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Descriptors-Aerospace Technology, *Earth Science, *Industrial Arts, Instructional Materials, Laboratory Manuals, Models, *Science Activities, *Secondary School Science

Identifiers-National Aeronautics and Space Administration

This publication provides twelve model spacecraft construction plans for use by secondary school teachers in industrial arts classes. These models were adopted and developed from plans supplied by the National Aeronautics and Space Administration and are representative selections from the many spacecraft used in space exploration programs. Some examples are Saturn, Explorer, Mariner, Apollo, Gemini, and Tiros. Each model is described and illustrated in detail, and background data are provided for each rocket model. (BC)

F-NASA

MODEL SPACECRAFT CONSTRUCTION

UNITS FOR SECONDARY SCHOOL INDUSTRIAL ARTS

A REPORT, WITH ADDENDUM, SUBMITTED BY THE

CALIFORNIA STATE COLLEGE AT LONG BEACH

TO THE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MODEL SPACECRAFT CONSTRUCTION

Units for Secondary School Industrial Arts

A Report

to the

National Aeronautics and Space Administration

submitted May 28, 1964

with an

Addendum Report submitted July 1, 1966

by the

California State College at Long Beach

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Introduction to Second Edition

This new, enlarged second edition of MODEL SPACECRAFT CONSTRUCTION has been prepared by the California State College at Long Beach, as a report to the National Aeronautics and Space Administration to meet the increasing need of secondary school industrial arts teachers for this information.

Six new sets of model drawings and instructions have been included as an addendum: X–15, Gemini Launch Vehicle (Titan II), Gemini, TIROS, Orbiting Astronomical Observatory (OAO) and Lunar Module.

The twelve spacecraft included in this new edition are a representative selection from the many used by NASA in space exploration programs.

TO THE TEACHER

This publication was prepared by a committee of industrial arts educators for the purpose of providing aerospace education activities in the secondary schools. It includes the six model plans completed in 1964 and an addendum of six additional model plans completed in June 1966. These were adapted and developed from plans supplied by the National Aeronautics and Space Administration.

The project committee comprised a group of carefully selected secondary school industrial arts teachers of the Long Beach-Los Angeles area, working under the direction of staff members of the Division of Applied Arts and Sciences of the California State College at Long Beach. Although this material was prepared by industrial arts teachers for industrial arts class activities, the project committee recognizes the numerous possibilities for relating these activities to other subjects of the curriculum.

Projects were developed as suggested procedural patterns with the intent that they be adapted to fit existing classroom and shop situations. The recommended materials and procedures are only guidelines. The student should be encouraged to experiment and apply scientific principles to problem solving techniques in constructing any of the model spacecraft.

MODEL SPACECRAFT CONSTRUCTION

Report submitted by the
Long Beach State College at Long Beach, California
May 28, 1964

PROJECT STAFF

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Mr. Arthur Steiner
Mr. Ray Young

Acknowledgments

Model Spacecraft Construction, an incentive guide in aerospace education for secondary teachers, was an outgrowth of the Aerospace Education Workshop at Long Beach State College at Long Beach, California in August 1963. The material was developed through the efforts of nine teachers selected on the basis of their ability and background in the design and construction of aerospace models. The project was supported by the National Aeronautics and Space Administration.

The material on Spacecraft Construction was made possible through the efforts of the following individuals: Mr. Floyd M. Grainge, Professor of Industrial Arts, Long Beach State College at Long Beach; Mrs. Dorothy DeBord, Secretary, Applied Arts and Sciences Division, Long Beach State College at Long Beach; Miss Toshiko Goto, Art Instructor, Jordan Senior High School, Long Beach, California; Mr. Jack Kerner, Graduate Student, Long Beach State College at Long Beach; Mr. Richard L. Krahenbuhl, Industrial Arts Teacher, Bancroft Junior High School, Long Beach, California; Dr. Irvin T. Lathrop, Associate Professor of Industrial Arts, Long Beach State College at Long Beach; Mr. Howard B. Levine, Industrial Arts Teacher, LaHabra High School, Fullerton, California; Mr. Arthur Steiner, Vice Principal, Dewey Continuation High School, Long Beach, California; Mr. Ray Young, Graduate Student, Long Beach State College at Long Beach.

I would also like to thank the teachers in the field and graduate students who assisted in the review of the material for basic concepts and procedures. Without the assistance of these fine critics, the project would not have been completed so readily for use in aerospace education. Our hope is that this project will provide a real stimulus for the implementation of advance work in the area of aerospace education in the secondary schools.

C. Thomas Dean

May 1964

C. Thomas Dean, Project Director
Chairman, Division of Applied Arts and Sciences
Long Beach State College
Long Beach, California

S A T U R N

With what envy man watched the birds wing through the air! He watched how they rose from the ground. He watched how they flew down from the trees. He watched the mighty ones soar and swoop. He studied in detail every one. If only he, too, could fly!

When Saturn V blasts Apollo on its mission, the astronauts might well smile as they remember this ancient wish. Without this wish, however, they might not be navigating through space; for space travel had to start with the wish of a dreamer. Daedelus, we are told, built wings of bird feathers and wax to escape from Crete. DaVinci's dream was more concrete. He only needed an engine to fly. The Wright brothers made the dream come true. Their memorable flight at Kitty Hawk started a continuing program of research and development in aerodynamics.

However, the first serious consideration of space flight probably grew out of the development of the rocket as a means of propulsion. The rocket is believed to have been introduced by the Chinese as early as the 13th century. They used powder rockets to direct "fire arrows" at the Mongols during the seige of Kaifeng. During the next five centuries, rockets were chiefly used for fireworks. About 1800, Congreve in England developed a solid fuel war rocket which led to its widespread military use.

Practical studies of using rocket propulsion for space flight started near the end of the 19th century. Konstantin Ziolkowsky, a Russian mathematics teacher; Herman Ganswindt, a German law student, and Robert Esnault-Pelterie of France did considerable theoretical work on space flight and rocket propulsion.

The generally acknowledged father of space flight, Dr. Robert H. Goddard of the United States, translated the dream and the theory into hardware. He conducted extensive research in rocketry between 1914 and World War II. On March 16, 1926, he successfully tested the world's first liquid fuel rocket.

Although Dr. Goddard continued his work until his death, he failed to arouse enthusiasm in the United States. In Europe, however, rocket power gained new impetus. The German army started a research program which culminated in the famed Peenemunde project and the V-2 missile, a 46-foot rocket of 200-mile range used to bombard London from the continent. This V-2 is the modern forerunner of our current boosters.

The rocket is the only power plant presently capable of traveling through interplanetary space. Although it is basically an internal combustion engine, it differs from all others in one respect. It carries its own oxydizer and therefore can operate in a vacuum. The rocket is also the only engine capable of producing propulsive power while moving at very high velocities. It is important as a booster because at present the rocket engine develops the greatest thrust per pound of engine weight and has the smallest frontal area per unit of thrust of all power plants.

Very high speed is necessary to travel into space. A satellite can be placed in earth orbit at the speed of 18.000 miles per hour.

By increasing the speed to 25,000 miles per hour, the gravitational pull of the earth can be overcome. To place a 90,000 pound spacecraft into translunar trajectory, then, requires a tremendous amount of power. This is the mission of Saturn V, the three stage rocket which is to boost Apollo to the moon.

The first stage of Saturn V will be powered by five F-I engines. Each is capable of delivering 1 1/2 million pounds of thrust and consumes 3 tons of liquid oxygen and kerosene every second. Largest of such engines being developed in the United States, it stands 18 feet high and weighs 10 tons. This first stage, the S-1C itself, will weigh 140 tons empty and over 2,300 tons fueled. It will be 33 feet in diameter and stand 138 feet tall.

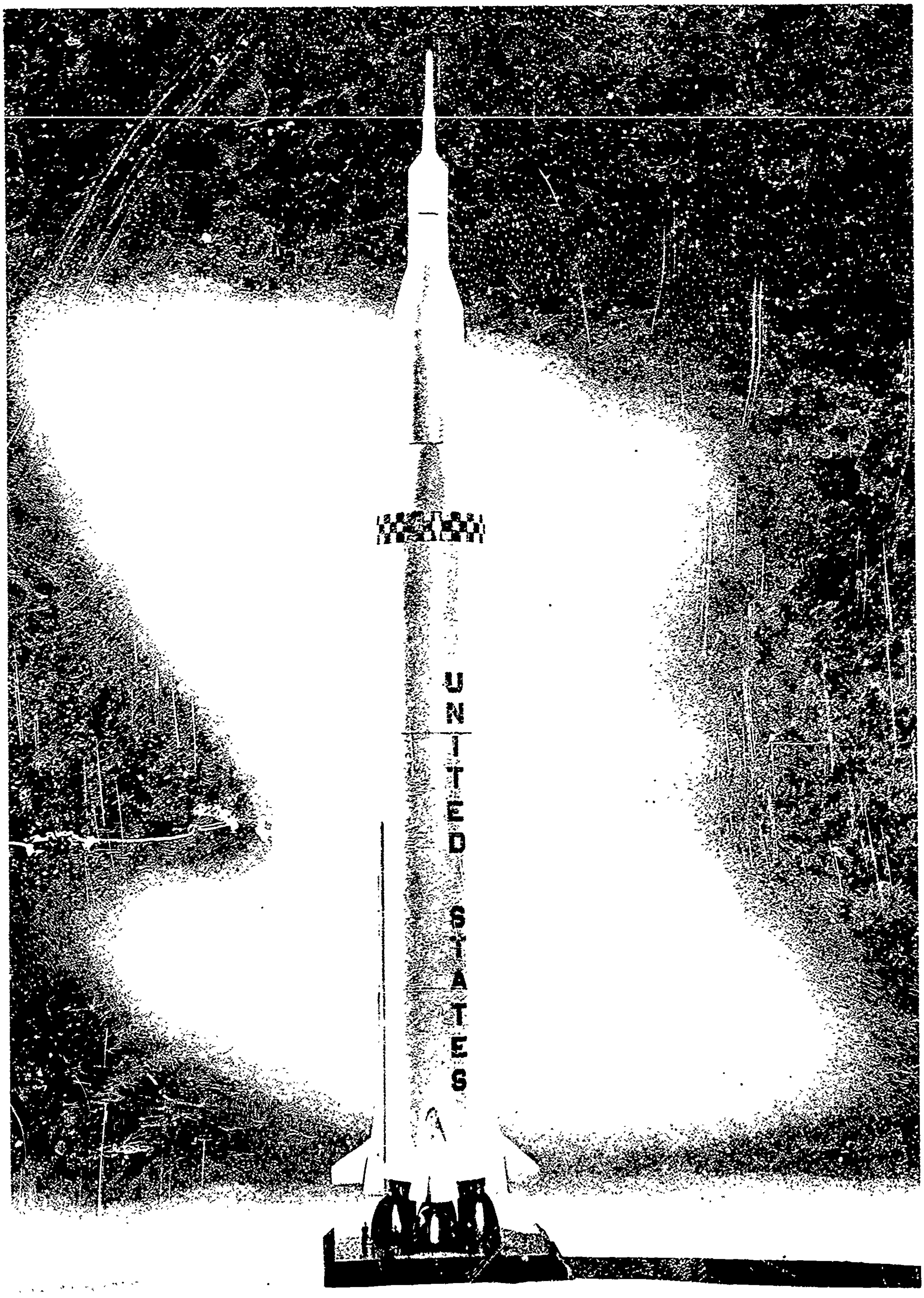
The second SII stage to be propelled by liquid hydrogen and liquid oxygen will deliver 1,000,000 pounds of t[illegible]st with its five J-2 engines. Being equal in diameter, 81 1/2 feet in height, and weighing 37 1/2 tons, it will ride atop the first stage.

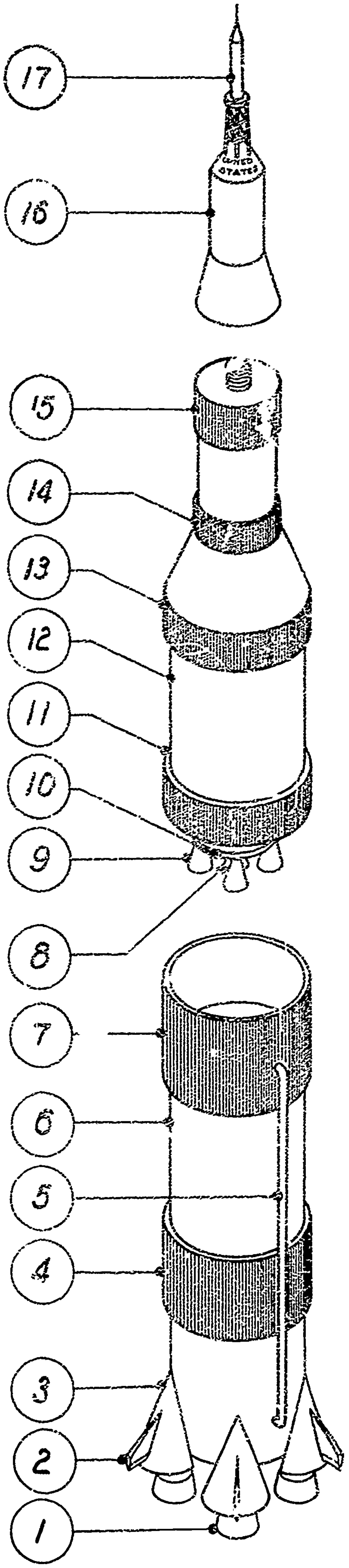
The S-IVB will be powered by a single J-2 engine with the thrust of 200,000 pounds. It will serve as the third stage of the Saturn V, the vehicle which will send the Apollo spacecraft on its mission to the moon.

Chemical combustion is presently used in rocket propulsion because no other means of accelerating mass to high exhaust speeds has been perfected. Other promising systems now under study include: nuclear fission, nuclear fusion, ion power, arc heating, solar power, and photon power.

To every action there is an equal and opposite reaction. Newton's third law translated to hardware, then, is surely man's passport to space.

SATURN





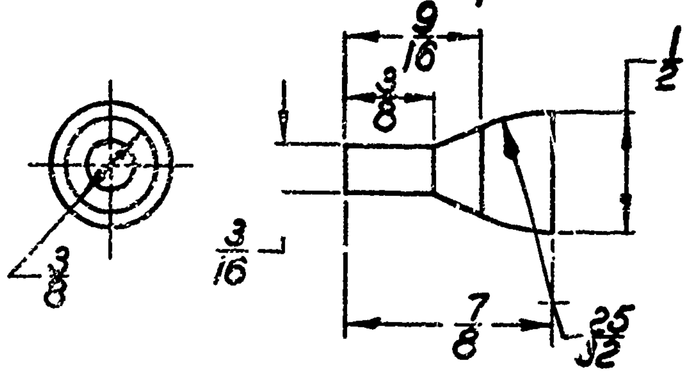
PARTS LIST- SATURN V ROCKET & APOLLO CAPSULE

NO.	NAME	REQ'D.	MAT'L	COLOR
1.	F-1 ENGINE	5	WOOD	WHITE
2.	STABILIZING FIN	4	WOOD	WHITE
3.	ENGINE SHIELD	4	WOOD	WHITE
4.	S-IC ROCKET BAND	1	BALSA WD.	BLACK
5.	FUEL LINE	1	$\frac{1}{16}$ BRS. ROD	POLISH
6.	S-IC 1ST STAGE	1	WOOD	WHITE
7.	S-IC ROCKET BAND	1	BALSA WD.	BLACK
8.	J-2 ENGINE	1	STEEL	WHITE
9.	J-2 ENGINE	4	WOOD	WHITE
10.	ENGINE MOUNT	1	WOOD	WHITE
11.	S-II ROCKET BAND	1	BALSA WD.	BLACK
12.	ROCKET-UPPER STAGE	1	WOOD	WHITE
13.	S-II ROCKET BAND	1	BALSA WD.	BLACK
14.	S-II ROCKET BAND	1	BALSA WD.	BLACK
15.	S-II ROCKET BAND	1	BALSA WD.	BLACK
16.	APOLLO CAPSULE	1	WOOD	WHITE
17.	ESCAPE SYSTEM	1	METAL	WHITE

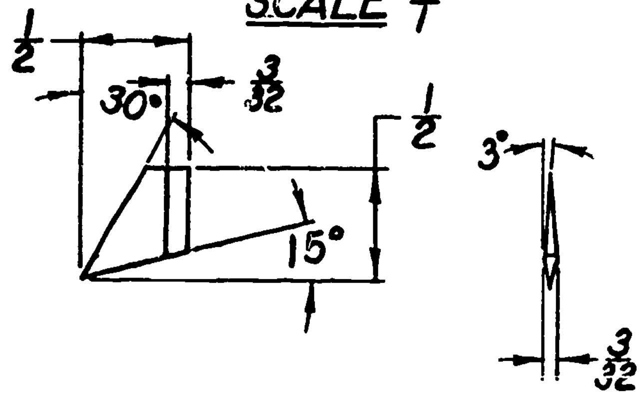
NOTES:

1.- S-IC ROCKET SECURED TO S-II ROCKET BY A 10-24 THREADED ROD AS SHOWN ON DETAILS.
2.- APOLLO CAPSULE SECURED TO S-II ROCKET BY $\frac{1}{4}$-20 THREADED ROD - SEE DETAILS.
3.- ALL PAINTED SURFACES-HAND RUBBED AND WAXED.

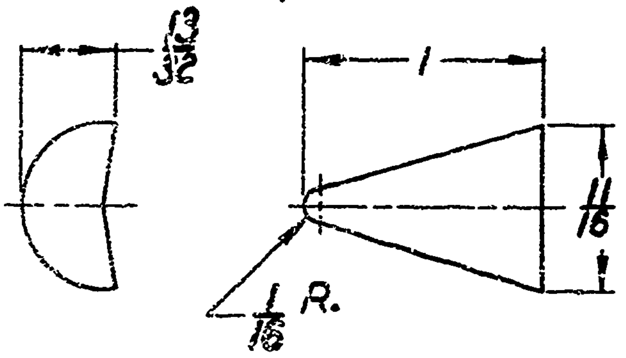
DETAIL NO. 1
SCALE 2/1



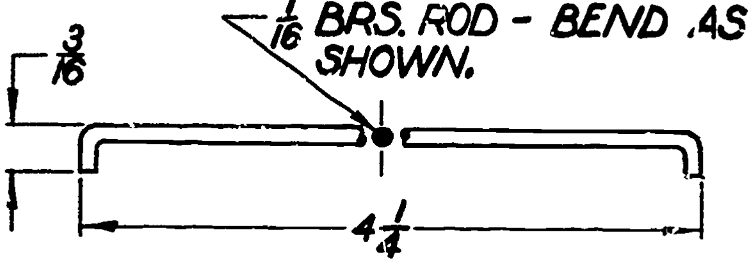
DETAIL NO. 2
SCALE 2/1

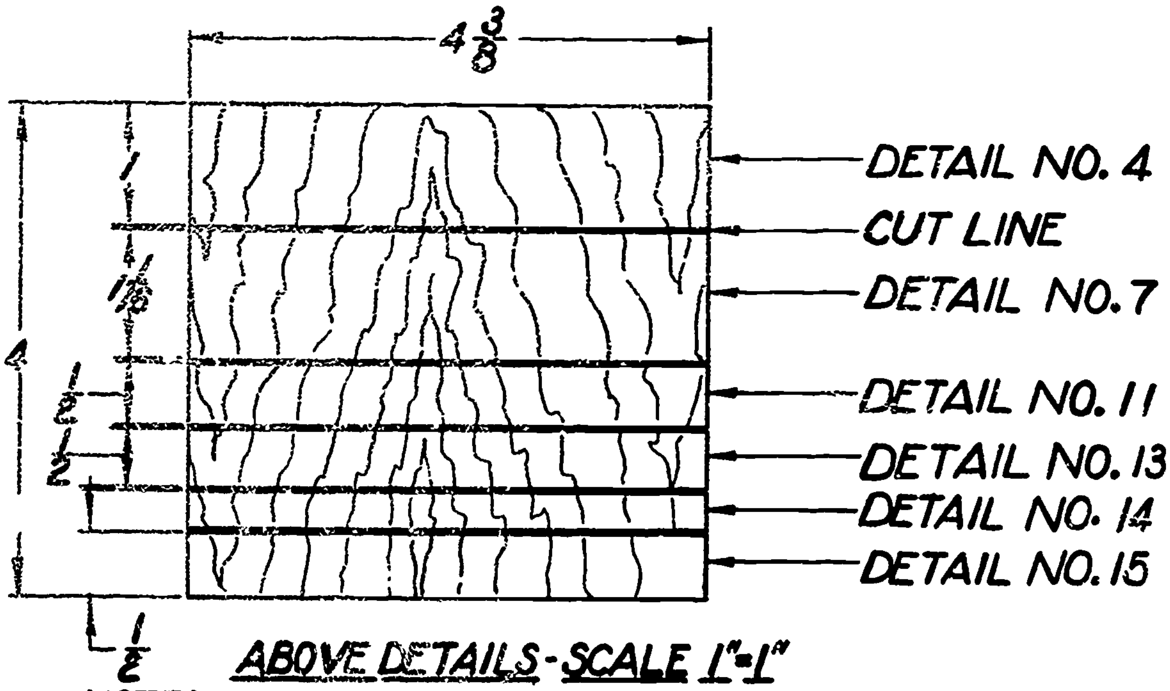


DETAIL NO. 3
SCALE 2/1



DETAIL NO. 5
SCALE 2/1



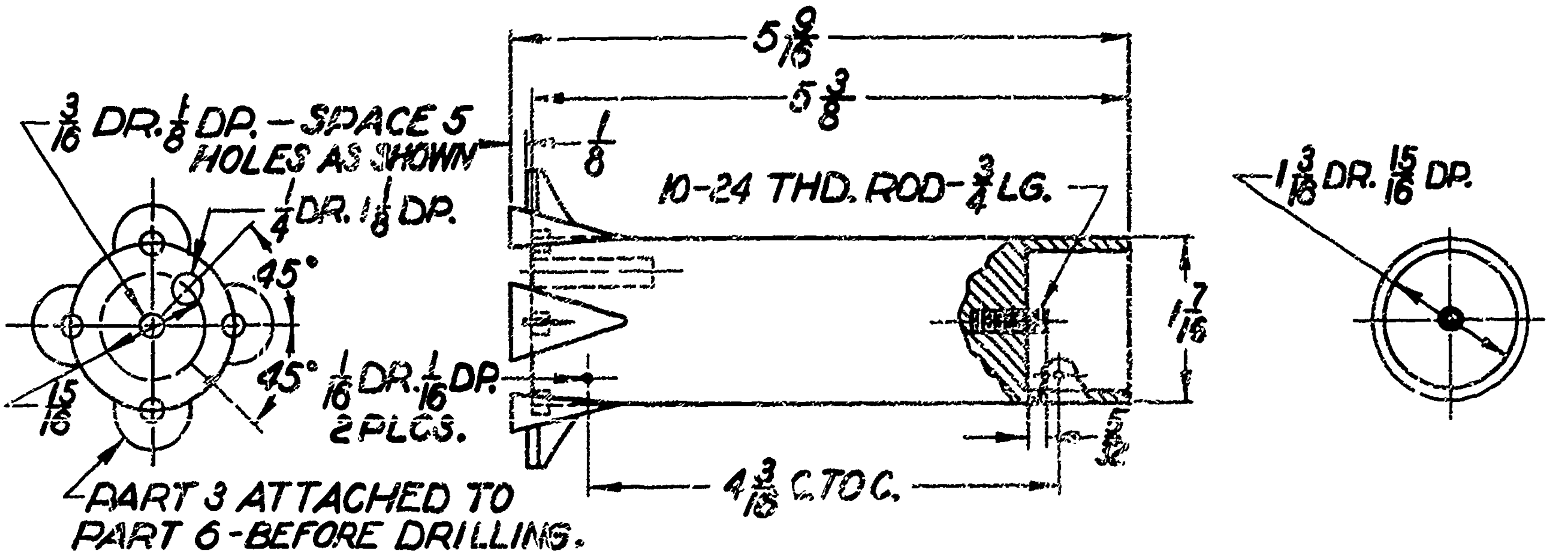


ABOVE DETAILS - SCALE 1"=1"

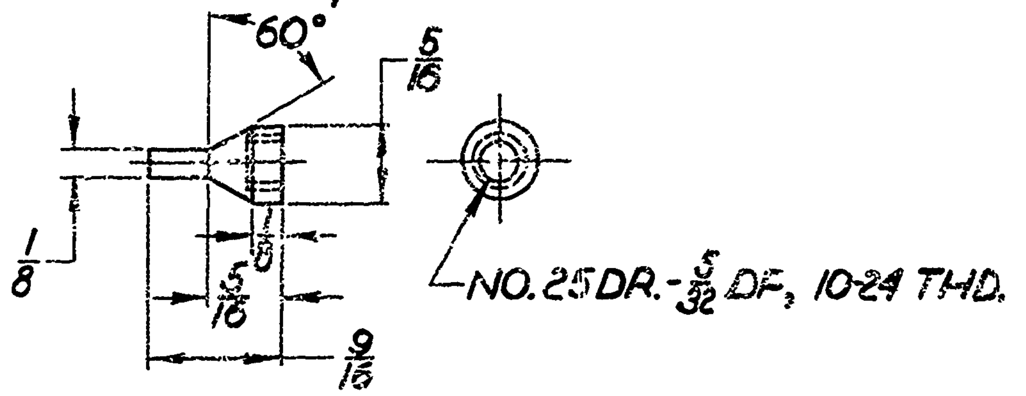
NOTES:

1.- MATL. 1/32" BALSA WD. LAYOUT WITH GRAIN PATTERN AS SHOWN.
2.- PAINT BANDS BLACK BEFORE CEMENTING IN PLACE.

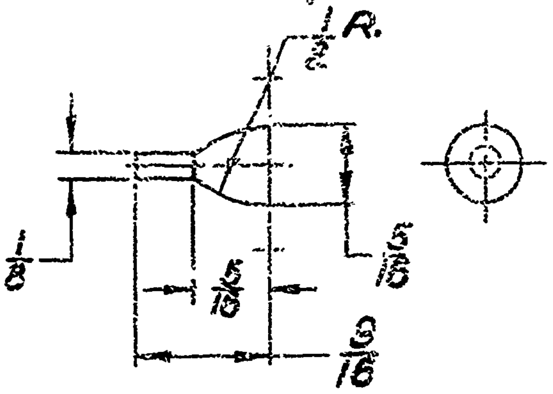
DETAIL NO. 6
SCALE 1"=1"



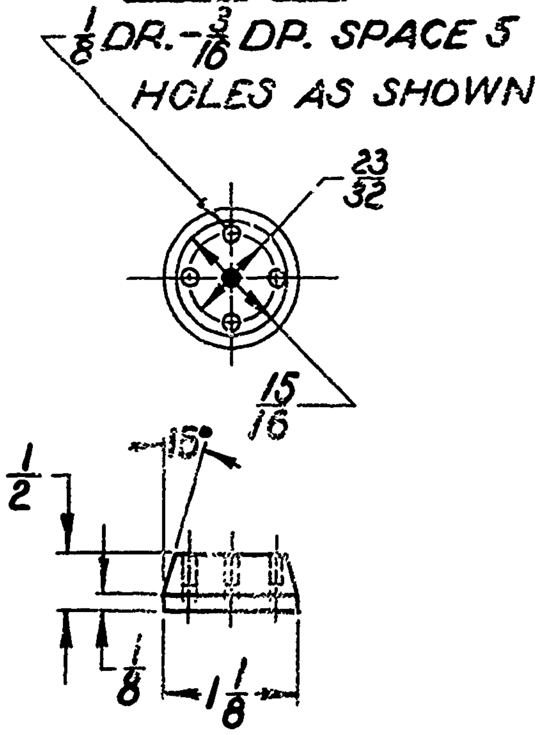
DETAIL NO. 8
SCALE 2/1



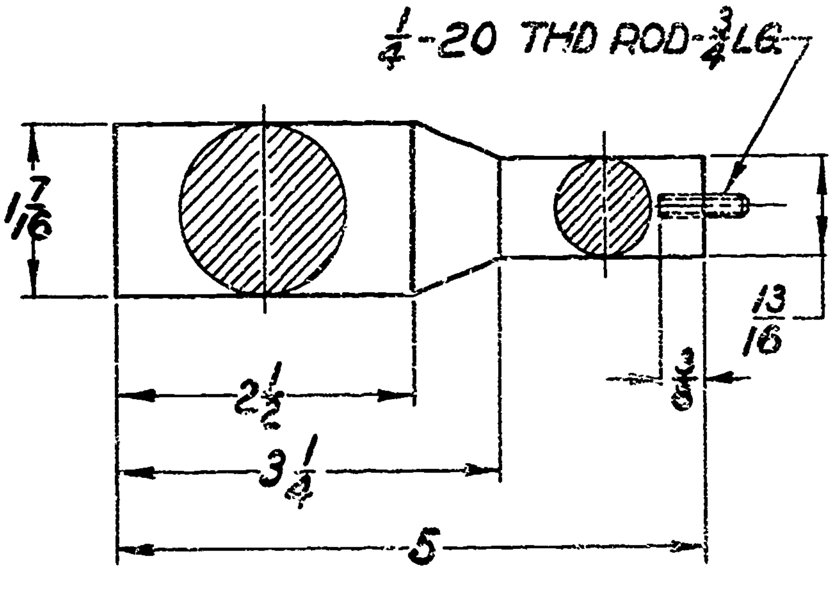
DETAIL NO. 9
SCALE 2/1

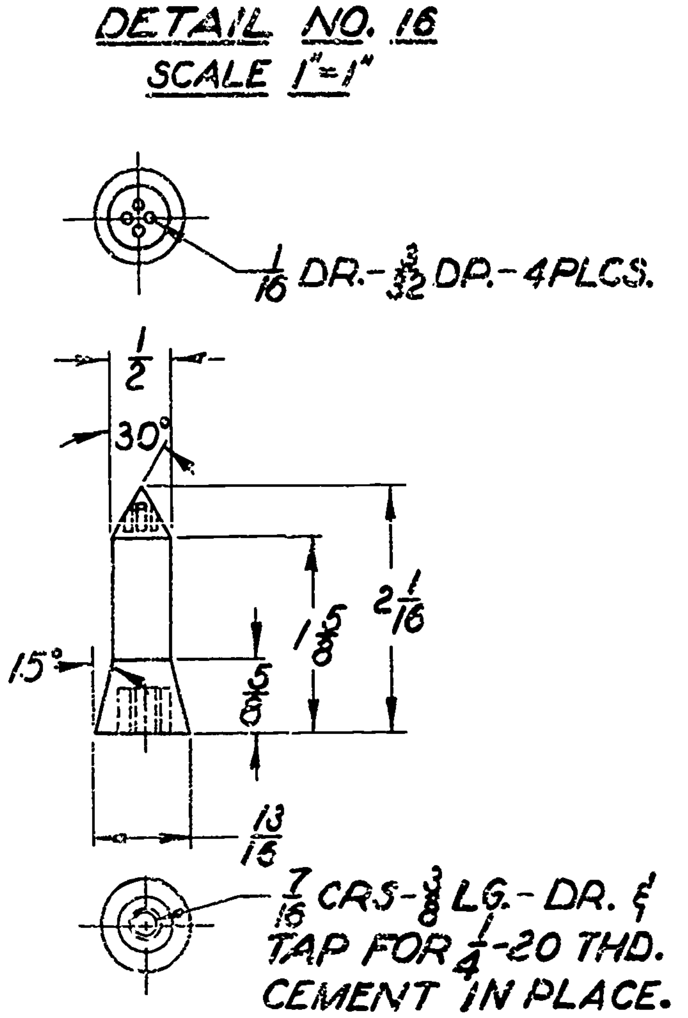


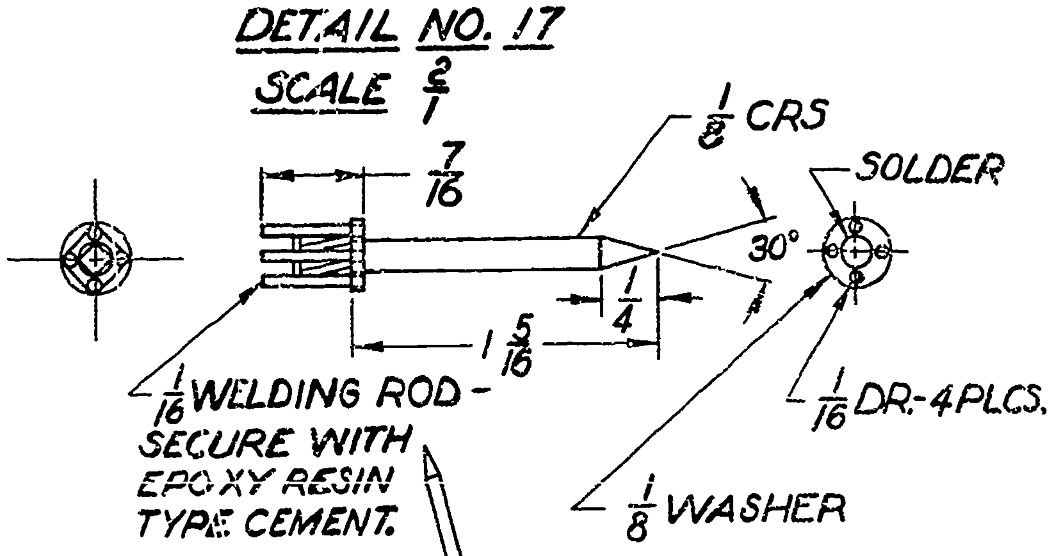
DETAIL NO. 10
SCALE 1"=1"

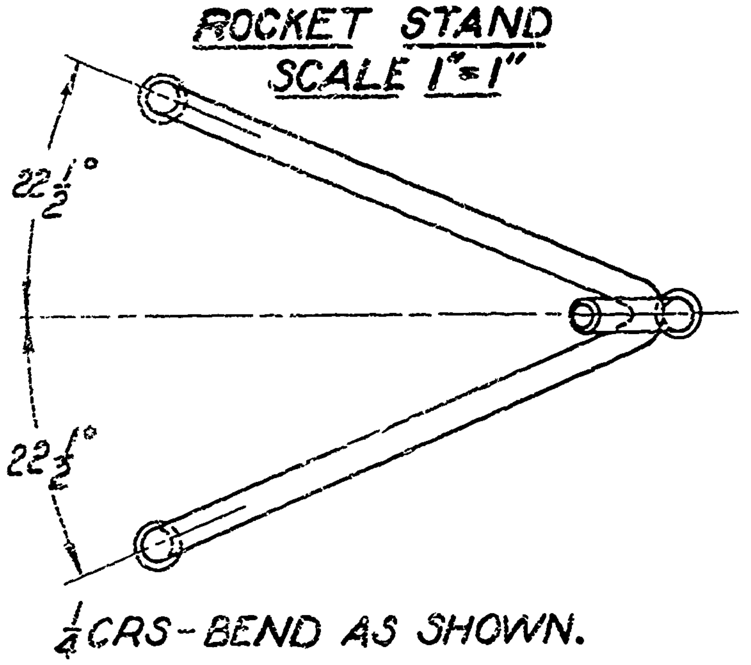


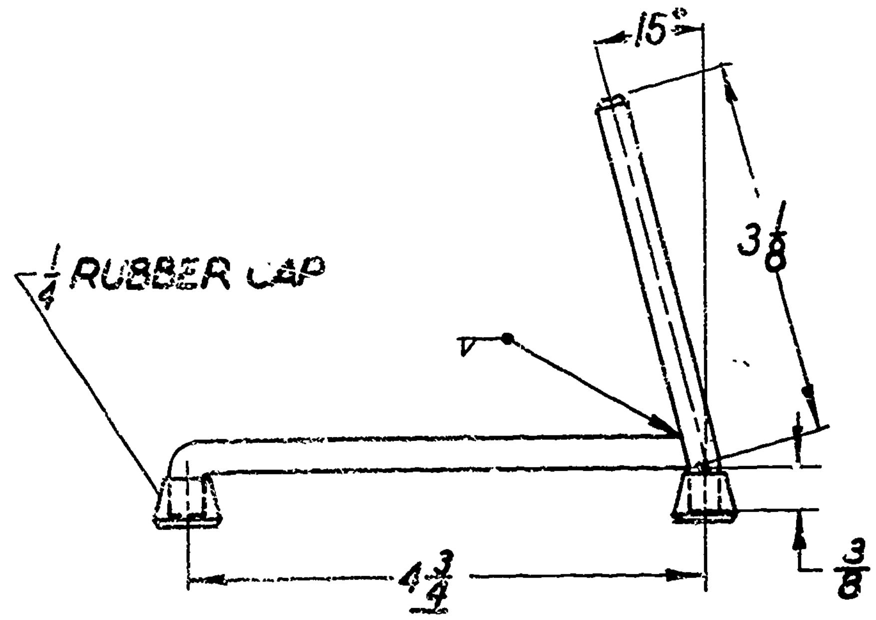
DETAIL NO. 12
SCALE 1"=1"

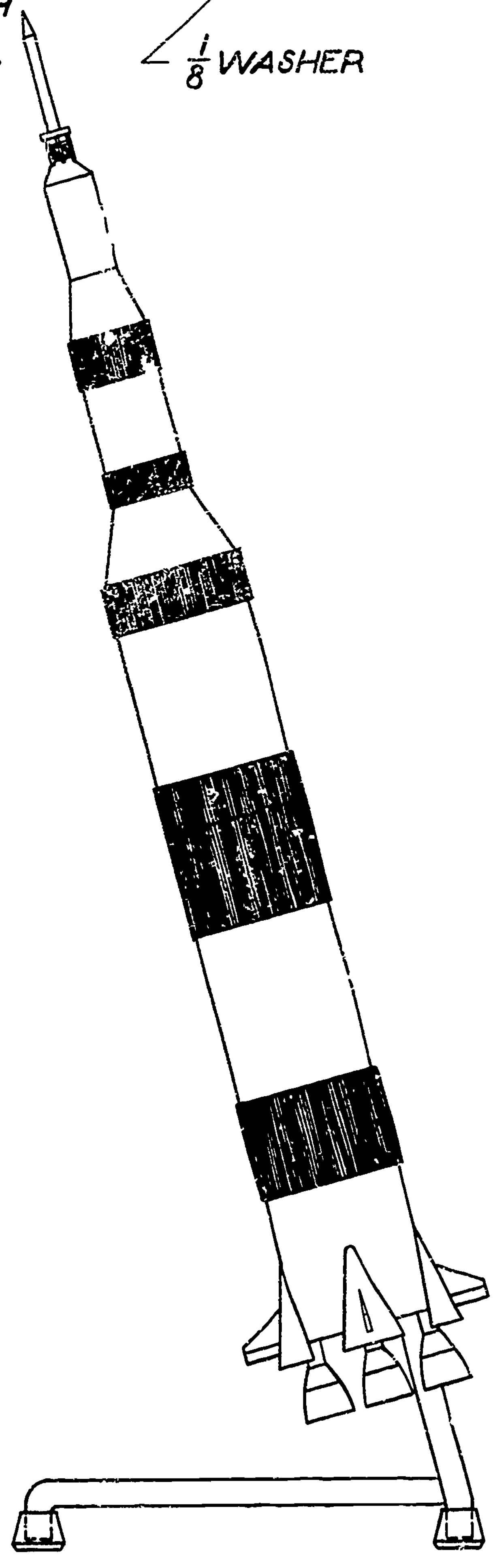



DETAIL NO. 16
SCALE 1"=1"
1/16 DR.-3/32 DP.-4PLCS.
1/2
30°
2 1/16
1 5/8
15°
5/8
13/16
7/16 CRS-3/8 LG.-DR. &
TAP FOR 1/4-20 THD.
CEMENT IN PLACE.


DETAIL NO. 17
SCALE 2/1
1/8 CRS
SOLDER
7/16
30°
1/4
1 5/16
1/16 WELDING ROD -
SECURE WITH
EPOXY RESIN
TYPE CEMENT.
1/16 DR.-4PLCS.
1/8 WASHER


ROCKET STAND
SCALE 1"=1"
22 1/2°
22 1/2°
1/4 CRS-BEND AS SHOWN.


