
marotta
SCIENTIFIC CONTROLS, INC.
MAN'S FIRST EARTH ASCENT, 1783
USA
LIFT-OFF
MAN'S FIRST JOURNEY TO THE MOON, 1969

"Ends and beginnings
—there are no such things.
There are only middles."

Robert Frost

The world's first liquid fuel rocket was successfully launched in 1926 by Dr. Robert H. Goddard. Since that time many technical achievements have advanced our knowledge of liquid propellant rockets. The first major U.S. effort in this field was greatly accelerated shortly after World War II at White Sands, New Mexico, where a small group of former German V-2 rocket scientists continued their experimental work under the cognizance of the U.S. government.

About this same time in Boonton, New Jersey, Marotta, a small firm established in 1943, was striving to build a reputation in the designing, developing and manufacturing of quality valves. As a part of the planned growth of the corporation, considerable effort and emphasis was being placed upon the development of specialized components for the infant rocket industry. Thus, Marotta's efforts were divided between supplying components for the aircraft industry and for the experimental rocket program.

The group of German scientists headed by Dr. Wernher von Braun was transferred to Redstone Arsenal in Huntsville, Alabama, to aid in the increased research program of the Army Ballistics Missile Agency (ABMA). By 1950 Marotta was expanding the number of different types of valves it was capable of supplying, and its reputation for technical competency and quality was growing throughout the United States.

As late as 1959, few people seriously believed that man would reach the moon. However, the von Braun group was already researching, designing and planning the development of large missiles suitable for future satellite launch vehicles. The REDSTONE and JUPITER missiles were the result of these engineering efforts. During the early phases of the REDSTONE and JUPITER missile programs, Marotta was contacted and requested to supply various types of valves to meet the stringent design parameters.

One of the first patented Marotta concepts to be incorporated into the missile program was a two-way, two-position magnetic solenoid valve (MV36). The MV36 design became a part of the attitude control system of the missile. Eight MV36 valves were used to control the pitch, yaw and roll of the missile. As a result of the success of the MV36, other Marotta valve designs were incorporated as part of the program. The other applications included the fuel tank pressure control valve (MV56A), LOX intervent cylinder control valve (MV74), spacial control vent valve (MV76), LOX dome purge valve (MV130), guidance system air bearing control valve (MV130A), and the outer space attitude control valve (MV162).

The von Braun design team submitted a proposal in 1957 entitled "Proposal for a National Integrated Missile and Space Development Program". This proposal outlined the need for a launch vehicle/booster capable of developing a million and one-half pounds of thrust. This proposal gave birth to a launch vehicle of the SATURN I size. The initial objective of this program was to prove that several rocket engines could be clustered together to provide the required thrust, permitting the use of existing hardware. The concept was demonstrated by building and testing a non-flight stage at Redstone Arsenal. The results of the studies showed that the liquid oxygen and fuel tanks used on the REDSTONE/JUPITER missiles could be incorporated as part of the program. It was found that the design of the previously used S-3D engine was adequate, and that its thrusts could be increased.

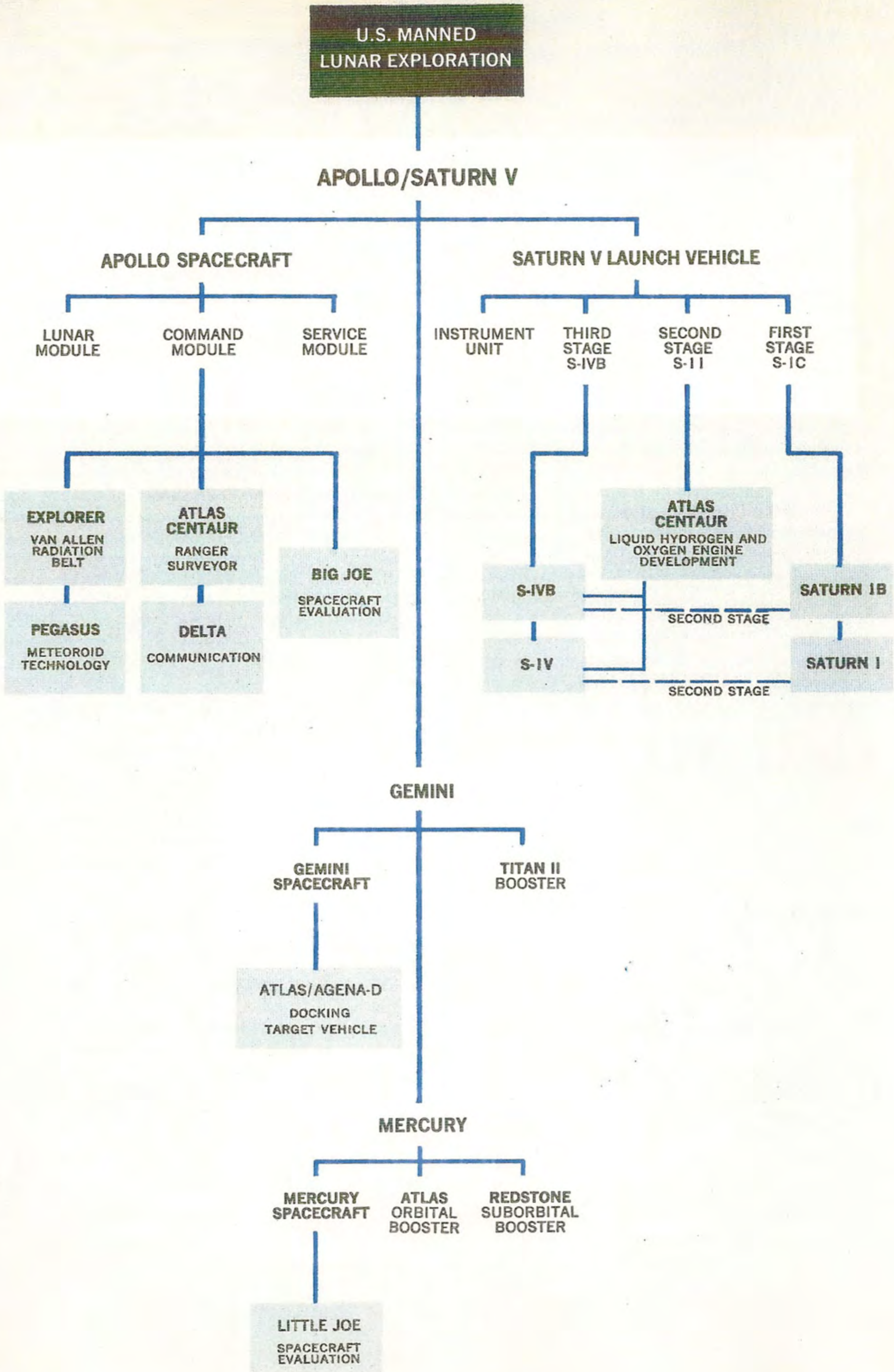
In 1958 the objectives of the program were changed from a ground testing program to the development of a high performance launch vehicle. The program was identified by the name JUNO. The main stage of the JUNO launch vehicle was an elongated version of the JUPITER missile. Marotta, as a part of the industrial development team for the REDSTONE and JUPITER missiles, became a part of the successful JUNO program. The JUNO II launch vehicle was used to place into orbit the EXPLORER II and PIONEER IV satellites.

The JUNO project designation was changed to SATURN in 1959 in order to coincide with the follow-on program for the JUPITER missile previously scheduled for the von Braun team. In this same year NASA formed a SATURN Vehicle Evaluation Committee, and in 1960 the von Braun technical team was formally transferred from the Army Ballistics Missile Agency (ABMA) to become a part of the National Aeronautics and Space Administration (NASA). This transfer of personnel became the nucleus of the newly created George C. Marshall Space Flight Center in Huntsville, Alabama. During the early phases of the program, Marotta had worked closely with all of the various government and industrial rocket and missile design teams. The experience and knowledge gained, combined with company-funded development programs, enabled Marotta to contribute many new concepts in the field of fluid controls.

In 1961 the SATURN program received national recognition and support when President John F. Kennedy addressed Congress and challenged the nation to place a man on the moon by 1970.

The APOLLO/SATURN program and its many successes are the result of the combined efforts of government agencies and private industries, and represent the sum total of the technical know-how, knowledge and experience gained from many previous missile and launch vehicle programs. Substantial technological contributions to the lunar flight were made by the ATLAS, REDSTONE, PEGASUS, JUPITER, JUNO, LITTLE JOE, BIG JOE, AGENA, TITAN and ATLAS/CENTAUR projects. The fact that new concepts could be developed and tested concurrent with the SATURN launch vehicle development permitted the United States to technically "leap frog". This greatly accelerated the APOLLO/SATURN program and kept the 1970 moon landing goal within our grasp.

Marotta is proud to have been a major supplier of components for almost every phase of flight, ground support and test facilities in each of the programs listed as well as many others. The following pages will not only describe the APOLLO/SATURN program, but will also outline our contributions to the program since its modest beginning.

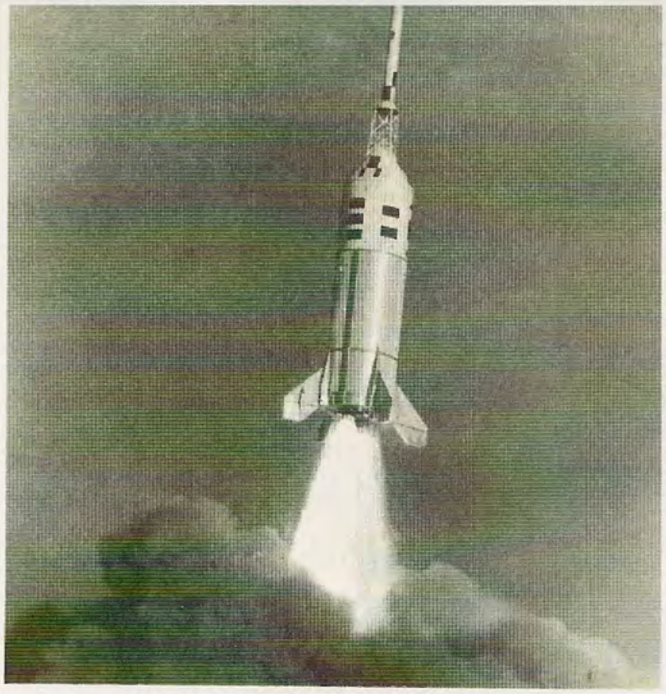

U.S. MANNED LUNAR EXPLORATION
APOLLO/SATURN V
APOLLO SPACECRAFT
SATURN V LAUNCH VEHICLE
LUNAR MODULE
COMMAND MODULE
SERVICE MODULE
INSTRUMENT UNIT
THIRD STAGE S-IVB
SECOND STAGE S-II
FIRST STAGE S-IC
EXPLORER
VAN ALLEN RADIATION BELT
ATLAS CENTAUR
RANGER SURVEYOR
BIG JOE
SPACECRAFT EVALUATION
PEGASUS
METEOROID TECHNOLOGY
DELTA
COMMUNICATION
ATLAS CENTAUR
LIQUID HYDROGEN AND OXYGEN ENGINE DEVELOPMENT
S-IVB
SATURN IB
SECOND STAGE
S-IV
SATURN I
SECOND STAGE
GEMINI
GEMINI SPACECRAFT
TITAN II BOOSTER
ATLAS/AGENA-D
DOCKING TARGET VEHICLE
MERCURY
MERCURY SPACECRAFT
ATLAS ORBITAL BOOSTER
REDSTONE SUBORBITAL BOOSTER
LITTLE JOE
SPACECRAFT EVALUATION

