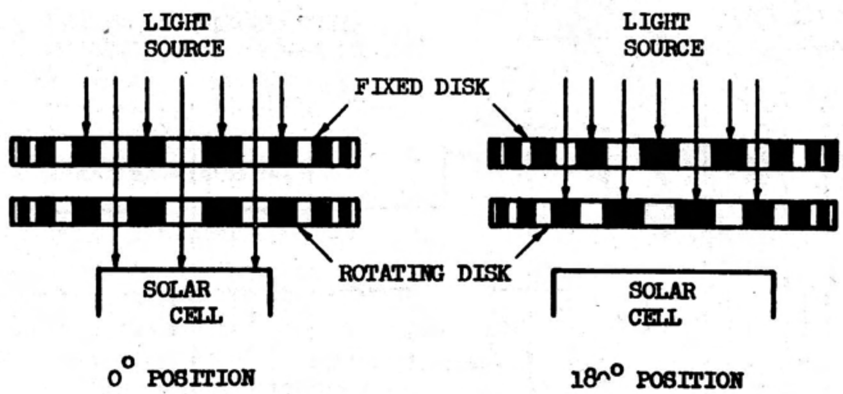


Figure 66 - Optisyn Cross Section

The more segments there are on the glass discs, the more accurately the shaft rotation can be measured. However, the narrower the segments on the disc, the smaller the signal which is available for the solar cell to detect. Therefore, the optisyn is built to operate from the light coming through several segments instead of one. This increases the signal strength several times.

It should be noted that this is possible only because the segments in both discs are approximately the same width and, therefore, in a short distance do not change position with respect to each other. If the segment shift is observed over any large distance, there is an appreciable change. In fact from 0° to 180° there is a shift of one segment. However, for the width of one solar cell, this shift is negligible.

The optisyn yields 4 x 512 or 2048 pulses for each rotation of the shaft. Do not confuse this with the fact that it is sampled 3200 times a second. Many of the samples yield no change of state. Since each revolution of the accelerometer shaft is equal to approximately 250 feet/second, each optisyn pulse is equal to a change in velocity of approximately .122 feet/second.

A question often arises as to why the fixed glass disc contains 1024 segments when only a portion of the segments are used. The answer seems to be that it is easier to manufacture a disc with all the segments than it is to produce one with several segments properly located every 90°.

MISSILE GUIDANCE COMPUTER (MGC)

The MGC is a binary digital, drum-memory computer. The computer is capable of directly handling three digital attitude inputs, 40 discrete inputs and twelve discrete outputs. The basic function of the missile guidance computer is to receive signals of time, velocity and attitude from the IMU and compute steering orders and commands (called discretes) to cause the warhead to impact on a predetermined target. Stored information such as target information and IMU coefficients are used to derive the correct steering orders and discretes at the proper time to cause the Re-entry Vehicle (R/V) to hit the target.

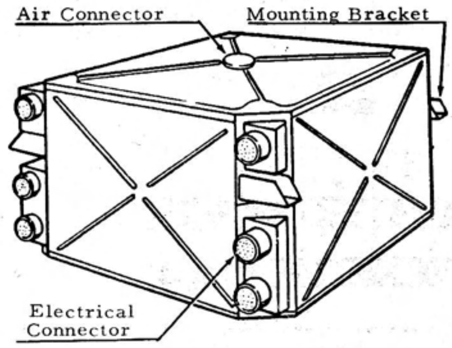


Figure 67 - Missile Guidance Computer

Description of the LGM-25 Computer

The MGC is shown in Figure 67. The basic computer structure is the frame, which is broken into two sections, outer and inner frames.

The outer frame consists of four aluminum corner posts which are welded to, and separated by, a series of aluminum rails to form a boxlike structure. Four identical side covers, plus a bottom and top cover, constitute the external appearance of the MGC. All covers are formed from laminated plastic, covered with gold-plated aluminum foil. The covers are convex and are formed with stiffening ridges for extra support. The plated foil on each cover provides radio interference shielding. This, in turn, is covered with a protective plastic covering.