15°
3 1/8
1/4 RUBBER CAP
4 3/4
3/8



RECOMMENDED MATERIALS FOR CONSTRUCTION

SATURN V

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	Five	Wood - pine	White
2	Four	Wood - pine	White
3	Four	Wood - pine	White
4	One	Wood - balsa	Black
5	One	Metal - brazing rod	Polish
6	One	Wood - pine	White
7	One	Wood - balsa	Black
8	One	Metal - rod	White
9	Four	Wood - pine	White
10	One	Wood - pine	White
11	One	Wood - balsa	Black
12	One	Wood - pine	White
13	One	Wood - balsa	Black
14	One	Wood - balsa	Black
15	One	Wood - balsa	Black
16	One	Wood - pine	White
17	One	Metal - rod	White

RECOMMENDED PROCEDURE FOR CONSTRUCTION

SATURN V

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood	Turn on lathe to specified dimensions	Finish sand all surfaces	
2	Wood or plastic	Cut and shape to specified dimensions	Finish sand all surfaces	
3	Wood or plastic	Turn on lathe to specified dimensions and saw to shape	Finish sand all surfaces	Glue part no. 2 to part no. 3 using epoxy resin
4) 7) 11) 13) 14) 15)	Balsa wood or cardboard	Cut and fabricate to specified dimensions and detail	Paint black prior to cementing to the main body	
5	Brass rod	Shape to specified dimensions	Polish	
6	Wood	Turn on lathe to specified dimensions. Drill as indicated on the detail drawing	Finish sand all surfaces	Glue parts no. 1, 3, 4, 7 and 5 to part no. 6 using epoxy resin

RECOMMENDED PROCEDURE FOR CONSTRUCTION

SATURN V

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8	Steel or brass	Turn on lathe to specified dimensions. Drill and tap as indicated on the detail drawing	Polish	
9	Wood	Turn on lathe to specified dimensions	Finish sand all surfaces	
10	Wood	Turn on lathe to specified dimensions. Drill as indicated on the detail drawing	Finish sand all surfaces	
12	Wood	Turn on lathe to specified dimensions. Drill as indicated on the detail drawing	Finish sand all surfaces	Glue parts no. 8, 9,10,11,13,14 and 15 to part no. 12. Glue treaded rod into position using epoxy resin
16	Wood	Turn on lathe to specified dimensions. Drill as indicated on the detail drawing	Finish sand all surfaces	Glue threaded bushing into place using epoxy resin

RECOMMENDED PROCEDURE FOR CONSTRUCTION

SATURN V

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
17	Steel or brass	Fabricate parts to dimensions and details indicated in detail no. 17		Cement to part no. 16 using epoxy resin
			Paint parts no. 1, 2,3,6,8,9,10,12,16 and 17 white	

E X P L O R E R

Twinkle, twinkle, little star;

How I wonder what you are!

Up above the world so high.

Like a diamond in the sky.*

Why do you twinkle? What are you doing there? Who put you there? Man's natural curiosity has led him on a never-ending search for answers to the mysteries of his universe.

Until recently our only source of information about outer-space lay entirely on light and other radiation that penetrated earth's atmosphere from the vastness of the universe. This atmosphere that makes the stars seem to twinkle obscures and distorts our vision. Through the use of sounding rockets, we have been able to gather information in outer space. These rockets are relatively small, relatively inexpensive vehicles for lofting simple payloads from a few score to a few thousand miles above the earth's surface. In the few minutes of flight before the rocket plunges back to earth, the payload instruments measure the selected properties of space. This technique highly developed in the decade following World War II was the only technique for on-site measurements of space until satellite flight was achieved in 1957.

Although the sounding rocket remains a basic tool for acquiring local instantaneous measurements of space properties, the satellite is our major tool for acquiring long-term measurements. It is possible to

*"The Little Star" Jane Taylor

gradually acquire a basic understanding of the space in all directions at distances up to several hundred thousand miles by varying the orbital inclination and the ellipticity of the satellite paths.

The Explorer program consists of geophysical satellites of various configurations to study the space environment and upper atmosphere surrounding the earth. Various payload instruments study such phenomena as radiation, micrometeoroids, temperatures, magnetic field and solar plasma.

Early in 1958 Van Allen discovered an additional layer of particles in the upper atmosphere by the analysis of geiger counter data from Explorer I. Until this time it was believed that the density of the upper air merged into the density of the interplanetary gas at an altitude of about 1,000 km. and that this marked the boundary of the atmosphere. This layer, eventually found to reach out to about 100,000 km., is called the magnetosphere because it exists only by virtue of the presence of the earth's magnetic field. This discovery was the most significant discovery of the IGY (International Geophysical Year).

Since the discovery of the Van Allen radiation belt, there has been a large number of investigations of these particles by sounding rockets and satellites. Explorer XII, the energetic particles satellite, added significantly to the radiation belt studies. Launched on August 15, 1961, into a highly eccentric orbit (apogee 48,000 miles perigee 182 miles), it transmitted data until December 6, 1961. It passed through the belt twice per orbit for a total of 204 transits.

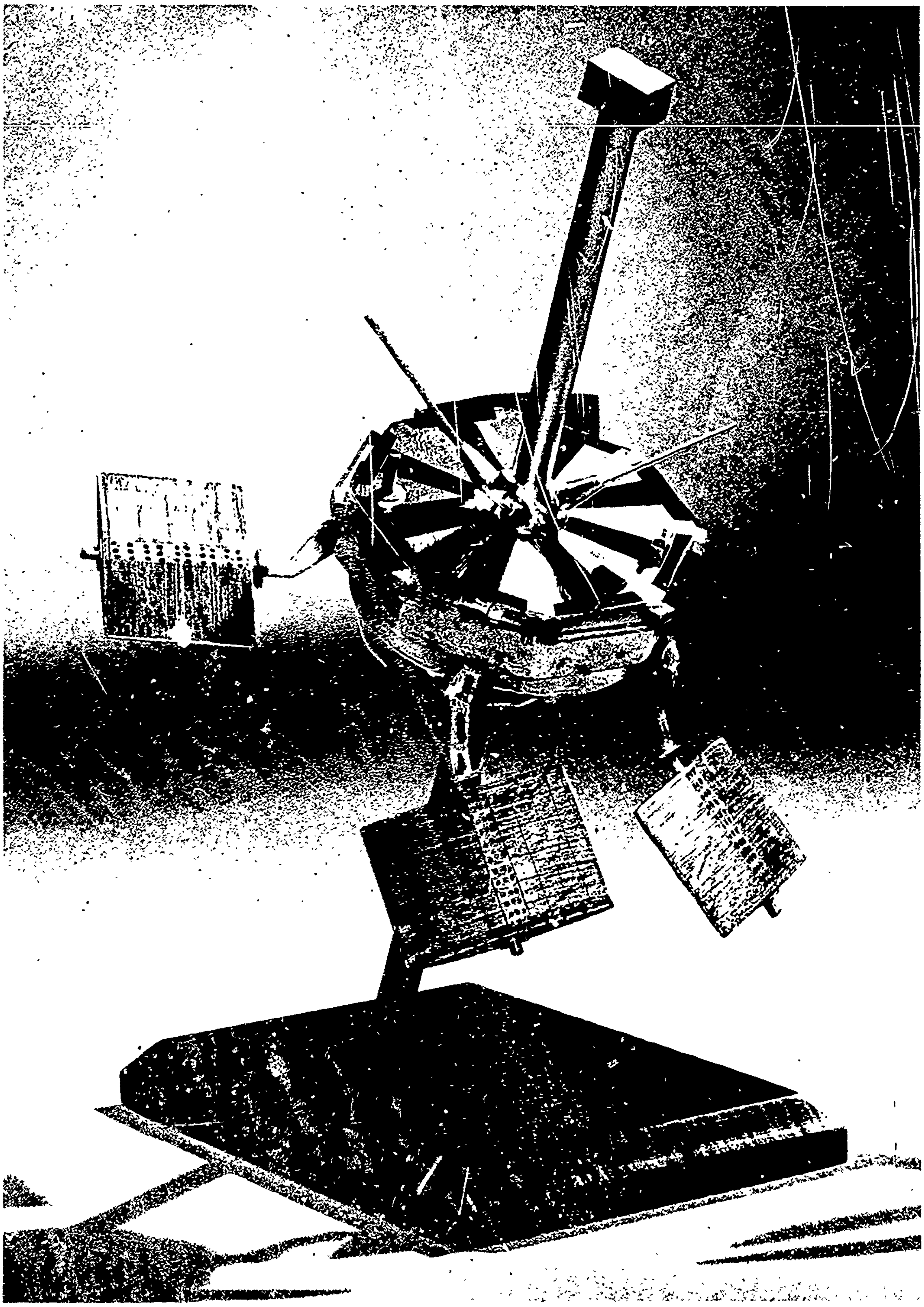
The instruments on the satellite revealed a large flux of medium-energy protons trapped in the outer zone of the radiation belt. No protons had been detected in the previous measurements and it was believed that the belt was populated only by electrons. The instruments also indicated that the level of electron flux in the outer Van Allen belt was about three orders lower than what had been previously considered to be present.

Such investigations have added much to the understanding of the phenomena of outer space but the most remarkable feature of the program has been its interdisciplinary nature. Science disciplines such as physics, astronomy, and geophysics that had gone their separate ways now attack space problems in close partnership.

With cooperative effort and our new found ability we have been able to reach out to the stars. In many instances the measurements increased our knowledge of space but we also learned more about the earth itself. In some cases we learned very new and very fundamental facts about the distant stars.

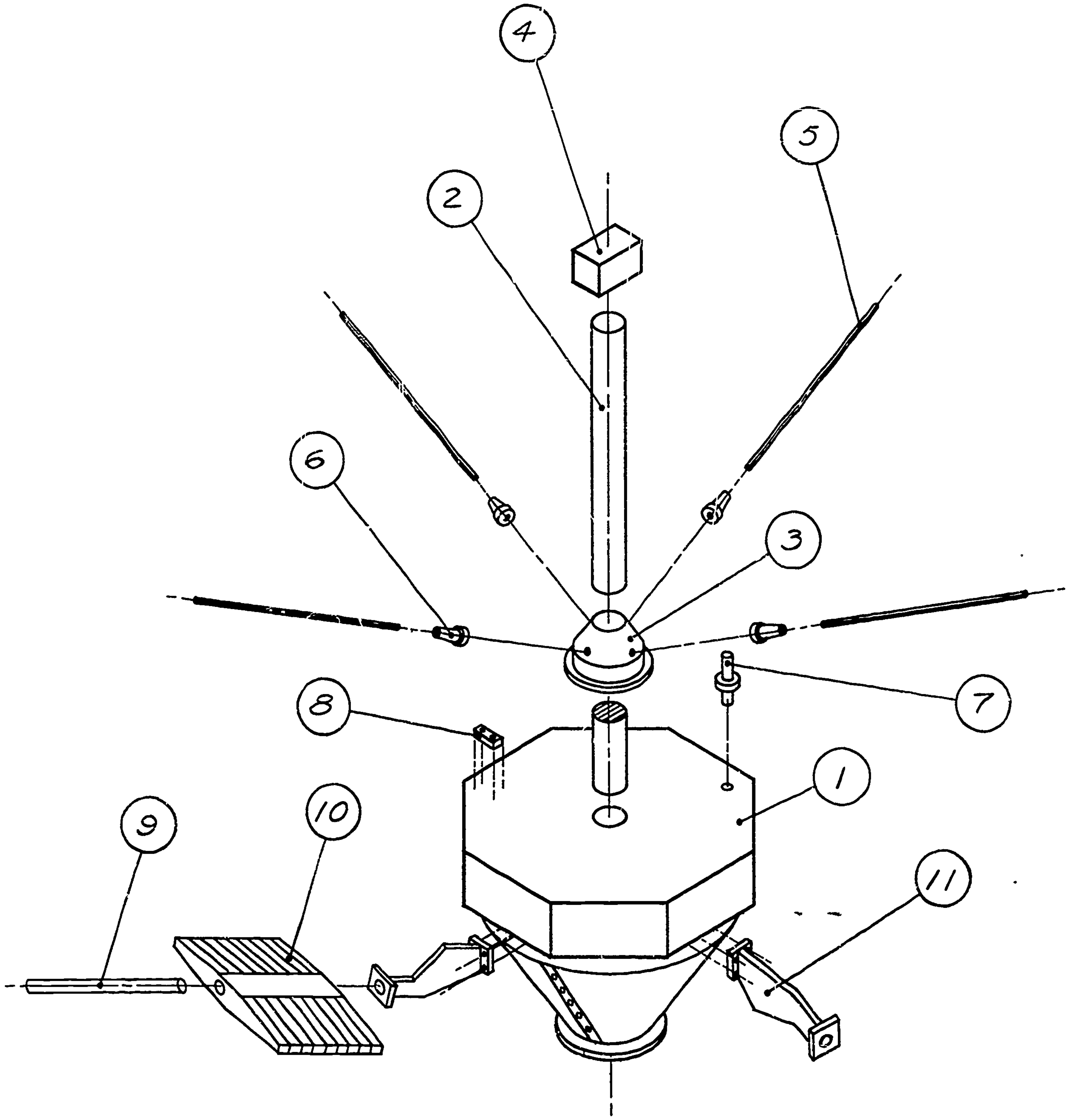
Twinkle, twinkle, little star, we'll soon find out what you are.

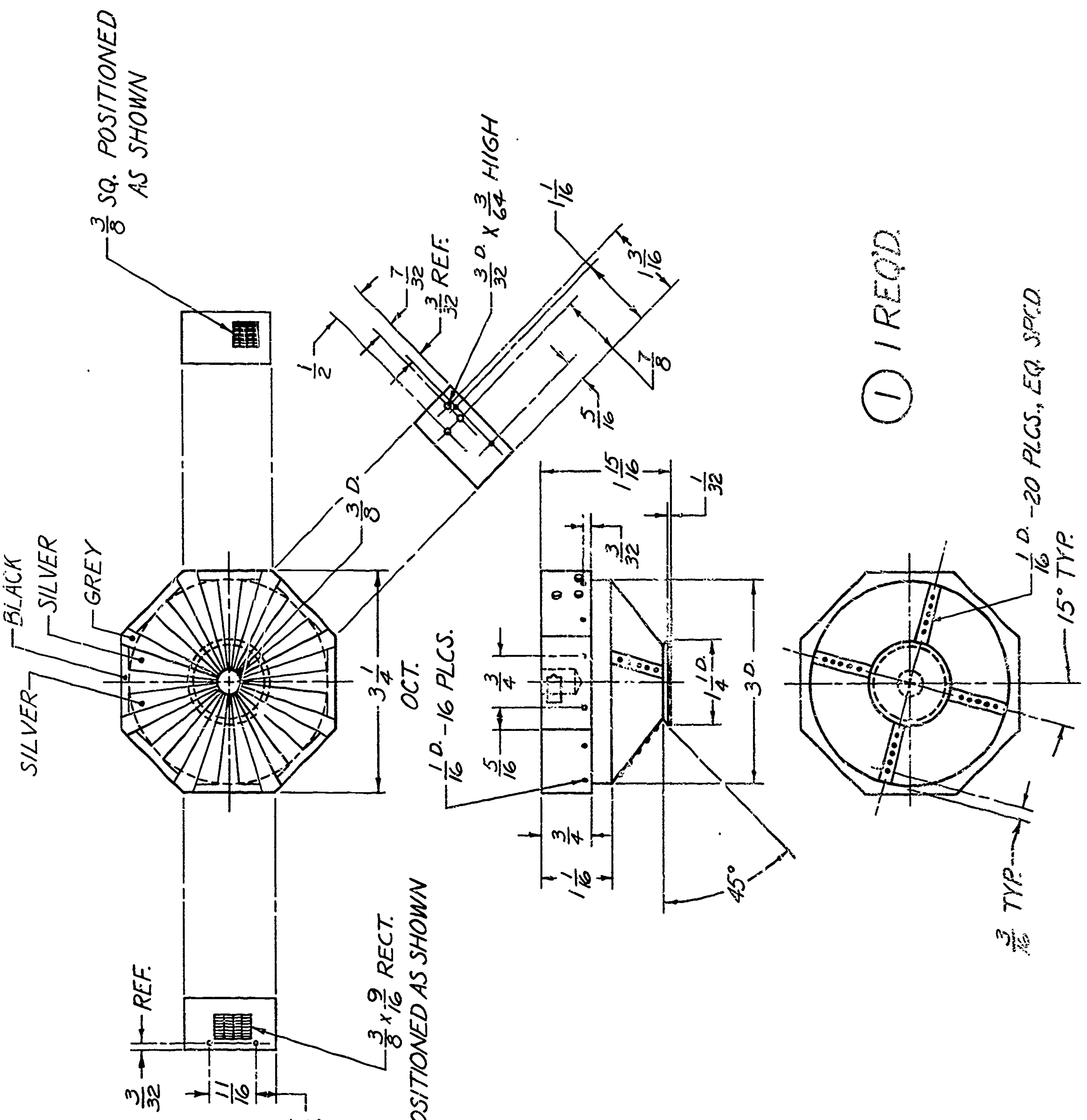
EXPLORER



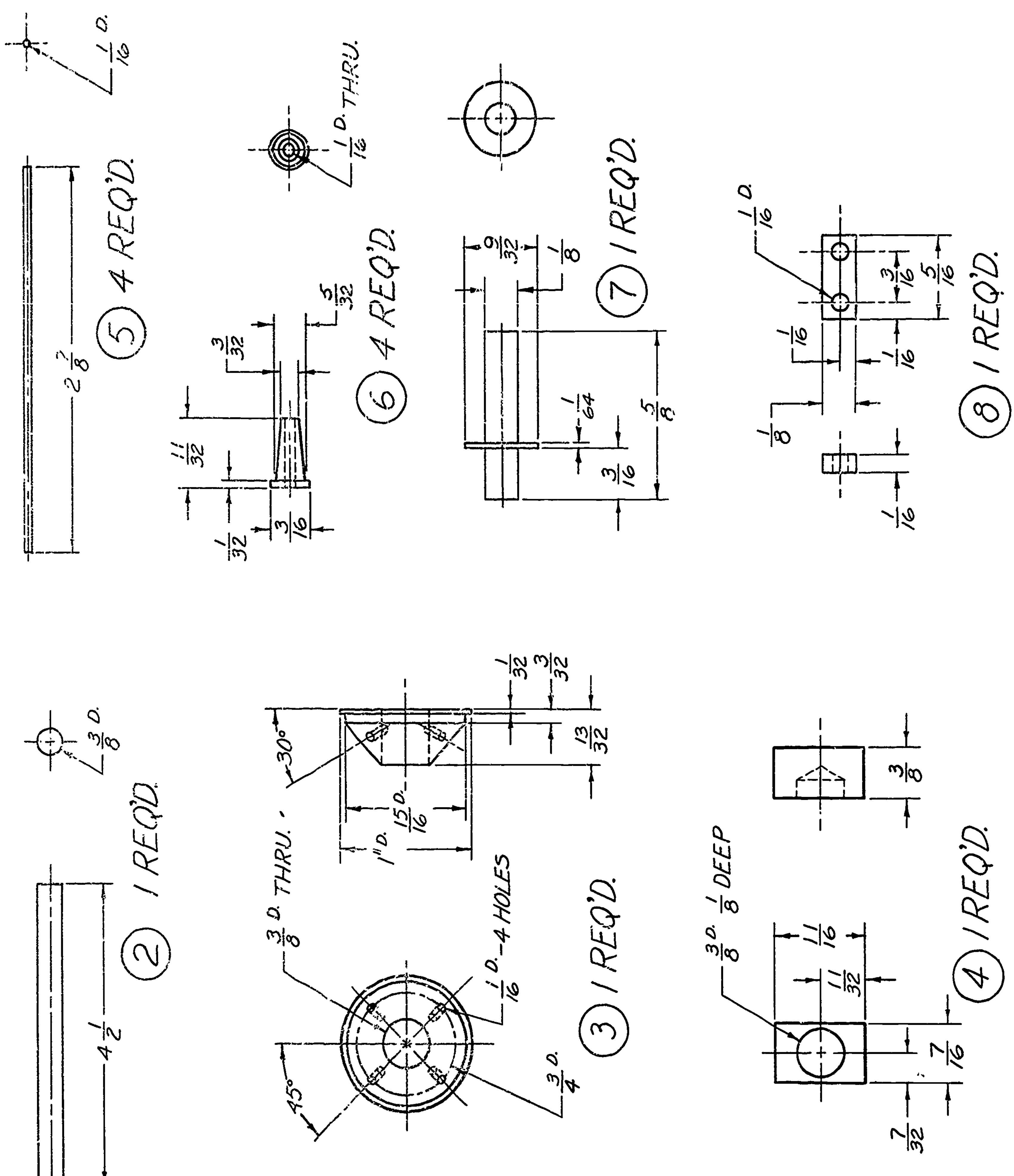
~EXPLORER XII~

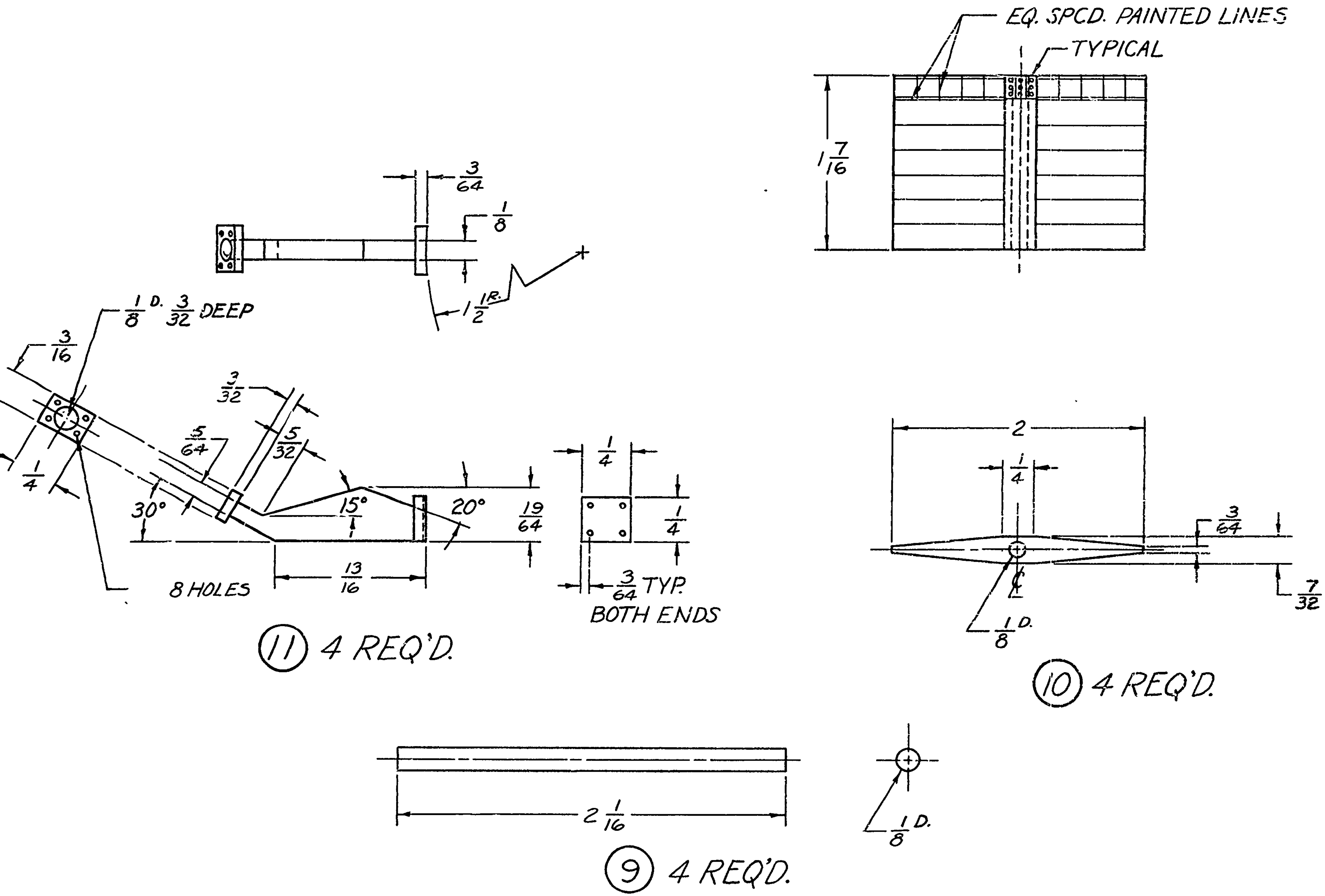
ASSEMBLY





3/8 SQ. POSITIONED AS SHOWN
3/32 D. X 3/64 HIGH
1/16
7/32
3/32 REF.
3/16
1/2
7/8
5/16
3/8 D.
BLACK
SILVER
GREY
SILVER
3 1/4 OCT.
1/16 D. -16 PLCS.
3/4
5/16
1 15/16
1/32
3/32
1 1/4 D.
3 D.
3/4
1 1/16
45°
REF.
3/32
11/16
5/16
3/8 x 9/16 RECT. POSITIONED AS SHOWN
1 REQD.
1/16 D. -20 PLCS., EQ. SPC.D.
15° TYP.
3/16 TYP.


2 1 REQ'D.
3 1 REQ'D.
4 1 REQ'D.
5 4 REQ'D.
6 4 REQ'D.
7 1 REQ'D.
8 1 REQ'D.
3/8 D. THRU.
1/16 D.-4 HOLES
3/8 D. 1/8 DEEP
1/16 D. THRU.


EQ. SPCD. PAINTED LINES
TYPICAL
1 7/16
2
1/4
3/64
7/32
1/8 D.
(10) 4 REQ'D.
3/64
1/8
1 1/2 R.
1/8 D. 3/32 DEEP
3/16
3/32
5/64
5/32
1/4
30°
15°
20°
19/64
13/16
8 HOLES
1/4
1/4
3/64 TYP.
BOTH ENDS
(11) 4 REQ'D.
2 1/16
1/8 D.
(9) 4 REQ'D.

RECOMMENDED MATERIALS FOR CONSTRUCTION

EXPLORER XII

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	One	Wood - pine	Silver with black surface details
2	One	Dowell - rod, metal or plastic rod, metal or plastic tubing	Silver
3	One	Wood - (maple), plastic or brass	Silver
4	One	Wood - (maple) or plastic	Yellow
5	Four	Metal brazing rod	Silver
6	Four	Wood - (maple) or plastic	Silver
7	One	Metal brazing rod and washer	Gold
8	One	Wood - (balsa) or sheet metal	Red
9	Four	Dowel - rod or brazing rod	Silver
10	Four	Wood - balsa or pine	Silver with black surface details
11	Four	Sheet metal	Silver with black surface details

RECOMMENDED PROCEDURE FOR CONSTRUCTION

EXPLORER XII

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - pine	Construct octagon bodyturn on lathe to specified dimensions. Drill all holes as per detailed drawing	Finish sand all surfaces	
2	Dowel - rod, metal or plastic rod, Metal or plastic tubing	Cut to length and square ends		
3	Wood, plastic or brass	Turn to specified dimensions. Drill all holes as per detailed drawing	Finish sand or polish surface	
4	Wood or plastic	Construct to specified dimensions. Drill as per detailed drawing	Finish sand or polish surface	
5	Metal rod	Cut to specified length		
6	Wood, plastic or brass	Shape on drill press or pencil sharpener or Machine on lathe	Finish sand Polish surface	
7	Brazing rod and brass washer	Fit washer onto rod	Polish	

229-357 O-66—3

RECOMMENDED PROCEDURE FOR CONSTRUCTION

EXPLORER XII

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8	Balsa wood or sheet metal	Drill holes as per detailed drawing		
9	Dowel - rod or brazing rod	Cut to specified length		
10	Balsa wood or soft pine	Layout and fabricate to specified dimensions and sand tapers. (May be constructed as one piece and divided into four equal pieces)	Finish sand	
11	Sheet metal	Construct both ends separate from the main body. Drill as specified on detail no. 11. All 3/64D. holes to be painted. Solder both ends to the body.		Assemble part no. 9 to part no.11 using epoxy resin or solder

RECOMMENDED PROCEDURE FOR CONSTRUCTION

EXPLORER XII

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
				Attach part no. 11 to part no.1 as indicated on the assembly drawing by alternating the position of part no.11
			Paint all parts silver except parts no. 7 and 8	
			Apply surface details to part no. 1 as specified using appropriate paint or India ink	
				Assemble part no. 7 to part no. 1
			Simulate solar cells on part no. 10 by drawing equally spaced lines on the surfaces as indicated on detail no. 10	

RECOMMENDED PROCEDURE FOR CONSTRUCTION

EXPLORER XII

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
			Paint part no.8 red and attach to part no. 1 with epoxy resin	
				Attach parts no. 2,3,4,5 and 6 to part no. 1
			Paint part no.4 yellow	
				Assemble part no. 10 to part no. 9
Model Stand	Wood - walnut	Design stand to support the assembled model	Natural rubbed oil finish	

O S O

(ORBITING SOLAR OBSERVATORY)

When the daylight sky turns to night, astronomers scurry from all over the world to see the phenomenon. The bright disk of the sun disappears and the full glory of the corona becomes visible. The stars and planets shine through the varicolored hue. The wispy pearl-colored corona stretches out away from the sun for several diameters. At the base of the corona, crimson prominences can be seen twisting from the dark outline of the moon. This splendor of the total eclipse can only be seen within a small black area some 100 miles in diameter. It is the ambition of every astronomer to place himself in this small black spot.

Although eclipse expeditions have given us a fundamental knowledge of the sun, observational time has been short, for total eclipses are rare, occurring not more than two or three times a year. The spot travels at a speed of 2,000 miles per hour along the eclipse track. Although it can be accurately calculated beforehand, careful preparation of the observational program is necessary because the moon's shadow only spends a few seconds over the chosen site. Even if an astronomer can travel to every eclipse track, he only has a few minutes of working time available each year. If the equipment fails or if it is cloudy, he must then wait for months before it is possible to observe again. And then the next eclipse track may cross over inaccessible parts of the world.

Other important sources of knowledge are the solar observatories, such as the one in the Hollywood Hills, California. There the smog, which makes life miserable for the populace, serves as a perfect filter through which valuable photographs can be taken.

Now, with rockets and satellites, the research work can be extended out into space. Telescopes can be carried out into space above earth's atmosphere for a better look, just as the astronomers in the past carried theirs to the mountain tops.

The sun, the major source of energy in the solar system, controls the environment in space as well as the weather on the earth. It is fitting, then, that the first observatory-class satellite should be designed primarily for the study of solar physics.

Why does the sun have an 11-year sunspot cycle? What causes solar flares? How are the energetic particles accelerated to their high energies? Understanding of the sun itself is one of the objectives of solar physics.

Another objective is to monitor continuously the radiation from the sun. Scientists need these data to understand the measurements they make on the atmosphere and ionosphere of the earth, in interplanetary space, and on the other planets.

The Orbiting Solar Observatory (OSO) has taken data pertinent to these objectives. By making continuous measurements of the ultraviolet light and soft X-rays emitted by the sun, it has given data on the solar processes.

OSO-I on its 344/370 mile orbit points continuously at the center of the sun with an accuracy of $\pm$ 1/2 arc minute. The upper portion, called the sail, which points at the sun, carries the solar cells which provide the energy for the satellite. The bottom section of this 458 pound craft known as the wheel rotates to provide stability. In it are housed the batteries, telemetry and experiments which need not be pointed at the sun.

One of the major experiments in the pointed section was a spectometer to study the solar spectrum of the sun in the wave length region from 50 to 400 Å. This is the portion of the solar spectrum that controls the properties of the upper layer of the earth's ionosphere. All of these lights are absorbed at extremely high altitudes. Many clues about the properties of the chromosphere and the corona of the sun were obtained from this experiment.

Another major experiment was to measure the intensity of X-rays in the 1 to 8 Å region. It was possible to observe X-rays from very weak flares and in some cases those from flares not observed on the ground.

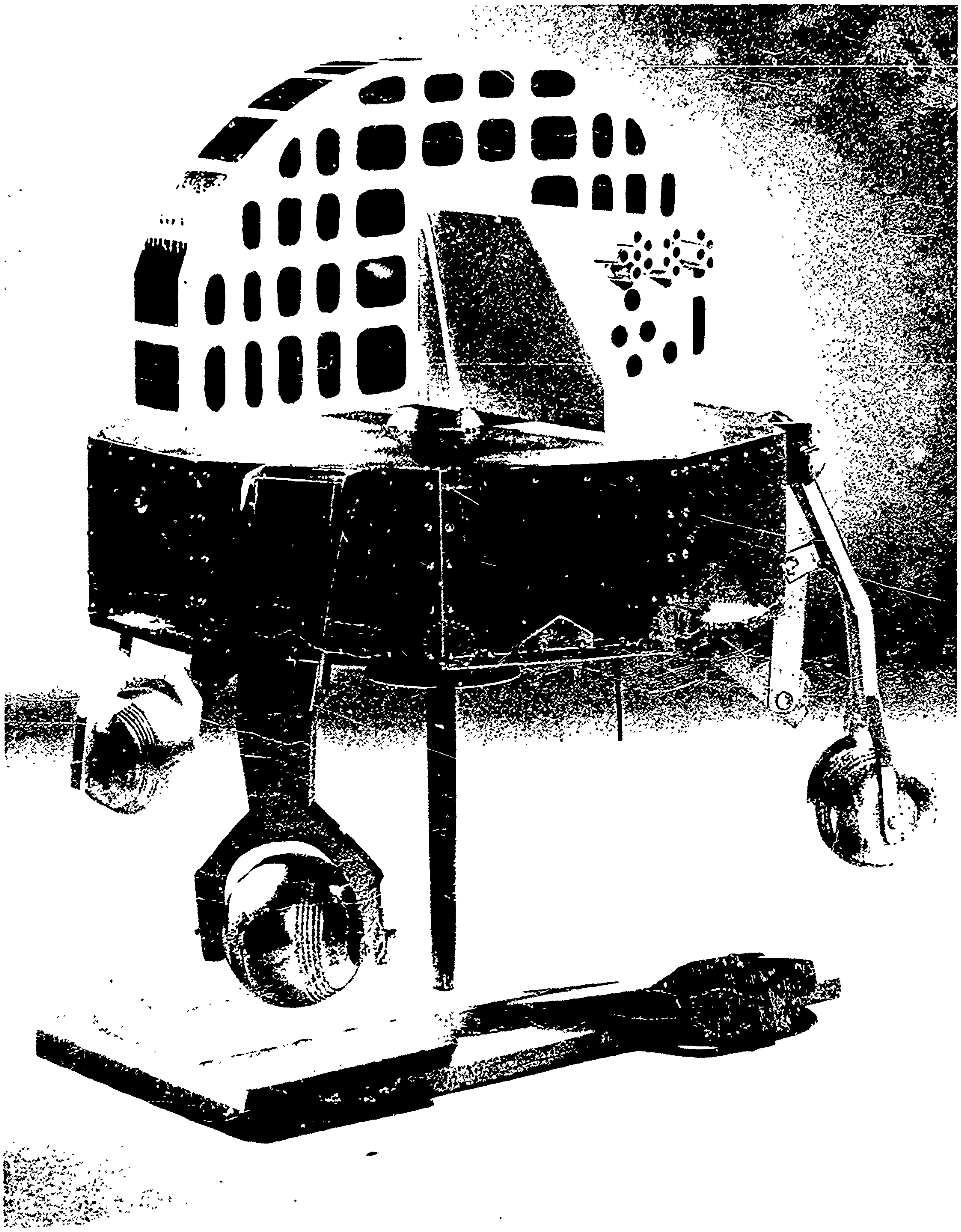
Continuous monitoring of the X-ray flux on the sun is very important because of the speed of its flares. Most of the X-rays occur in the earliest phase of the flare and much of the phenomena of interest were missed by the earlier method of rocket probes because of the time involved.

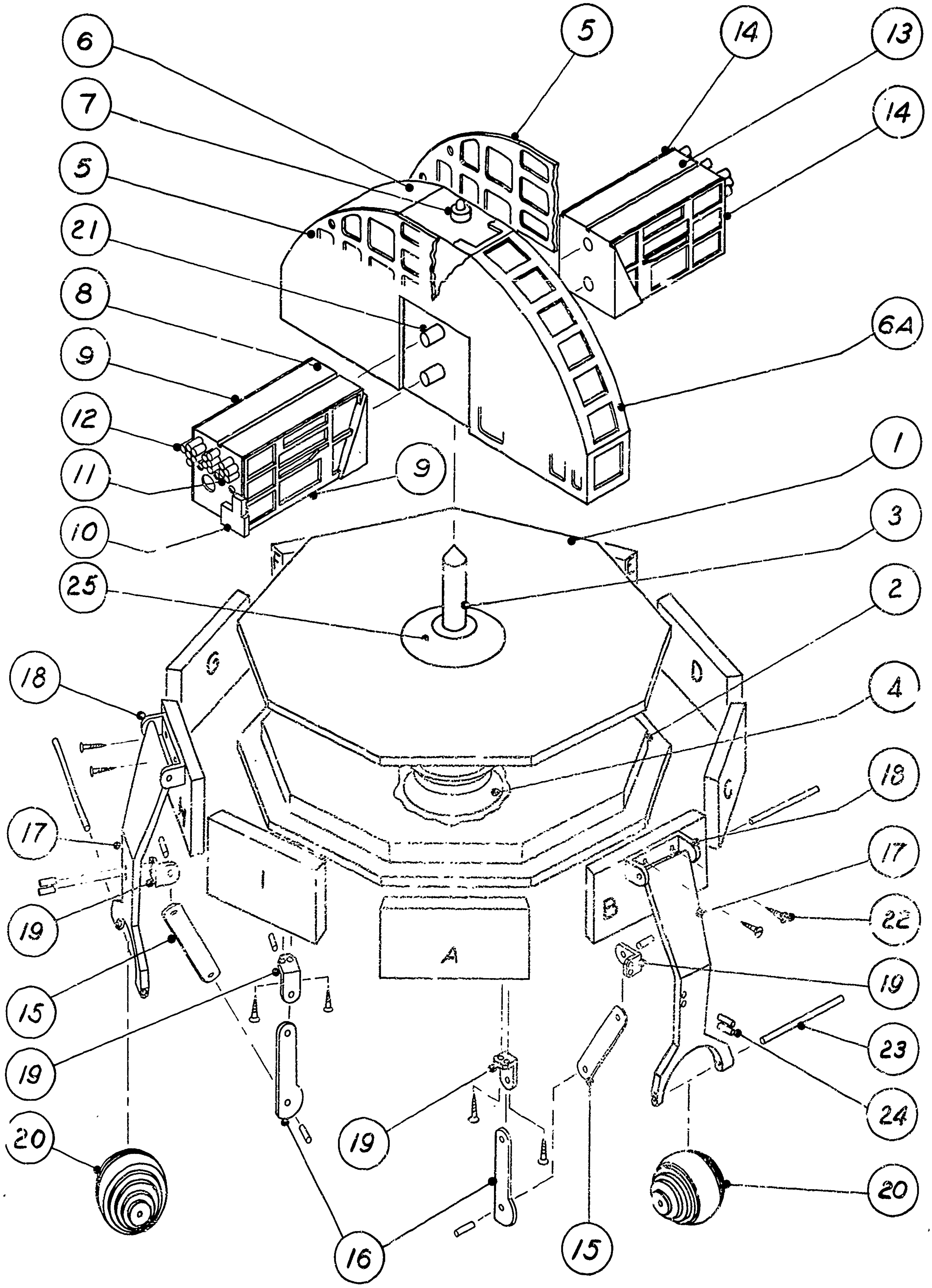
OSO-I was designed to measure the radiation of the entire sun over a broad wave-length region which is inaccessible to measurements by solar observatories on earth. Other more complex orbiting observatories are planned for the future.

With the success of OSO-I we entered a new phase of complex spacecrafts capable of precise orientation over long periods of time.

Thus, we can surpass the old astronomer's dream by placing the telescopes higher than the highest mountain.