> *"First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to earth. No single space project in this period will be more impressive to mankind or more important for the long range exploration of space. And none will be so difficult or expensive to accomplish."*
>
> John F. Kennedy, May 25, 1961

The APOLLO/SATURN V program is the largest non-military government-sponsored and industrial scientific achievement of our time. The advancements of science and engineering know-how, combined with vast and complex coordination, required a maximum effort of all the government agencies and industrial enterprises. Each successful APOLLO mission placed us closer to the ultimate goal of landing a man on the moon. The completion of the APOLLO program will place us upon the threshold of space travel.

To reach this point in the United States space program, it was necessary for our scientists and engineers to develop launch vehicle/boosters capable of propelling satellites and spacecraft into earth orbit and outer space. Our knowledge in almost every scientific and engineering field was expanded. Because of the differences of each program, mission and the weight of the pay load, various launch vehicle/boosters were used. The APOLLO/SATURN program required the construction of many new installations, expansive test facilities, manufacturing plants and ultimately resulted in the construction of the free world's largest space vehicle launching facility, Launch Complex 39.

The chart outlines a number of the programs and launch vehicle projects which were all important steps in the APOLLO/SATURN program. The MERCURY and GEMINI manned flight programs were primary steps in man's travel through space and, therefore, are better known than such programs as the REDSTONE, JUPITER C, JUNO II, ATLAS, TITAN II, AGENA, LITTLE JOE, BIG JOE, PEGASUS, CENTAUR and DELTA. All of these programs provided new knowledge, proved new concepts, required thousands of engineering hours and utilized the talents of almost all technical fields and skills. Numerous static test firings and hours of pre-launch checks were required to assure the reliable performance of each launch vehicle and each of its components. Marotta valves were used in each of the programs listed.



BIG JOE FLIGHT TESTS APOLLO SPACECRAFT

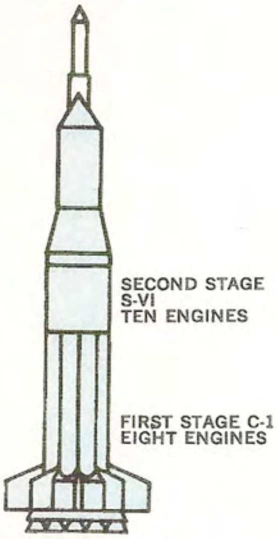
TEST SYSTEM USING MAROTTA VALVES.
2 MV140MM'S
2 MV121'S
1 RV53D

FORMING A SPACECRAFT'S HEAT SHIELD

LAUNCH VEHICLES

(SHOWN IN RELATIVE PROPORTION)

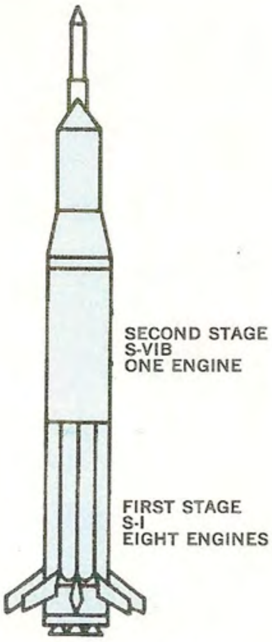
APOLLO — SATURN I



EIGHTEEN ENGINES
TOTAL THRUST 1,504,000 LBS

EARTH ORBITAL PAYLOAD 10 TONS

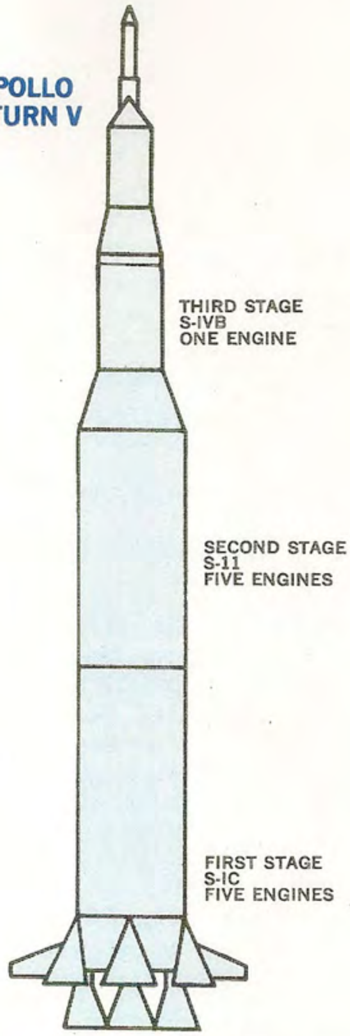
APOLLO — SATURN IB



NINE ENGINES
TOTAL THRUST 1,640,000 LBS

EARTH ORBITAL PAYLOAD 16 TONS

APOLLO SATURN V



ELEVEN ENGINES
TOTAL THRUST 7,500,000 LBS

EARTH ORBITAL PAYLOAD 120 TONS

MOON ORBITAL PAYLOAD 45 TONS

MERCURY — REDSTONE

ONE ENGINE
TOTAL THRUST 78,000 LBS

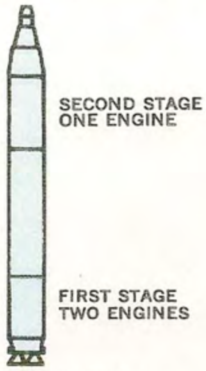
EARTH SUB-ORBITAL PAYLOAD 1½ TONS

MERCURY — ATLAS

THREE ENGINES
TOTAL THRUST 390,000 LBS

EARTH ORBITAL PAYLOAD 1½ TONS

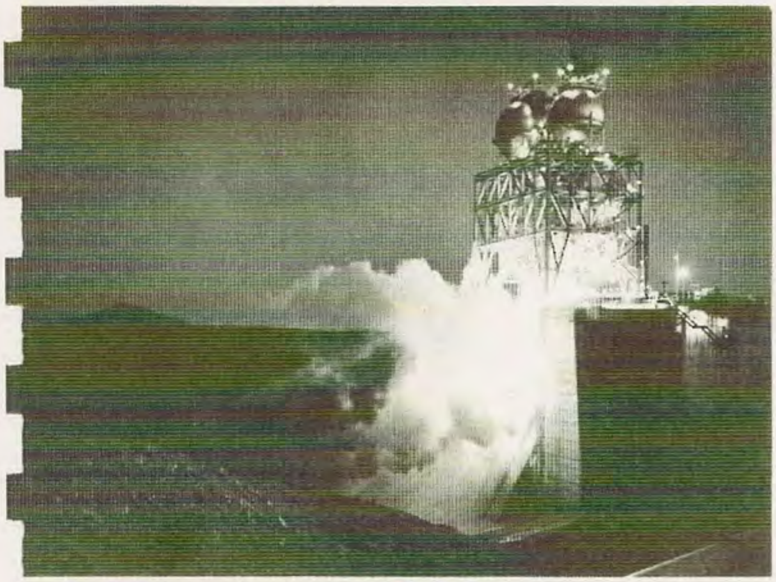
GEMINI — TITAN II



THREE ENGINES
TOTAL THRUST 430,000 LBS

EARTH ORBITAL PAYLOAD 4 TONS

F-I ROCKET ENGINE BEING TEST FIRED



"I'll put a girdle 'round the earth in forty minutes."

William Shakespeare

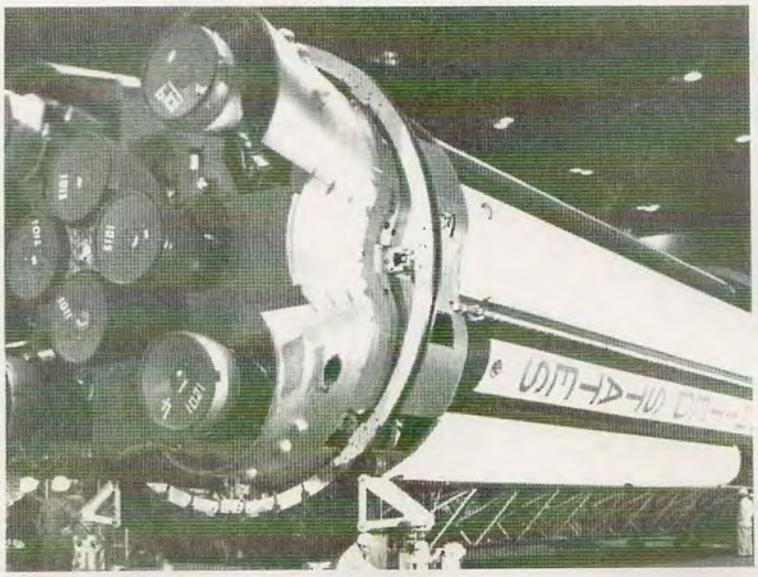
The fantasy flight described by William Shakespeare in "Mid Summer's Night Dream" might well be describing the present APOLLO spacecraft, but it usually requires 90 minutes to completely encircle the earth. The actual orbiting time varies slightly depending upon the exact velocity and altitude of the parking orbit. In order to propel an APOLLO spacecraft out of the earth's gravitational field for a journey to outer space, it is necessary to exceed the parking orbit velocity of approximately 17,500 miles per hour. The final velocity required to propel an APOLLO spacecraft to the moon exceeds 24,000 miles per hour. To reach this speed with an APOLLO spacecraft carrying three astronauts, necessary life support equipment, lunar landing module, navigational and guidance systems and the fuel and oxidizers required to complete the trip, requires several powerful rocket engines. Our present SATURN V launch vehicle is capable of placing 120 tons into orbit or propelling 45 tons into lunar orbit. Our first satellite was launched on January 31, 1958, using a JUPITER C launch vehicle. The total weight of the EXPLORER I satellite was 30 lbs. When compared with our present capability, it is easy to realize the fantastic advancements that have been made in a short span of time.