The four side covers support a total of fifty-two logic sticks, each containing four welded encapsulated modules, consisting of resistor, transistors, capacitors, relays, etc. These logic sticks contain the logic circuitry of the MGC and are encased inside the side covers of the MGC. The four sides of the computer are identified as North, South, East and West, and are located as such by the North wall which has external electrical connections exposed. Cold plates, used to direct refrigerated air and heat sinks, complete the walls of the outer frame.

The inner frame, or bell, is encased by the walls of the outer frame and supports the input and output module panels and power supplies (regulators and converters). Inside the bell is the magnetic drum housing which further protects and shields the magnetic drum. Figure 68 shows the construction of the MGC and the location of its major components.

Magnetic Drum

The magnetic drum assembly consists of a rotor, stator, read heads, write heads, a head lifting device and electric motor, and supporting framework encased in the drum housing, all hermetically sealed.

The rotor assembly is a thin walled stainless steel cylinder covered with a magnetic nickel-cobalt alloy. The two end pieces and shaft of the rotor support the armature of a 400 CPS synchronous motor. The stator of the motor is cased in the lower end of the drum housing. The upper end of the housing contains the head lifting mechanisms which are rotating camshafts with sprockets and a miniature chain driven by a small 28V DC motor (Figure 69). The head lifting mechanism is utilized to raise and lower the read and write heads. During the "Power OFF" sequence, the 28V DC motor drives a gear and chain drive assembly (Figure 69) which operates cams to raise the heads away from the drum. This is done to prevent scoring the drum with the heads. Normally, these heads are held away from the drum by a boundary layer of air erected by the speed of the drum. The "Power ON" sequence allows the head lifting motor to slowly release the heads after the drum has attained its normal speed.