O. S. O.

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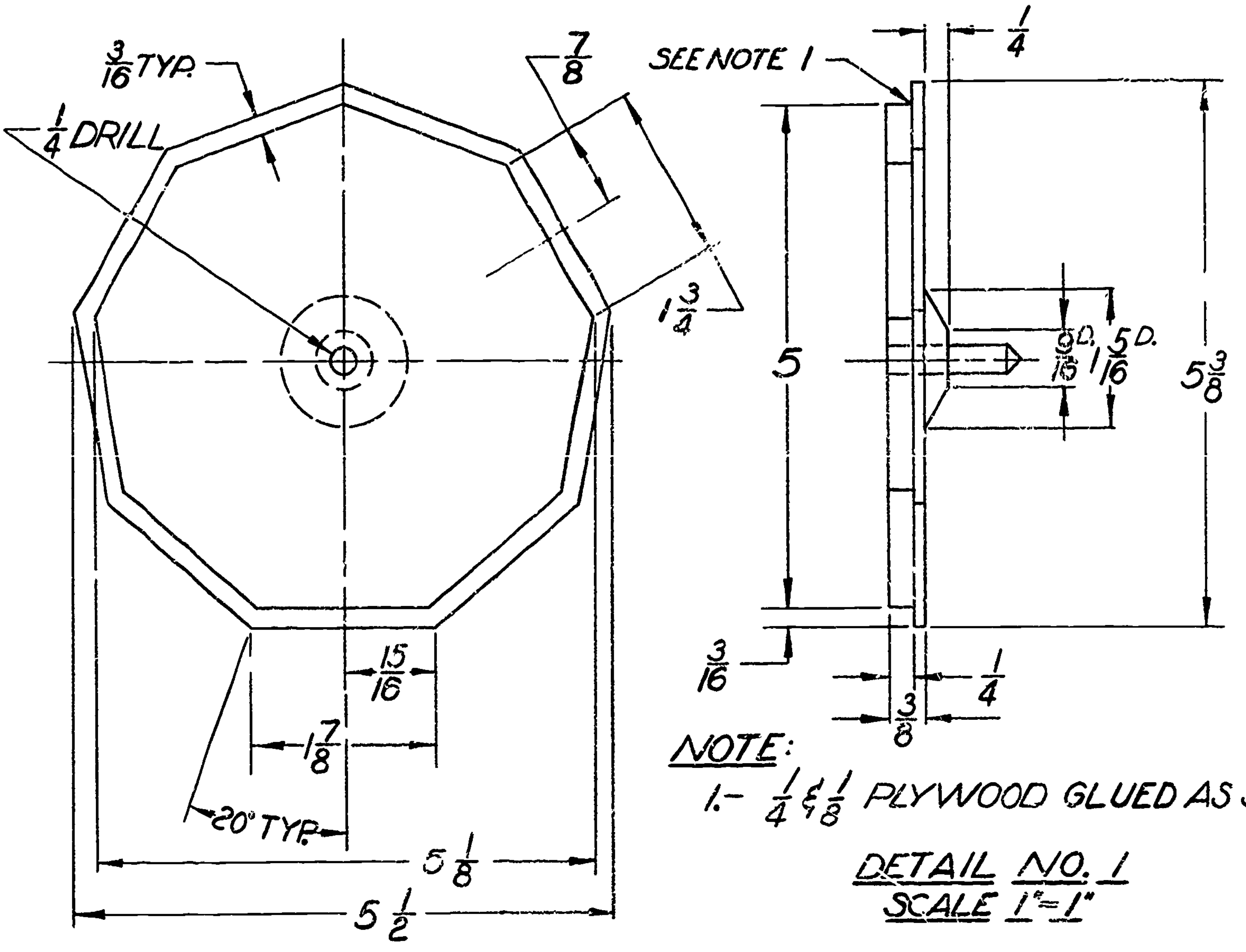
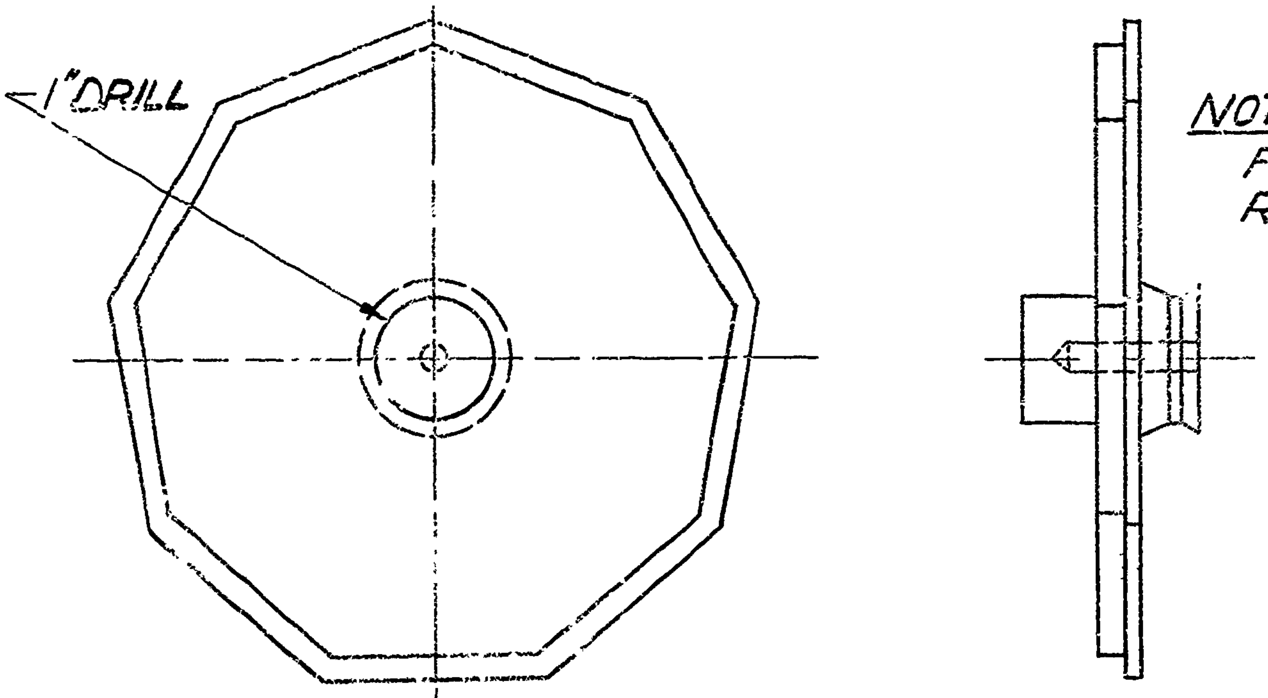


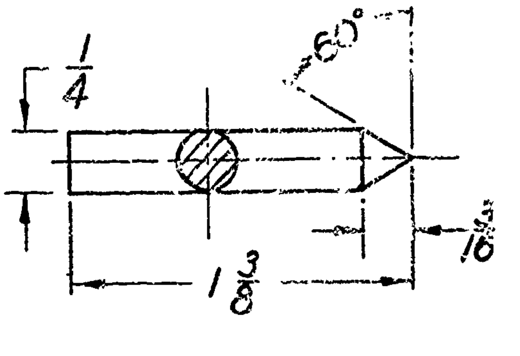
NOTE:
1.- 1/4 & 1/8 PLYWOOD GLUED AS SHOWN

DETAIL NO. 1
SCALE 1"=1"

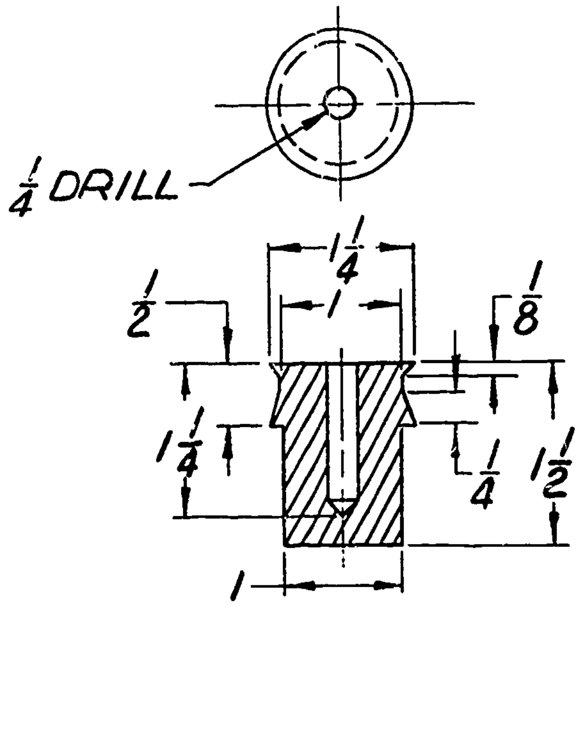


NOTE:
FOR DIMENSIONS
REFER TO DETAIL NO. 1

DETAIL NO. 2
SCALE 1"=1"

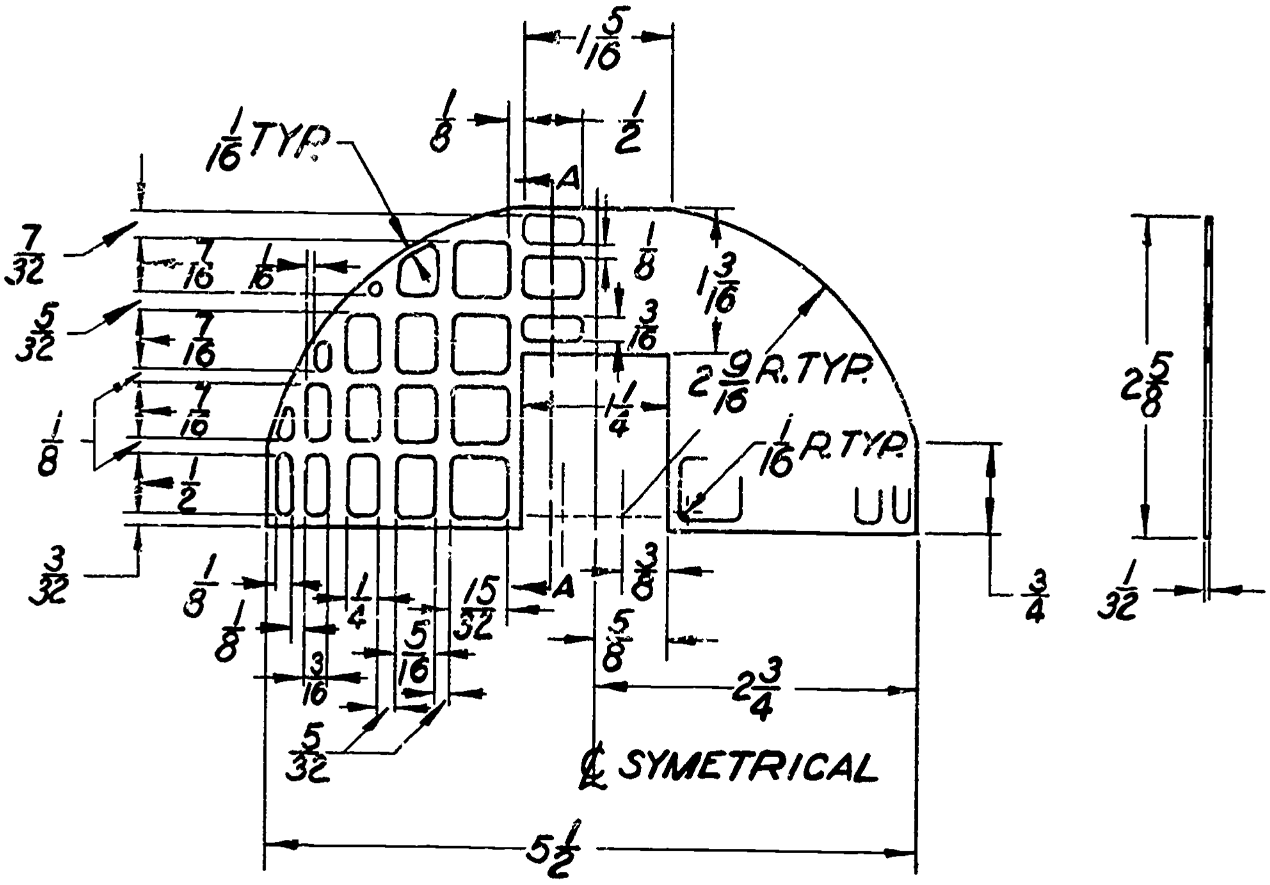


DETAIL NO. 3
SCALE 2/1

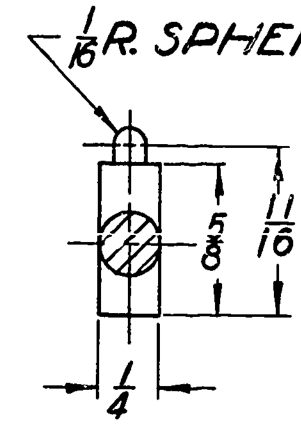


DETAIL NO. 4
SCALE 1"=1"

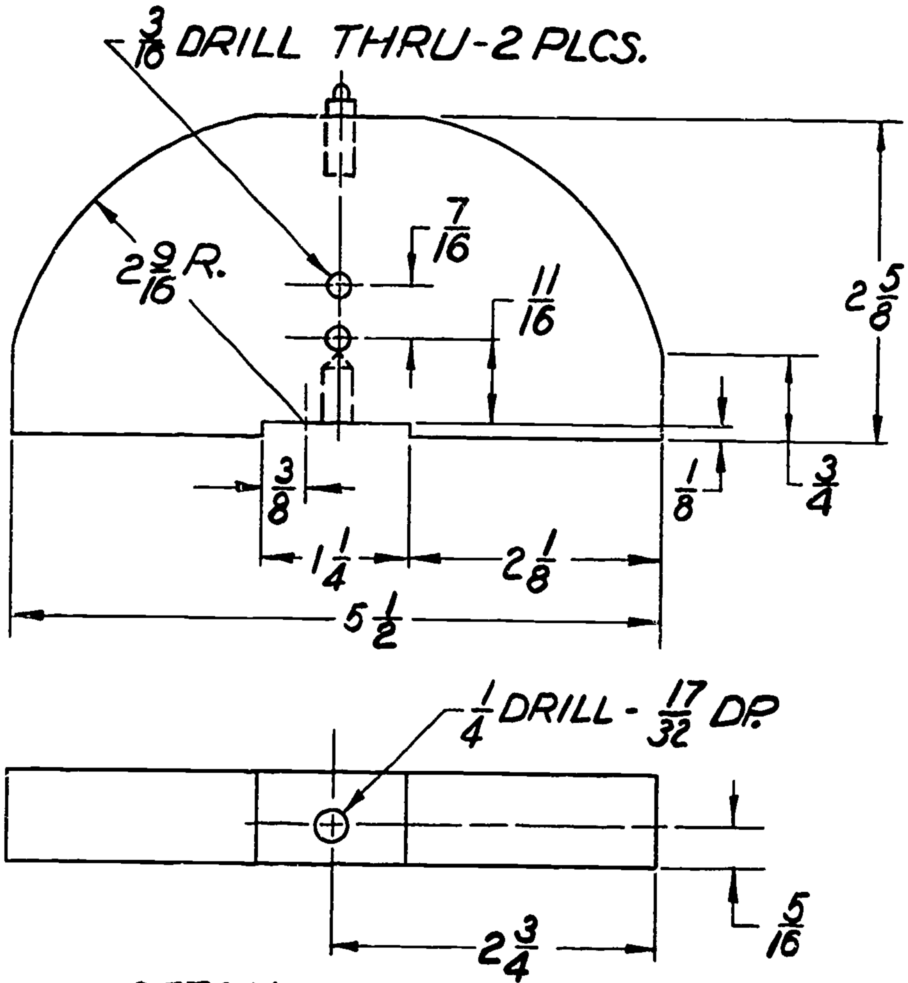
DETAIL NO. 5
SCALE 1"=1"

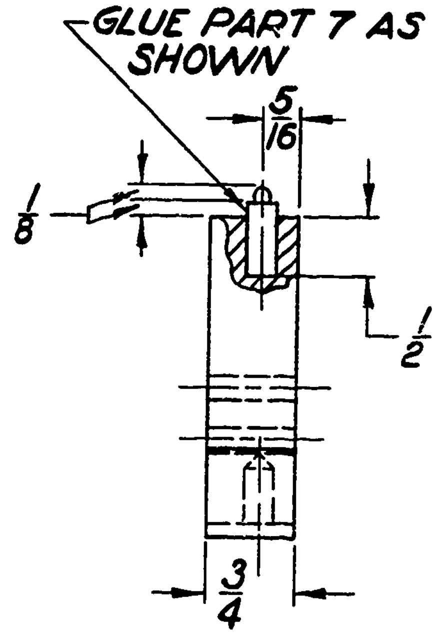


DETAIL NO. 7
SCALE 2/1



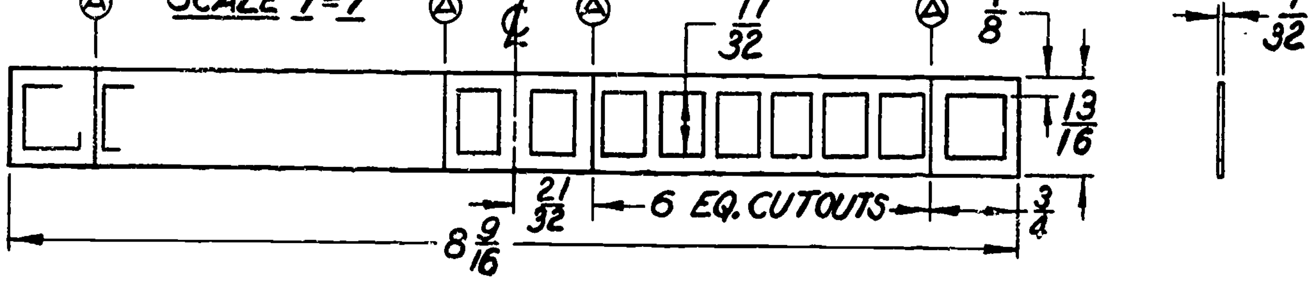
DETAIL NO. 6
SCALE 1"=1"

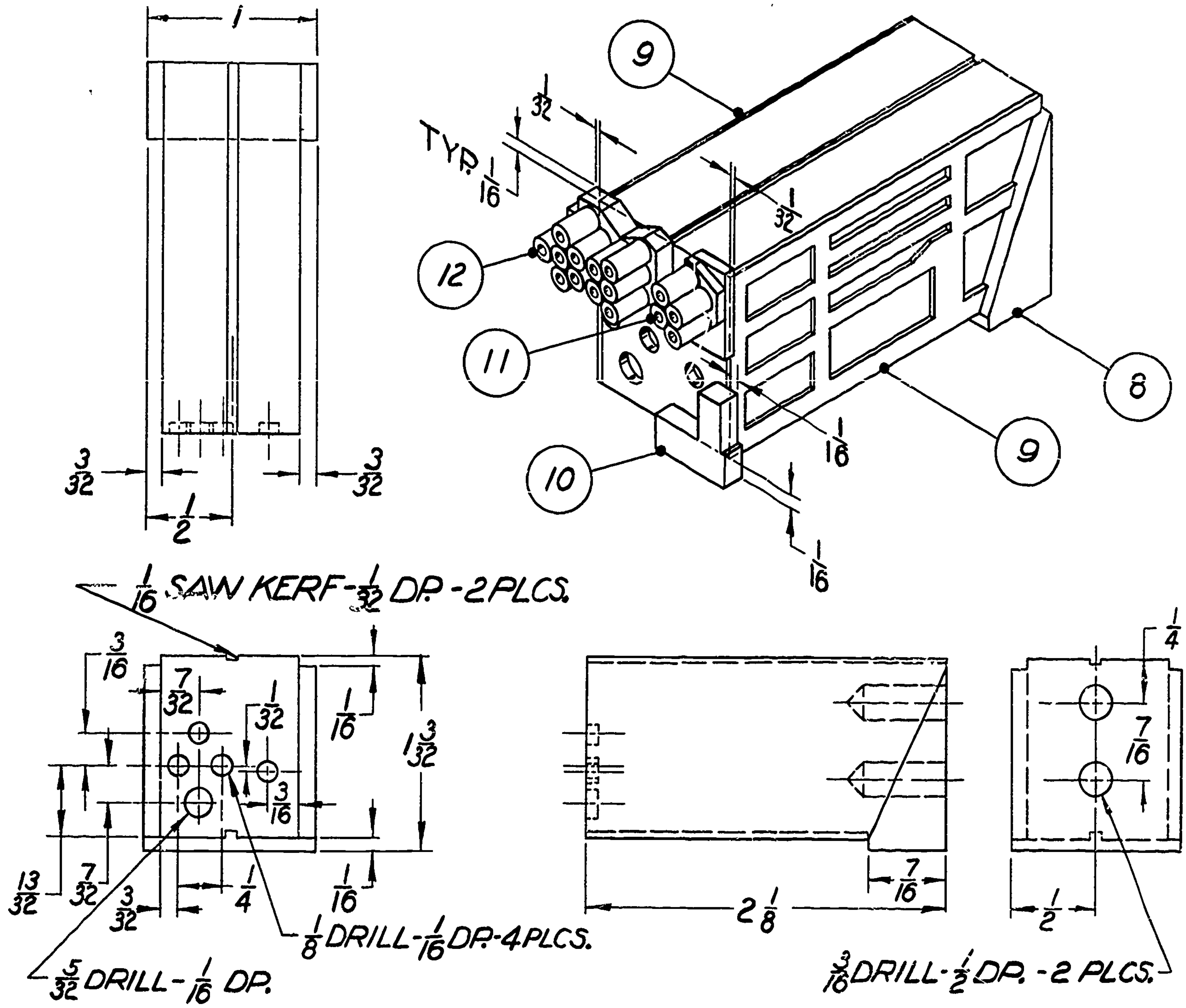




Ⓐ POSITION INDICATES CUT LINES PRIOR TO CEMENTING TO PART 6.

DETAIL NO. 6A
SCALE 1"=1"

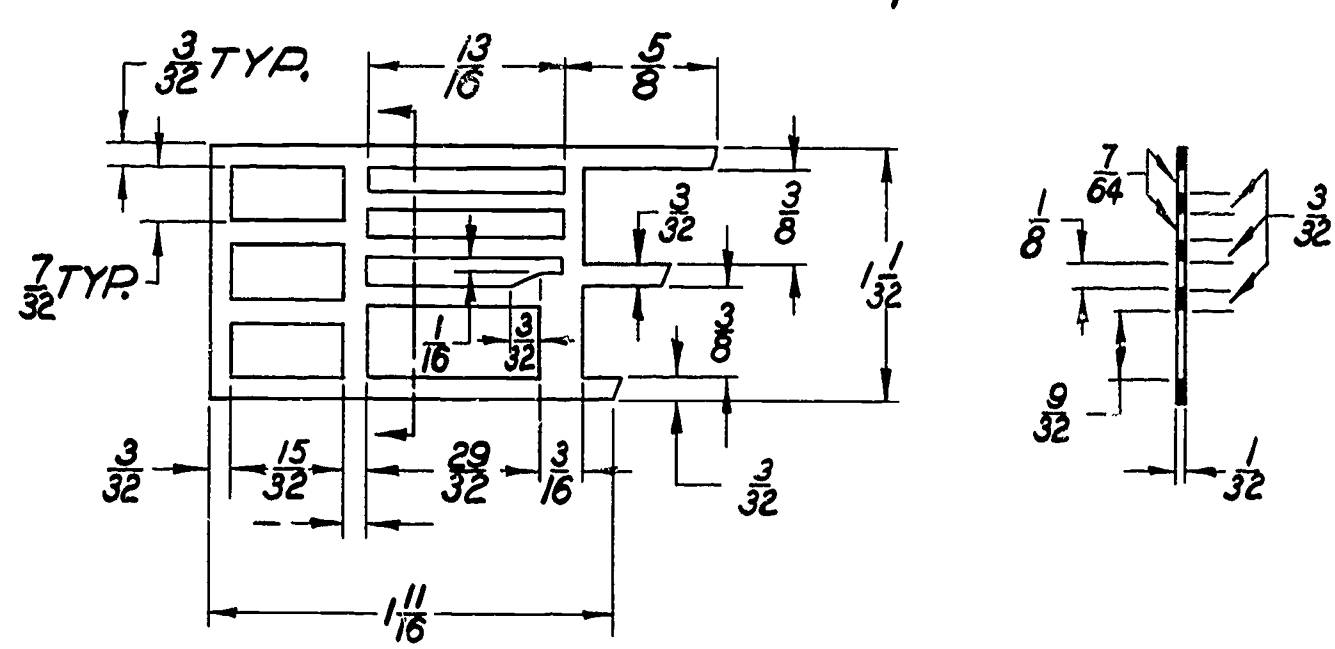


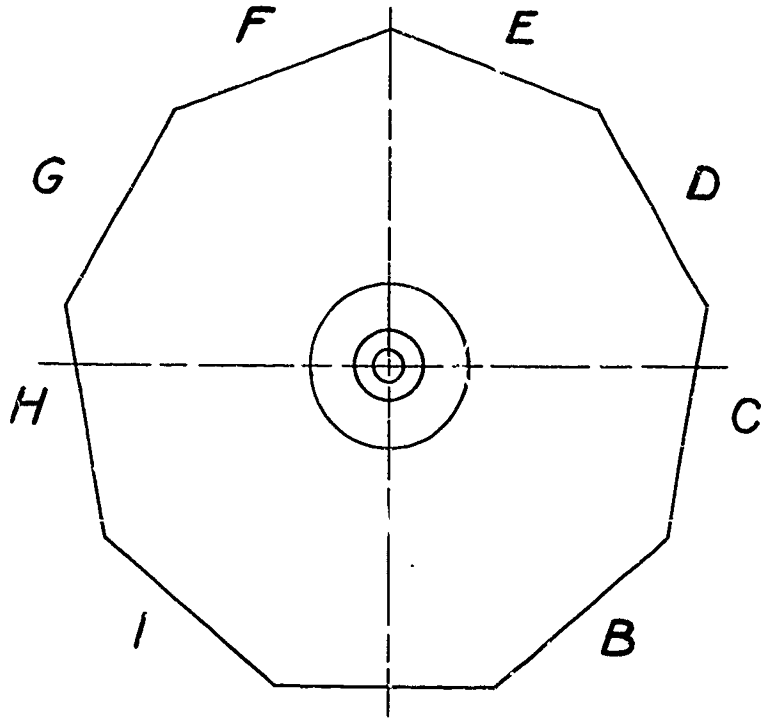


DETAIL NO. 8
SCALE 2/1

DETAIL NO. 9
SCALE 2/1

NOTE:
PARTS 9, 10, 11 & 12 TO BE GLUED TO PART 8 AS SHOWN ABOVE.





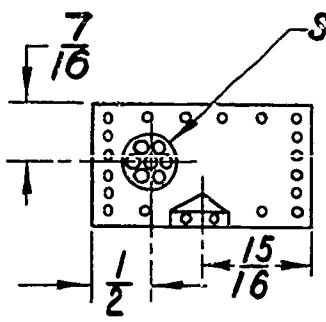
SIDE A
(REF. FRONT)

NOTES:

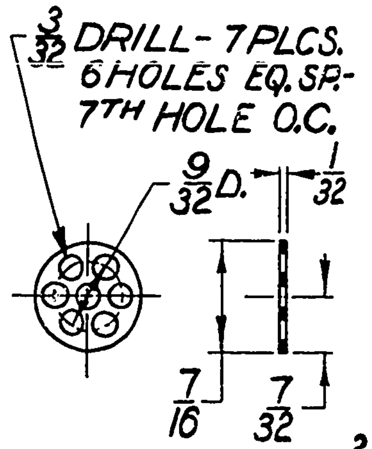
1.-RIVETS TO BE ESCUTCHEON PINS OR STRAIGHT PINS-CUT SHANK.

2.-PAINT ALL PARTS SILVER-EX. VIEW "A" SIDE C-TO BE BLACK.

DETAILS-SIDE C

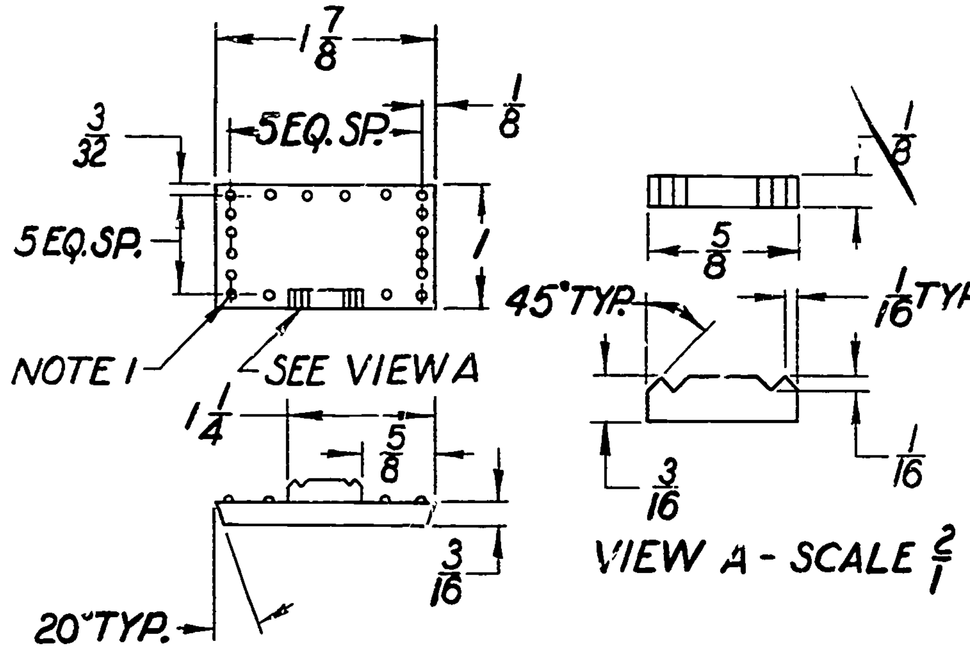


NOTE:
FOR OTHER DIMENSIONS-SEE DETAILS SIDES A & F.



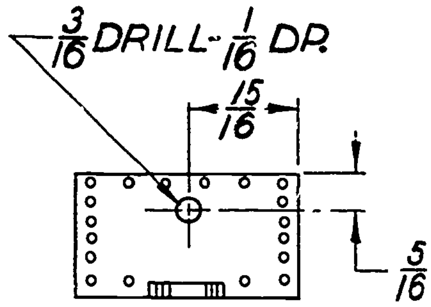
VIEW A - SCALE 2/1

DETAILS - SIDE A & G



VIEW A - SCALE 2/1

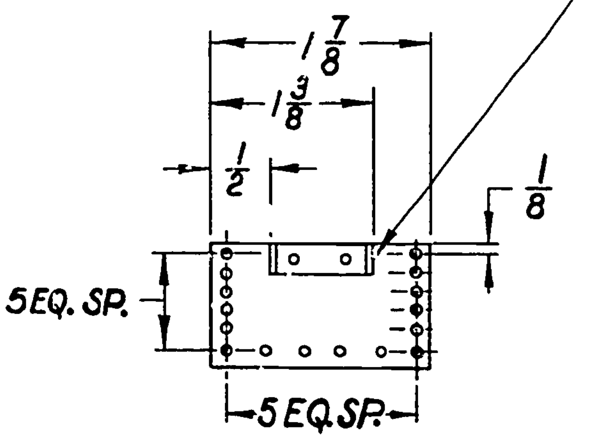
DETAILS - SIDE D



NOTE:
FOR OTHER DIMENSIONS SEE SIDE A.

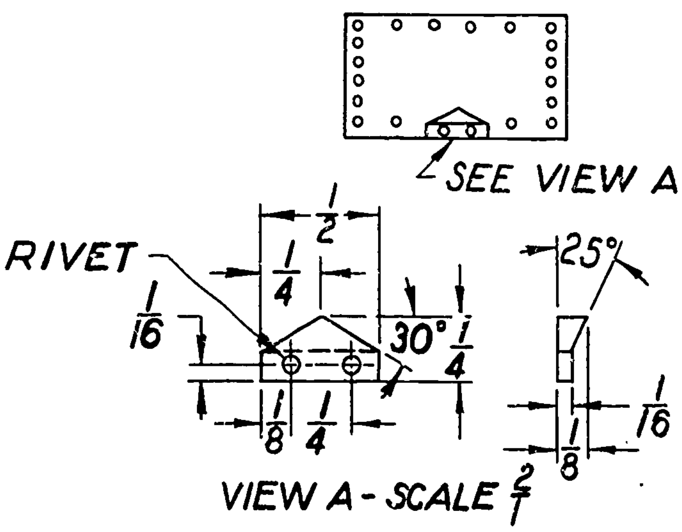
DETAILS - SIDES B, E & H

PART 18-POSITIONED



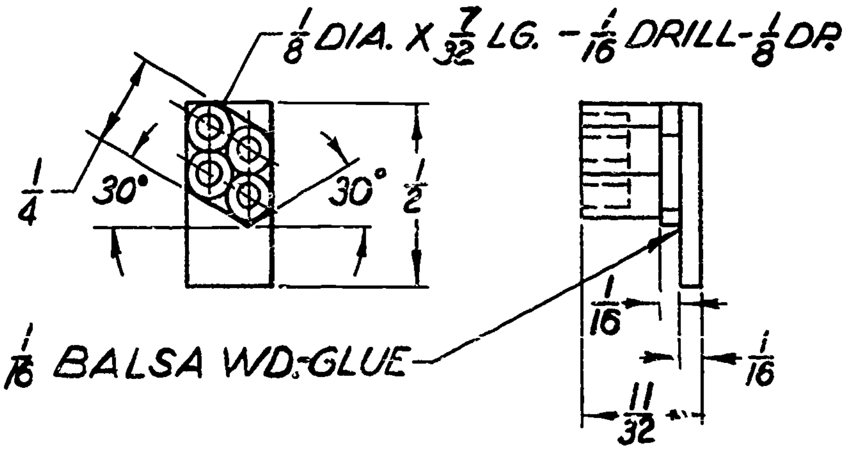
DETAILS - SIDE F

NOTE:
FOR OTHER DIMENSIONS SEE SIDE A.

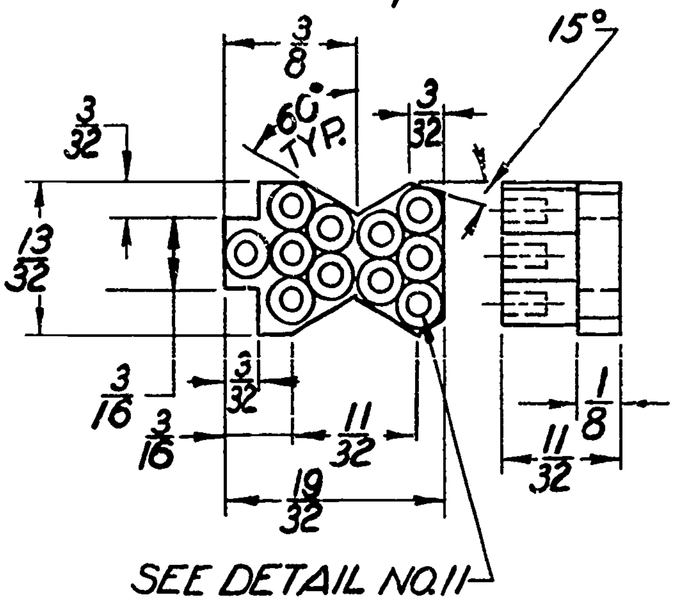


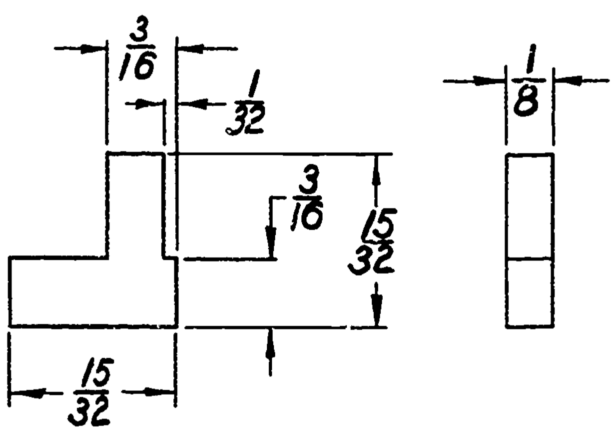
VIEW A - SCALE 2/1

DETAIL NO. 11
SCALE 3/1



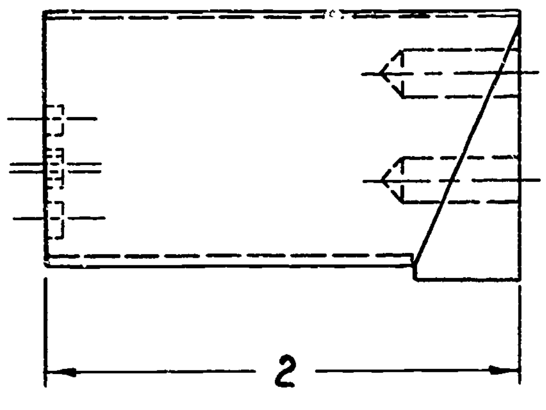
DETAIL NO. 12
SCALE 3/1





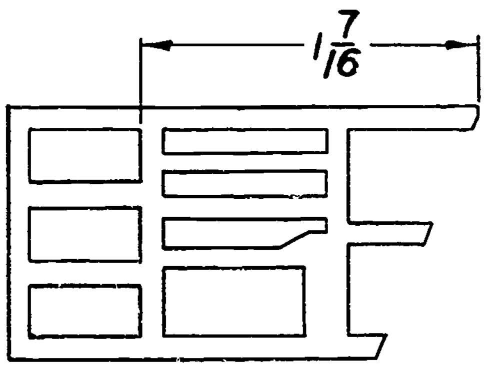
DETAIL NO. 10
SCALE 3/1

DETAIL NO. 13
SCALE 2/1

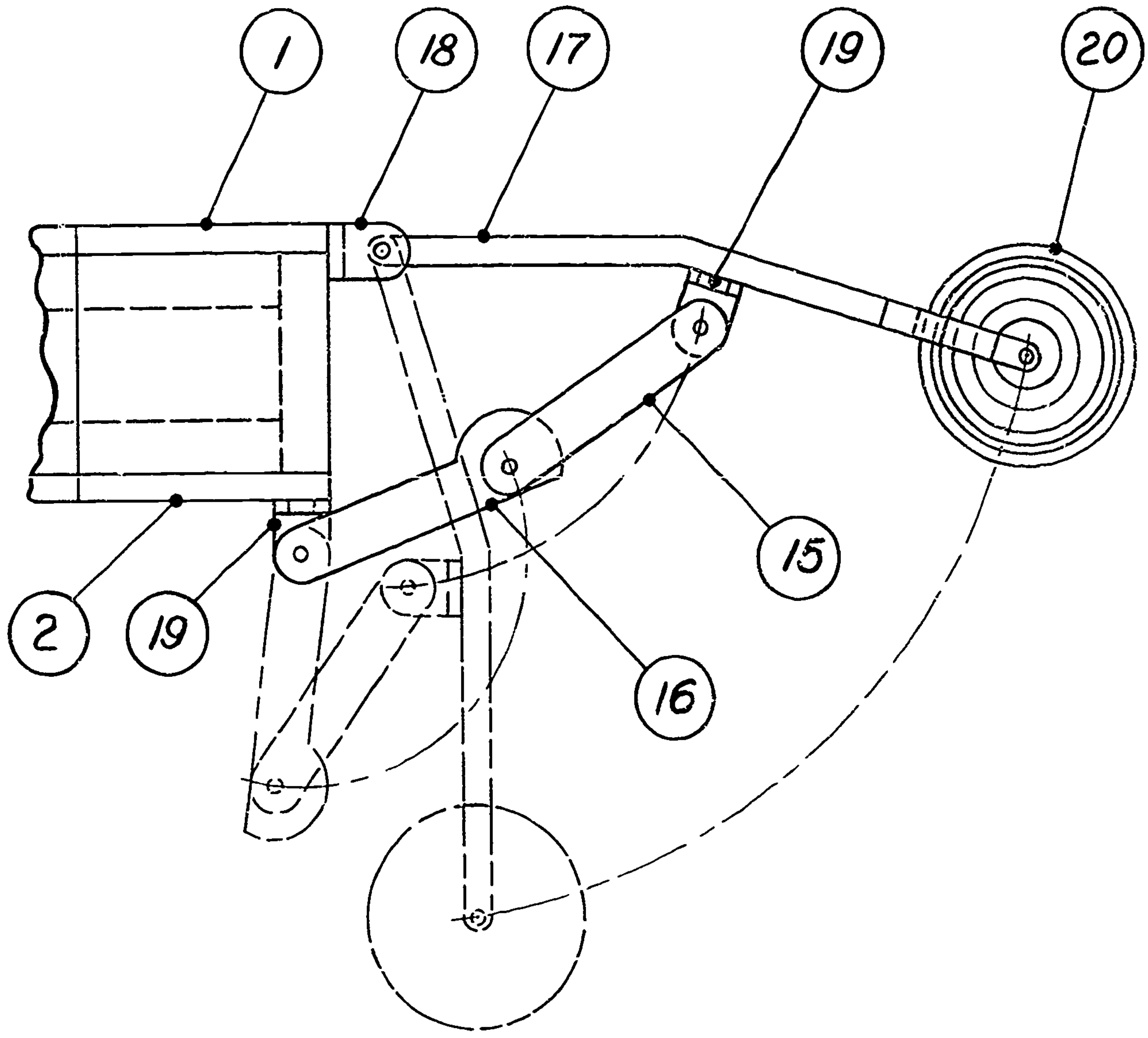


NOTE:
FOR ALL OTHER DIMENSIONS
SEE DETAIL NO. 8.