The rocket engine development program not only provided increased knowledge of motor design but included the development of new, lighter, high temperature materials, and new methods of controlling the engine position during launch and course corrections for vehicle stabilization. New oxidizers and fuels were developed. New methods and components which permitted the rocket engines to be varied in thrust, started, stopped and re-started during flight, all are significant achievements concurrent with the development of larger rocket engines. Other programs were aimed at the development of reliable, efficient, light-weight, smaller thrust engines to be used for attitude control, mid-course correction and for controlling the ascent and descent of the spacecraft. Marotta valves performed many vital functions in the various propulsion systems of the SATURN launch vehicles. The reliability of Marotta designs can be attested by the fact that they were used extensively throughout the important engine system of the service propulsion module of the APOLLO spacecraft. The close proximity of Marotta's West Coast Division to the static test firing facilities in California permitted us to provide technical and field support assistance at a moment's notice.

Besides flight components, thousands of Marotta valves are used throughout the United States at the various static test firing facilities, launch vehicle manufacturing plants, launch check-out system and launch support systems at Cape Kennedy, Wallops Island and the Pacific Missile Range.

ANOTHER MAROTTA VALVE FOR SATURN'S ENGINES

SATURN I FIRST STAGE IN PRODUCTION



project mercury

FREEDOM 7 • LIBERTY BELL 7 • FRIENDSHIP 7 • AURORA 7 • SIGMA 7 • FAITH 7

Project MERCURY was the first United States manned space flight program. The project was organized October 5, 1958, and was successfully completed in less than five years on May 16, 1963. Its primary goal was to provide a design base for future manned flights by placing a spacecraft in orbital flight around the earth and to investigate man's performance capabilities in the unvisited environment of space.

The successful MERCURY program included six manned flights and five unmanned flights.

The MERCURY spacecraft, a one man bell-shaped vehicle, was 9.5 feet high and 6 feet across at its re-entry heat shield base. The weight at lift-off was approximately 4,000 lbs.

Two launch vehicles were used during the MERCURY program, the REDSTONE and ATLAS. The MERCURY/REDSTONE combination was used for sub-orbital missions. The MERCURY/ATLAS provided the United States with our first manned orbital capabilities.

The chart below lists the various Marotta components which were used to support both the sub-orbital and orbital missions.

MAROTTA COMPONENTS QUALIFIED FOR MERCURY / REDSTONE / ATLAS

SOLENOID OPERATED VALVES

MV34A	GSE*	MV57A	GSE	MV76	FLIGHT	MV105B	GSE	MV173C	GSE
MV36	FLIGHT	MV57C	GSE	MV87	GSE	MV130	GSE	MV500A	GSE
MV36J	FLIGHT	MV59	GSE	MV93	GSE	MV130A	GSE	MV508B	FLIGHT
MV36V	GSE	MV68A	GSE	MV100	GSE	MV130EA	GSE	MV537	GSE
MV40A	GSE	MV74	FLIGHT GSE	MV100N	GSE	MV130HA	GSE	MV544	FLIGHT
MV40J	GSE	MV74TA	GSE	MV100UA	GSE	MV162	GSE	MV547	GSE
MV56A	GSE								

PRESSURE OPERATED VALVES

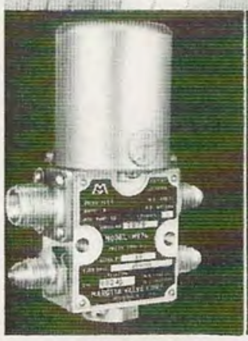
PV3 GSE   PV20 GSE   PV21A GSE   PV21B GSE

CHECK VALVES

CVM4 FLIGHT-GSE	CVM6D GSE	CVM 16-3A GSE	CVM506E FLIGHT	SCV508 GSE
CVM6 FLIGHT-GSE	CVM8 FLIGHT GSE	CVM504B GSE	CVM512C GSE	SCV532 GSE

PRESSURE REGULATING VALVES	PRESSURE RELIEF VALVES
RV23SC GSE	PRV520 GSE

*GSE: Ground Support Equipment



MV74

MV100

MV510K

RV23SC

PV20

CVM8

project gemini

GEMINI III GEMINI IV GEMINI V GEMINI VI GEMINI VII GEMINI VIII GEMINI IX GEMINI X GEMINI XI

The GEMINI Program was established as an interim research program bridging the gap between short duration MERCURY missions and the proposed long duration space flight missions of the APOLLO spacecraft. The key objectives of the GEMINI flights were to:

1. Investigate long duration space flights.
2. Develop rendezvous techniques and post docking maneuvers.
3. Develop re-entry flight path control.
4. Provide the flight and ground crews with needed experience.
5. Permit the astronauts to develop extra vehicular capabilities.
6. Conduct various space environmental experiments.

All of the program objectives were achieved in less than two years (November 1966).

The GEMINI spacecraft carried two men and was similar to the bell-shaped MERCURY vehicle. However, it was almost twice as heavy as the MERCURY spacecraft and provided more internal volume (approximately 50%). The GEMINI program used a modified TITAN II launch vehicle and as part of the objectives, employed an ATLAS/AGENA D vehicle in the development of rendezvous docking techniques.

Marotta valves were used to control the fuel and oxidizer vehicle pressurization systems during the critical fueling and launch countdown sequences. This program was the first manned space program to incorporate the patented pressure reducers and full flow pressure relief regulator designs. The accompanying photographs and charts show the number of components and their locations.

MAROTTA COMPONENTS QUALIFIED FOR GEMINI / TITAN

PRESSURE REGULATING VALVES

RV24P GSE	RV24Q GSE	RV31S GSE
RV24PG GSE	RV24QC GSE	RV31SQ GSE
RV24R GSE	RV24QG GSE	RV31SL GSE

SOLENOID OPERATED VALVES

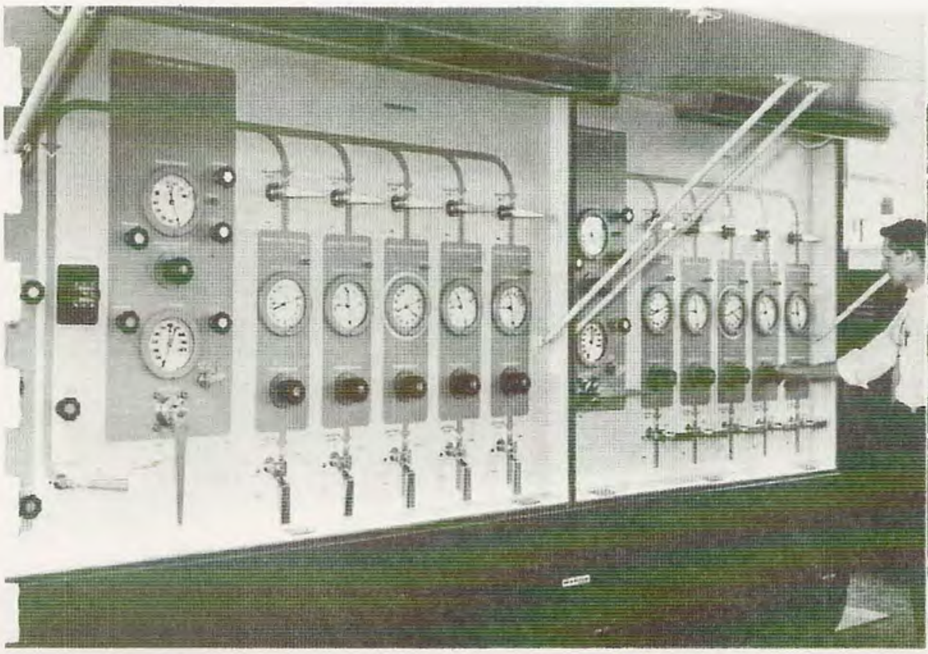
MV41G FLIGHT	MV130 FLIGHT	MV510K GSE
MV100 FLIGHT	MV130B FLIGHT	MV549K GSE
MV123A FLIGHT	MV159DB FLIGHT	