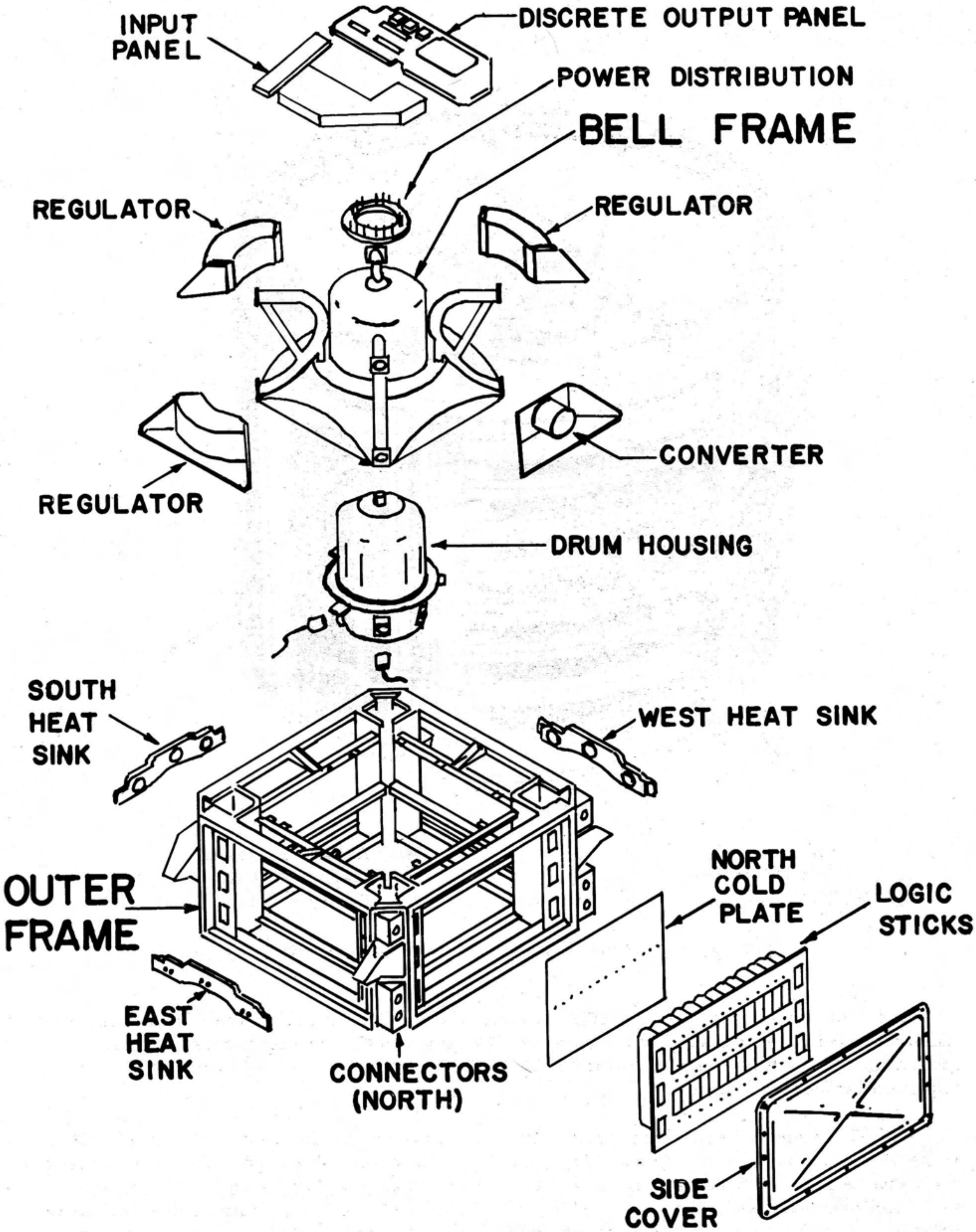
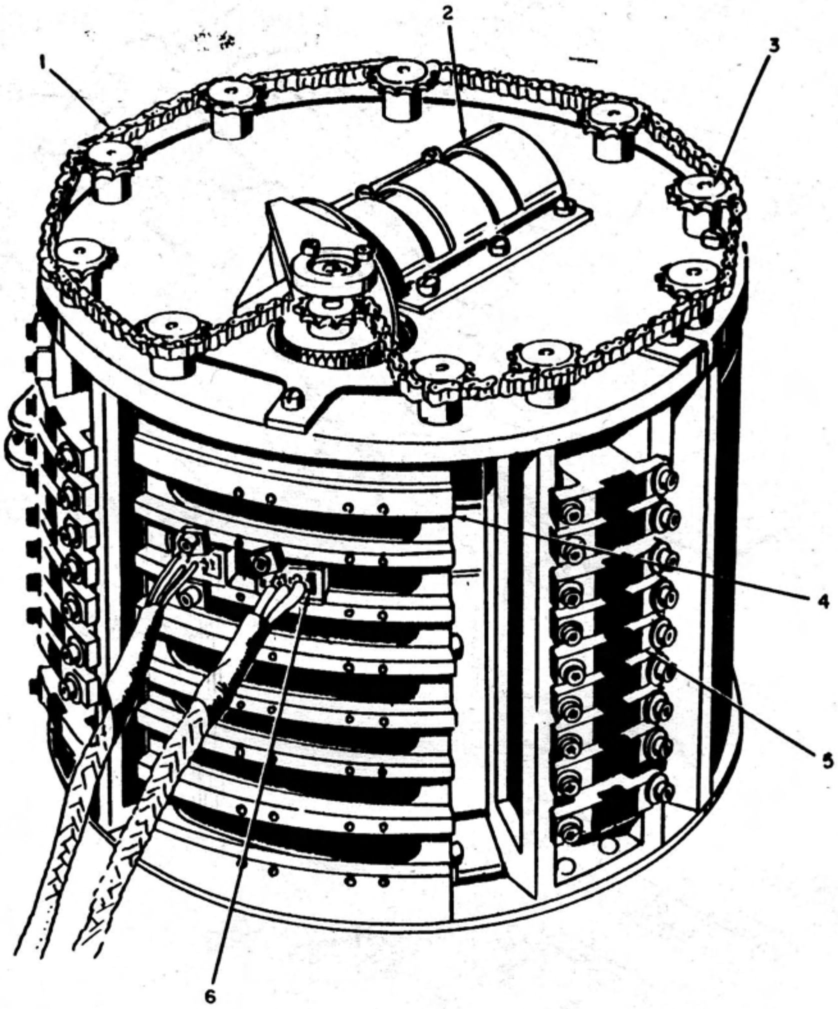