DETAIL NO. 14
SCALE 2/1



NOTE:
FOR ALL OTHER DIMENSIONS
SEE DETAIL NO. 9.



NOTES:

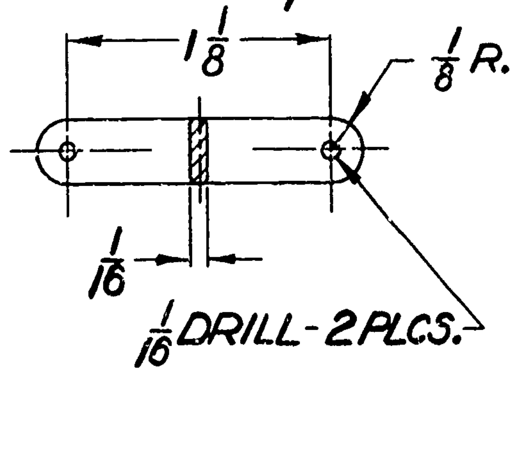
1.- ATTACH BRACKETS 18 & 19 TO PARTS 1 & 2 WITH NO. 0 F.H. WD. SCR. - $\frac{3}{8}$ LG.

2.- ATTACH BRACKET 19 TO PART 17 WITH $\frac{1}{16}$" RIVETS (BRAZING ROD).

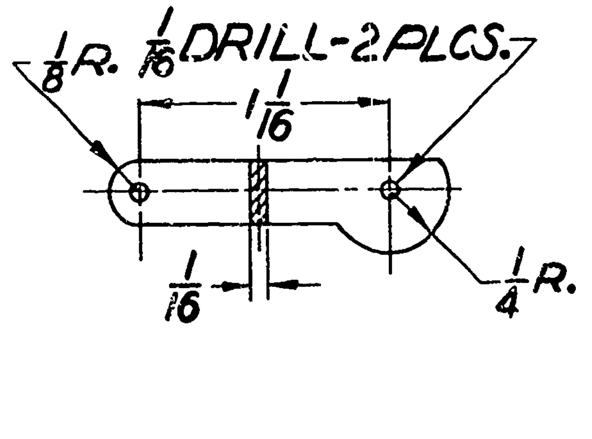
3.- LINKAGE ARMS NOS. 15 & 16 RIVETED TOGETHER & TO BRACKETS 19 WITH $\frac{1}{16}$" RIVETS (BRAZING ROD).

4.- STABILIZING ARMS (17) TO BE ATTACHED TO THE NONAGON SIDES B, E & H.

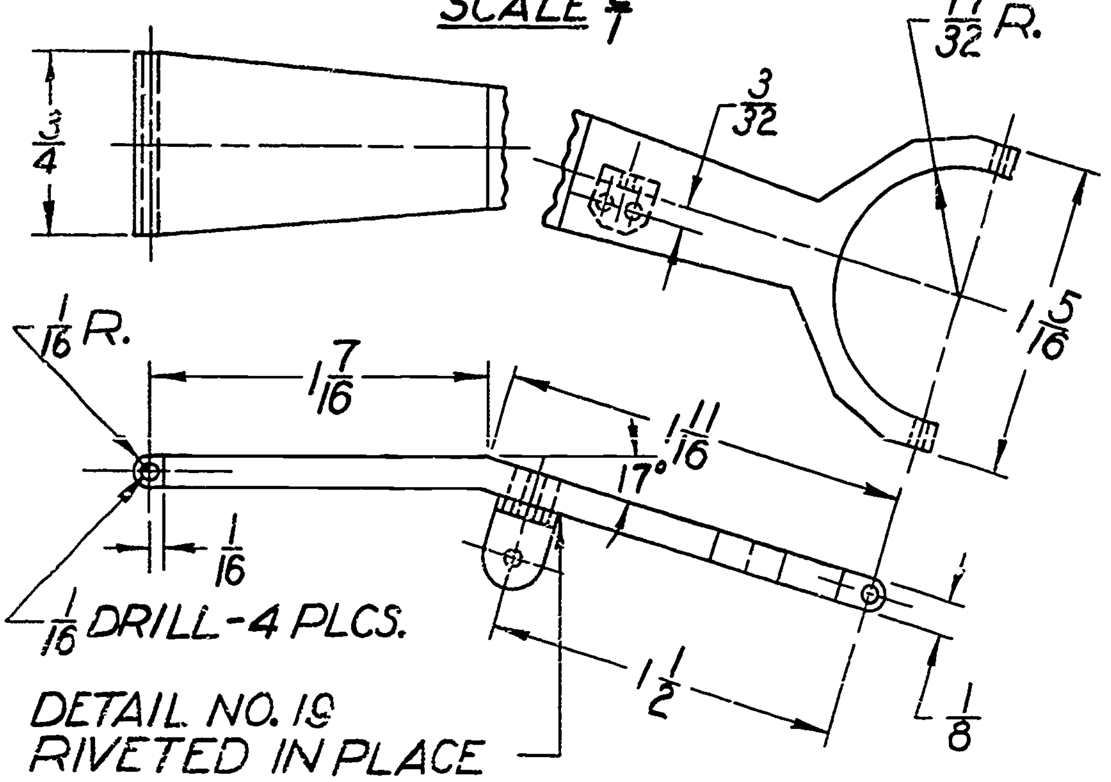
DETAIL NO. 15
SCALE $\frac{2}{1}$

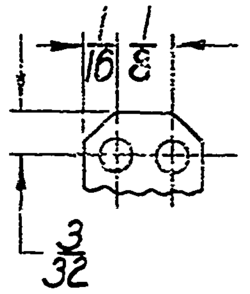


DETAIL NO. 16
SCALE $\frac{2}{1}$

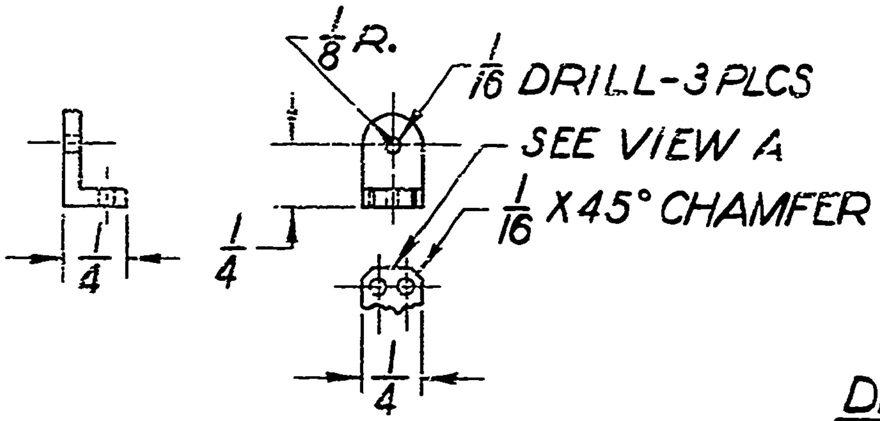


DETAIL NO. 17
SCALE 2/1



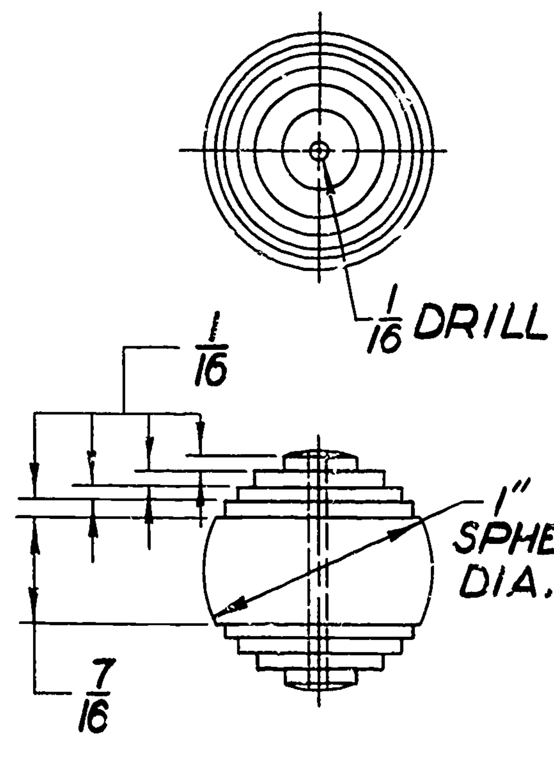


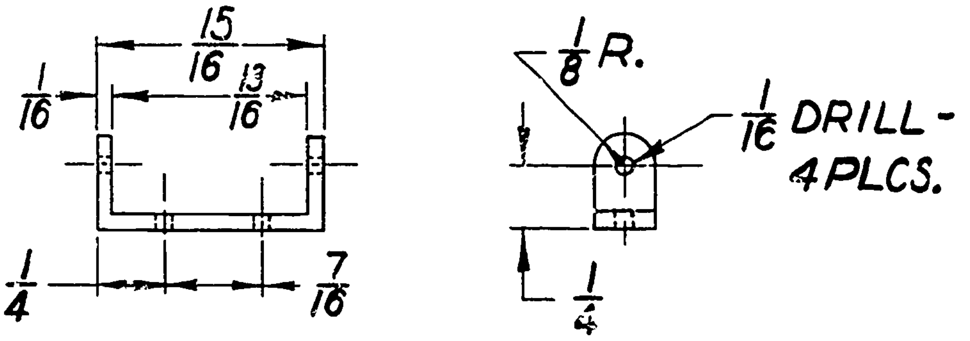
VIEW A
SCALE 4/1



DETAIL NO. 19
SCALE 2/1

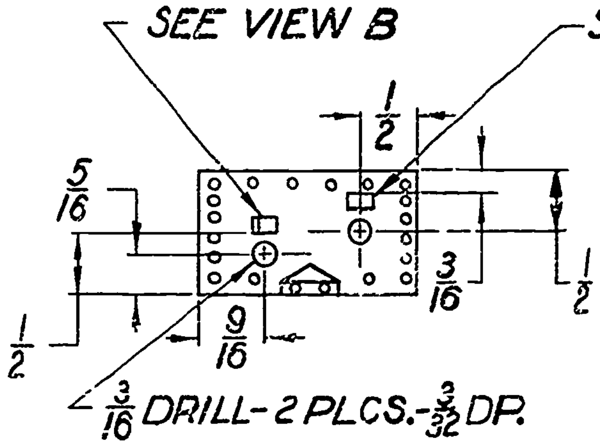
DETAIL NO. 20
SCALE 2/1

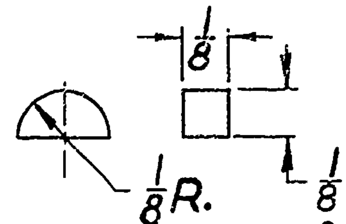




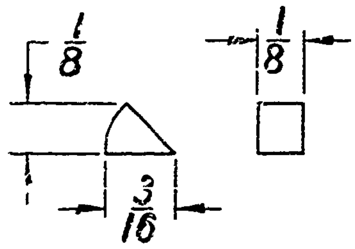
DETAIL NO. 18
SCALE 2/1

DETAILS - SIDE 1





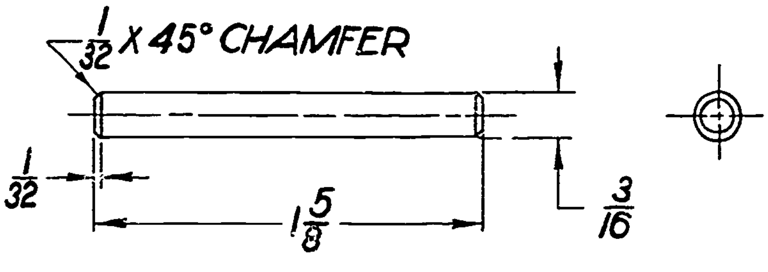
VIEW A - SCALE 3/1



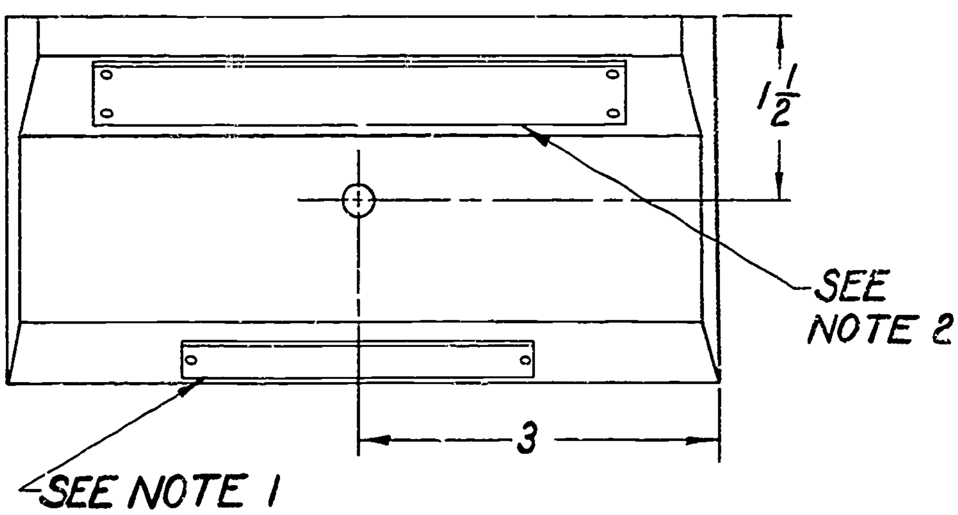
VIEW B - SCALE 3/1

NOTE:
FOR OTHER DIMENSIONS - SEE SIDES A & F.

DETAIL NO. 21
SCALE - 2/1

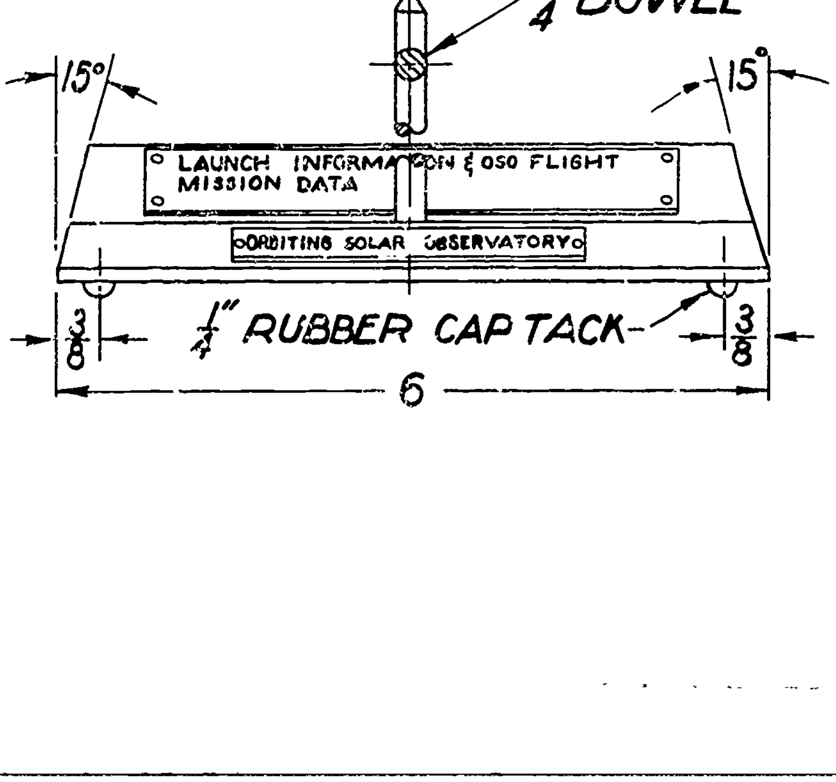


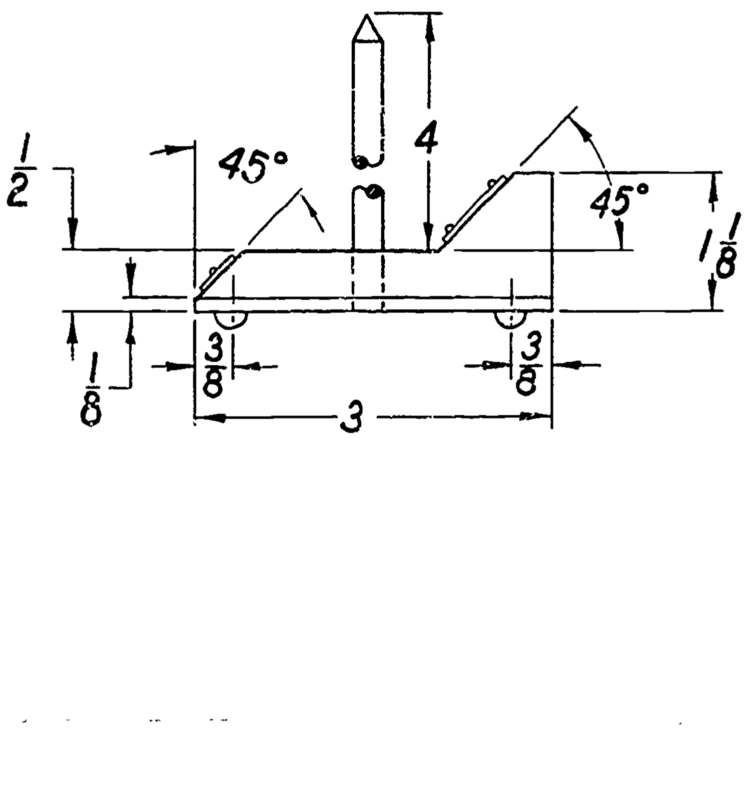
O.S.O. MODEL STAND
SCALE 1" = 1"



NOTES:

1. - 3/8" X 3" BRASS PLATE - STAMP WITH 1/8" LETTERS.
2. - COVER TYPED INFORMATION WITH 1/16" X 3/4" X 4 1/2" CLEAR PLASTIC.





RECOMMENDED MATERIALS FOR CONSTRUCTION

ORBITING SOLAR OBSERVATORY

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	Two	Plywood - 1/8"	Silver
2	Two	Plywood - 1/4"	Natural
3	One	Wood - maple	Silver
4	One	Wood - maple	Silver
5	Two	Wood - balsa	Silver
6	One	Wood - pine	Black
6A	One	Wood - balsa	Silver
7	One	Wood - maple	Black
8	One	Wood - pine	Black
9	Two	Wood - balsa	Silver
10	Two	Wood - maple	Silver
11	Two	Wood - maple	Silver
12	Two	Wood - maple	Silver
13	One	Wood - pine	Black
14	Two	Wood - balsa	Silver
15	Three	Band iron	Silver
16	Three	Band iron	Silver
17	Three	Band iron	Silver
18	Three	Band iron	Silver
19	Six	Band iron	Silver

RECOMMENDED MATERIALS FOR CONSTRUCTION

ORBITING SOLAR OBSERVATORY

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
20	Three	Wood - maple	Silver
21	Two	Dowel - rod	Natu
22	Twelve	Metal wood screws	Silver
23	Three	Metal brazing rod	Natural
24	Fifteen	Metal brazing rod	Natural
25	One	Wood - maple	Silver
A-I	Nine	Wood - pine	Silver

RECOMMENDED PROCEDURE FOR CONSTRUCTION

ORBITING SOLAR OBSERVATORY

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - 1/8" plywood	Layout and cut a nonagon to specified dimensions		
2	Wood - 1/4" plywood	Layout and cut a nonagon to specified dimensions		
4	Wood - maple	Turn on lathe to specified dimensions and drill as specified		
A&G) B,E,H) C) D) F) I)	Wood - pine Use escutcheon pins for surface effect	Fabricate parts to specified dimensions and details	Finish sand all surfaces	Subassemble as indicated on detailed drawings
25	Wood - maple	Turn on lathe as specified on detail no. 1 and drill to accommodate part no. 3	Finish sand all surfaces	
3	Dowel - rod	Cut and shape to specified dimensions		Subassemple parts 1,2,3,4,25 and A through I

RECOMMENDED PROCEDURE FOR CONSTRUCTION

ORBITING SOLAR OBSERVATORY

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
15,16, 17,18, 19	Band iron	Cut and shape to specified dimensions		Subassemble parts 15,16,17,18 and 19 as noted and attach one each to parts B,E and H with part no. 22
20	Wood - maple	Turn on lathe to specified dimensions and drill for part no. 23	Finish sand all surfaces	
23	Brass rod	Cut to specified length	Polish	Assemble part no.20 to part no.17 using part no.23
			Paint assembled parts 1,3,4,15, 16,17,18,19,20, 23,25 and A through I silver	
6	Wood - pine	Cut and shape to specified dimensions		

RECOMMENDED PROCEDURE FOR CONSTRUCION

ORBITING SOLAR OBSERVATORY

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
7	Dowel - rod	Cut and shape to specified dimensions	Finish sand all surfaces	Assemble to part no.6 as indicated
6A	Wood - balsa	Cut and fabricate to specified dimensions		Glue to part no. 6 as indicated
5	Wood - balsa	Cut and fabricate to specified dimensions		Glue to part no. 6 as indicated
8	Wood - pine	Cut and fabricate to specified dimensions		
9	Wood - balsa	Cut and fabricate to specified dimensions		
10	Wood - hard	Fabricate to specified dimensions		
11&12	Wood - Dowel-rod and balsa	Fabricate to specified dimensions	Finish sand all surfaces	Glue parts 9,10,11 & 12 to part no. 8 as indicated
13	Wood - pine	Cut and fabricate to specified dimensions		

RECOMMENDED PROCEDURE FOR CONSTRUCTION

ORBITING SOLAR OBSERVATORY

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
14	Wood - balsa	Cut and fabricate to specified dimensions		Glue parts 10,11, 12 and 14 to part no. 13 as indicated on detail no.8
			Finish sand all surfaces	
			Paint assembled part nos. 5,6A, 9,10,11,12 and 14 silver	
			Paint assembled part nos. 6,7,8 and 13 black	
Model Stand	Wood - walnut	Recommended construction is indicated on detail sheet	Natural rubbed oil finish	

R E L A Y

Around the world in 80 days --- around the world in 80 hours ---- around the world in 80 minutes ---- around the world in 80 seconds. In this rapidly shrinking time-world, instantaneous global communication is becoming a necessity.

Studies indicate that the conventional limited-capacity overseas communications facilities will not be adequate for the expected increase in traffic. In 1960 there were almost four million overseas telephone calls. Reliable estimates indicate a five-fold increase in the next decade. Such an increase will overtax the current as well as the planned underseas cable and high frequency radio facilities. There is little doubt that transoceanic satellite communications will be needed to supplement these facilities.

Economic studies which have already been undertaken indicate that the comsats (communications satellite) can provide services comparable to those of the undersea cable at a lower cost per channel of capacity. Also it may well be the only means of providing high quality communication to remote, less-developed areas.

The comsat era began in 1958 when the famous Christmas message from the president was transmitted to the world by the Project Score satellite. It was followed in 1960 by Echo I, the first passive communications satellite; and Courier, the "delayed repeater" satellite. Telstar was boosted into orbit in July 1962, Relay in December 1962, and Syncom in February 1963.

These satellites represent the beginning stages of the investigation and exploitation of the three basic techniques applicable to operational communication systems. Active satellites in low and medium altitude orbits, active satellites in 24-hour synchronous orbits, and passive reflector satellites in low orbits are the techniques under study.

Echo I, a 100-foot metallized balloon, performed many successful transcontinental and transoceanic experiments but a radio mirror such as this passive reflector satellite merely reflects signals. Because they do not amplify signals, the reflecting area of the satellites must be large and the ground stations must be large and complex.

The active satellites, which carry receivers and transmitters for amplifying and retransmitting the received signals, hold great promise for the future. The dramatic demonstrations of trans-Atlantic television which have taken place via Telstar and Relay have proved that satellites of this type are capable of providing excellent inter-continental communications. Because it is a powered amplifying repeater, the active communications satellite can be quite small. It is also possible to use less sensitive ground transmitting equipment.

The Relay is an interesting example of an experimental satellite of the intermediate-altitude type. The spacecraft weighs 172 pounds, is 32 inches high and has a maximum breadth of 29 inches. From one end extends the 18-inch ringlike antenna structure which handles both the transmission and the reception of communication signals. Its eight sides contain more than 8,000 solar cells. The whiplike antennas at the broad end of the craft are part of the systems for turning Relay experiments on and off. It also acquires and sends to Earth data on component behavior and on radiation in space.

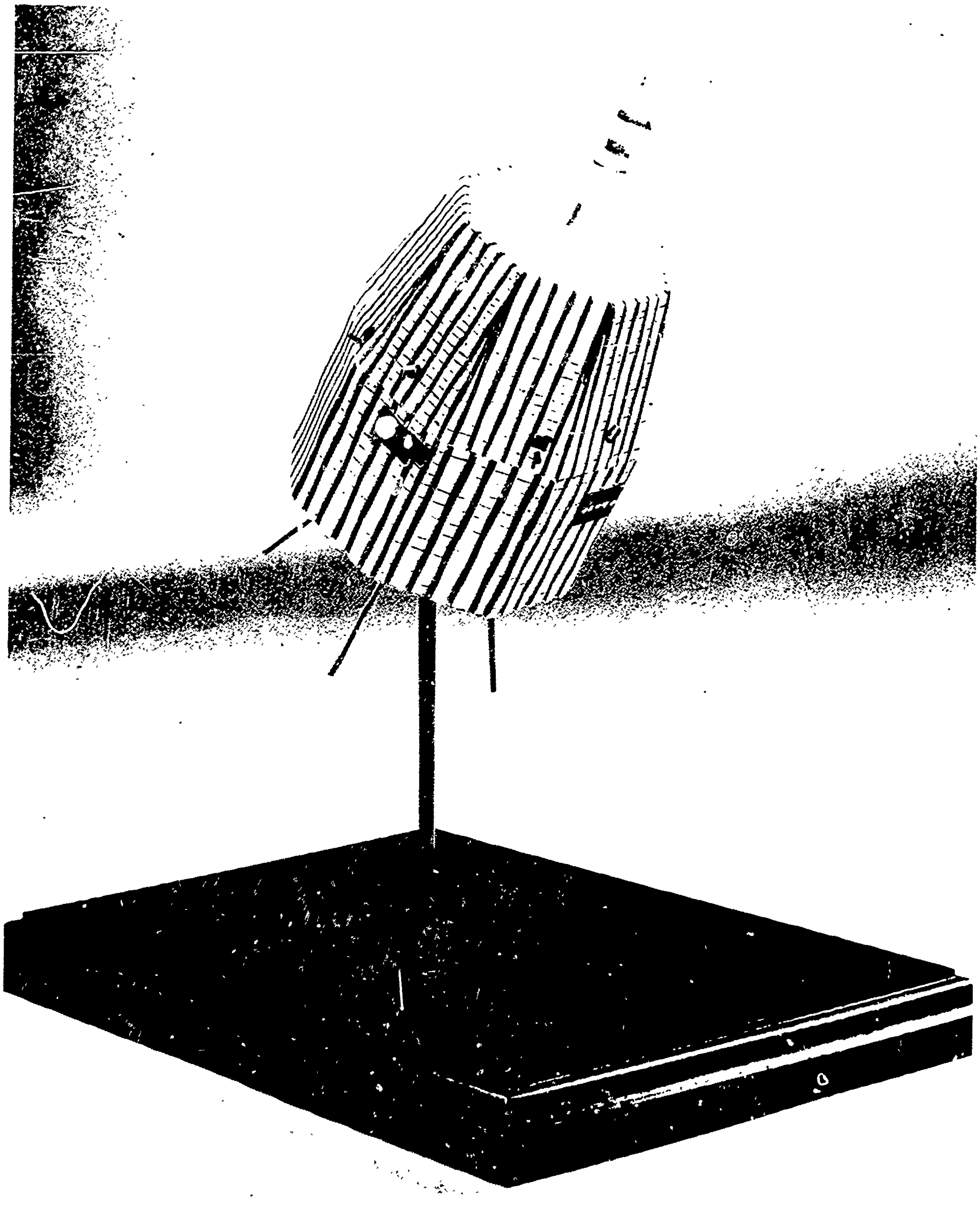
After successful injection into a 819/4612 mile orbit by a Delta vehicle on December 13, 1962, an abnormal power drain initially prevented tests. Failure of the voltage regulator was found to be the cause and the use of the redundant transponder permitted experiments beginning January 3, 1963. On January 9, a television program from the National Gallery of Art in Washington D.C. was successfully telecast to stations in France and Great Britain. Since then many other engineering tests and demonstrations have been performed using this satellite.

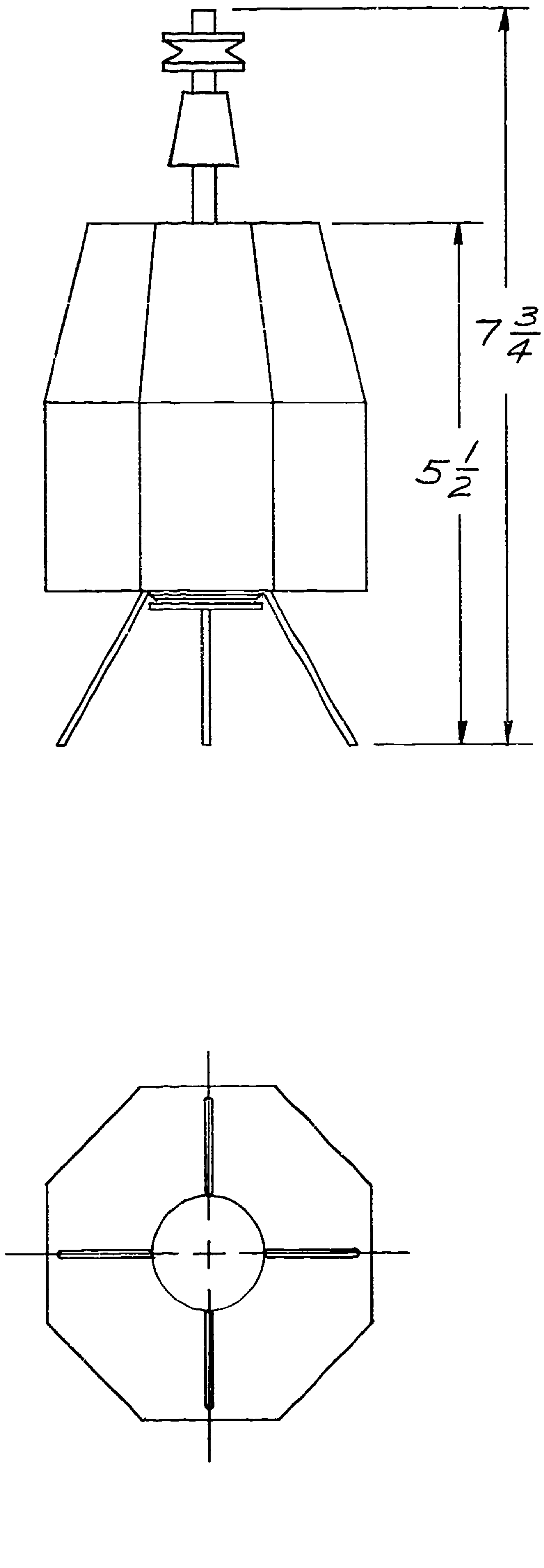
The usefulness of the communications satellite and its importance in world-wide communications are beyond question. The involvement of the world in the peaceful use of these satellites is another important aspect of the program. The extent to which other countries are willing to fund ground facilities for experimental purposes illustrates the broad international interest in the communications satellites. Stations in the United States, Brazil, France, England, Italy and Germany are cooperating in the Relay experiments. The station in Japan will be operational in 1964. Interest in providing ground stations has been indicated by several other countries including the Scandinavian countries, Canada and India.

Satellites thousands of miles above Earth's surface can provide not only efficient communication for the entire world but can link all the countries in the peaceful use of space. In the words of the late President Kennedy: "There is no more important field at the present time than communications and we must grasp the advantages presented to us by the communications satellites to use this medium wisely and effectively to insure greater understanding among the people of the world."*

*Public statement by John F. Kennedy in 1962.

RELAY





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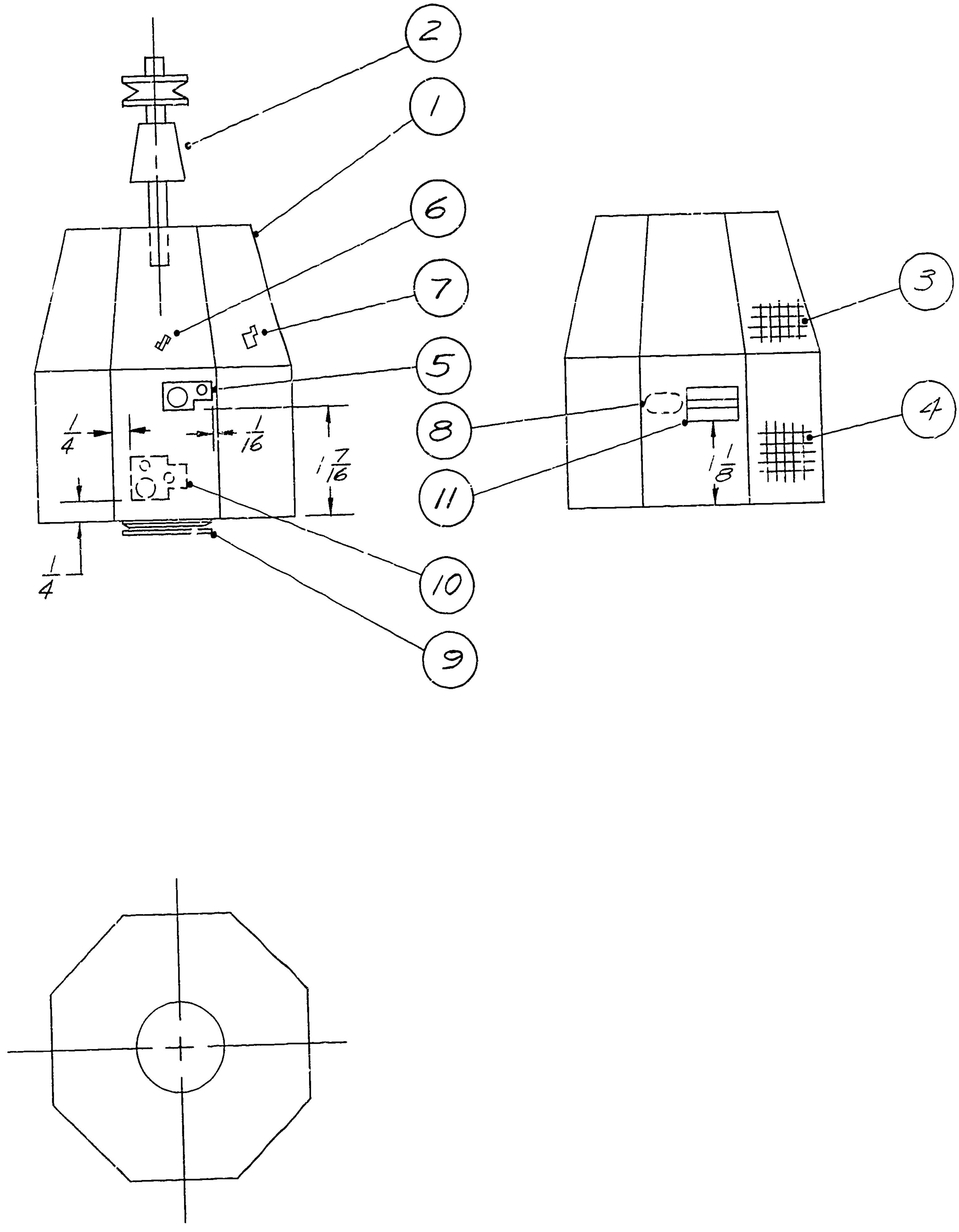

2-A RELAY

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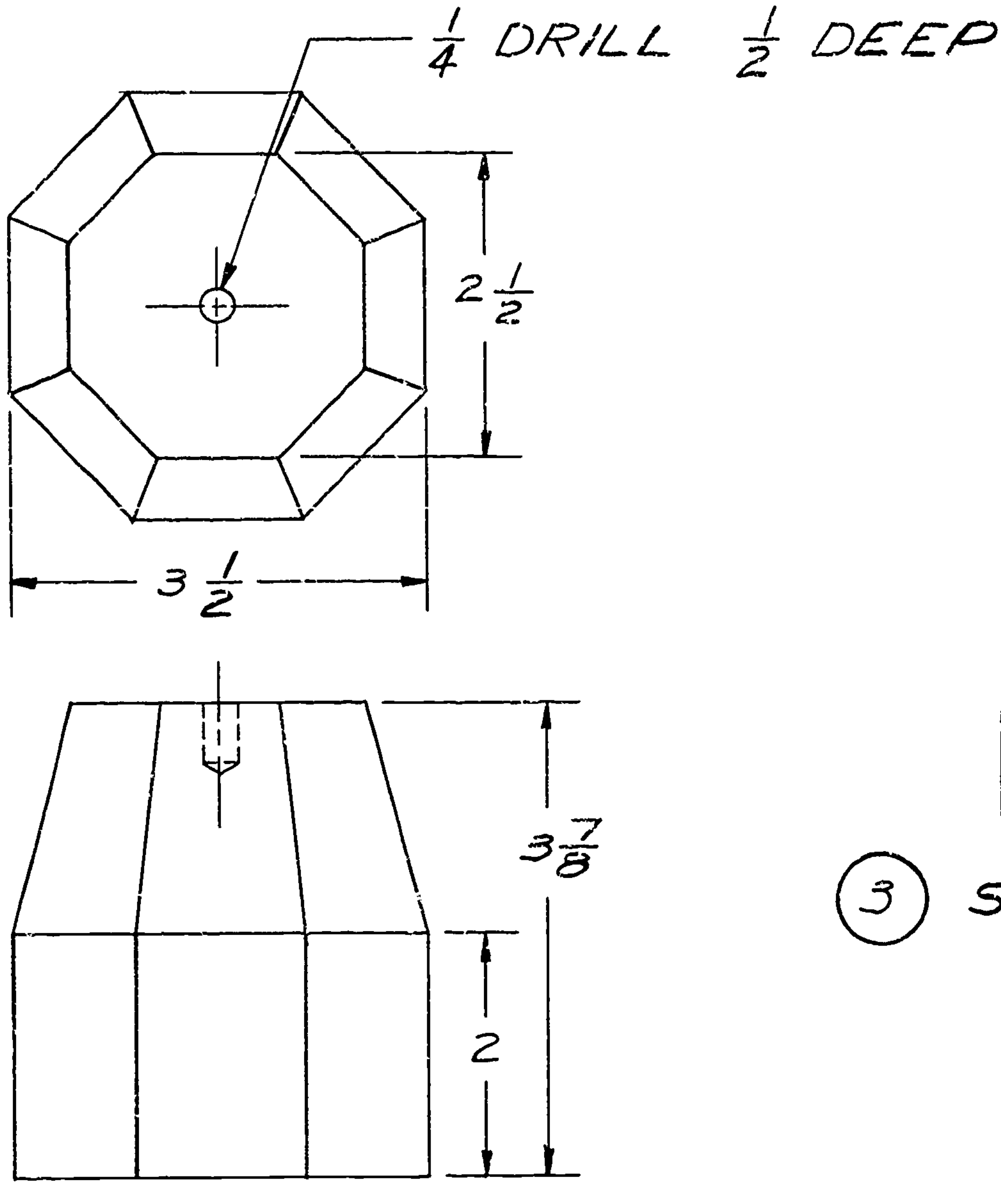

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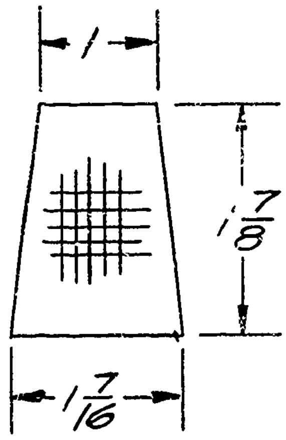
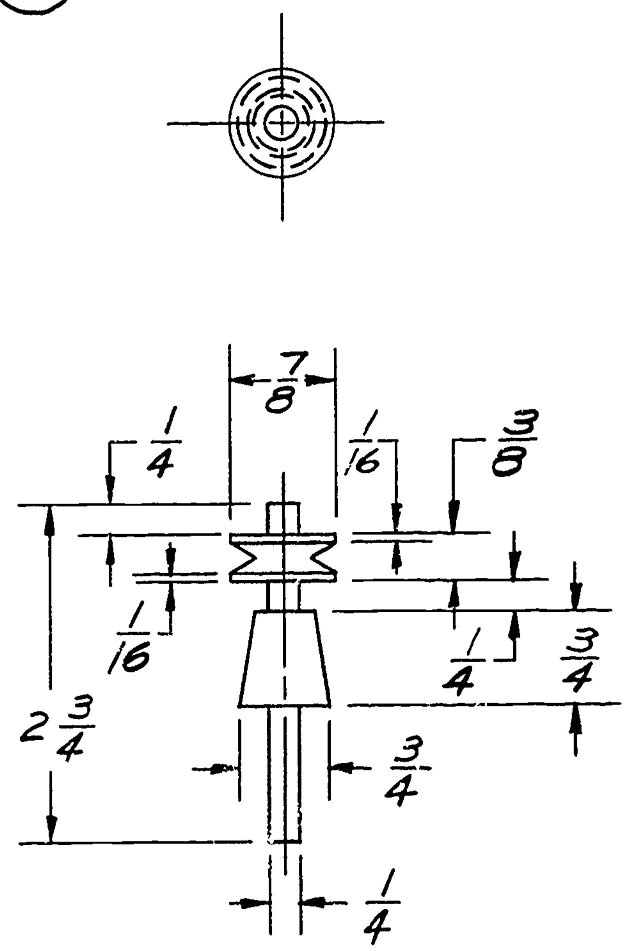


(3) SOLAR CELL
8-REQD.