PRESSURE RELIEF VALVES

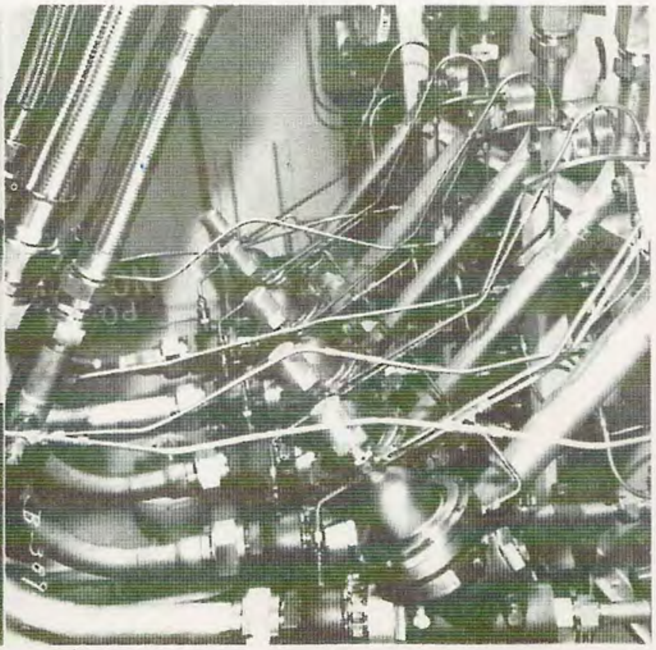
PRV6 FLIGHT PRV41A GSE

CHECK VALVE

CV32 GSE



TITAN SYSTEM SUPPLY PRESSURE CONTROL PANEL WITH RV31 TYPE REGULATORS



INSIDE CONTROL UNIT: RV24's, CV32's, PRV41A's and RV31's

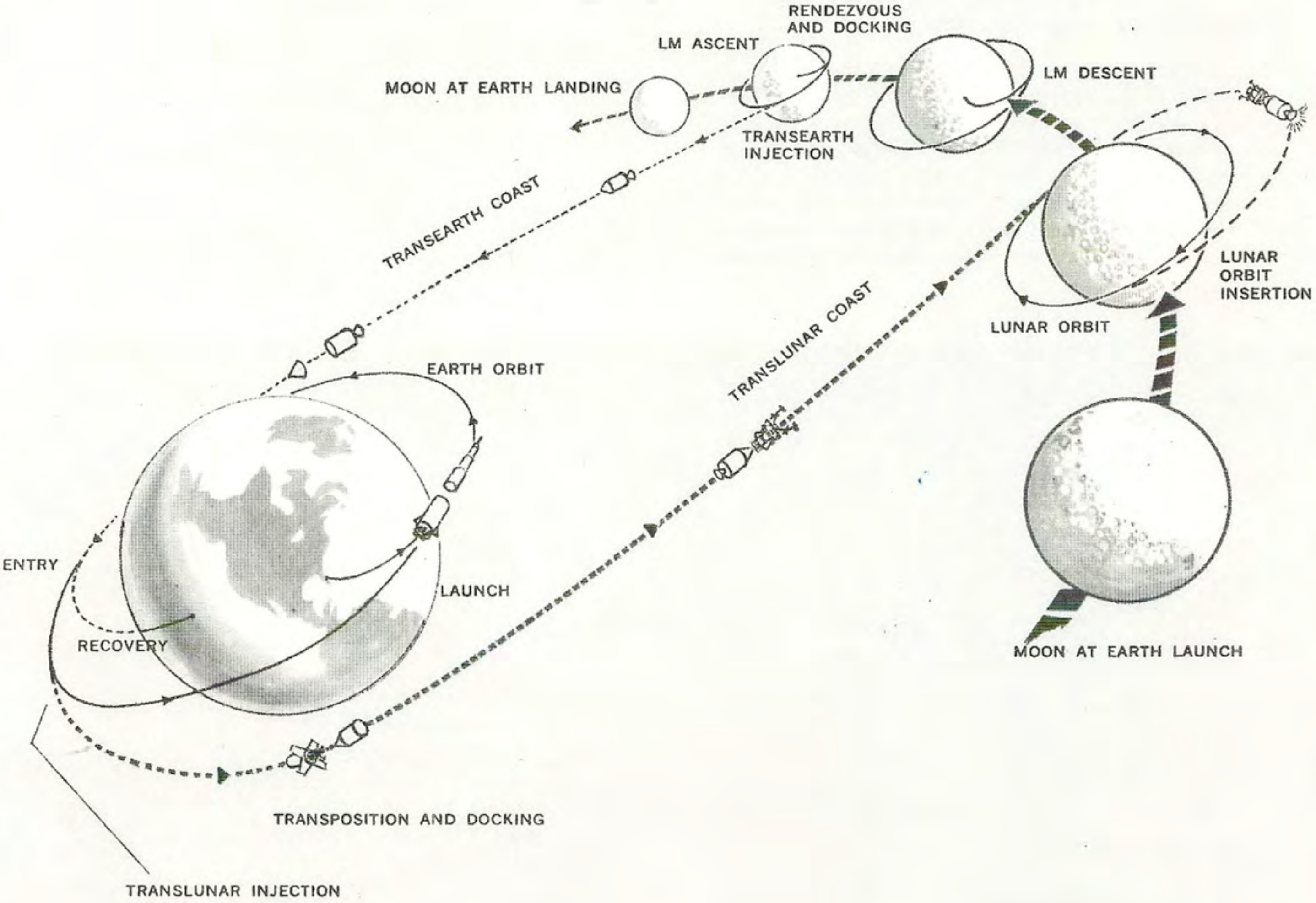
apollo / saturn

The APOLLO/SATURN is the largest of our present manned space flight programs. Placing a United States astronaut on the surface of the moon and returning him safely to earth upon completion of his lunar adventure is the primary goal of the APOLLO/SATURN program. The APOLLO/SATURN program is serving as the beginning of our space travel and should open the door to future planet probing.

The APOLLO/SATURN may be divided into three major design efforts:

1. APOLLO spacecraft.
2. SATURN V launch vehicle.
3. LAUNCH COMPLEX 39, complete with its ground handling equipment and support transportation equipment.

TYPICAL APOLLO MOON MISSION



apollo spacecraft

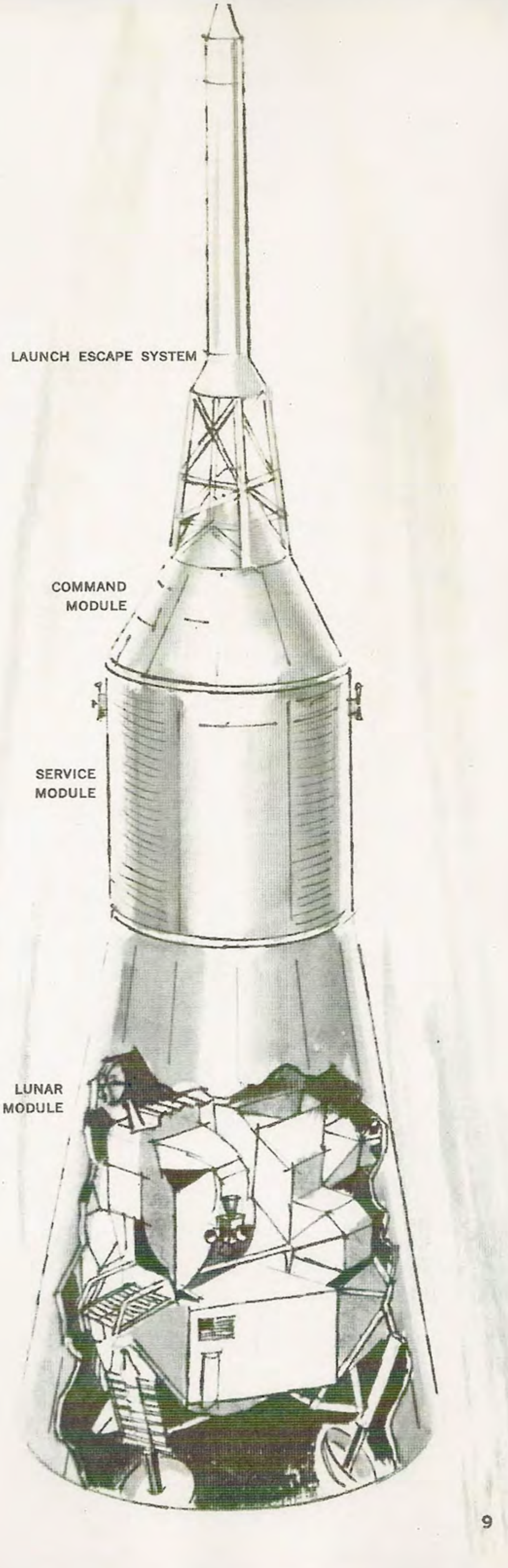
The APOLLO spacecraft is composed of four basic elements:

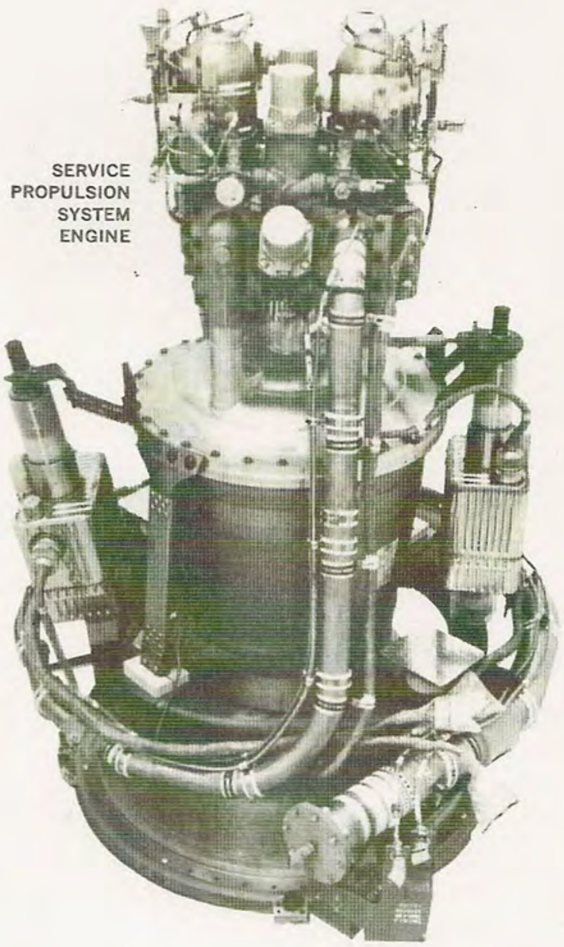
1. LAUNCH ESCAPE SYSTEM
2. COMMAND MODULE
3. SERVICE MODULE
4. LUNAR MODULE

The Launch Escape System provides a means of removing the Command Module and safely returning it to earth should a malfunction occur that would affect the launch or at sometime during the lift-off phase, but prior to the spacecraft's flight leaving our atmosphere.

The Command Module is the portion of the spacecraft most seen during televised APOLLO flights. It is designed so that the astronauts can perform their duties without wearing pressurized suits and is the portion of the spacecraft which returns to earth carrying the three astronauts. In addition to housing the flight crew, it contains the equipment necessary to control and monitor the spacecraft's sub-systems as well as containing the equipment required for the comfort and safety of the crew. It is divided into three compartments . . . forward, crew and aft.

The Service Module contains the spacecraft's major systems and the propulsion system required to propel the spacecraft through outer space and into lunar orbit. The service propulsion engine is depended upon for course corrections during the journey both to and from the moon, and must be capable of being re-started at least fifty times.



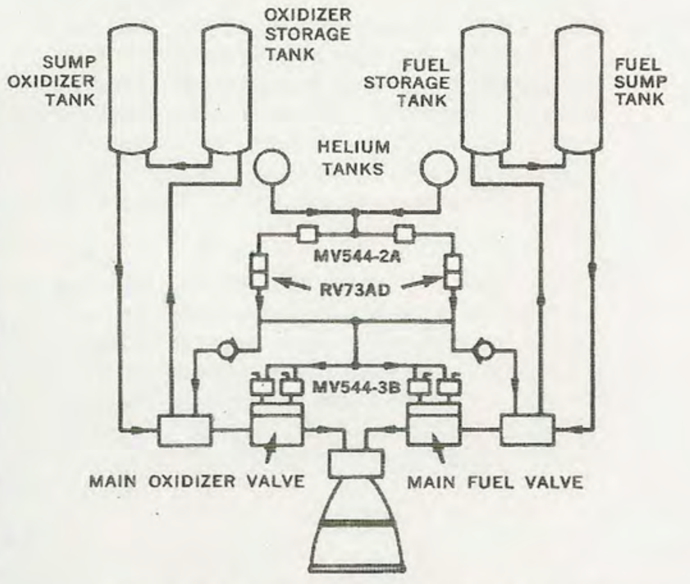


The Service Propulsion Module received considerable publicity during the APOLLO 8 mission. Col. Frank Borman was quoted a few days prior to the APOLLO 8 launching as saying: "Our engine simply has to work at that point. We have no other way of getting out of moon orbit."