Figure 68 - MGC Components



1. Chain
2. 28 volt DC motor
3. Rotating cam shaft with sprockets
4. Revolver housing
5. Magnetic head
6. Revolver head

Figure 69 - Magnetic Drum with Head Lifting Mechanism

Since the power supply to the IGS comes from the PDC while on the ground, extreme caution should be exercised before turning OFF any circuit breaker while the IGS is operating. The drum could be ruined if 28V DC is lost before the "Power OFF" sequence is accomplished.

The 80 magnetic heads (Figure 70) are placed around the drum coincidental to 58 of the 70 total tracks of the drum. Sixty-seven of the heads are read heads and thirteen are write heads. The remaining twelve tracks are spares. The drum is 3" long and 4-1/2" in diameter and gives a capability of storing 100,224 binary bits on the 58 tracks utilized. A track consists of 64 words, each consisting of 27 bits. A track completely encompasses the drum and each track is 0.043" wide.

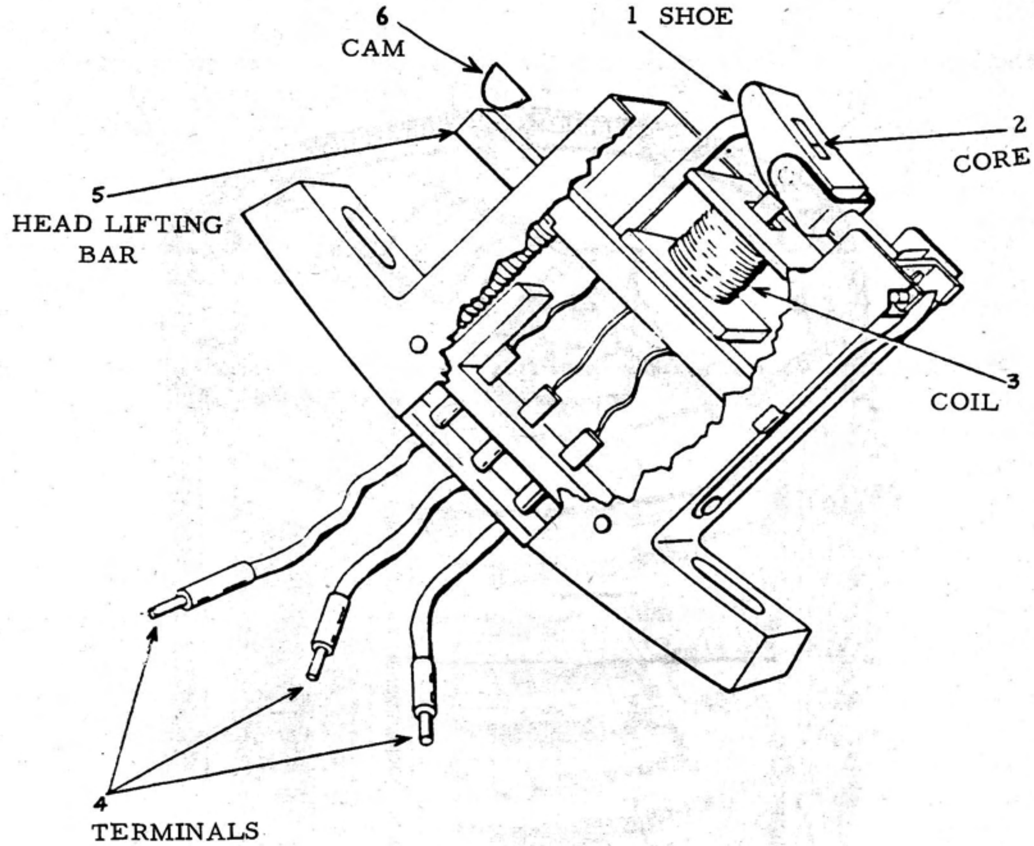


Figure 70 - Magnetic Head

COMPUTER DATA FLOW (Figure 97, page 131)

Memory

The memory unit for the MGC is the rotating magnetic drum. The 58 tracks now used are utilized as follows:

34 are instruction tracks for programmed information.