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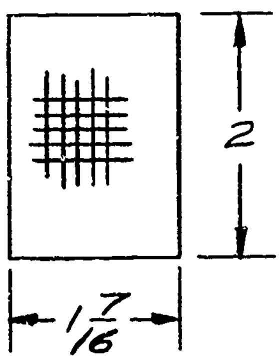

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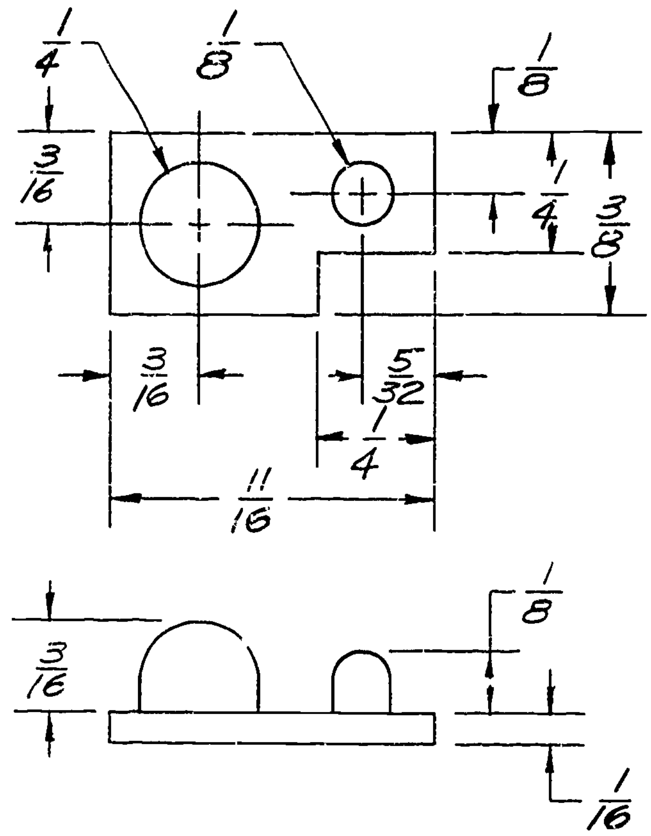
8-REQD.



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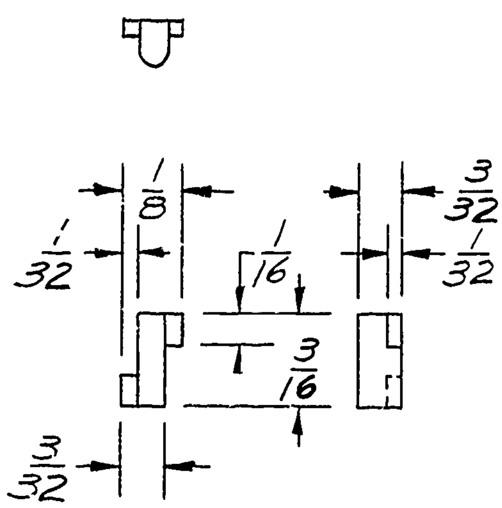

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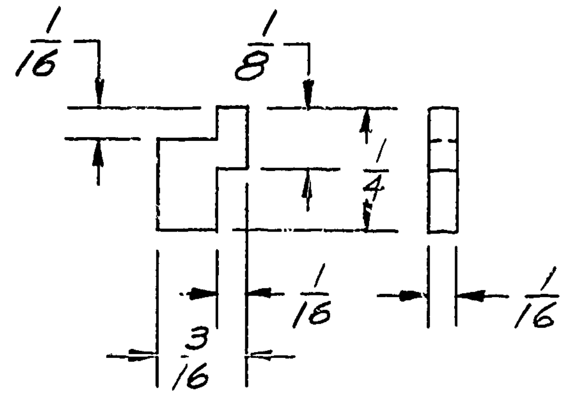

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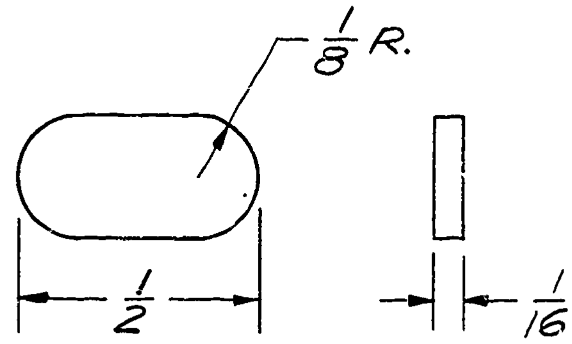

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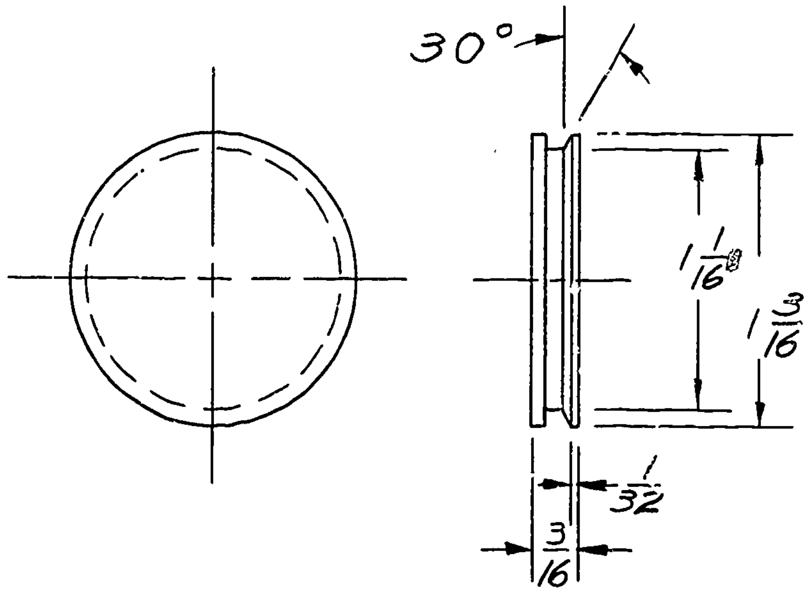

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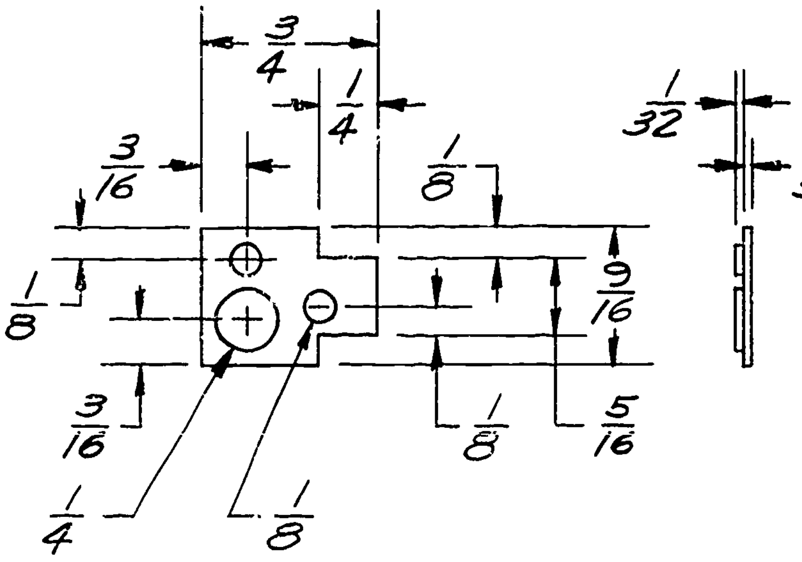
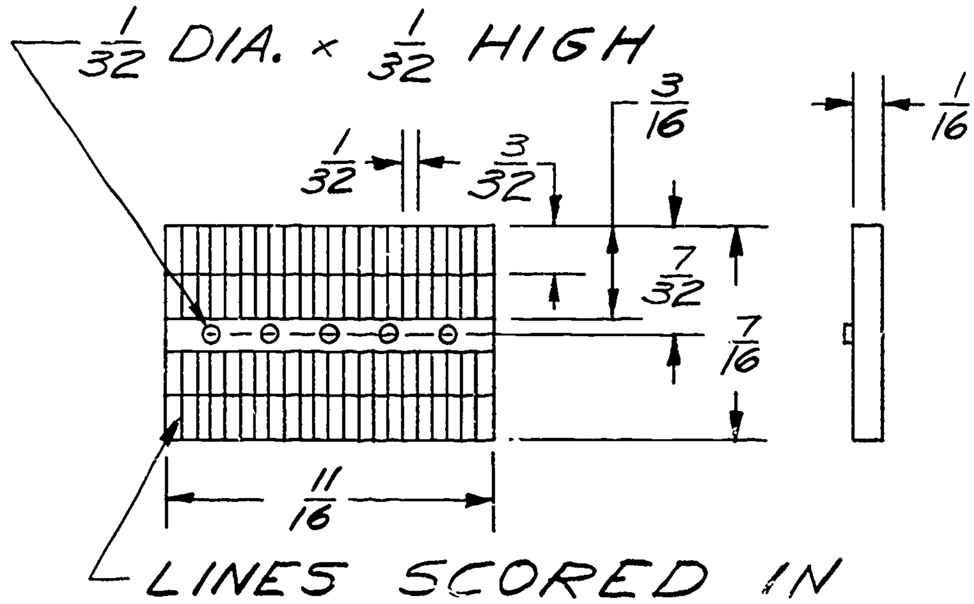


(10) 1-REQD 2X



(11) 1-REQD 4X

RECOMMENDED MATERIALS FOR CONSTRUCTION

RELAY

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	One	Wood - pine	White
2	One	Wood - maple	White
3&4	Eight each	-	Black lines on part no. 1 to indicate solar cell surfaces
5	One	Wood - balsa	Blue base
6	Four	Wood - balsa	Gold
7	Four	Wood - balsa	Blue
8	One	Plastic	Blue
9	One	Wood - maple	Silver
10	One	Wood - balsa	Blue base and white projections
11	One	Wood - balsa	Blue base and white projection

RECOMMENDED PROCEDURE FOR CONSTRUCTION

RELAY

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - pine	Construct octagon body to specified dimensions. Drill as per detailed drawing	Finish sand all surfaces. Paint white	
		Layout and mark solar cells on all surfaces as indicated on detail nos. 3 and 4	Marks to be made with India ink	
2	Wood (maple), plastic or brass	Turn on lathe to specified dimensions	Finish sand all surfaces and paint white	Assemble part no. 2 to part no. 1 using epoxy resin
5	Balsa wood, fiber or plastic with dowel rod for the round parts	Construct to specified dimensions	Finish sand all surfaces	
6	Balsa wood, fiber or plastic	Construct to specified dimensions	Finish sand all surfaces	
7	Balsa wood, fiber or plastic	Construct to specified dimensions	Finish sand all surfaces	
8	Balsa wood, fiber or plastic	Construct to specified dimensions	Finish sand all surfaces	

RECOMMENDED PROCEDURE FOR CONSTRUCTION

RELAY

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
9	Wood (maple) or plastic	Turn on lathe to specified dimensions	Finish sand all surfaces	Assemble part no. 9 to part no. 1 using epoxy resin
10	Balsa wood and dowel rod	Construct to specified dimensions	Finish sand all surfaces	Assemble parts no. 5,6,7,8,10 and 11 to part no. 1 using epoxy resin
11	Balsa wood, fiber or plastic	Construct to specified dimensions	Finish sand all surfaces Paint parts no. 5,7,8,10 and 11 blue Paint part no. 6 gold Paint part no. 9 silver Paint projections on parts no. 5,10, and 11 white	

M A R I N E R

In the beginning there was -------. No one can continue this sentence with absolute certainty because it is like trying to describe one's own birth. He would have to start with present conditions and work backwards in time through areas in which knowledge is still incomplete. Although scientists today know many more facts than those in the past, they must explain much more than the ocean and dry land or sun by day and moon by night. How did the earth begin? How did life begin? Is this the only planet on which life exists?

When we unravel the mysteries of other planets we may gain more understanding of our own. Can some of the answers be provided by man's "morning and evening star"? Venus, hiding in her perpetual cloud, has been the object of much speculation because of her almost identical size to the earth and her similar gravitational field. Is there life on our sister planet, Venus?

A "giant" step was taken on December 14, 1962, when Mariner II flew past Venus at a distance of 21,648 miles, giving man his first relatively close-up observation of earth's closest planetary neighbor. Until the present time, only extremely long-range methods of gathering data have been available with which to study this planet. Analysis of radar echoes and sunlight reflection over a distance of 26 million miles are the techniques which have been used.

The Mariner spacecrafts were built for the purpose of obtaining scientific information on Venus from close range. The first Mariner vanished in flames on July 22, 1962, after 290 seconds of flight. It was deliberately destroyed because it was off course. No more than a misplaced hyphen in the equations fed into a computer was the cause of the failure!

A month later on August 27, Mariner II was boosted by a two-stage Atlas-Agena B rocket on its journey into space. The gleaming spacecraft was five feet in diameter and nine feet eleven inches high. In cruise position with solar paddles and antenna extended, it measured sixteen feet six inches across and eleven inches high. Of its 449 pounds, the scientific equipment for gathering information weighed 40 pounds. The remainder of its weight consisted of structure, power supply, propulsion, communication, electronics and other support equipment.

Aiming the launch and timing the take-off had to be figured with precision. The scientists had to take into consideration the orbital speed of Earth and Venus around the sun, the Earth's rotation, and the movement of the sun as well as the gravitational pull of these bodies. Mariner II was lobbed into space in the opposite direction from its rendezvous point with Venus. The reason for this was that Earth and Venus are locked in solar orbit with Venus closer to the sun. When an orbiting body slows down, it is drawn inward by the sun's gravitational pull. Mariner II had to be fired in the opposite direction to lose some of the earth's orbital speed which it already had before it was even launched. This feat of marksmanship has been likened to hitting "a fast-flying clay pigeon from a spinning merry-go-round using a rifle fastened to the merry-go-round."

With its solar panel wings spread, the spacecraft created electric power for its instrumentation (by means of 9,800 solar cells) during its journey. Its high gain antenna pointed toward earth for communication. A complex system of sun and earth sensors, gyroscopes, and nitrogen gas jets kept Mariner in proper attitude. Other major equipment included an omni-antenna, other radio equipment, temperature controls and a 50-pound-thrust mid-course correction rocket system used to correct its course 1,490,000 miles out in space.

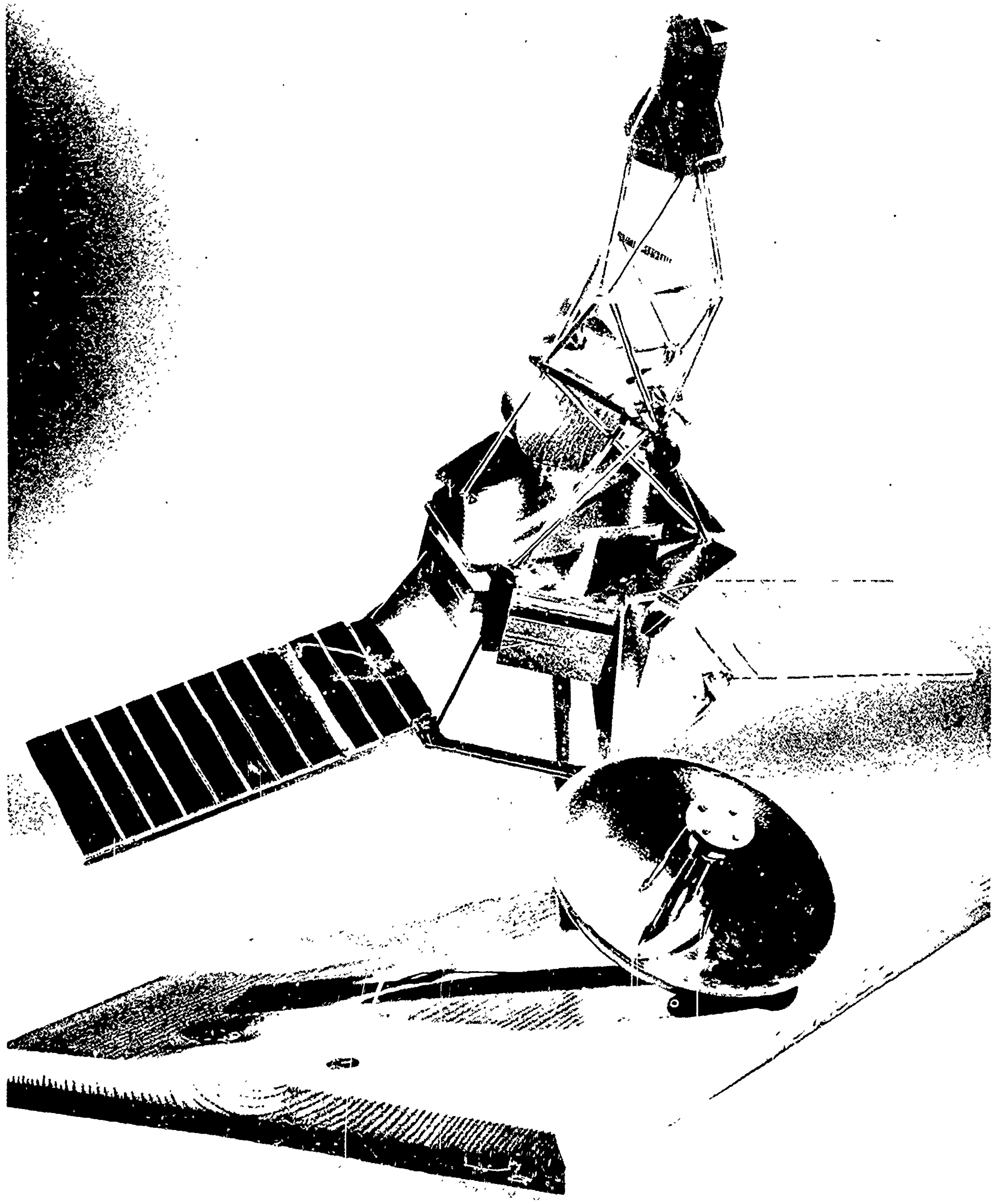
Mariner II's mission was officially completed when it passed Venus and joined the other planetoids in solar orbit. This Venus fly-by significantly advanced the world's knowledge about Venus and about interplanetary space. In addition to the 18 data readings covering the night and day side of Venus and the terminator which separates them, the spacecraft sent an abundance of information while enroute. It continued to transmit data about interplanetary space until January 3, 1963. When radio contact was lost, the Mariner was nearly 6 million miles beyond Venus and about 54 million miles from earth. The successful space bird rewarded its creators with 90 million bits (from <u>bi</u>nary digi<u>t</u> meaning a unit of information) which translated and interpreted with other experiments give a fascinating picture of "our morning and evening star".

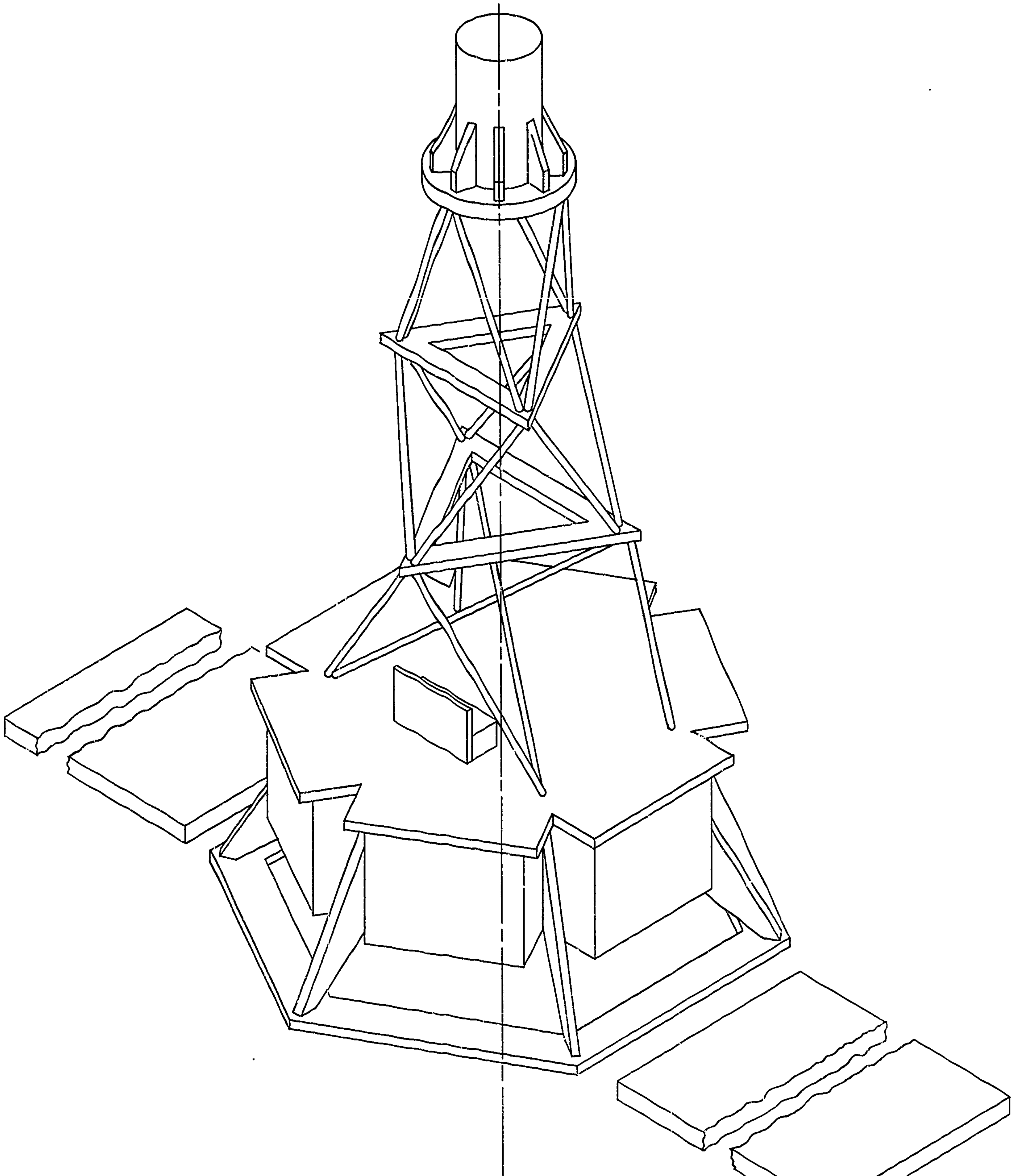
After months of study, a report was made to the world. Rich in carbon dioxide and poor in water vapor and oxygen, the atmosphere is hostile to life as we know it on earth. A continuous cloud cover 15 to 20 miles thick starts 45 miles above the surface. It creates a "greenhouse effect" by letting solar energy reach the surface but preventing much of the heat from escaping. The Mariner also reported that the temperature of the apparently dry and granular surface may be 800° F. Over it winds circulate dense gases compressed in an atmosphere 10 to 30 times heavier than ours. The speculation that the gases readily conduct heat around the planet may explain why the spacecraft found no temperature difference between the sunlit and the dark sides. The cloud temperature was found by the Mariner to be 200° F. at the base, -30° F. at the middle level and -60° F. at the upper level. It is speculated that the clouds are composed of condensed hydrocarbons like those found in smog.

No evidence of Venusian magnetic field nor any bands of radiation was reported by Mariner's instruments at the fly-by distance. The absence of such bands agrees with other observations that indicate a very slow rotation of the planet. Radar studies provide evidence that Venus rotates once each 225 earth days; thus Venus's day will equal its year. Studies also suggest that Venus rotates backwards with respect to earth. On Venus, then, the sun rises in the west and sets in the east.

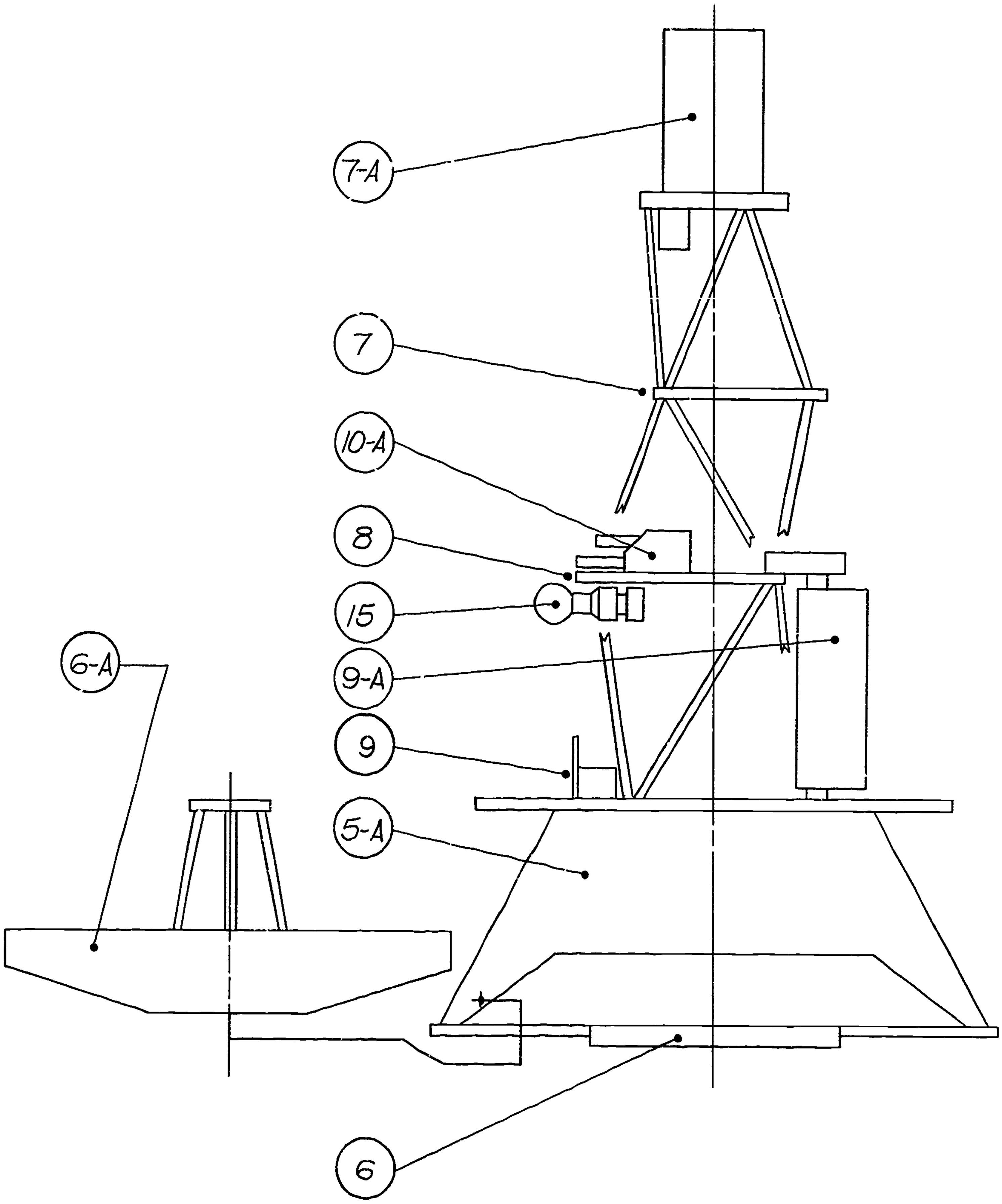
The conditions on the Venusian surface suggest that the planet supports no life as we know it on earth, but biologists reserve judgment on the existence of lower forms of life in its upper atmosphere. The fundamental scientific question lies unanswered. Is there life on Venus?