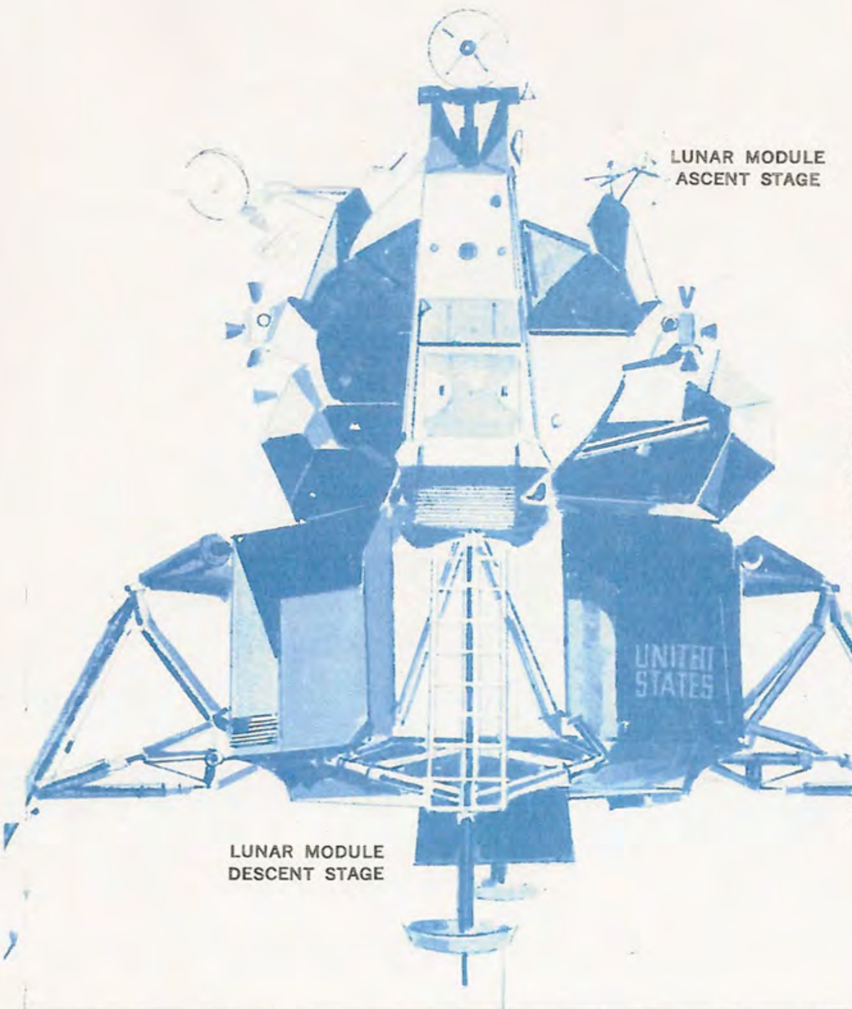
The Service Module enables the astronauts to maneuver their craft into and out of lunar orbit and allows them to alter their course and speed during a trans-lunar and trans-earth variation. One of the most critical portions of the Service Module is the Service Propulsion System (SPS). The SPS engine is re-started — at a point out of radio contact with the earth on the other side of the moon — in order to lift the spacecraft out of moon orbit and on its course back to earth. The SPS rocket engine burns hypergolic fuels and most of its critical and/or functional components and valves are installed in duplicate. Eight Marotta valves (two RV73AD's, two MV544-2B's and four MV544-3B's) are used in the Service Module propulsion system.

RV73AD

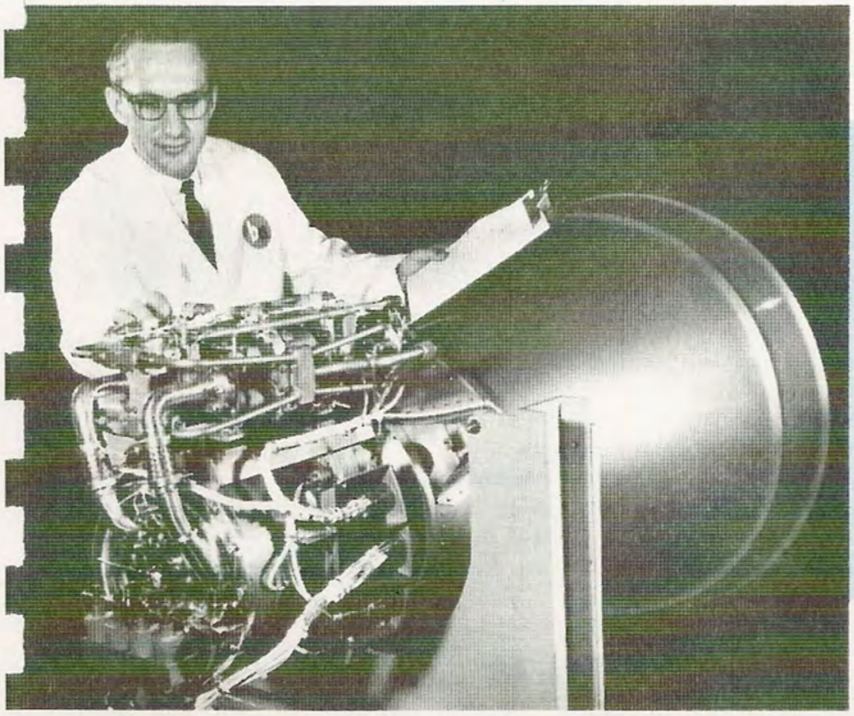
MV544 TYPE



SERVICE PROPULSION SYSTEM SCHEMATIC



The Lunar Module is designed to carry two men from the Command Module in lunar orbit to the moon's surface for exploration, then return them into lunar orbit for a rendezvous with the Command and Service Module. The Lunar Module contains two separate engine systems, an ascent and descent engine. The descent engine controls the Lunar Module during the trip to the surface of the moon and the ascent engine is used on the trip back to lunar orbit. The reliability of both the ascent and descent engine systems are equally important as the service propulsion engine system. A malfunction during the trip to the moon or upon return to lunar orbit would mean mission failure. The ascent engine incorporates Marotta Model MV140RA solenoid valves as part of the propulsion system. Upon return to the Command Service Module, the Lunar Module is jettisoned and left in orbit around the moon as the Command Module heads toward earth.