7 are constants tracks for storing such information as known formulas, time delay inherent to the circuits and constants affecting the flight profile.

8 are target tracks for specific information pertinent to a particular target. Simulated target information for checkout programs is included on these tracks.

2 are data tracks for temporary storage and transfer of bit information. IMU coefficients are also stored here.

5 are revolvers for extra fast access storage of time, velocity, attitude and results of computations.

2 are timing tracks for basic timing and synchronization of computer operations.

Control

The Instruction Selector will select the instruction sequence commanded. Selected instructions are used to tell the Data Selector where to obtain information (Constants, Data, Results of Computations, Time, Velocity, Attitude, IMU coefficients, or Selected Target Data).

Selected data from the Data Selector is sent to the Arithmetic units. The computation performed is dependent upon the instructions from the Instruction Selector. For example, if the Selected data is sent to the Adder unit, it will be added. The result of the computation is then stored on the drum.

Computer timing is permanently stored on the drum. This simplifies computer synchronization and timing. All computer units receive timing pulses, insuring proper sequencing and operation of the computer.

Inputs

Airborne inputs come from the IMU. Time, velocity and attitude are sent to Arithmetic units and are either added to, or subtracted from, existing information and stored in Memory. 81-1/2 volts, 400 CPS power is used to drive the drum at 6000 RPM.

OGE inputs come from the CCU in the MGACG. These include target data and IMU coefficients that have been read from tapes by the Tape Reader. This information is transferred to the correct drum track by Arithmetic Transfer units. The "Select Target" signal insures that only the correct target data can be fed into the Data Selector from the Target Selector. Mode Code words are commands and instructions to the computer from the CCU. These include such commands as putting the computer into 'Ready' to monitor accelerometer outputs and 'Load' command to store tape data on the drum.

Arithmetic

Arithmetic units can perform such computations as adding, subtracting, and multiplying. Results of computations are stored in Memory for further usage. Arithmetic units can also accumulate time, velocity and attitude inputs. For example, if stored, elapsed time is 26.004 seconds and a time signal is received from the frequency standard. Arithmetic units will read the stored time, add the new pulse and feed the result (26.005 seconds) to the drum. Time, velocity and attitude accumulation is accomplished throughout the flight, regardless of what other computations are being performed.

Arithmetic Transfer units can transfer IMU and target data to the correct track on the magnetic drum. Some computations will require outputs. When this occurs, steering pulses will be sent to the ladder decoders, or the computer will 'jump' to an instruction sequence that causes the proper output to be issued. For example, when V_g computations indicate the $V_g = 0$, the computer will 'jump' to a program that will cause VOF (Vernier Engines OFF) to be issued from the Discrete Output section.

Outputs

The Ladder Decoders will issue roll, pitch and yaw steering signals to Flight Controls when computations indicate they are necessary (for programmed movements, attitude corrections or trajectory corrections). The Ladder Decoders are digital to analog converters that will change the digital pulses, used in the computer, to DC voltages used by flight controls.