MARINER

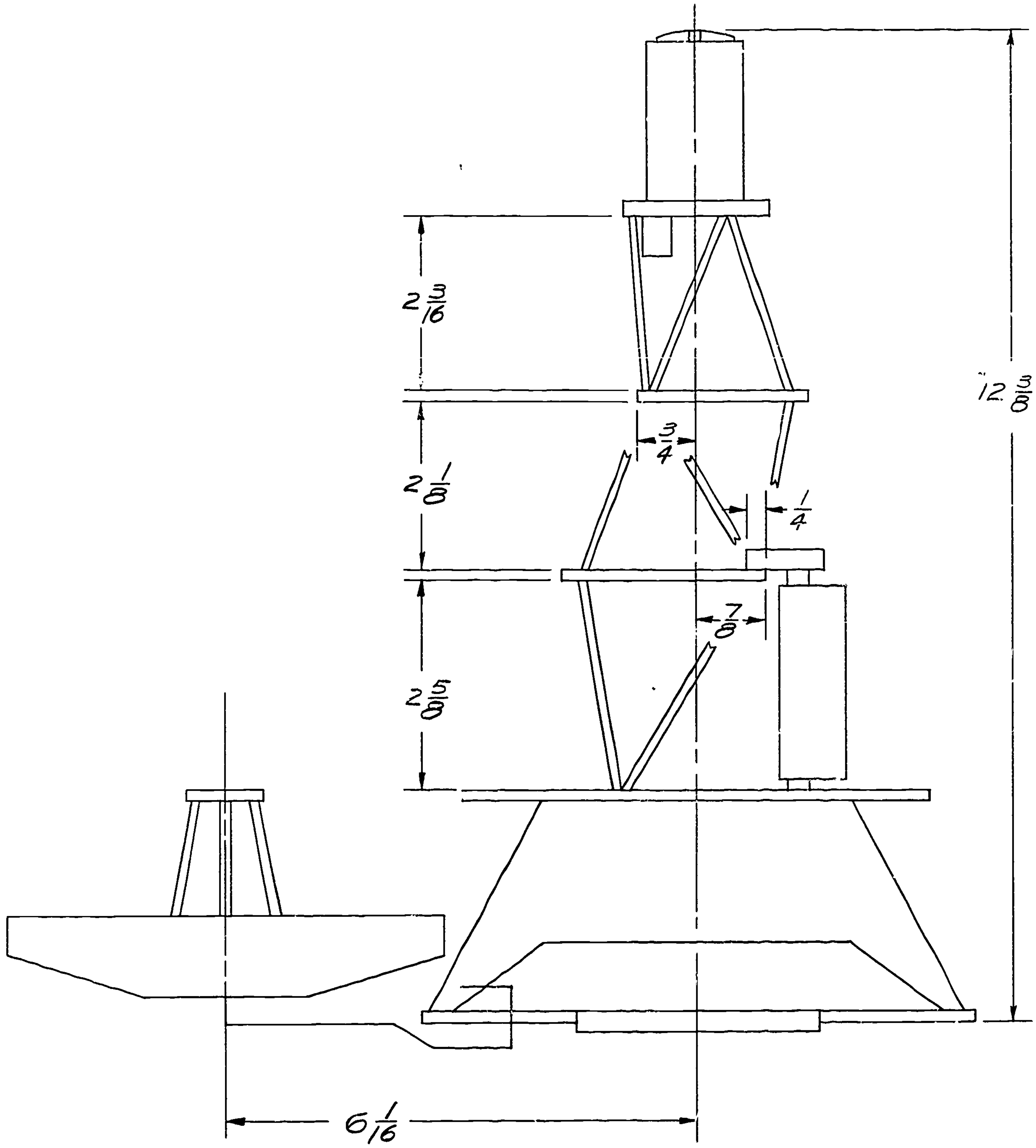




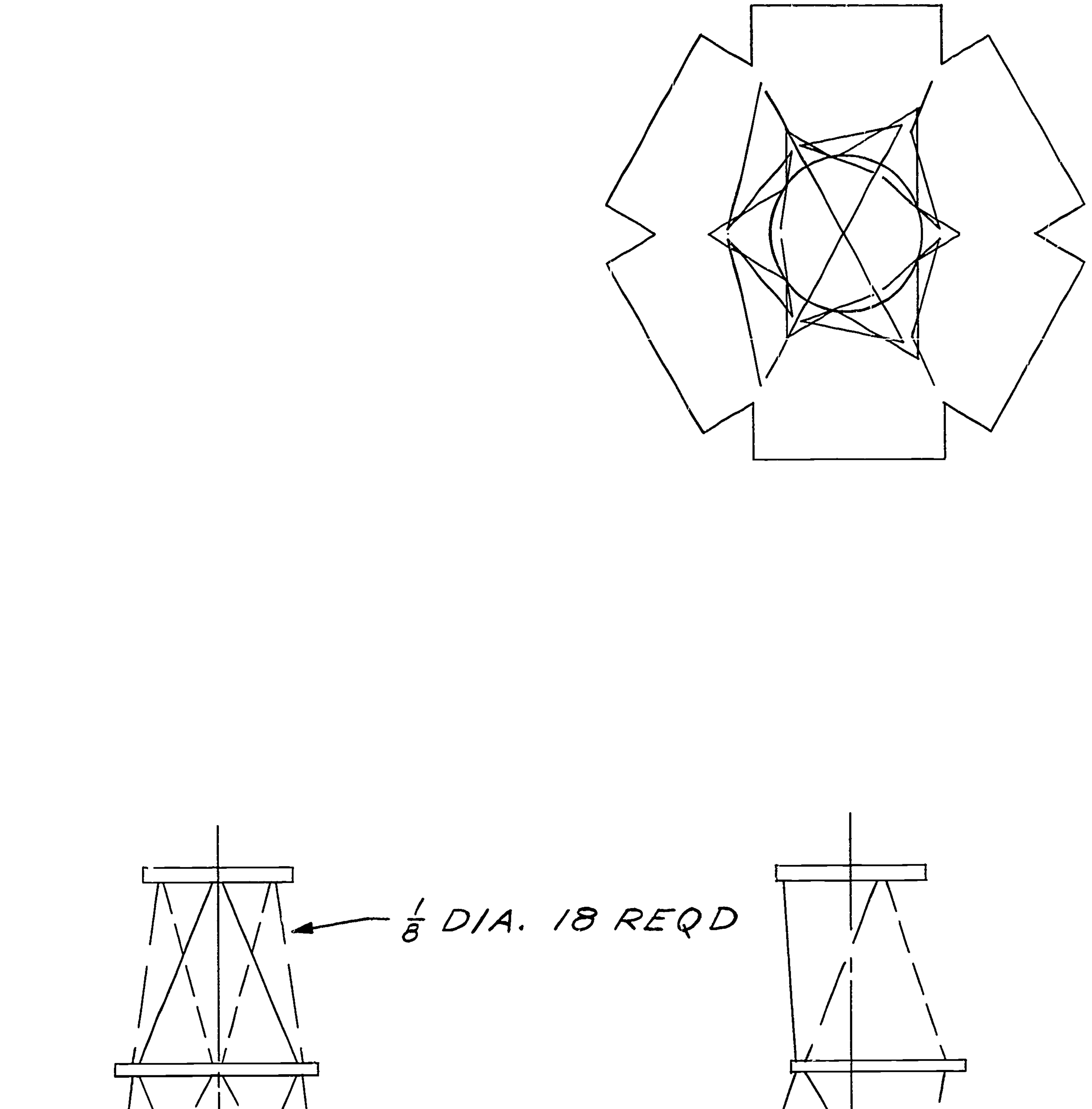
(1-A) MARINER
PARTIAL ELEVATION



(2-A) SIDE ELEVATION



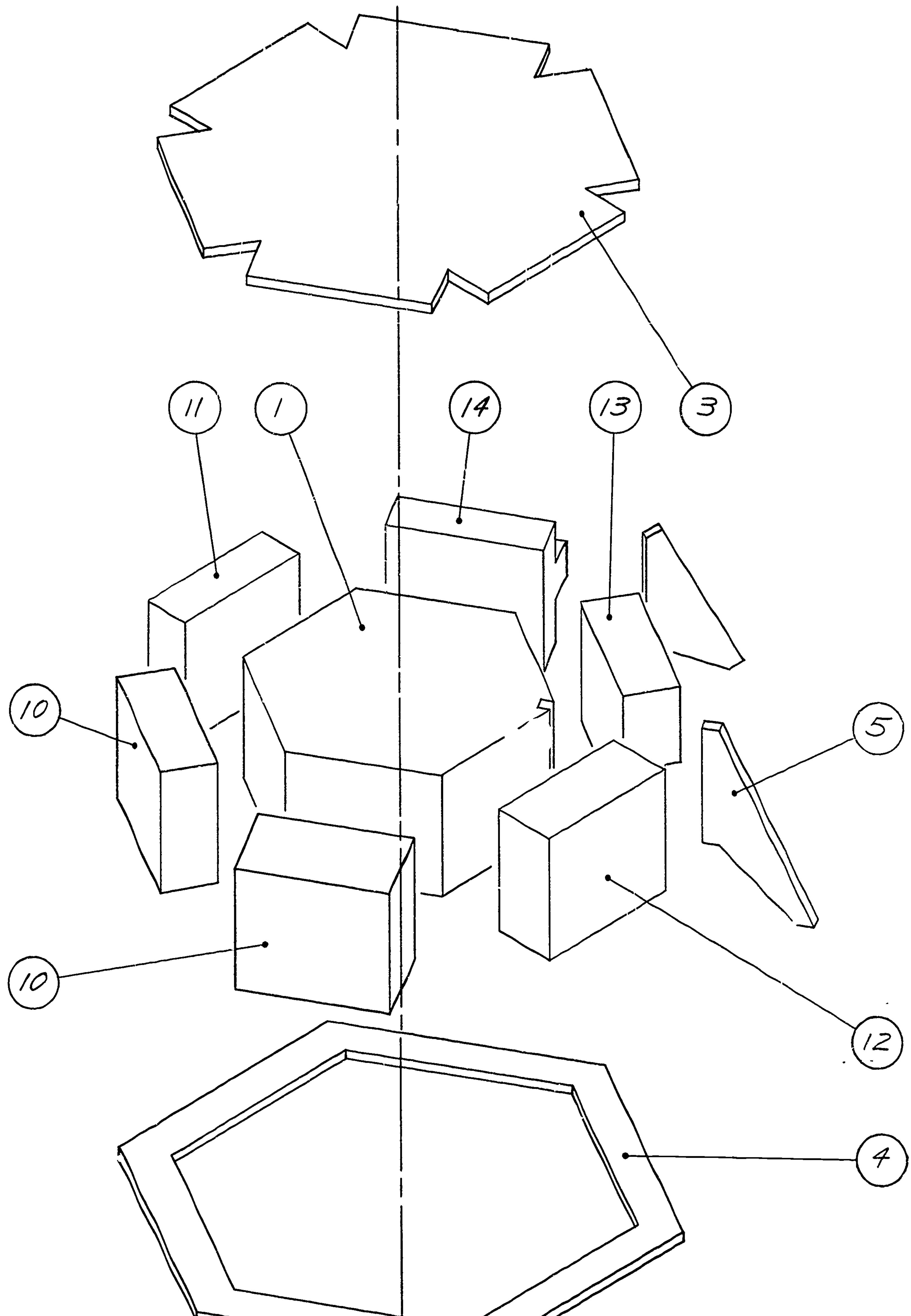
(3-A) SIDE ELEVATION



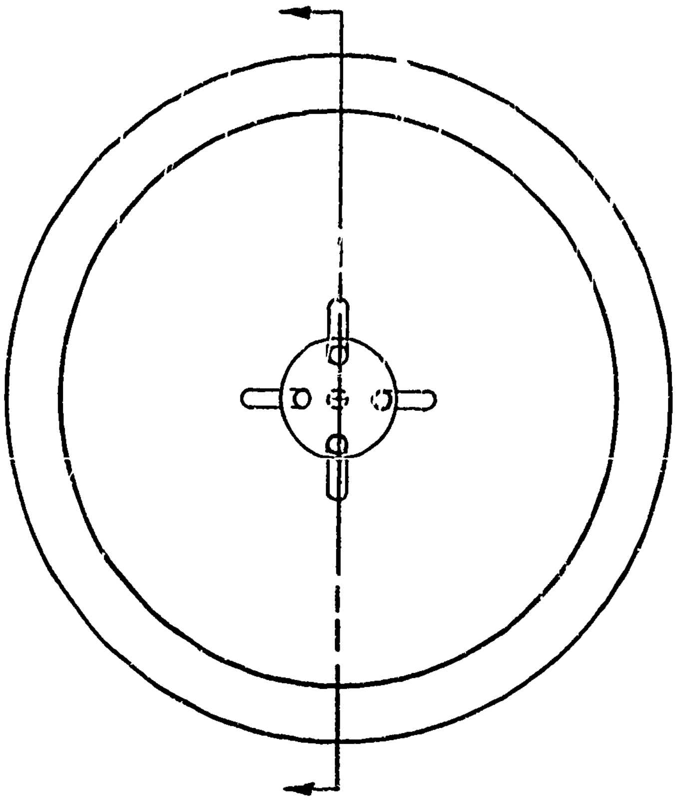
(4-A) FRONT

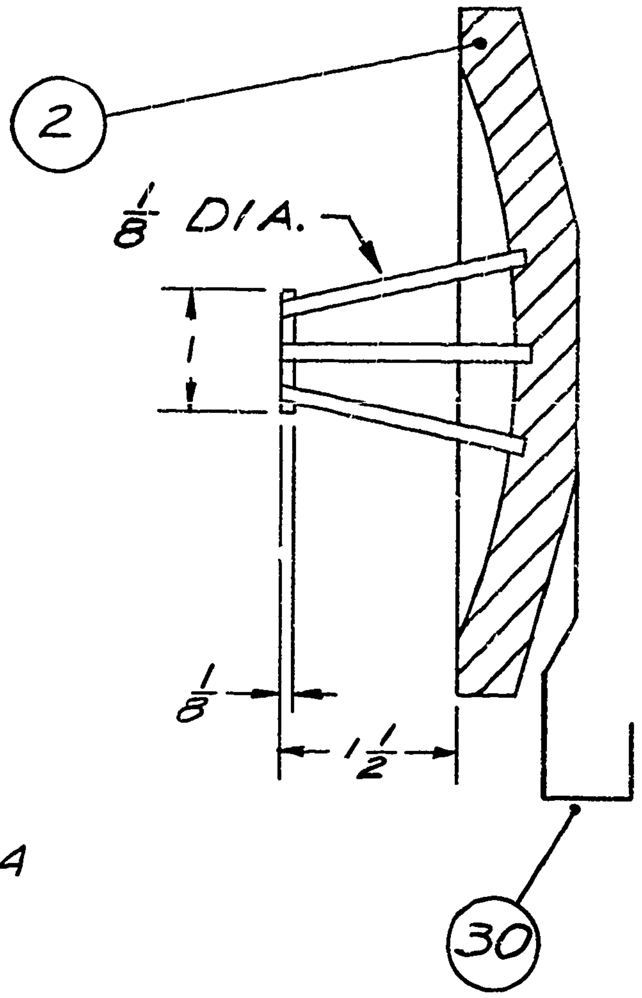
SIDE

229-357 O-66—6

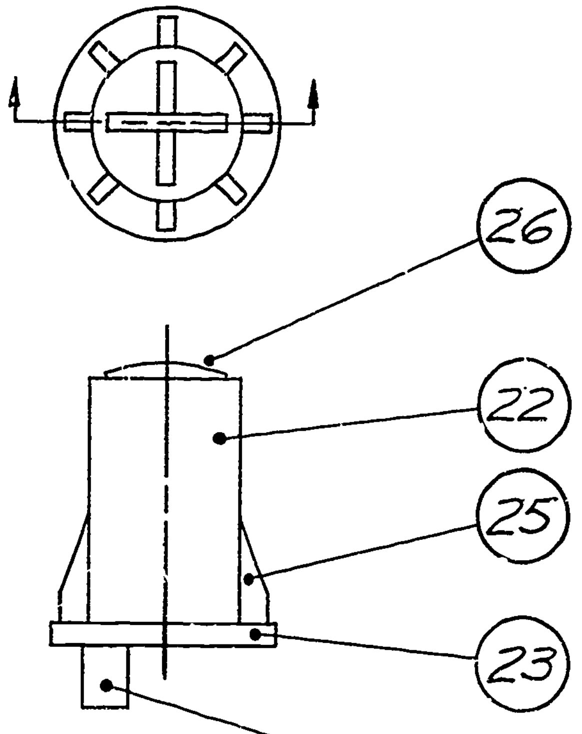


5-A BASE ASSEMBLY

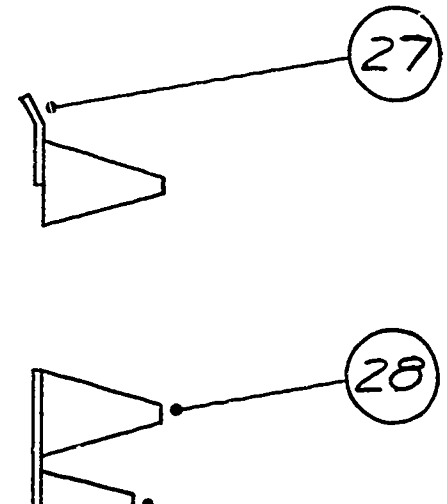




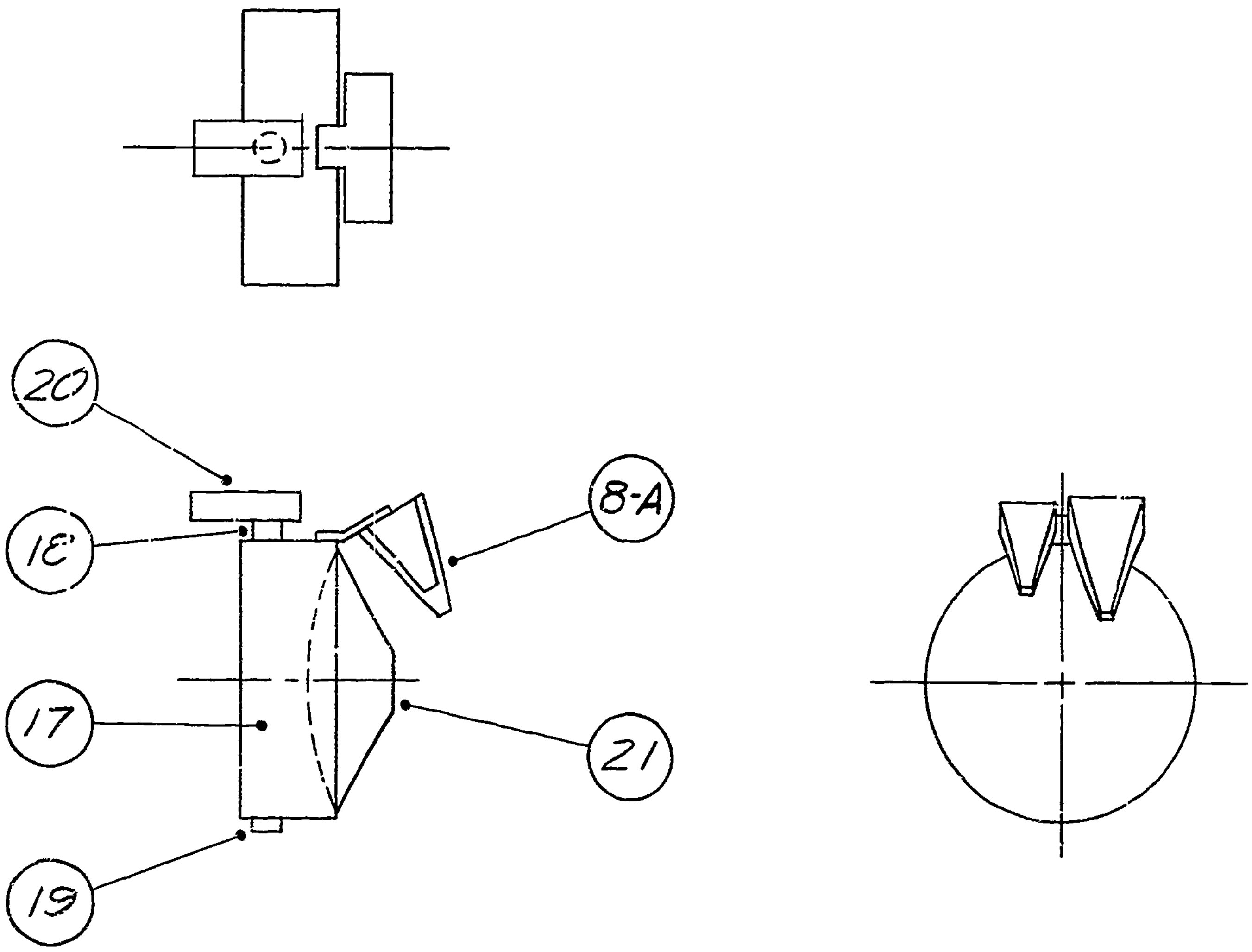
6-A HIGH-GAIN ANTENNA



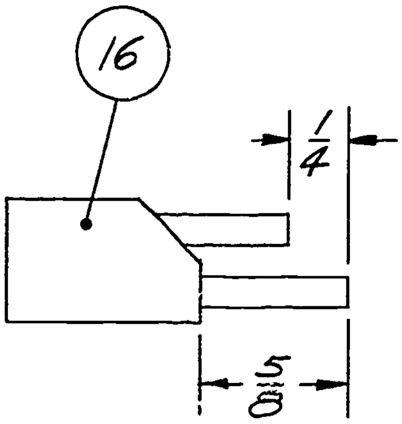
7-A OMNI-ANTENNA



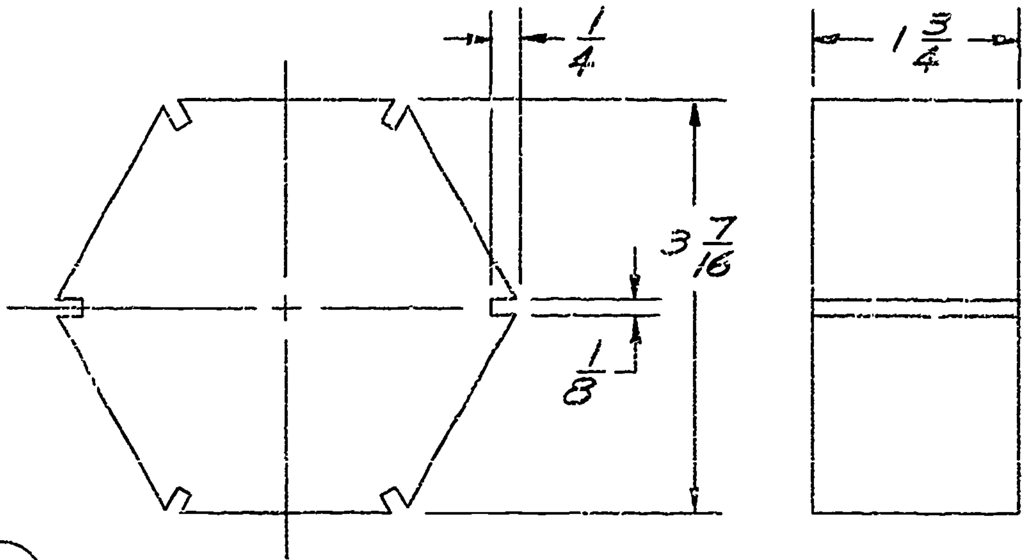
8-A RADIOMETER REFERENCE HORNS



9-A RADIOMETER



10-A COSMIC DUST DETECTOR



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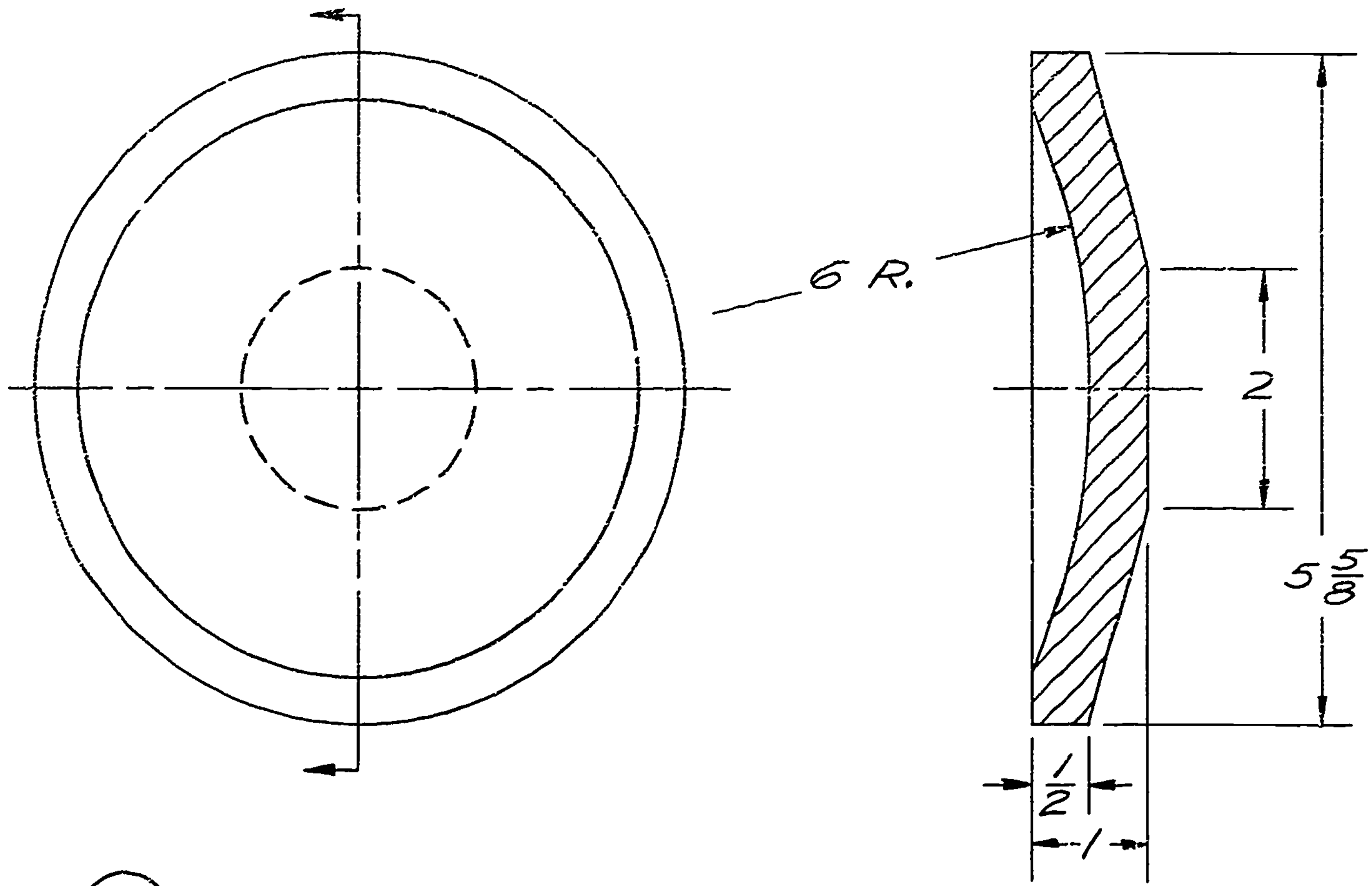

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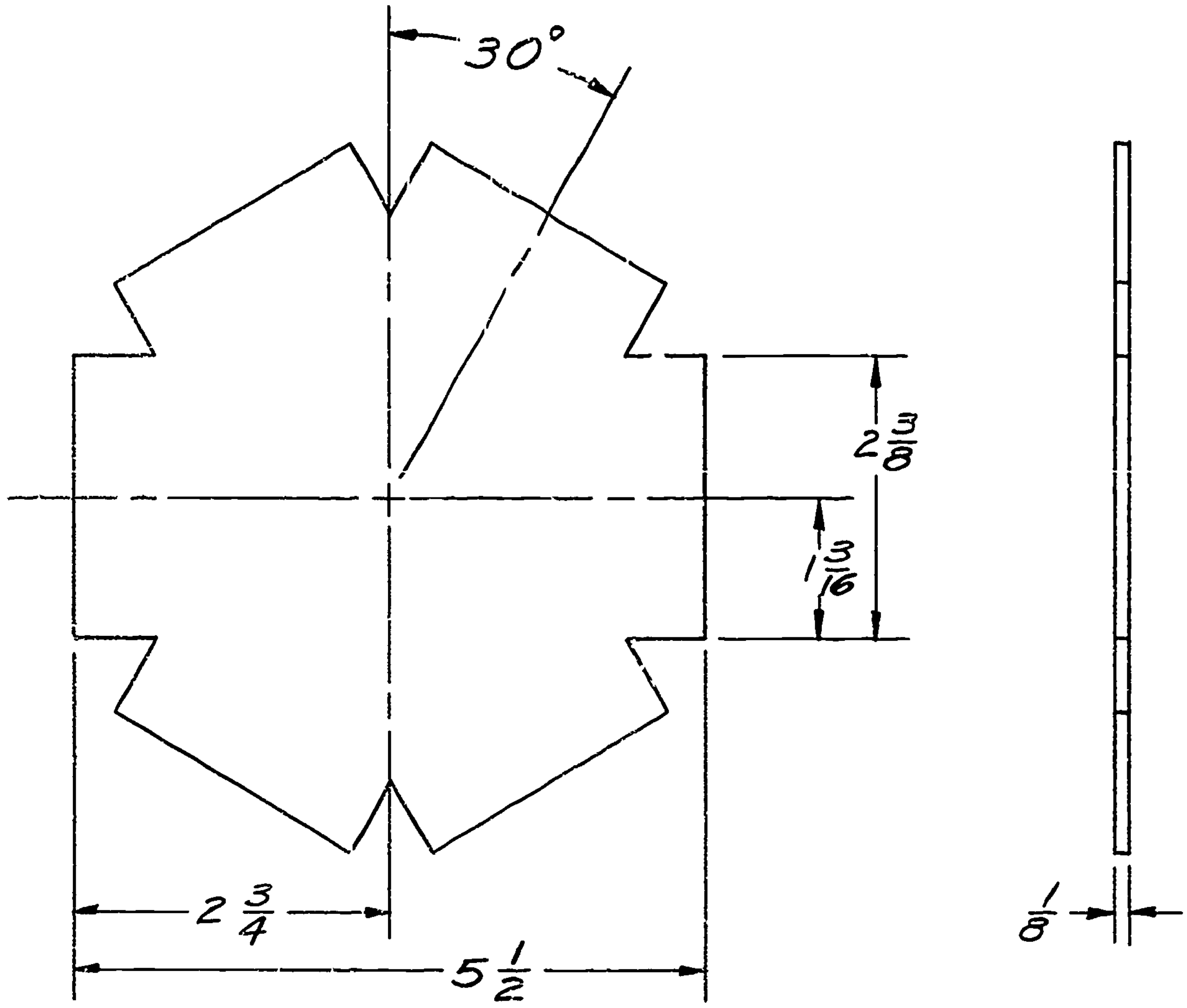

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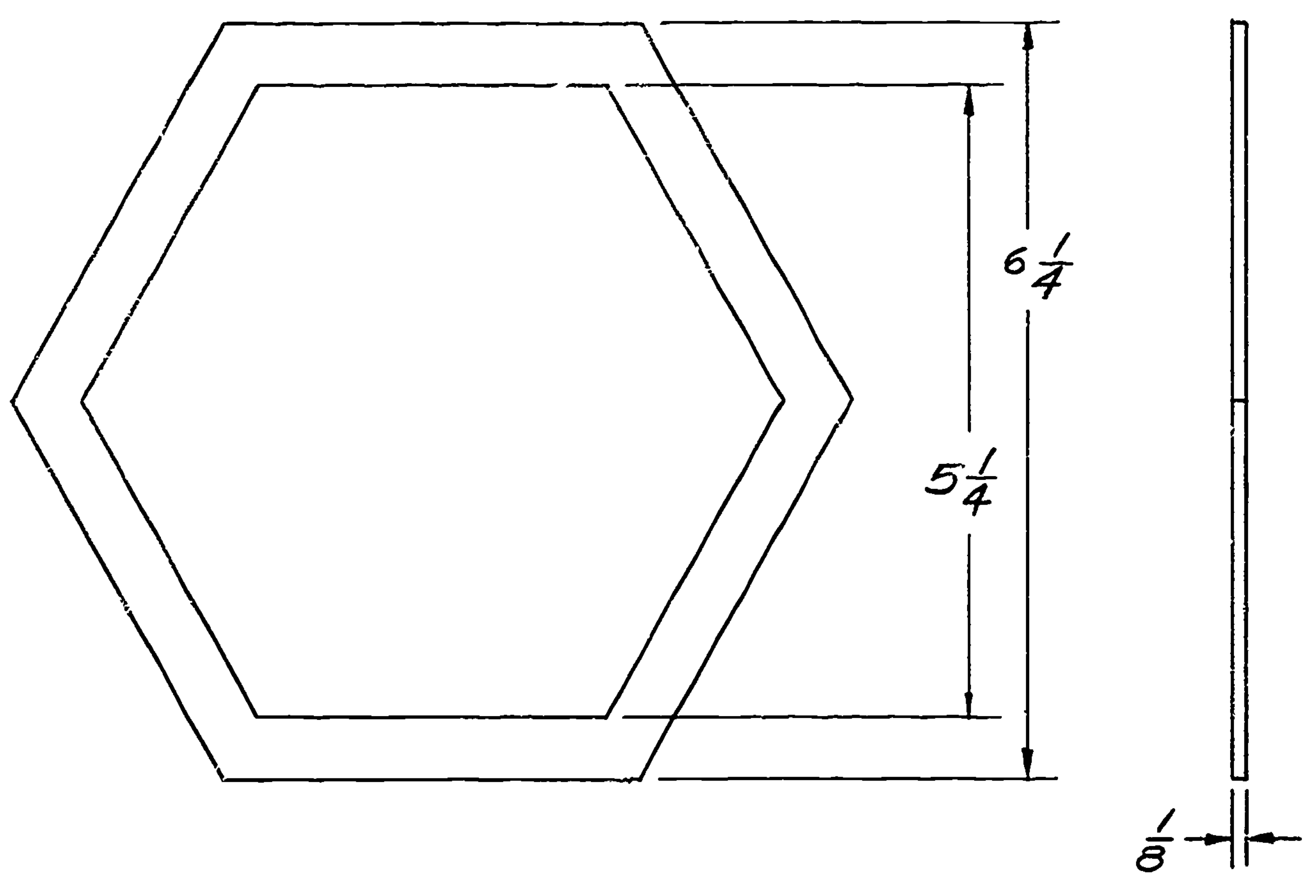
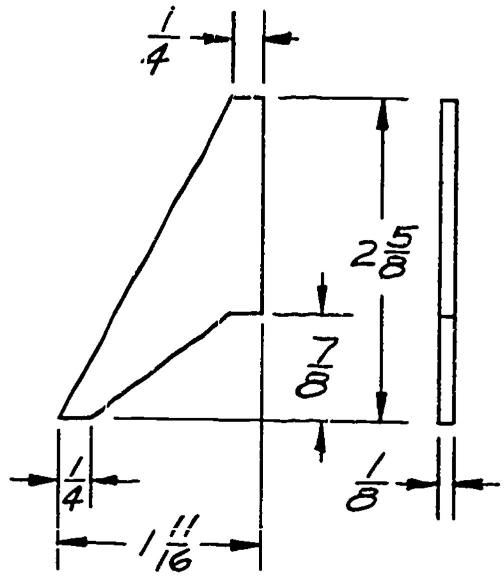


(4) LEG BASE 1-REQD.



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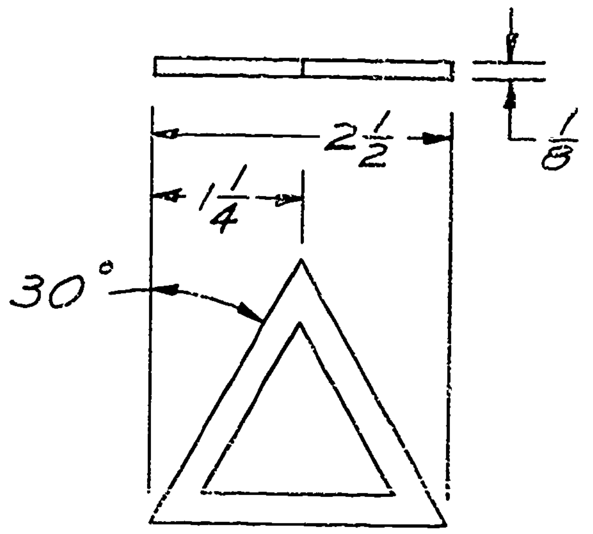
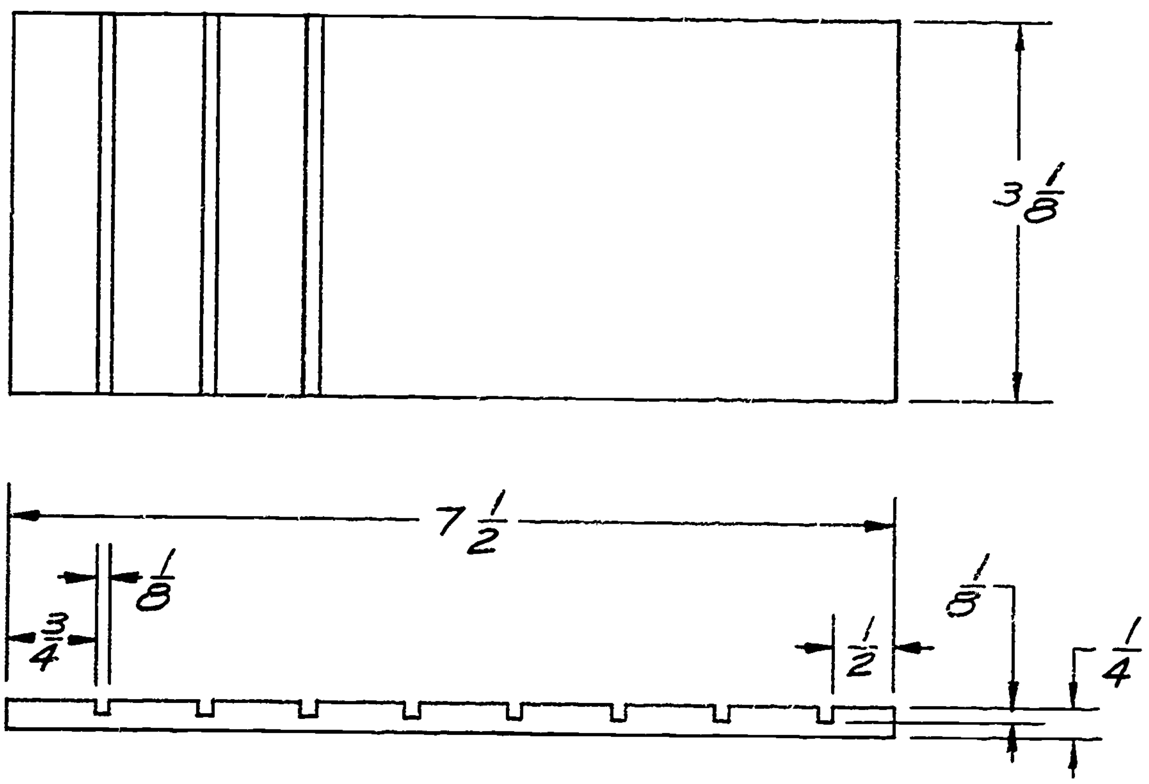
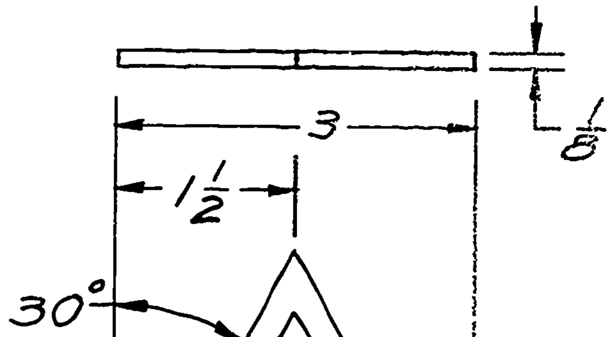
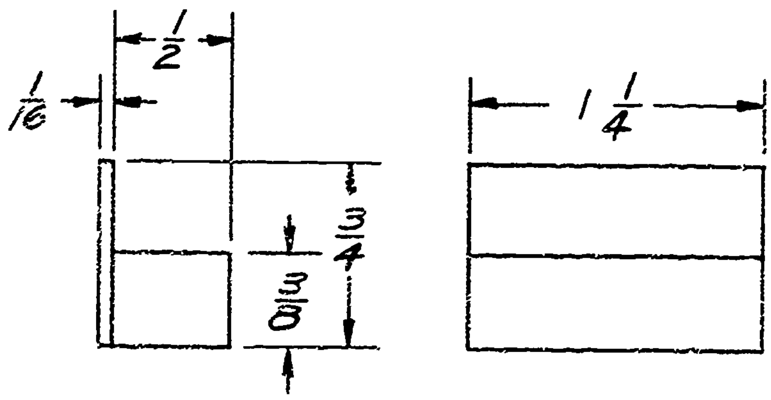


(7) UPPER ANTENNA SUPPORT 1-REQD



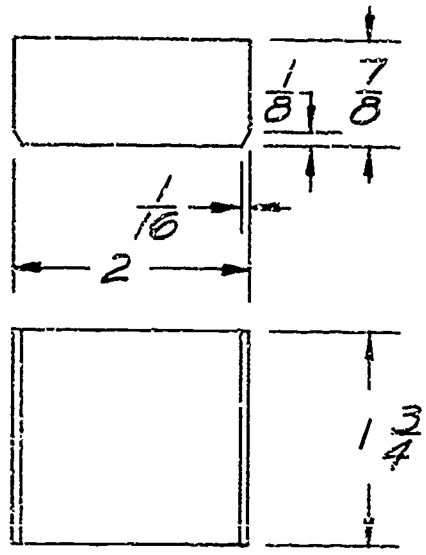
(6) SOLAR PANEL 2-REQD





(9) COSMIC DUST DETECTOR

(8) LOWER ANTENNA SUPPORT 1-REQD



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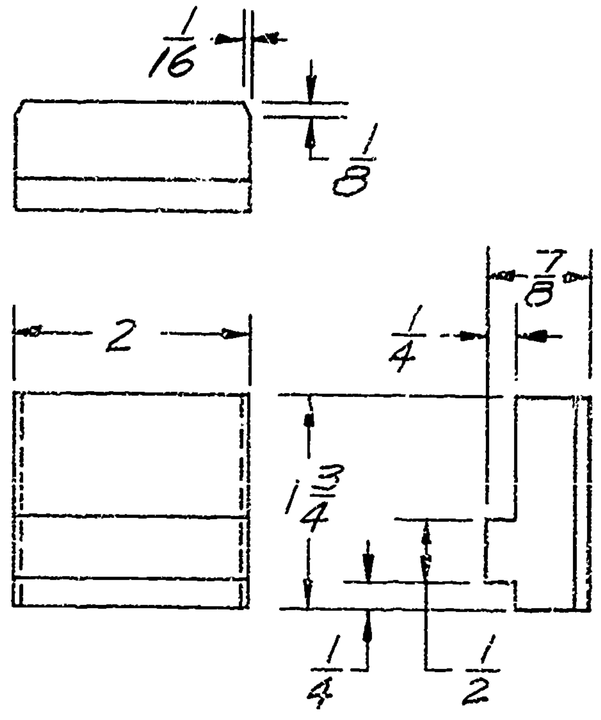

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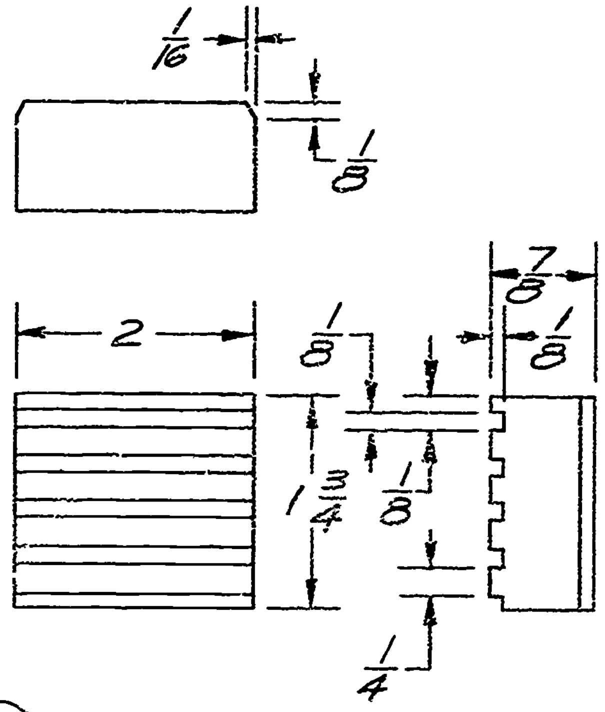

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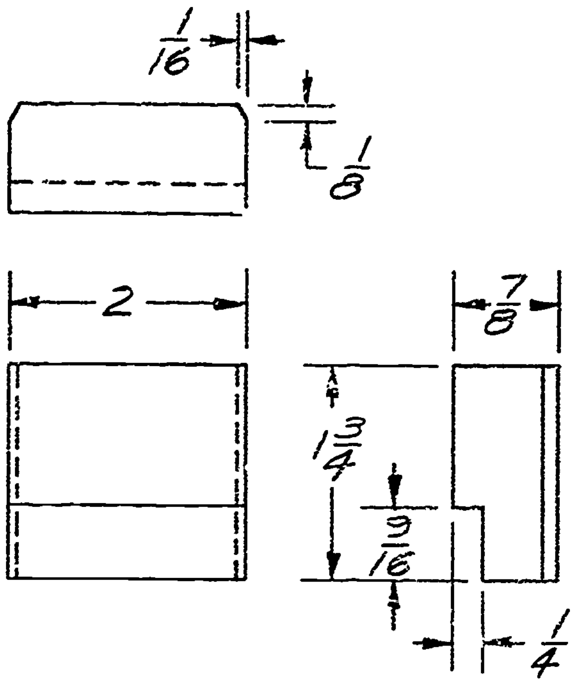

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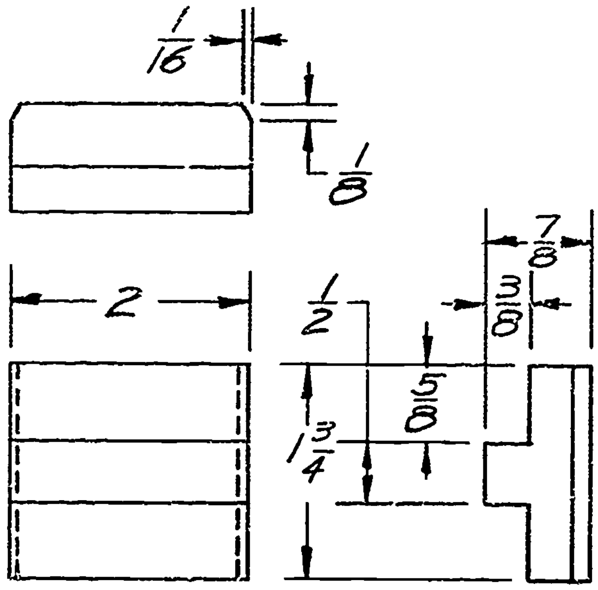
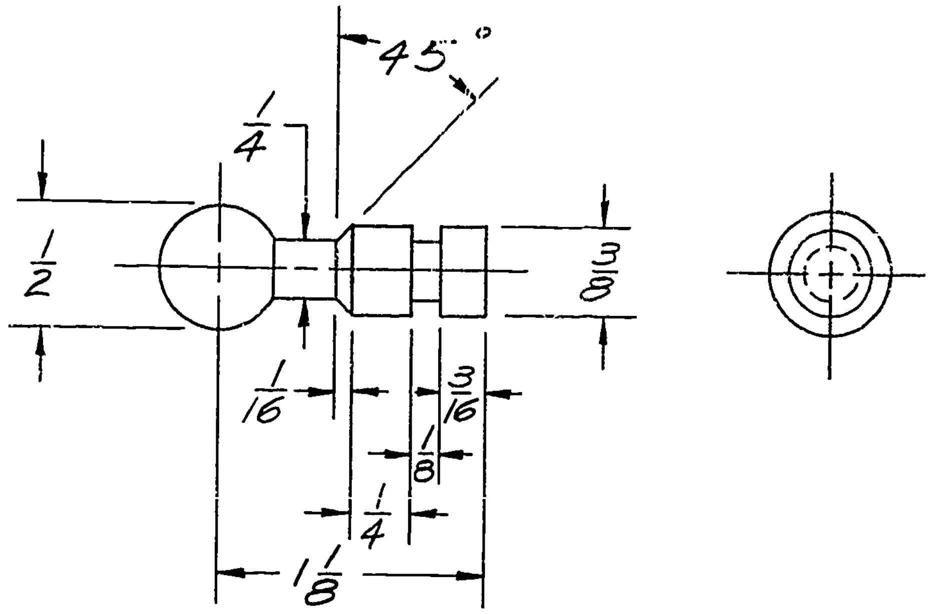
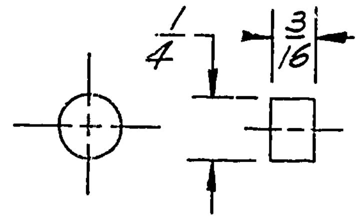