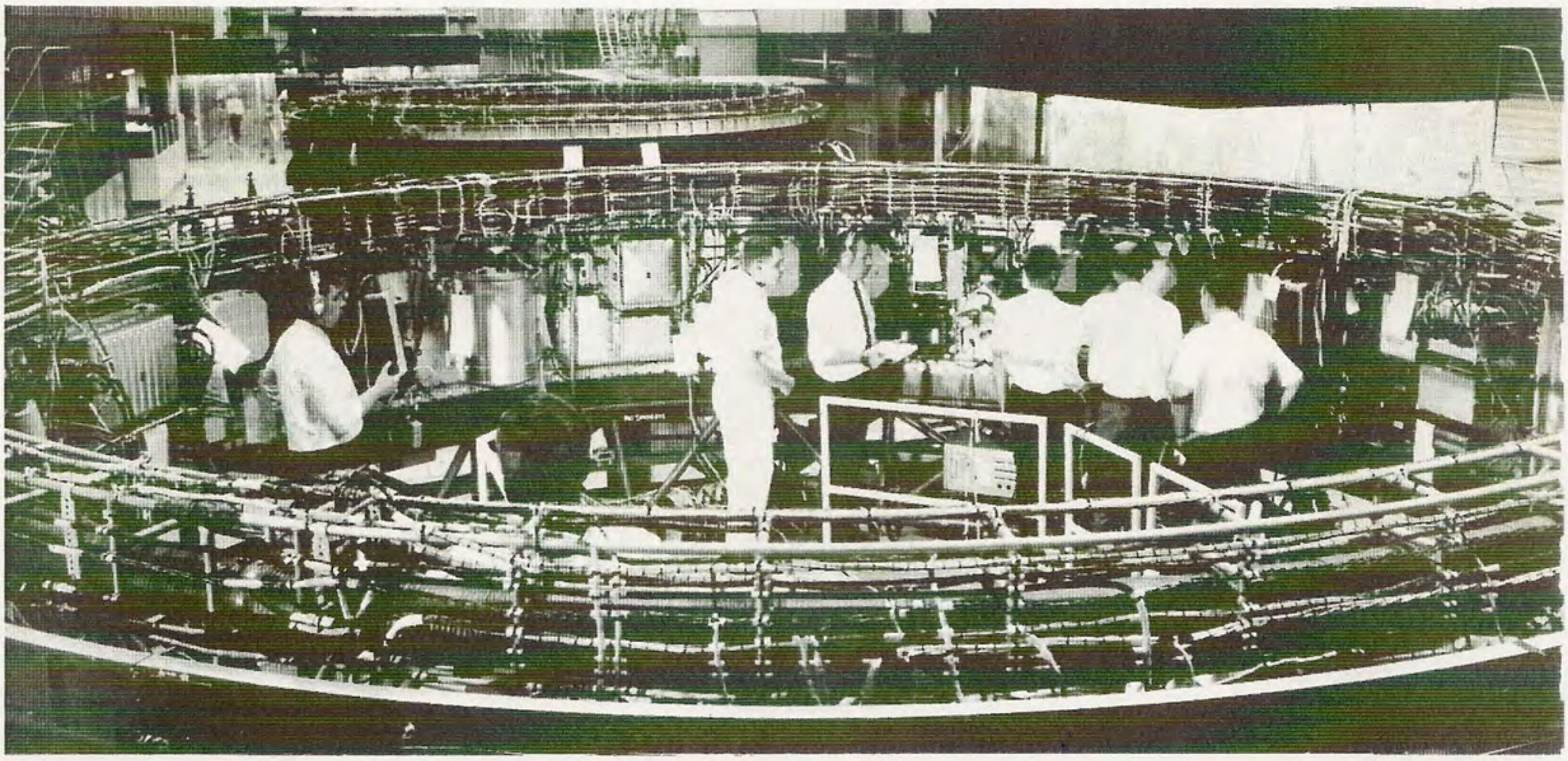
ASCENT ENGINE

MV140RA

saturn launch vehicle

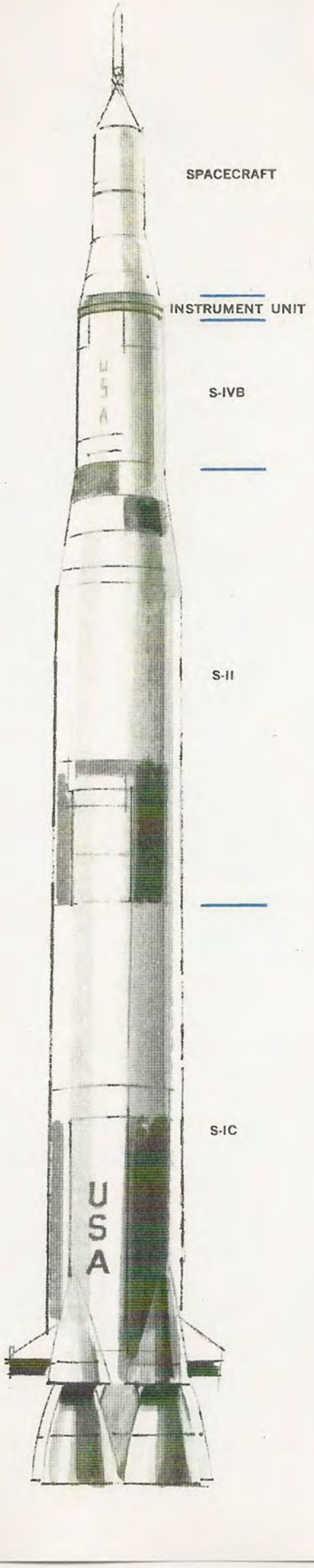
MV130TE

The APOLLO spacecraft may use the SATURN IB or SATURN V launch vehicles. All the lunar missions use the huge SATURN V launch vehicle. The SATURN V launch vehicle consists of three propulsion stages and the Instrument Unit (IU) or "Engineless Stage." The Instrument Unit is 3 feet high and 21.7 feet in diameter. It contains the intricate electronic and electrical equipment



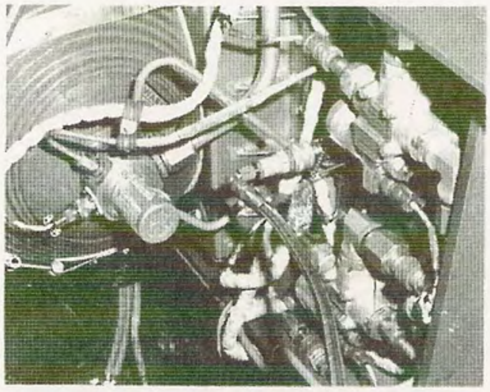
required to guide, navigate and issue commands that control the SATURN launch vehicle from lift-off to APOLLO/SATURN vehicle separation. Marotta solenoid valves (MV130TE and SPV130A) are used in the environmental control system of the IU stage. The environmental control provides the required cooling for the electronic equipment as it soars through space. The environmental controls remove the heat generated by the electronic and electrical system and maintain the temperature at approximately 60° above zero.

SPV130A



The S-IVB is located directly beneath the IU stage. It is 21.5 feet in diameter, 58.4 feet in length, weighs 34,000 lbs. without fuel and 262,000 lbs. when fueled. The liquid hydrogen-liquid oxygen J2 engine develops 200,000 lbs. thrust. The S-IVB carries 77,680 gallons of liquid hydrogen and 20,107 gallons of liquid oxygen. It is designed so that the engine may be re-started in earth orbit to increase the APOLLO spacecraft's velocity to 24,600 miles per hour propelling it on its journey toward the moon.

The Second Stage S-II is 33 feet in diameter and 81.5 feet in length and weighs 95,000 lbs. without fuel and 1,037,000 lbs. when fueled. The five liquid hydrogen-liquid oxygen J2 engines develop a total of 1,150,000 lbs. thrust. Each engine develops a thrust of 230,000 lbs. The liquid hydrogen tank contains 282,555 gallons of liquid hydrogen and the liquid oxygen tank contains 85,973 gallons of liquid oxygen.



MAROTTA MV168 AND MV159CC VALVES

The largest of the booster stages is the S-IC, which is 33 feet in diameter, 138 feet long, weighs 300,000 lbs. dry and 4,792,000 when fueled. The five F-1 engines burn 212,846 gallons of RP-1 fuel and 346,372 gallons of liquid oxygen during its approximate life of $2^1/_2$ minutes in flight. These five engines develop and sustain a thrust of 7,500,000 pounds.

MAROTTA COMPONENTS QUALIFIED FOR SATURN IB AND SATURN IC

SOLENOID OPERATED VALVES

MV74	FLIGHT	MV100	FLIGHT	MV159CC	FLIGHT
MV74MM	FLIGHT	MV100VB	FLIGHT	MV159CF	FLIGHT
MV74V	FLIGHT	MV130B	FLIGHT	MV168	FLIGHT
MV74VE	FLIGHT	MV159CA	FLIGHT	MV199A	FLIGHT
		MV159CB	FLIGHT		

PRESSURE OPERATED VALVES

PV33D FLIGHT

REGULATOR VALVES

RV78AH FLIGHT

CHECK VALVES

CVM12 FLIGHT

launch complex 39

The huge APOLLO/SATURN V vehicle required the construction of a massive launch complex . . . Launch Complex 39. This is the nation's first operational space port and incorporated several new concepts in the methods of launching space vehicles. Most important of these new techniques was the "Mobile Concept", it permits frequent launches and a high degree of equipment flexibility. Launch Complex 39 consists of six basic elements:

1. Vertical Assembly Building
2. Mobile Launcher
3. Transporter
4. Concrete Launch Pad
5. Mobile Service Structure
6. Launch Control Center

The Vertical Assembly Building consists of two major work areas:

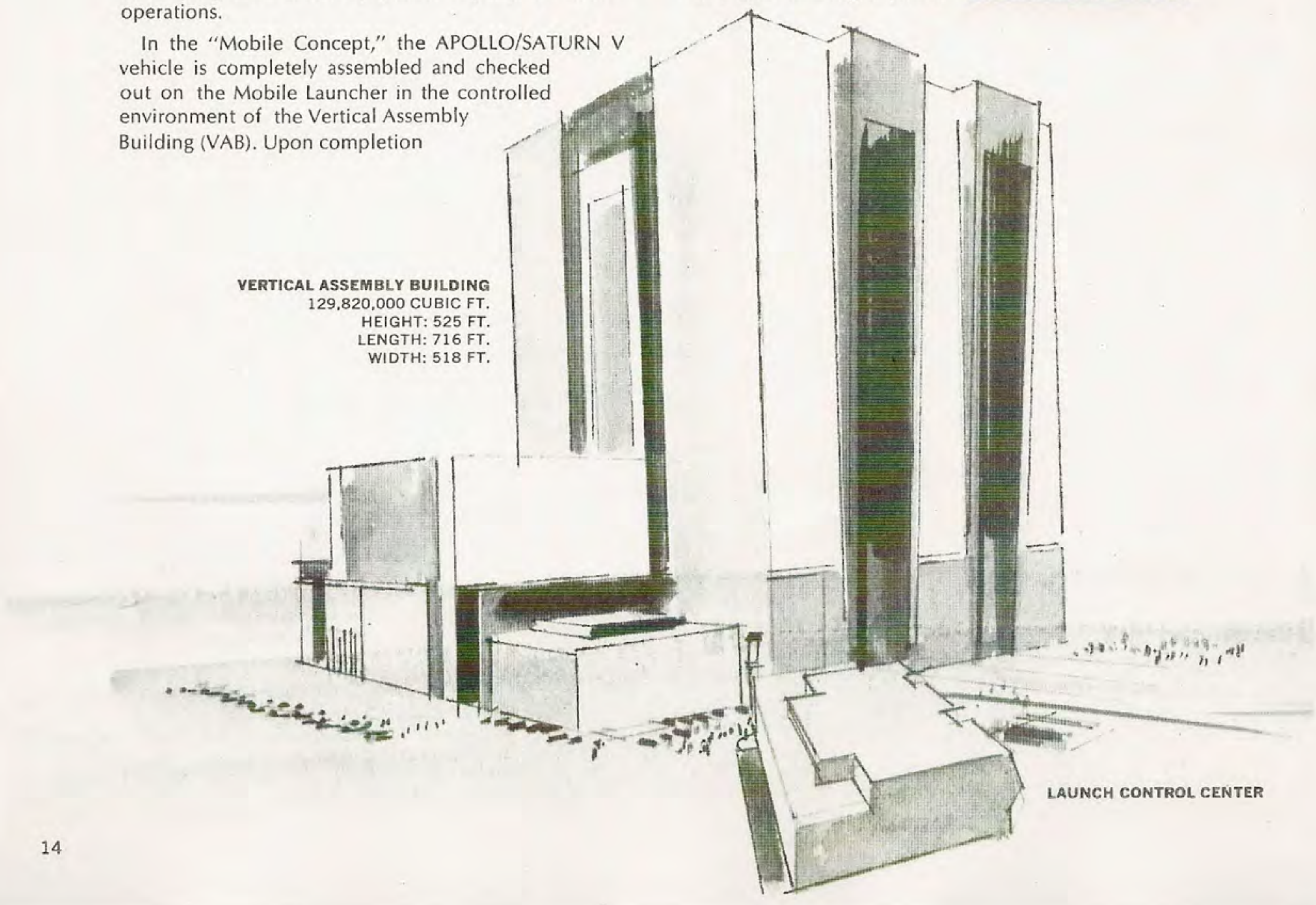
1. The "High Bay Area" may be used to simultaneously assemble and checkout four separate heavy class launch vehicles.
2. The "Low Bay Area" is used for assembly and checkout of the upper stages and spacecraft prior to mating with the main booster sections.

The Launch Control Center is located adjacent to the Vertical Assembly Building and contains the display, monitoring and control equipment required for launch operations.

In the "Mobile Concept," the APOLLO/SATURN V vehicle is completely assembled and checked out on the Mobile Launcher in the controlled environment of the Vertical Assembly Building (VAB). Upon completion of the checkout procedures, the vehicle is then transported to the launch site via the Transporter.

The Mobile Launcher – upon which the space vehicle is erected for checkout, transfer and launching – is a key to launch operations at Complex 39. It serves a dual function, as an assembly platform within the Vertical Assembly Building, a Launch and Umbilical Tower at the launch site. On each Launch Umbilical Tower 325 Marotta valves are used throughout the various hydraulic and pneumatic control circuits. This covers over sixty different valve models and practically every type of Marotta valve . . . pressure regulating, pressure relief, solenoid, check, hand and pressure operated.