Discrete output signals issued by the MGC are: (Figure 71)

1.	GAN	Flight Control System gain change c. 105 sec
2.	Spare	
3.	LOK	Enable Thrust Chamber Pressure switch
4.	SUS	Sustainer Engine Cutoff
5.	JET	Jettison Decoys
6.	VOF	Vernier Engines OFF
7.	ARM	Prearm Warhead
8.	REL	Nose Cone Release
9.	PIT-1	Pitch Rocket #1 ON
10.	PIT-2	Pitch Rocket #2 ON
11.	TON	Translation Rockets ON
12.	TOF	Translation Rockets OFF

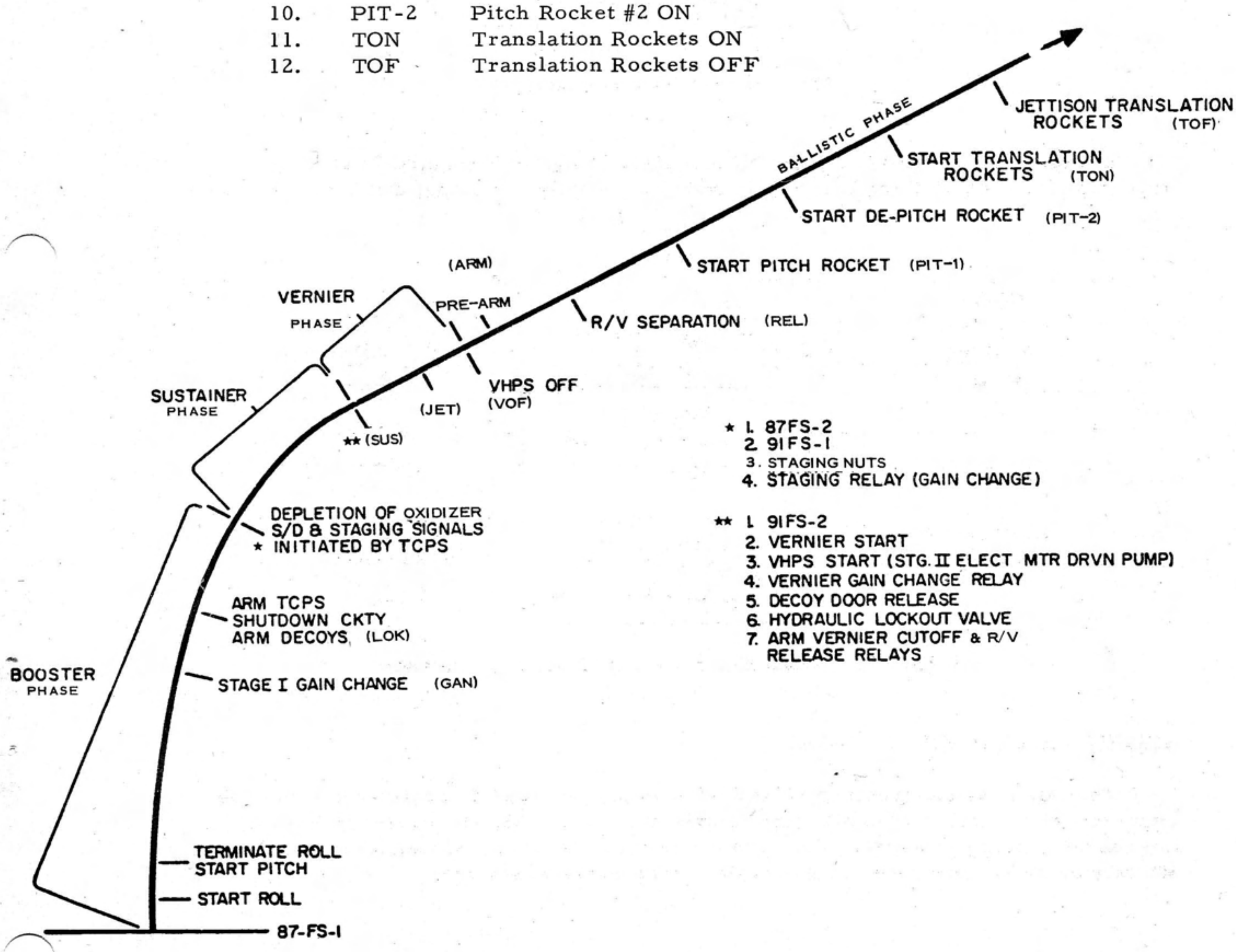


Figure 71 - Titan II Flight Phases