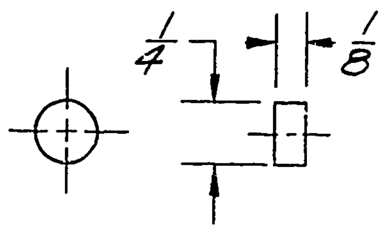
(14) TEMPERATURE CONTROL LOUVER 1-REQD



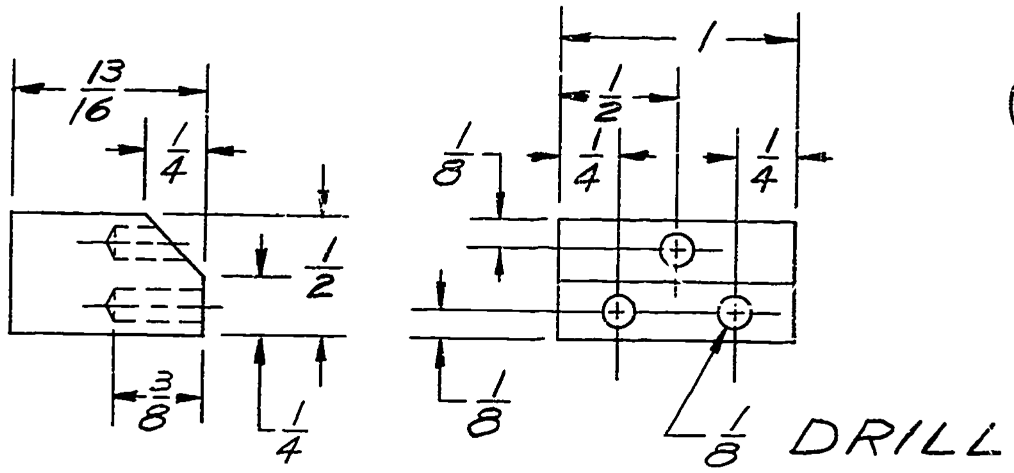
(15) ION CHAMBER 1-REQD



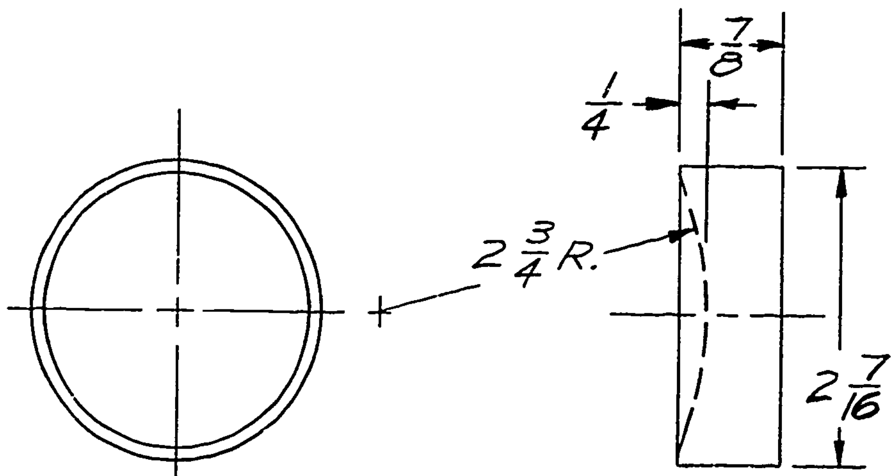
(18) SPACER 1-REQD



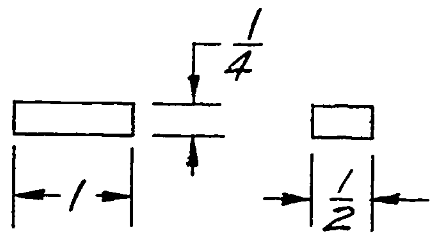
(19) SPACER 1-REQD



(16) PARTICLE FLUX DETECTOR 1-REQD



(17) RADIOMETER 1-REQD



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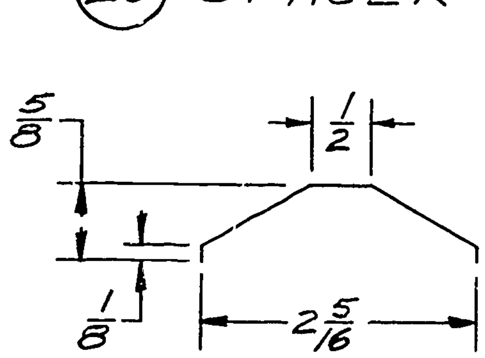
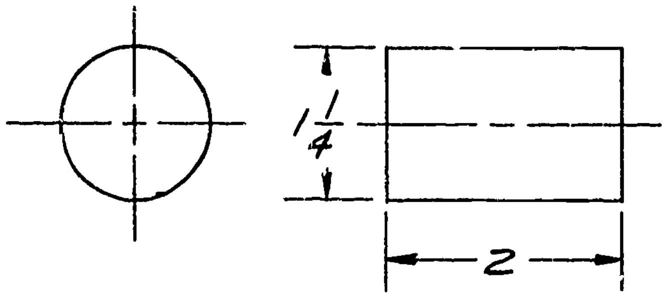
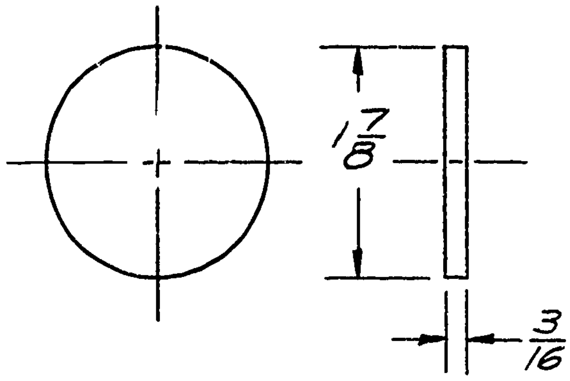


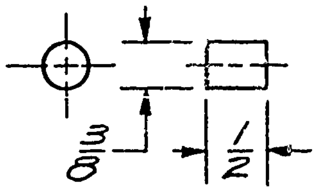
(21) WIRE 2-REQD



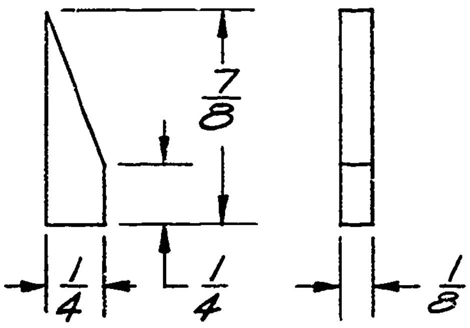
(22) OMNI SHAFT



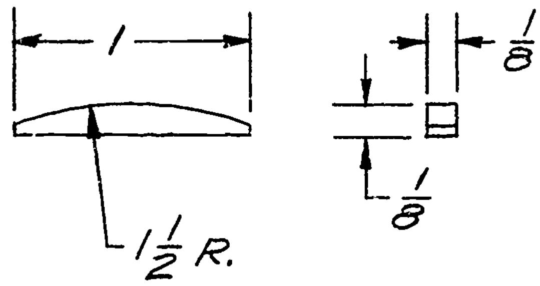
(23) OMNI BASE



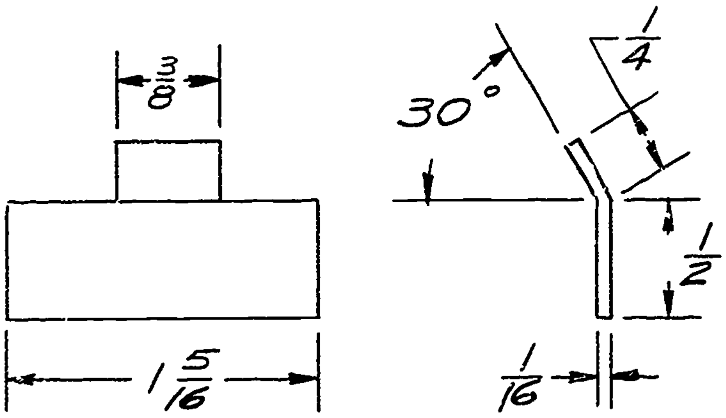
(24) SENSOR



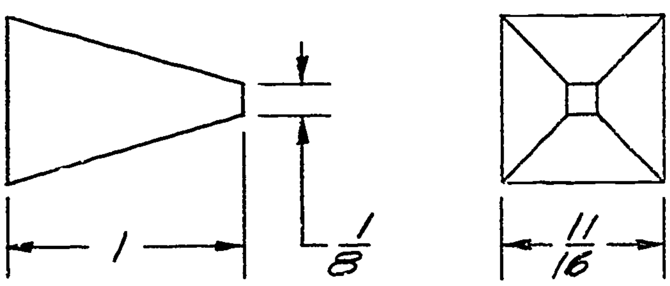
(25) OMNI BRACE 8-REQD
2 X



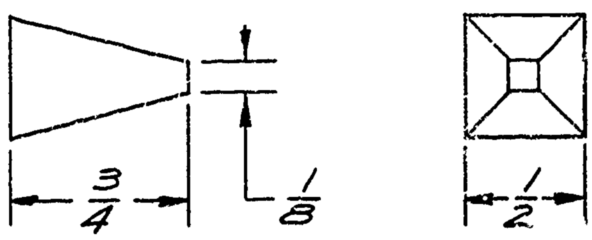
(26) OMNI TOP 2-REQD
2 X



(27) HORN BASE 2 X



(28) HORN 2 X



(29) HORN 2 X

RECOMMENDED MATERIALS FOR CONSTRUCTION

MARINER

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	One	Wood - pine	Silver
2	One	Wood - maple	Gold
3	One	Wood - pine	Silver
4	One	Aluminum	Gold
5	Six	Aluminum	Gold
6	Two	Plastic	Silver-Purple
7	One	Wood - pine	Gold
8	One	Wood - pine	Gold
9	One	Wood - balsa	Gold
10	Two	Wood - pine	Silver
11	One	Wood - pine	Silver
12	One	Wood - pine	Silver
13	One	Wood - pine	Silver
14	One	Wood - pine	Silver
15	One	Wood - maple	Black
16	One	Wood - pine	Silver
17	One	Wood - maple	Silver
18	One	Dowel - rod	Silver
19	One	Dowel - rod	Silver

RECOMMENDED MATERIALS FOR CONSTRUCTION

MARINER

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
20	One	Wood - pine	Silver
21	Two	Wire	Silver
22	One	Wood - pine	Light Brown
23	One	Wood - pine	Light Brown
24	One	Dowel - rod	Light Brown
25	Eight	Balsa wood	Light Brown
26	One	Wood - pine	Light Brown
27	One	Aluminum	Silver
28	One	Wood - pine	Silver
29	One	Wood - pine	Silver
30	One	Wire	Gold
31	Two	Sheet metal	Gold

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood or plastic	Layout and cut a hexagon to specified dimensions and "slot" to accommodate part no. 5 as indicated on detail no. 1	Finish sand all surfaces	
3	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	
4	Metal - sheet aluminum	Cut and shape to specified dimensions	Polish	
5	Metal - sheet aluminum	Cut and shape to specified dimensions	Polish	Subassemble parts no. 5,1 and 4 using epoxy resin
10	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no.1 as specified on detail no. 5A
11	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no.1 as specified on detail no. 5A

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
12	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no.1 as specified on detail no. 5A
13	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no.1 as specified on detail no. 5A
14	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no.1 as specified on detail no. 5A
7	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	
8	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	
22	Wood - pine	Turn on lathe to specified dimensions	Finish sand	
23	Wood - pine	Cut and shape to specified dimensions	Finish sand	

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
24	Dowel - rod	Cut and shape to specified dimensions	Finish sand	
25	Balsa wood	Cut and shape to specified dimensions	Finish sand all surfaces	
26	Wood - pine	Cut and shape to specified dimensions	Finish sand	Glue parts no. 22,23,24,25 and 26 as indicated on detail drawing no.7A Assemble parts no. 3,7 and 8 and subassemble no.7A using 1/8" dowel rod as indicated on detail nos. 1A,3A, and 4A
9	Wood - balsa	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no.3 as indicated on detail no. 1A

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
15	Wood - maple	Turn on lathe to specified dimensions	Finish sand	Glue to 1/8" dowel rods supporting part no. 8 as indicated on detail no. 2A
16	Wood - pine	Cut and shape to specified dimensions. Layout and drill holes as specified	Finish sand all surfaces	
10A				Glue 1/8" dowels to part no. 16 as specified on detail no. 10A. Glue part no. 10A to part no. 8 as indicated on detail no. 2A
17	Wood - maple	Turn on lathe to specified dimensions	Finish sand all surfaces	
18	Dowel - rod	Cut to specified length		Glue to part no. 17 using epoxy resin

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
19	Dowel - rod	Cut to specified length		Glue to part no. 17 using epoxy resin
20	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	Glue to part no. 18 using epoxy resin as indicated on detail no. 9A
21	Wire	Shape as specified on detail no. 21		Glue to part no. 17 as indicated on detail no. 9A using epoxy resin
27	Metal - sheet aluminum	Cut and shape to specified dimensions		
28	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	
29	Wood - pine	Cut and shape to specified dimensions	Finish sand all surfaces	

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RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8A				Subassemble parts no. 27,28 and 29 as specified. Glue to part no. 9A using epoxy resin
31	Sheet metal	Cut and shape to specified dimensions	Finish all surfaces	
6	Plastic or wood (maple)	Cut and shape to specified dimensions	Finish all surfaces	Assemble to part no. 31 using brads. Glue part no. 31 to part no. 4 using epoxy resin
2	Wood - maple	Turn on lathe as specified on detail no. 2	Finish sand	
6A		Complete fabrication of antenna as indicated on detail no. 6A		

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
30		Using no. 16 wire construct hinge as indicated on detail no. 2A		Attach to part no. 6A using epoxy resin. Secure remaining end to part no.5 so antenna will hinge into part no. 4
			Paint parts no. 1,3,6,10,11,12, 13,14,16,17,18, 19,20,21,27,28 and 29 silver	
			Paint parts no.2 4,5,7,8,9,30 and 31 gold	
			Paint part no. 15 black	
			Paint parts no.22, 23,24,25 and 26 light brown	

RECOMMENDED PROCEDURE FOR CONSTRUCTION

MARINER

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
			Paint solar cell surfaces on part no. 6 purple	

A P O L L O

"------- no more than the man in the moon." In spite of the unbelievers, there may be a man in the moon.

No one knows where or when the idea of space travel started. This dream of exploring the moon probably dates back to the time when man first realized that it was not part of his own planet. One of the first science fiction stories, a novel of a moon journey, was written by Lucian of Samos in the middle of the second century A.D. A period of 1500 years passed before another space travel story appeared. Francis Godwin wrote about a trip to the moon by bird propulsion in 1638. In more modern times, the early 19th century, Jules Verne wrote how space exploration would be accomplished. H. G. Wells in his War of the Worlds fascinated and frightened many.

In an enterprise such as the exploration of space, a clear-cut goal is necessary for impetus, order and efficiency. The relative nearness of the moon makes it the logical place in space where the men and equipment for future and more distant space travel can be tested. Little as we know about the moon, it still exceeds our knowledge of any other celestial bodies.

Because of the importance for night illumination, the ancients gave a great deal of attention to the moon's motions. The exactitude of the observations made was in advance of those in the other physical sciences. As early as the second century B.C., Hipparchus discovered the eccentricity of the moon's orbit. He determined the inclination of the orbit to the ecliptic and advanced the theory that the motion of the moon is uniform in circular orbit with the moon placed eccentrically. No new theory was introduced until the middle of the seventeenth century when Newton advanced his gravitational theory. In this century E. W. Brown introduced a completely new theory. His set of tables first used in 1923 will likely be used throughout the twentieth century.

The surface of the moon has also been a subject of continuous telescopic study since the time of Galileo. With large telescopes it is now possible to see an area less than a mile square. Telescopic observers have drawn detailed descriptions of the lunar surface and have laid its features down on maps. These together with photographs give a good indication of the moon's surface. It is believed now that the whole visible surface is rough and mountainous. The most striking features are the craters scattered over the surface with great profusion and frequently overlapping. Meteorites striking the moon are believed to have formed these craters. Erosion of the lunar surface may be the result of electrostatic charge by high energy solar radiation.

Among the other information gathered that will affect our exploration is the belief that the moon is devoid of air and water. No meteorological variations such as our weather is probable. The change by the direct action of the sun's rays indicates an enormous range in the temperature of the surface. It also means that an artificial earth environment must be a necessary equipment of the moon explorers.

In spite of our powerful telescopes, earth's life-giving atmosphere clouds our vision. The Ranger and the Surveyor programs will gather information above its shimmering moving layer before a manned moon exploration will be attempted. However, the dream of space exploration has now taken on a more concrete aspect. By the decision of the elected representatives of the people in the United States, Project Apollo is under way. The objective of this project is to develop the ability to explore the moon before the end of this decade.

Besides the gathering and analyzing of information, the competences necessary for the lunar exploration must be developed. At present there are three manned space flight programs ---- Mercury, Gemini, and Apollo. They constitute a step-by-step program to develop a broad capability for the manned exploration of space.

Project Mercury established adequately man's ability to perform effectively in the environment of orbital flight and developed the foundation of a manned space flight technology.

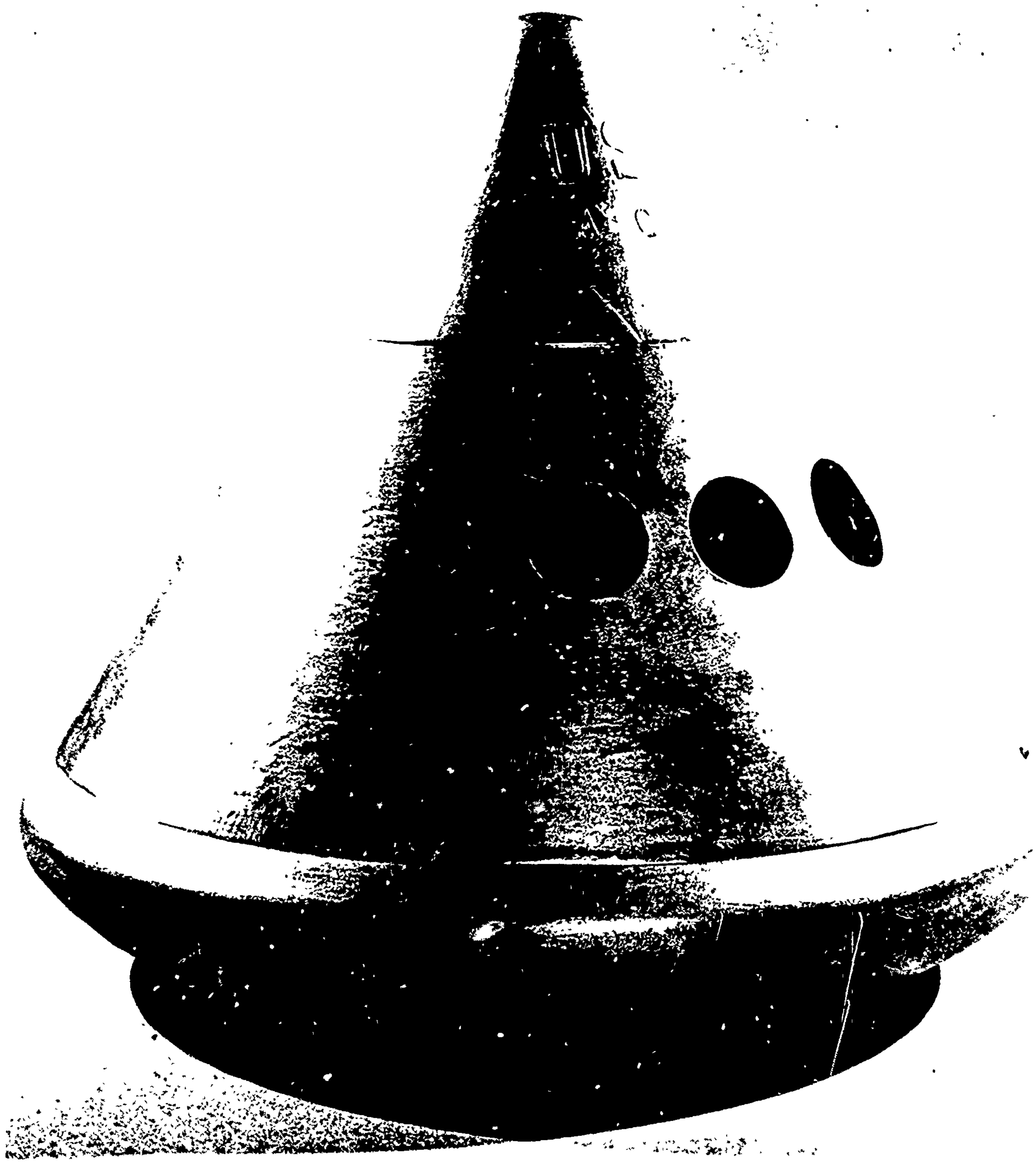
Operational proficiency and the development of new techniques including rendezvous will be gained in Project Gemini.

Finally in Project Apollo, three astronauts will be sent to explore the moon. The moon explorers will start their expedition by boarding an 80 feet tall spaceship perched atop Saturn V, a multi-stage rocket. This spaceship will consist of three modules. The Command Module will house the three astronauts on the trip to and from the moon and serve as the control center. The Service Module will contain the life support system and the propulsion unit for mid-course correction and injection into and out of lunar orbit. The Lunar Excursion Module will transport the explorers to the surface of the moon and back to rendezvous with the Command Module in its orbit around the moon. In addition, a launch escape rocket system will be attached to the top of the Command Module in the event of trouble during the initial phase of the flight.

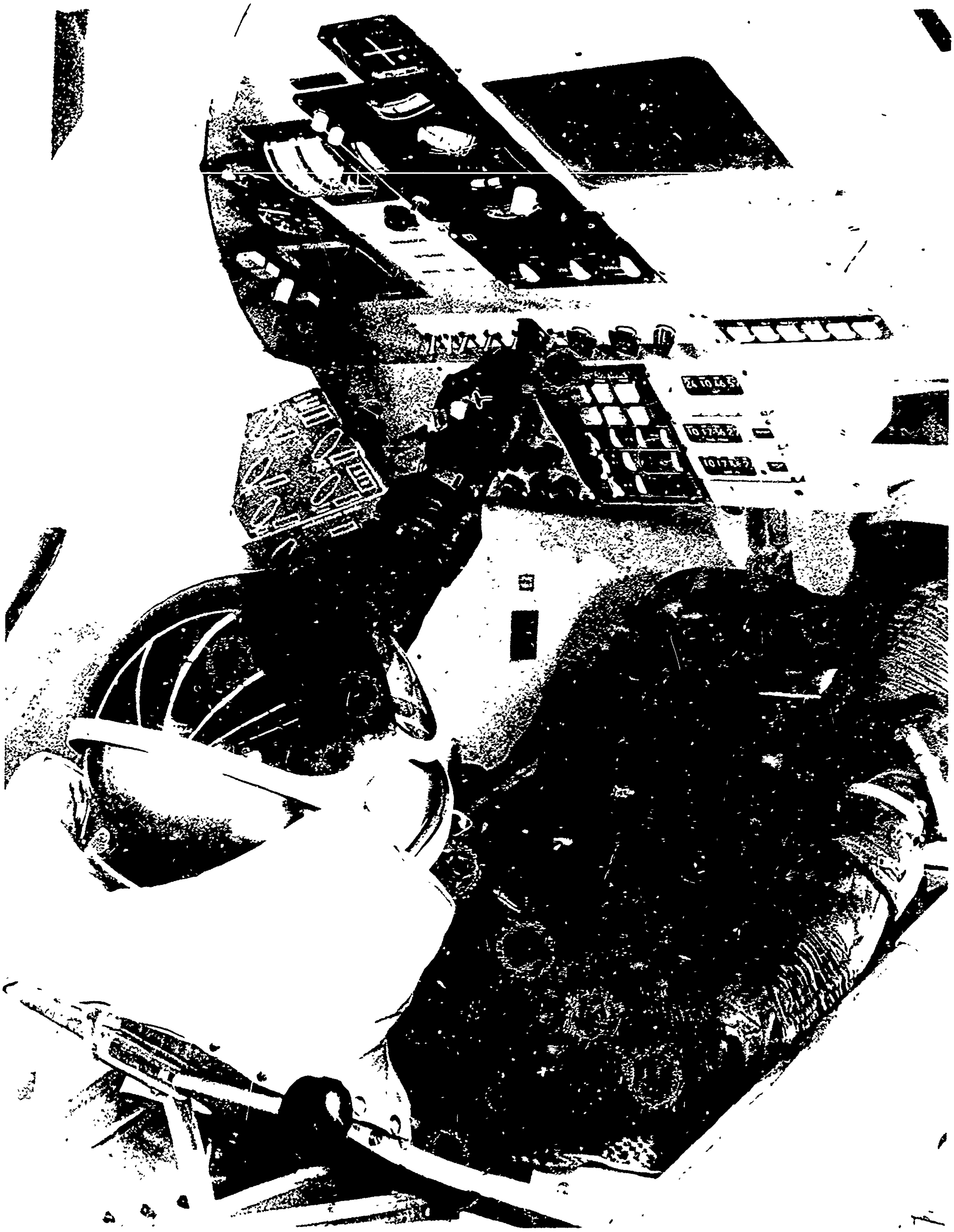
After the checkout, Apollo will be blasted to a speed of 25,000 miles per hour on a trajectory that will carry it to the vicinity of the moon in about 2 1/2 days. On arrival near the moon, it will be maneuvered into lunar orbit. Two of the three astronauts will then climb into the Lunar Excursion Module, separate from the rest of the spaceship and descend to the surface. After exploring the planned area for about 24 hours, the two explorers will rejoin the third crewman for the return back to earth. Leaving the empty Lunar Excursion Module circling the moon, the Service Module will provide the thrust for the spaceship's return trip. This module will be in turn jettisoned before re-entry into the atmosphere. The Command Module will re-enter alone and descend by parachute.

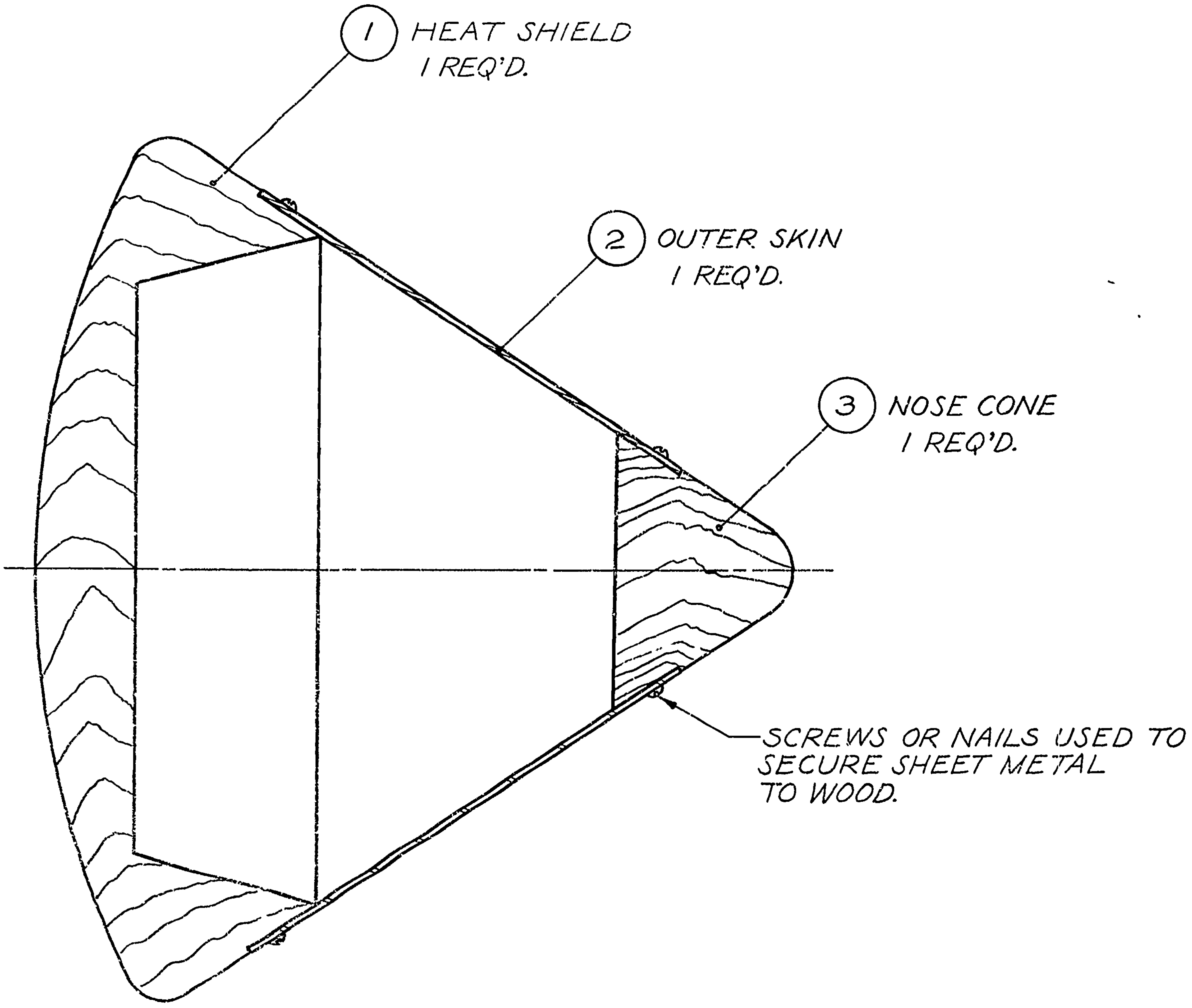
Today, moon and earth are closer in time than Europe and America were when Columbus set sail toward the unknown. Who knows what wonders will be found by the crewmen of the Apollo when they blast off toward the unknown.

APOLLO



APOLLO CONSOLE

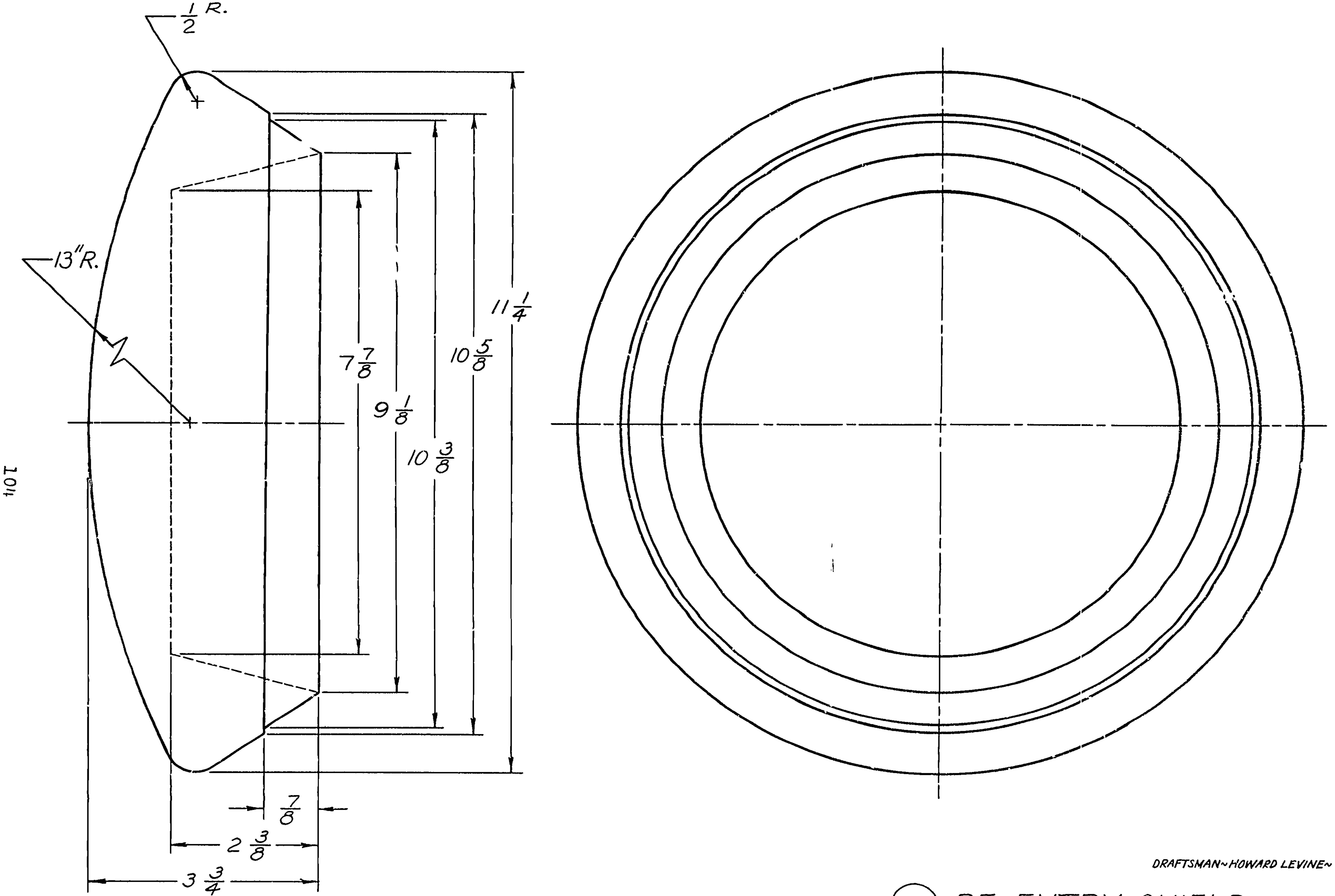




ASSEMBLY - FULL SECTION

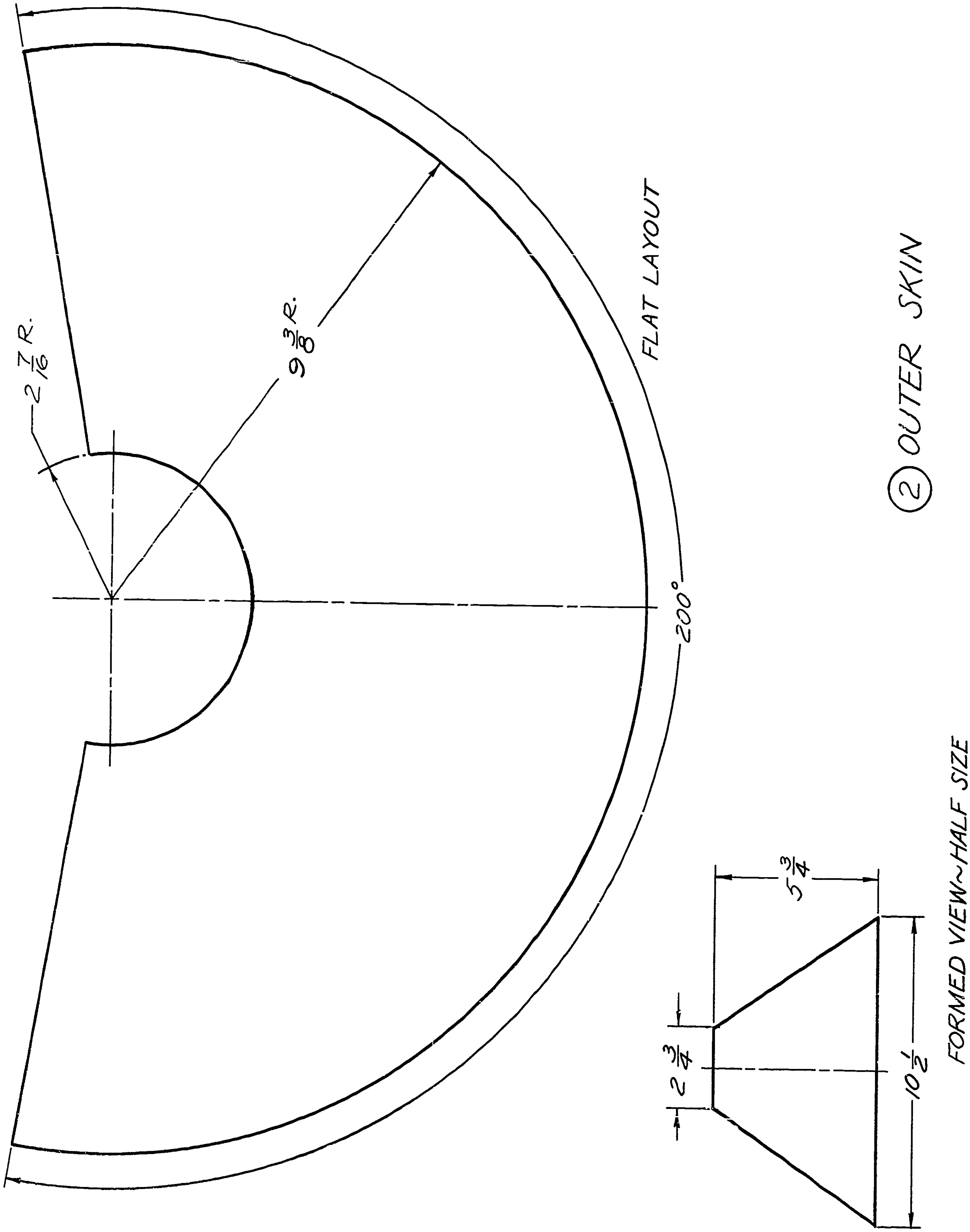
DRAFTSMAN~HOWARD LEVINE~1964

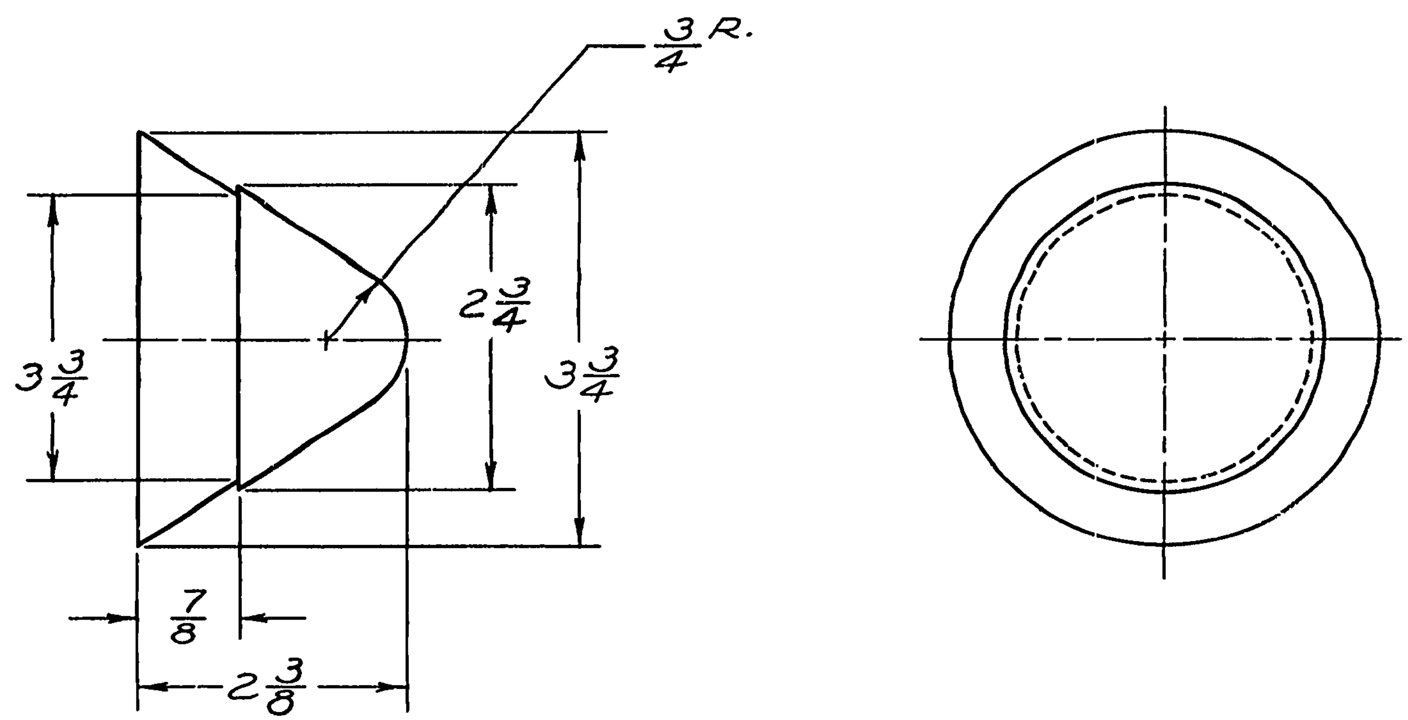
APOLLO~COMMAND MODULE



DRAFTSMAN~HOWARD LEVINE~

(1) RE-ENTRY SHIELD


2 7/16 R.
9 3/8 R.
FLAT LAYOUT
200°
2 OUTER SKIN
5 3/4
2 3/4
10 1/2
FORMED VIEW~HALF SIZE



(3) NOSE CONE

RECOMMENDED MATERIALS FOR CONSTRUCTION

APOLLO

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	One	Wood or aluminum	White
2	One	Metal - sheet aluminum or cold rolled steel	White
3	One	Wood or aluminum	White

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RECOMMENDED PROCEDURE FOR CONSTRUCTION

APOLLO

PART NO.	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood or cast aluminum	Turn on lathe to specified dimensions	Finish sand or polish surface	
2	Metal - sheet aluminum or sheet steel	Layout and fabricate to specified dimensions		
3	Wood or cast aluminum	Turn on lathe to specified dimensions	Finish sand or polish surface Paint white	Assemble parts no. 1, 2 and 3

MODEL SPACECRAFT CONSTRUCTION

Addendum to the Report of May 28, 1964,

submitted July 1, 1966

by the

California State College at Long Beach

Project Staff

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Dr. Irvin T. Lathrop
Mr. Richard L. Krahenbuhl
Mr. Arthur Steiner
Mr. James L. Denison
Mrs. Arthur DeBord

Acknowledgements

The addendum to Model Spacecraft Construction is an addition to the original Model Spacecraft Construction, a report submitted to the National Aeronautics and Space Administration by the California State College at Long Beach. The demand for the original publication was so great that it was felt that additional material should be developed prior to the second printing of the bulletin. The material was developed through the efforts of four teachers selected on the basis of their ability to critically analyze engineering drawings of space models and modify these for use in an educational program. The project was supported by the National Aeronautics and Space Administration.