The first stage, S-1C, is held in position by four hold down/support arms on the Mobile Launcher. These arms hold the APOLLO/SATURN V vehicle in position until full thrust is developed prior to lift-off. When full thrust is achieved the holddown arms are simultaneously and rapidly released. Marotta components, such as the MV173K, have been an integral part of



VERTICAL ASSEMBLY BUILDING
129,820,000 CUBIC FT.
HEIGHT: 525 FT.
LENGTH: 716 FT.
WIDTH: 518 FT.

LAUNCH CONTROL CENTER

the hold down assemblies on SATURN Complex 34, 37, and 39.

The Launch Umbilical Tower (LUT) has nine swing arms (service arms). The purpose of these arms is to provide support and disconnect capability. Umbilical lines supply the necessary propellant, pneumatic, electrical and data lines to and from the space vehicle and permit this information to be transmitted back to the Launch Control Center. Each of the service arms is equipped with a cat walk for access to the vehicle during the final phases of the countdown sequence. The uppermost arm of the Launch Umbilical Tower is an access arm and provides an environmentally controlled entrance from the White Room located at the top of the Launch Umbilical Tower into the APOLLO Command Module.

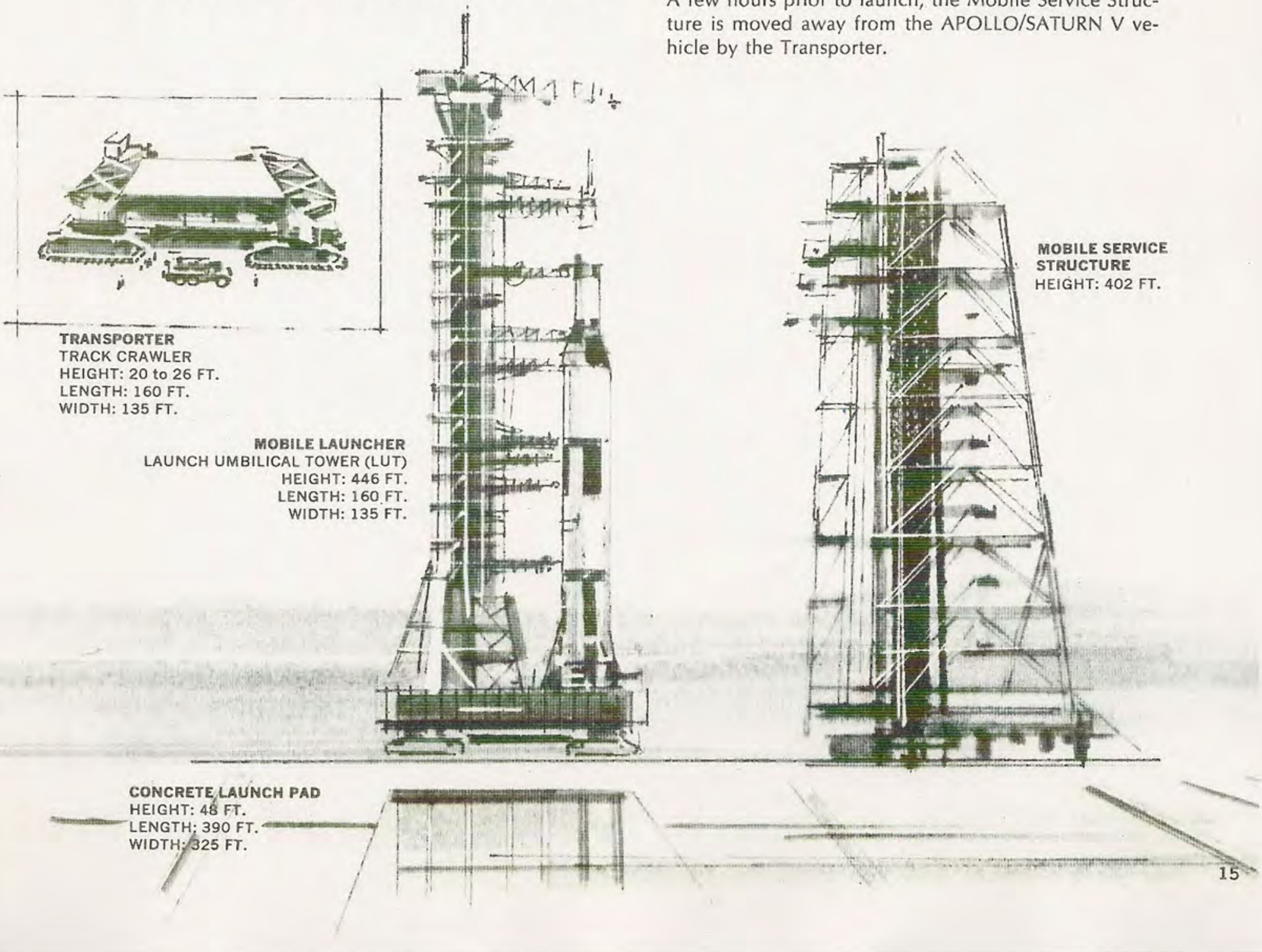
The tenth arm located above the Command Module access arm was provided to grasp the Launch Escape System during the launch check out procedures and prevent the vehicle from swaying during high winds.

At the base of the Mobile Launcher, adjacent to the support/hold down arms, are located devices called "Tail Service Masts". The Tail Service Masts are similar in function to the service arms.

The combined weight of the Transporter/Mobile Launcher and APOLLO/SATURN V vehicle exceeds 17 million pounds at the time of transfer from the Vertical Assembly Building to the launch site. Because of this tremendous weight and size, the Mobile Launcher must be maintained in a level position at all times. This feat is accomplished by optically aligning each corner of the Mobile Launcher and correcting for any error in misalignment via the use of large hydraulic cylinders. To prevent a loss of hydraulic pressure, should there be a break in one of the hydraulic lines, the Transporter incorporates a patented Marotta concept . . . an excess flow valve. The FVA 16, Flo-Fuse, automatically closes if a hydraulic line breaks and increases the hydraulic fluid flow.

The Launch Pad is a re-enforced concrete hardsite measuring 390 feet x 325 feet. After the Transporter has moved the Mobile Launch and APOLLO/SATURN V vehicle into position on the Concrete Launch Pad, it returns to move the Mobile Service Structure into position.

The Mobile Service Structure contains five service platforms which permit circular access to the APOLLO/SATURN V vehicle. The three upper platforms are fixed in position and the two lower platforms may be raised or lowered. The total structure weighs 9,400,000 lbs. A few hours prior to launch, the Mobile Service Structure is moved away from the APOLLO/SATURN V vehicle by the Transporter.



test facilities and transportation

The design and construction challenges of the test facilities and transportation equipment — although less glamorous than those of the spacecraft and launch vehicle — resulted in technical accomplishments absolutely necessary for the completion of the APOLLO/SATURN V program. Much of the vibration test equipment, structural test equipment, pneumatic/hydraulic high pressure, and high flow test areas exceeded the design parameters of standard equipment and, therefore, required designs which advanced the state of the art. The scattered locations of the spacecraft, launch vehicle and launch support equipment, manufacturing and test areas required the design and manufacture of unique modes of transporting this equipment to its final destination . . . Launch Complex 39 at Kennedy Space Center. All modes of transportation were used — aircraft, seagoing barge, motor vehicle and rail. To transport the various sections of the APOLLO/SATURN V, special containers were constructed which had provision for environmentally controlling the atmosphere surrounding these sections to assure their safe journey. Prior to shipment, each piece of equipment was tested to the same conditions that would be experienced at Cape Kennedy prior to launch, during launch and after launch. This testing was required to assure that the APOLLO/SATURN V vehicle and auxiliary equipment would perform reliably throughout each mission.

HIGH PRESSURE TEST LABORATORY

George C. Marshall Space Flight Center, Huntsville, Alabama

The up-to-date high pressure test laboratory design provided a high pressure, high flow testing capability that was previously unavailable anywhere in the United States. This facility incorporated some of the most modern test equipment with many of the unique requirements requiring special component designs. The primary pressure source of 15,000 psi gaseous nitrogen is regulated to the desired test pressures of 10,000 psi to 500 psi **in a single stage** by Marotta model RV64E pressure regulators. The shut-off capability of these systems is provided by Marotta model MV206 pilot actuated solenoid valves. Increased accuracy in control, versatility and rapid changes in test conditions were provided by a Marotta developed analog electronic controller — Marotta model CDU2A.

TRANSPORTATION

The Marotta model RV84 pressure regulators are used to provide a positive pressure environmental control on the containers used to transport the rocket stages which are shipped by air in the specially designed aircraft — "Guppy" and "Super Guppy".

RANDOM MOTION SIMULATOR

The random motion simulator was especially designed to test the Launch Umbilical Tower's (LUT) swing arms under the conditions expected during and after a launch. The Marotta model MV213B performed the function of a pneumatic oscillator and/or variable spring in each of the random motion simulators and permitted the frequency of oscillation to be rapidly varied.

MAROTTA COMPONENTS QUALIFIED FOR APOLLO/SATURN PROGRAMS

SOLENOID OPERATED VALVES

MV34A		GSE
MV36	Flight	GSE
MV36J	Flight	GSE
MV36V		GSE
MV36VA		GSE
MV40	Flight	
MV40A	Flight	
MV40A-2	Flight	
MV40J	Flight	
MV40L		GSE
MV41G	Flight	
MV43SA		GSE
MV56A		GSE
MV56BS		GSE
MV57A		GSE
MV57C		GSE
MV59		GSE
MV68A		GSE
MV74	Flight	GSE
MV74H		GSE
MV74J		GSE
MV74MH-1		GSE
MV74MM		GSE
MV74MP	Flight	
MV74P		GSE
MV74TA		GSE
MV74TB		GSE
MV74V	Flight	GSE
MV74VB	Flight	
MV74VE	Flight	GSE
MV74Z	Flight	GSE
MV74ZA	Flight	GSE
MV76	Flight	
MV78A		GSE
MV87		GSE
MV92B		GSE
MV93		GSE
MV100	Flight	GSE
MV100A	Flight	GSE
MV100AA		GSE
MV100AK		GSE
MV100AS		GSE
MV100G		GSE
MV100H		GSE
MV100J		GSE
MV100N		GSE
MV100NA		GSE
MV100T	Flight	GSE
MV100UA		GSE
MV100UG	Flight	GSE
MV100VA	Flight	
MV100VB	Flight	GSE
MV100WB		GSE
MV100WD		GSE
MV105	Flight	
MV121		GSE
MV121E		GSE
MV121Z		GSE
MV123	Flight	GSE
MV123B		GSE
MV123BA		GSE
MV123BC		GSE
MV123C		GSE
MV123K		GSE
MV123KA		GSE
MV123KB		GSE
MV123KC		GSE
MV126K		GSE
MV130	Flight	GSE
MV130A	Flight	GSE
MV130AZ	Flight	
MV130B	Flight	
MV130EA		GSE
MV130EB		GSE
MV130EC		GSE
MV130ED		GSE
MV130HA		GSE
MV130J		GSE
MV130S		GSE
MV130T	Flight	GSE
MV130TB		GSE
MV130TC		GSE
MV130V		GSE
MV130Z	Flight	
MV136A		GSE
MV140		GSE
MV140M		GSE
MV140RA	Flight	
MV152DC	Flight	
MV159CA	Flight	GSE
MV159CB	Flight	GSE
MV159CC	Flight	GSE
MV159CD	Flight	GSE
MV159CE	Flight	GSE
MV159CF	Flight	GSE
MV159CG	Flight	GSE
MV159CH	Flight	GSE
MV159KA		GSE
MV162		GSE
MV168	Flight	
MV173A		GSE
MV173B		GSE
MV173C		GSE
MV173K		GSE
MV174		GSE
MV178A		GSE
MV182C		GSE
MV185		GSE
MV199A	Flight	
MV202		GSE
MV203		GSE
MV213A		GSE
MV213B		GSE
MV500		GSE
MV500A		GSE
MV500B		GSE
MV508B	Flight	
MV509J		GSE
MV510H-2A		GSE
MV510H-3A		GSE
MV519A		GSE
MV524	Flight	GSE
MV524Z		GSE
MV528		GSE
MV537		GSE
MV540PH-1A		GSE
MV543		GSE
MV543K		GSE
MV544	Flight	GSE
MV547		GSE
MV549		GSE
MV549K		GSE
MV555		GSE
MV557H		GSE
MV563		GSE
MV563HC		GSE
MV563K		GSE
MV583H		GSE
MV583H-2A		GSE
MV583H-4A		GSE
MV583J		GSE
PLV34B		GSE
PLV34E		GSE
SPV130		GSE
SPV130A	Flight	GSE
SPV130B		GSE
SPV130M		GSE
SPV130M-LA		GSE

AUTOMATIC SAFETY SHUT OFF VALVES

FVA8		GSE
FVA12		GSE
FVA16		GSE
FVA32B		GSE
SPV19B		GSE

PRESSURE REGULATING VALVES

RH292EB-04		GSE
RV23B		GSE
RV23BA		GSE
RV23BZ		GSE
RV23C		GSE
RV23D-1		GSE
RV23DK		GSE
RV23FC		GSE
RV23H		GSE
RV23HS		GSE
RV23SC		GSE
RV23SK		GSE
RV23ZA		GSE
RV23ZB		GSE
RV23ZD		GSE
RV23ZE		GSE
RV24P		GSE
RV24PG		GSE
RV24Q		GSE
RV24QC		GSE
RV24QS		GSE
RV24R		GSE
RV31		GSE
RV31G		GSE
RV31H		GSE
RV31HA		GSE
RV31HB		GSE
RV31K		GSE
RV31ME		GSE
RV31MJ		GSE
RV31S		GSE
RV31SL		GSE
RV31SQ		GSE
RV31SS		GSE
RV41AK		GSE
RV41B		GSE
RV41B-1		GSE
RV41D		GSE
RV41D-1		GSE
RV42B		GSE
RV43		GSE
RV44P		GSE
RV52CA		GSE
RV52CC		GSE
RV52CD		GSE
RV52DW		GSE
RV52DY		GSE
RV53DF		GSE
RV53DW		GSE
RV53DY		GSE
RV53LS		GSE
RV60D		GSE
RV61D		GSE
RV64E		GSE
RV74AS		GSE
RV74EB		GSE
RV78A		GSE
RV78AH	Flight	
RV78AN		GSE
RV78BM-1		GSE
RV78BN		GSE
RV78E		GSE
RV79C		GSE
RV79CA		GSE
RV79G		GSE
RV79L		GSE
RV79LK		GSE
RV84		GSE

CHECK VALVES

CRV500		GSE
CV32		GSE
CV33		GSE
CVF508J-1A		GSE
CVF516J-1A		GSE
CVM4	Flight	GSE
CVM6	Flight	GSE
CVM6D		GSE
CVM8	Flight	GSE
CVM10	Flight	GSE
CVM12	Flight	GSE
CVM16	Flight	GSE
CVM16-3A		GSE
CVM24	Flight	GSE
CVM37	Flight	GSE
CVM504-1A		GSE
CVM504B		GSE
CVM506E	Flight	
CVM508-1A		GSE
CVM512C		GSE
CVM516-1A		GSE
SCV508		GSE
SCV532		GSE

HAND OPERATED VALVES

HVN4D		GSE
HVN6D		GSE
HVA8D		GSE
HVA12D		GSE
HVA16A		GSE
LV74M		GSE
LV140B		GSE
SPV27		GSE
SPV27A		GSE
SPV29A		GSE
SPV29AA		GSE
SPV29B		GSE
SPV29BA		GSE

PRESSURE OPERATED VALVES

PV3		GSE
PV3G		GSE
PV14		GSE
PV20		GSE
PV20J		GSE
PV21A		GSE
PV21B		GSE
PV33D	Flight	
PV43C		GSE
PV43D		GSE
PV563K-1A		GSE
PV583K-1A		GSE
PVM555-30-1A		GSE

PRESSURE RELIEF VALVES

PRV4M		GSE
PRV14C		GSE
PRV14C		GSE
PRV30F		GSE
PRV47		GSE
PRV47A		GSE
PRV47D		GSE
PRV49A		GSE
PRV520		GSE

marotta

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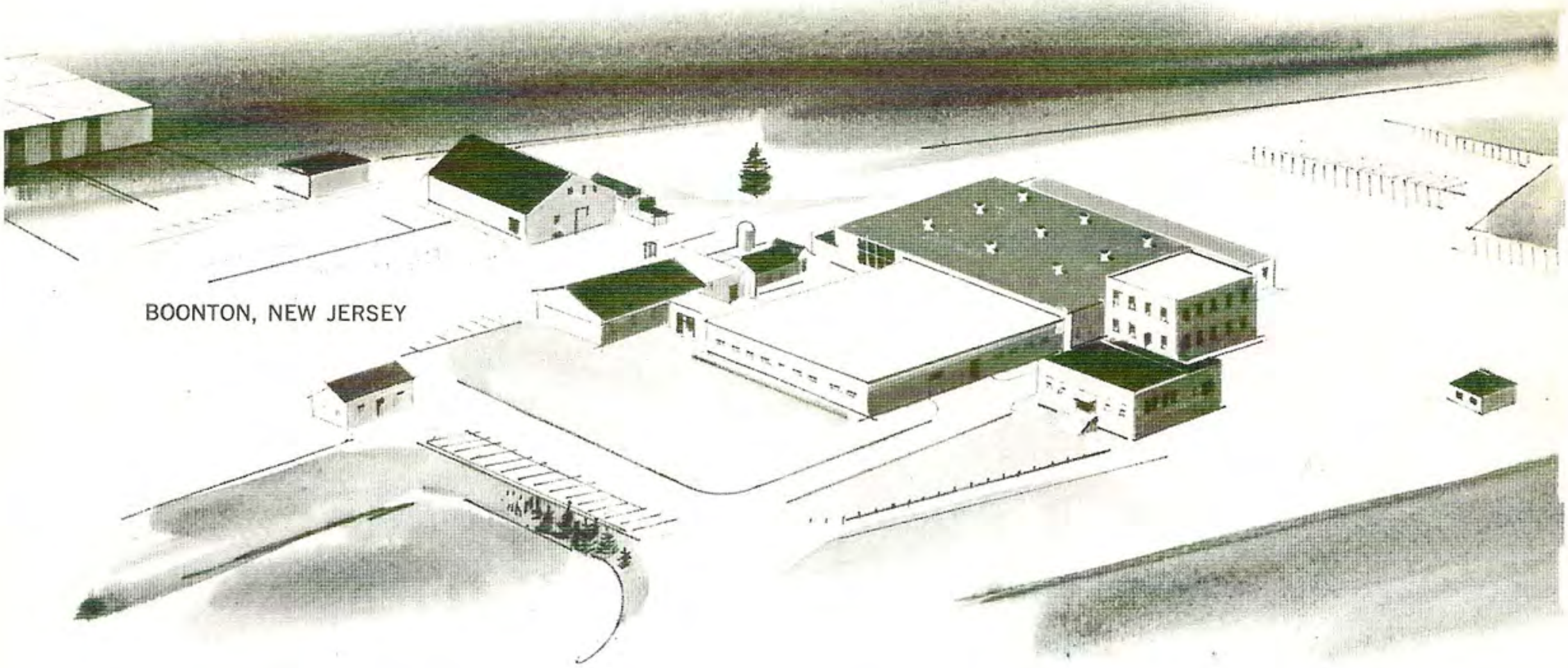
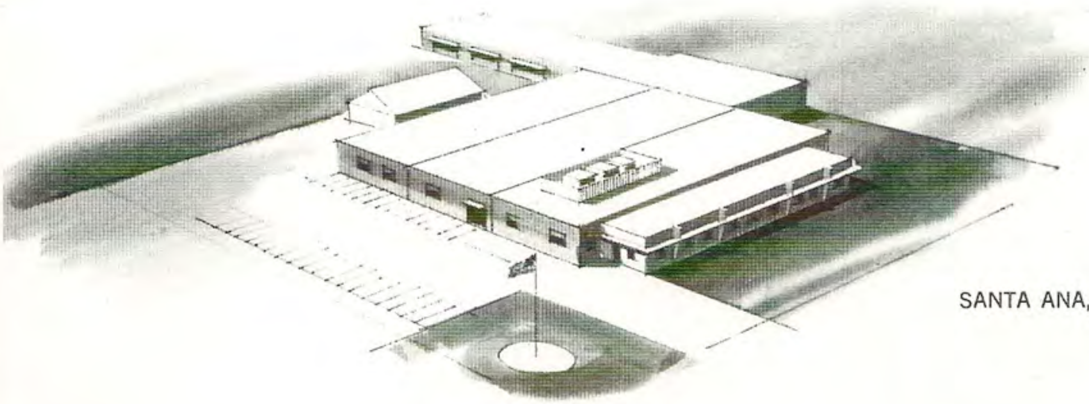


BOONTON, NEW JERSEY



SANTA ANA, CALIFORNIA