The addendum material for the Model Spacecraft Construction publication was made possible through the efforts of the following individuals: Dr. Irvin T. Lathrop, Associate Professor of Industrial Arts, California State College at Long Beach; Mr. Richard L. Krahenbuhl, Industrial Arts Teacher, Bancroft Junior High School, Long Beach, California; Mr. Arthur Steiner, Counselor, Long Beach Business and Technical College, Long Beach, California; Mr. James L. Denison, Industrial Arts Teacher, Millikan Senior High School, Long Beach, California; Mrs. Arthur DeBord, Secretary, Applied Arts and Sciences Division, California State College at Long Beach.

In expressing my appreciation I would like to thank the staff members of the National Aeronautics and Space Administration who provided information on the spacecraft included in this addendum. Without the assistance and support of these people, this project would not have been completed. Our hope is that this project will provide additional stimulus for further implementation of advanced work in the area of aerospace education in the secondary schools.

July 1, 1966

C. Thomas Dean, Project Director
Chairman, Division of Applied Arts and Sciences
California State College at Long Beach

X-15

Over the radio comes the countdown - "Five, four, three, two, one . . . . DROP!" The rocket engine fires and the research plane has been launched into another test at the very edge of space. The X-15, the most advanced craft of its type, has been dropped from the mother ship and will operate to provide much needed information in the field of aerodynamics.

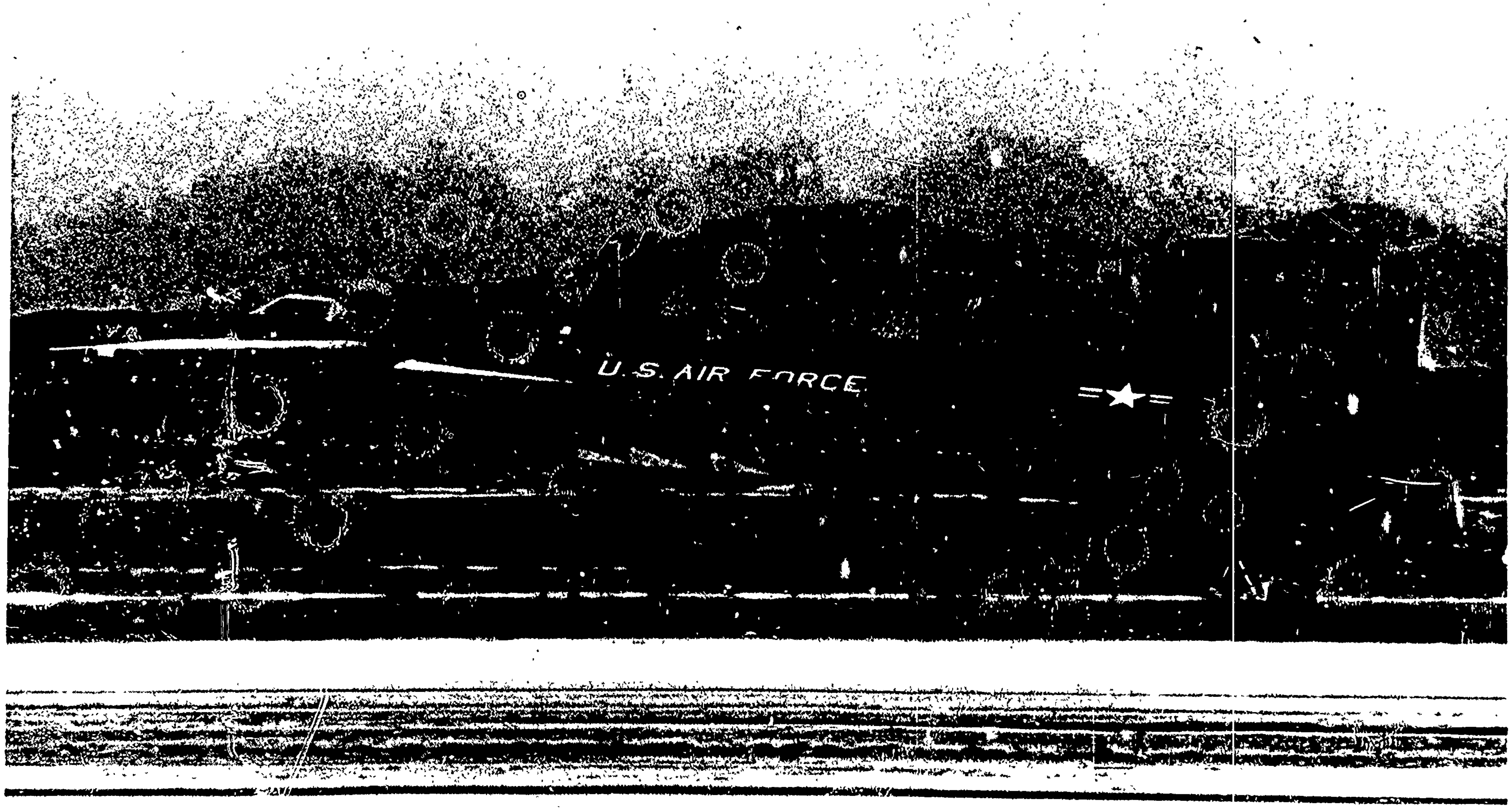
The X-15 project had its birth in the summer of 1952 and has been in continuous operation since that time. Probing ever higher and faster in the course of a progressive series of research flights, it has reached a peak altitude of 354,200 feet and a speed of 4104 miles per hour. Never before has manned aircraft achieved such phenomenal performance. There have been in excess of 120 flights made by the three test models from which reams of research data have been gathered.

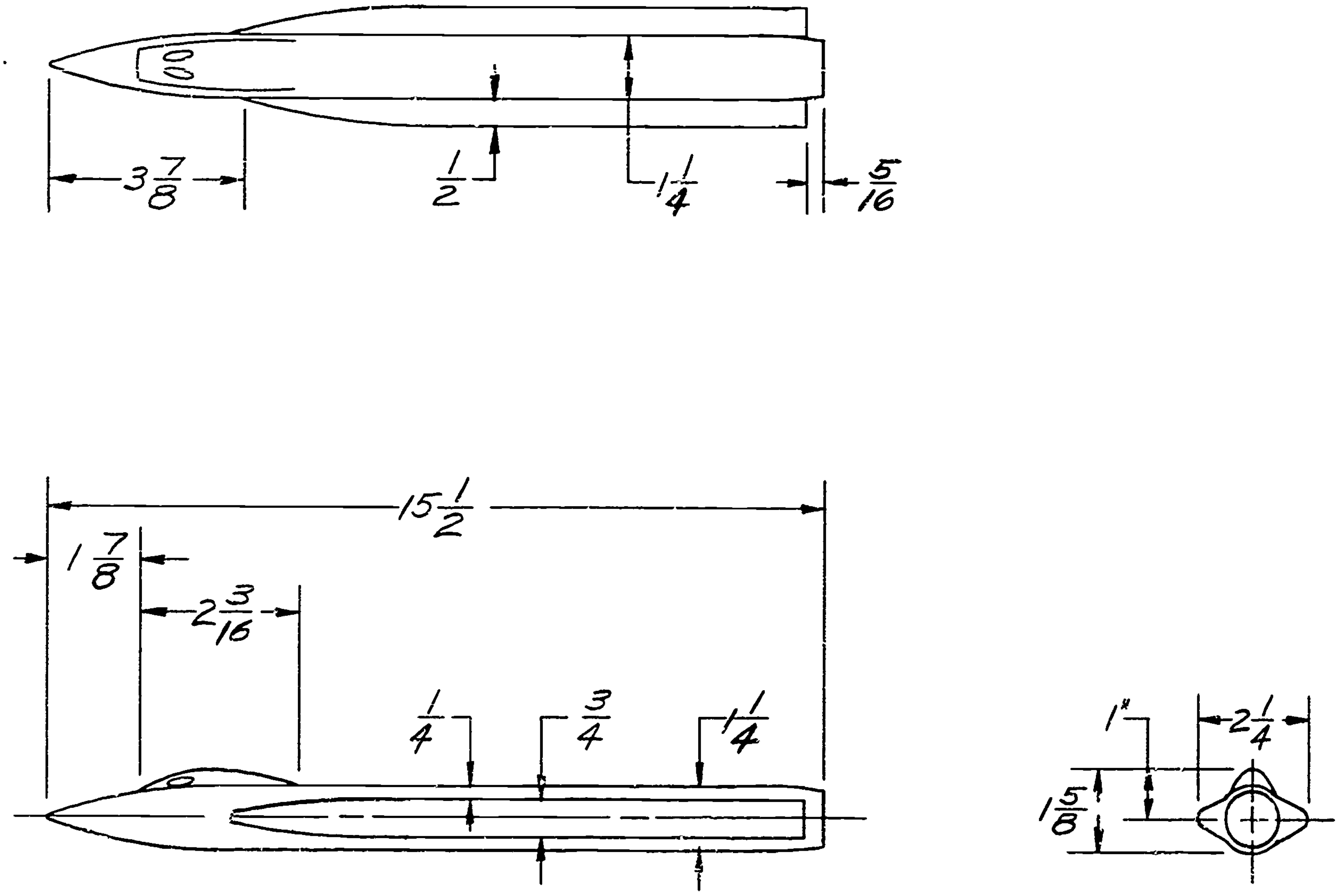
The X-15 is relatively small as modern aircraft go, its thin fuselage stretching 50 feet from nose to tail. The wings are thin and stubby and span only 22.36 feet with only 200 square feet of surface area. Due to its construction and design it flies like a plane in the atmosphere and like a space vehicle in space.

Upon reentry into the earth's atmosphere from outer space, the aerodynamic heating causes the exposed areas such as the fuselage, wing, and tail to glow a cherry red. Because of this a special heat-treated Inconel X nickel-steel alloy is used for the skin covering. All three of the test planes are painted black to radiate as much heat as possible on reentry to the atmosphere.

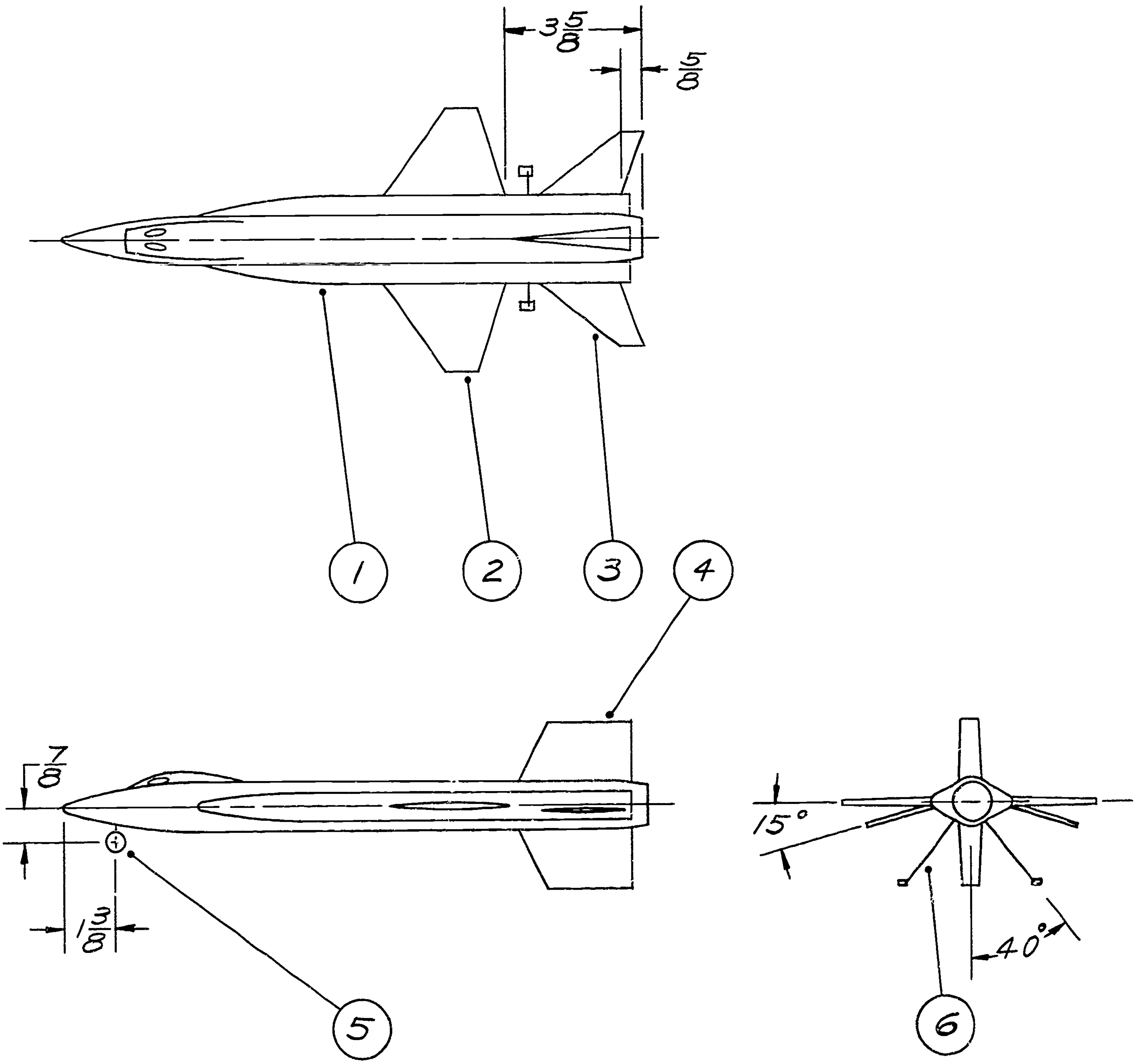
The X-15 program has been the source of much new knowledge. A large measure of the success of the program has been due to the individuals of extraordinary vision who had the resolution to push ahead and solve the unknowns that faced them throughout the entire project. They were men who knew that the foundations upon which the X-15 would be built were sound, yet knew that they couldn't wait for the answers before forging ahead.

Rarely has a research program encompassed so many fields of basic and applied science, and less often still has any been able to continue contributing for such a long period in a fast advancing technological age. Yet, just as the Wright Brothers left many questions unanswered, today, long after the X-15 first flew 4000 miles per hour, men are still trying to find a complete explanation for airflow. The X-15 did open many of the secrets of the earth's atmosphere and will serve as a guiding light for those researchers in the years ahead.

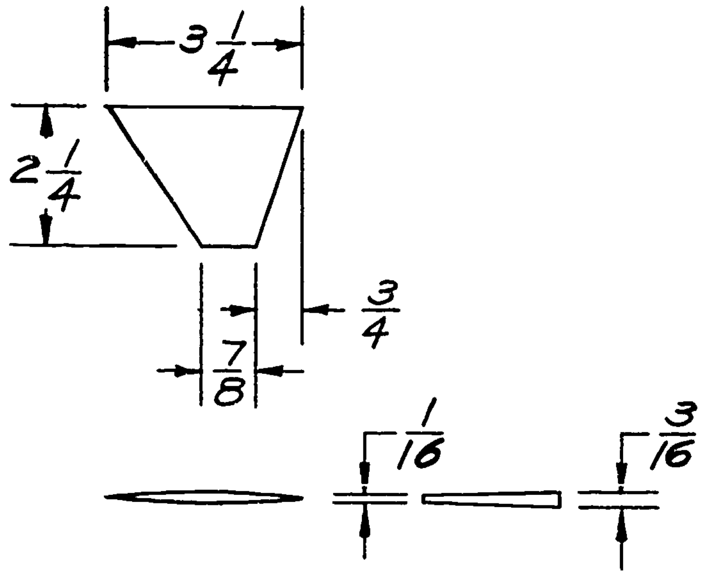

U.S. AIR FORCE



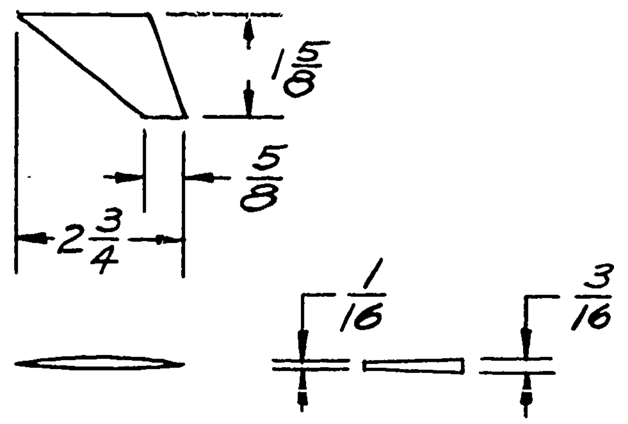
(1) 1-REQ'D 1/2 X



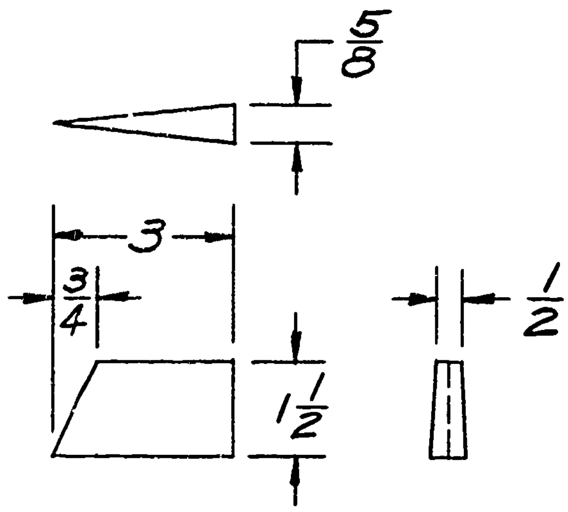
(1-A) X-15



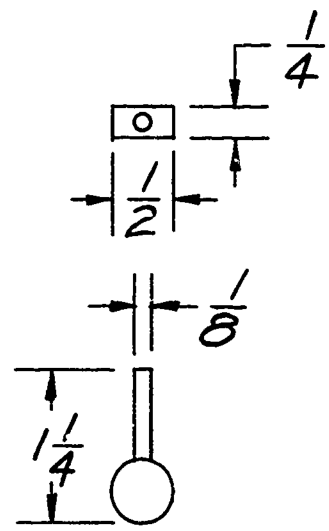
(2) 2-REQ'D $\frac{1}{2}$ X



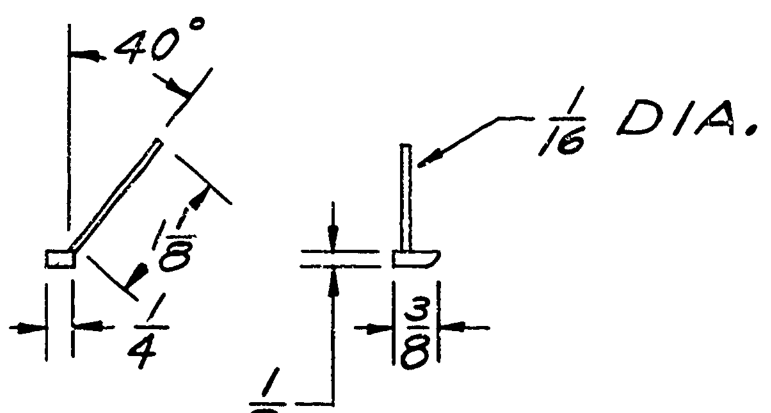
(3) 2-REQ'D $\frac{1}{2}$ X



(4) 2-REQ'D $\frac{1}{2}$ X



(5) 1-REQ'D $\frac{1}{2}$ X



(6) 2-REQ'D 1X

RECOMMENDED MATERIALS FOR CONSTRUCTION

X-15

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	1	Wood - Balsa	Black
2	2	Wood or plastic	Black
3	2	Wood or plastic	Black
4	2	Wood or plastic	Black
5	1	Wood, plastic, fiber, or metal	Black
6	2	Wood or metal	Black

RECOMMENDED PROCEDURE FOR CONSTRUCTION

X-15

PART NUMBER	SUGGESTED MATERIAL	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - Balsa	Form to specified dimensions.	Finish sand all surfaces. Paint black.	
2	Wood or Plastic	Construct to specified dimensions.	Finish sand all surfaces. Paint black.	
3	Wood or Plastic	Construct to specified dimensions.	Finish sand all surfaces. Paint black.	
4	Wood or Plastic	Construct to specified dimensions.	Finish sand all surfaces. Paint black.	
5	Wood, Plastic, Fiber, or Metal	Construct to specified dimensions.	Finish sand all surfaces. Paint black.	
6	Wood or Metal	Construct to specified dimensions.	Finish sand all surfaces. Paint black.	Assemble parts no. 2, 3, 4, 5, and 6 to part 1.

GEMINI LAUNCH VEHICLE (GLV)

(A Modified TITAN II)

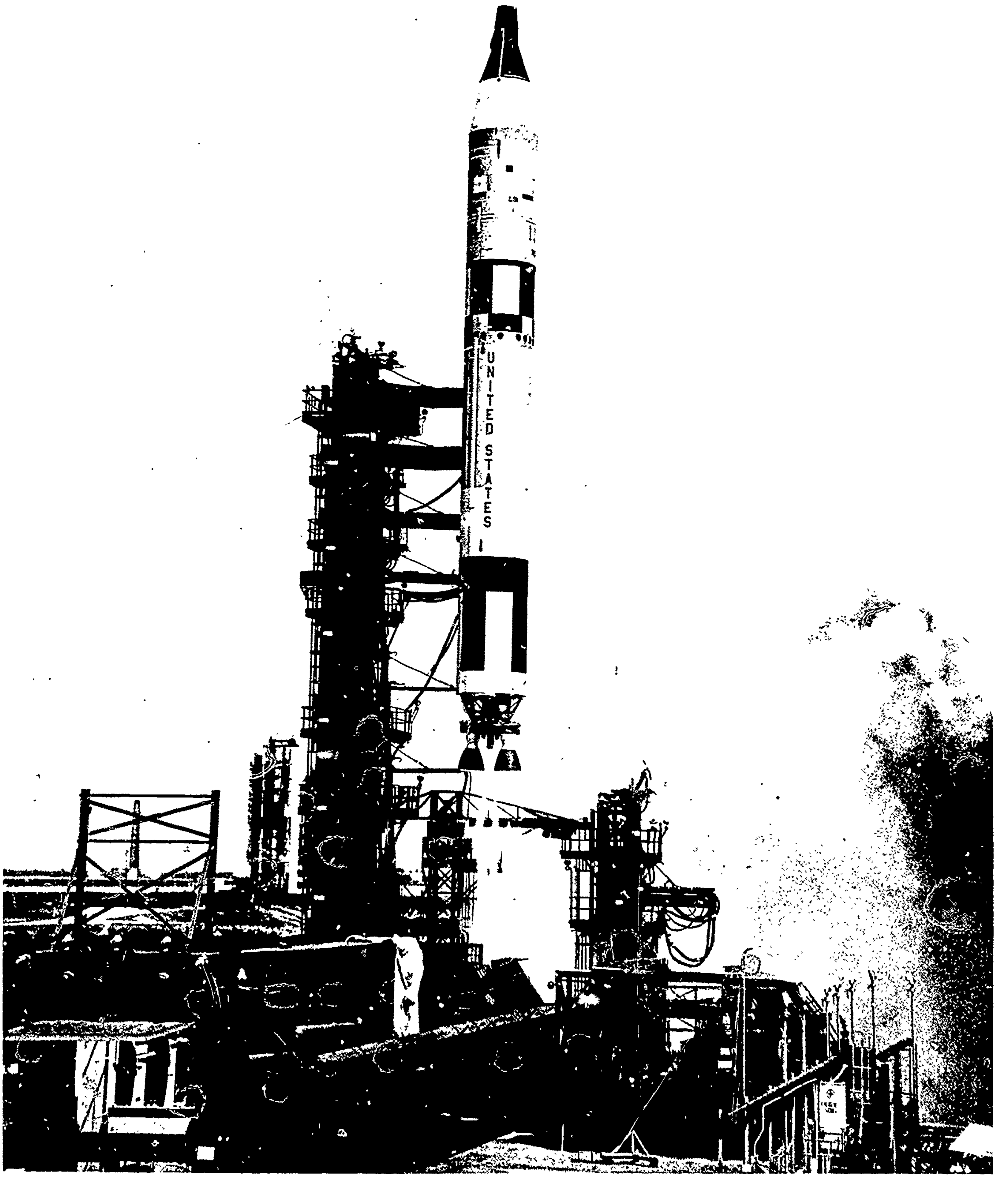
The Gemini Launch Vehicle is a modification of the United States Air Force Titan II rocket vehicle, first used sucessfully with a Gemini spacecraft on April 8, 1964.

The propellant used for launching purposes is hypergolic and therefore does not need an ignition system. It can also be stored indefinitely in Titan's fuel tanks. The launch vehicle can be readied for use on short notice and need not be drained of fuel if a launch is temporarily postponed.

The Titan makes an ideal launch vehicle with the manned Gemini spacecraft as it will permit practice of rendezvous maneuvers in orbit which is so essential to the future success of the space program.

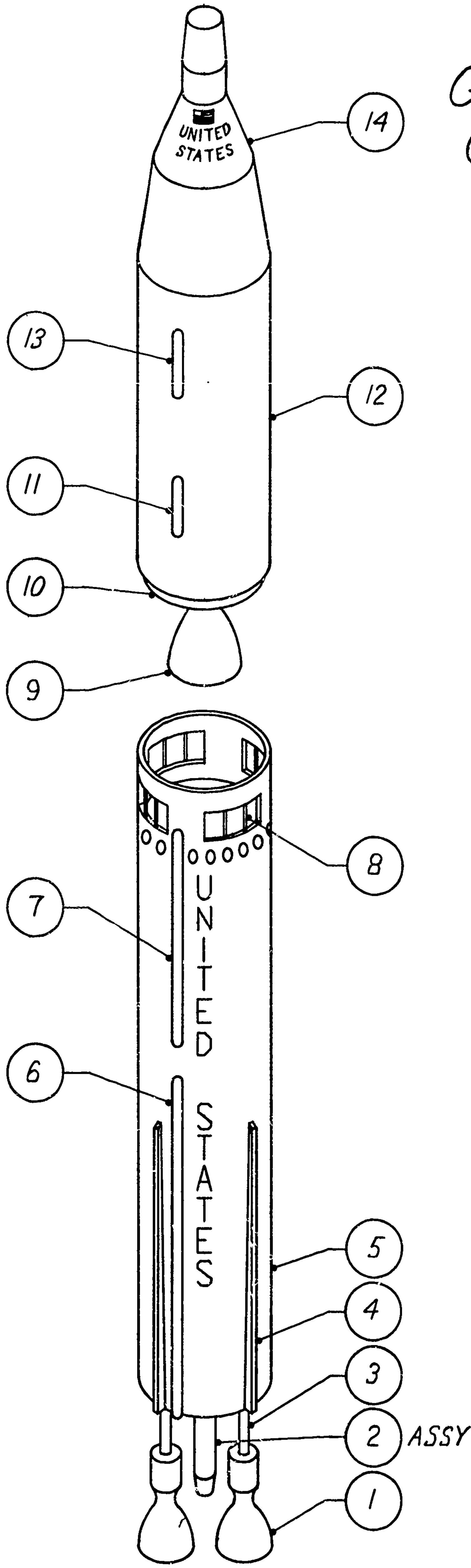
The modified Titan II is a powerful booster which generates a 430,000 pound thrust during the first stage and a 100,000 pound thrust during the second stage. It is ninety feet tall and ten feet in diameter at the base.

The success of the Gemini project is largely dependent upon this booster and will move our country many steps forward in our challenge for the leadership position in the race in space.

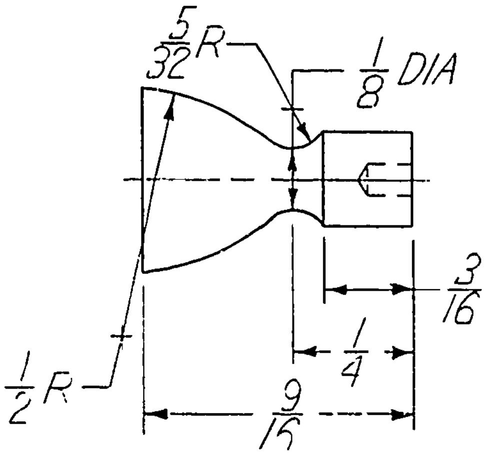

UNITED STATES

TITAN II ROCKET

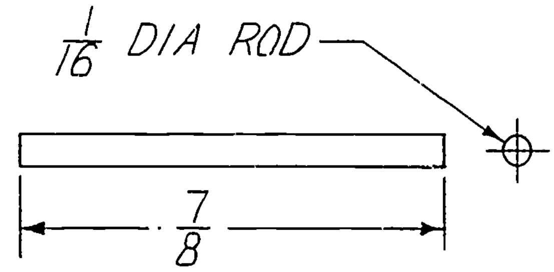
GEMINI VII CAPSULE



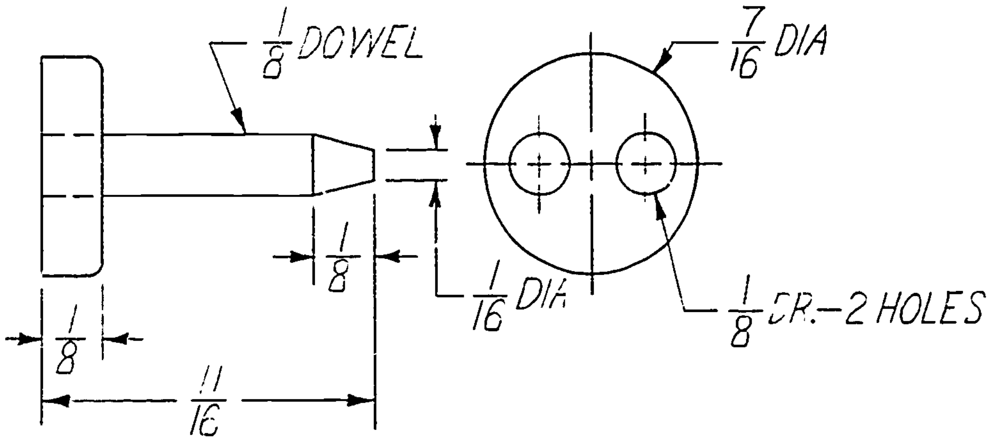
229-357 O-66—9



(1) 1ST STAGE MOTOR 2 REQ'D
SCALE: 2/1

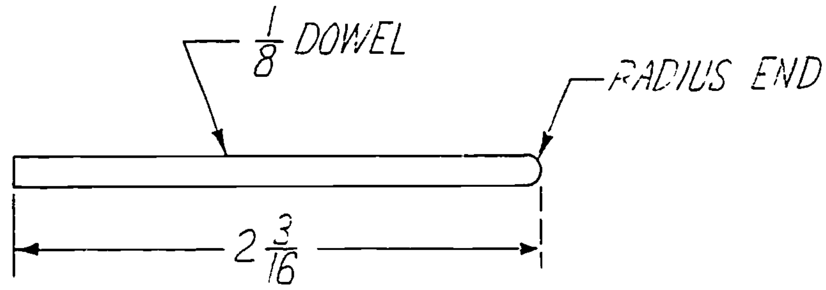


(3) MOTOR BRACE — 2 REQ'D
SCALE: 2/1

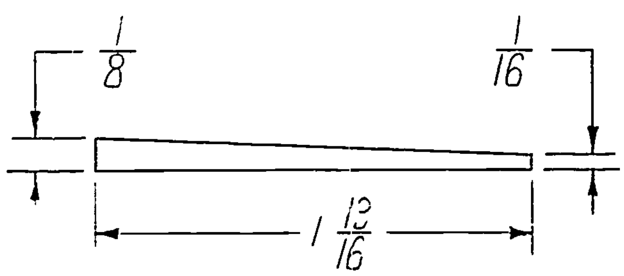


(2) ASSY - EXHAUST SYSTEM — 1 REQ'D
SCALE: 2/1

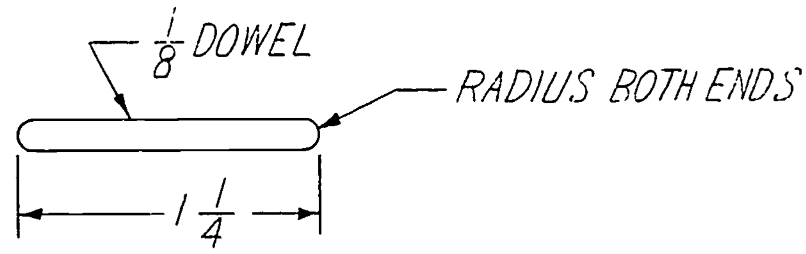
NOTE: ASSEMBLY CONSISTS OF THREE PARTS:
2 PIECES – 1/8 DOWEL X 11/16 LONG
1 PIECE – 7/16 DIA X 1/8 THICK STOCK



(6) FUEL LINE—LOWER — 1 REQ'D
SCALE: 1/1

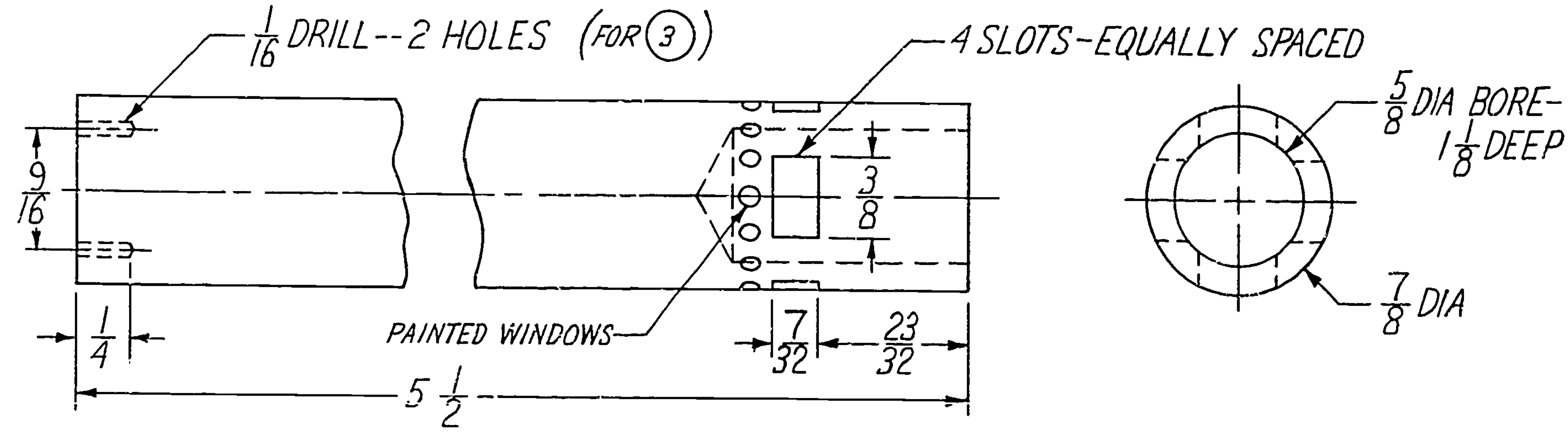


(4) STABILIZER — 4 REQ'D
SCALE: 1/1

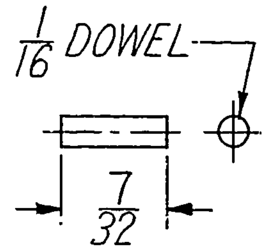


(7) FUEL LINE - CENTER — 1 REQ'D
SCALE: 1/1

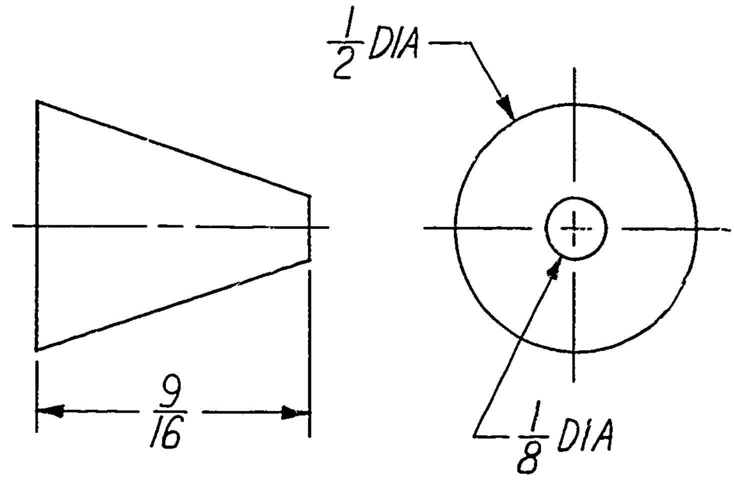
3



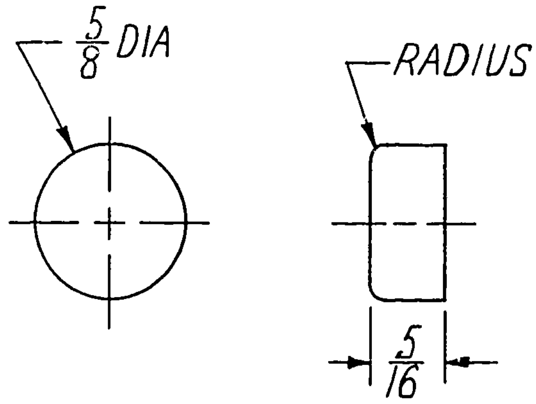
(5) 1ST STAGE BODY—1 REQ'D
SCALE: 1/1



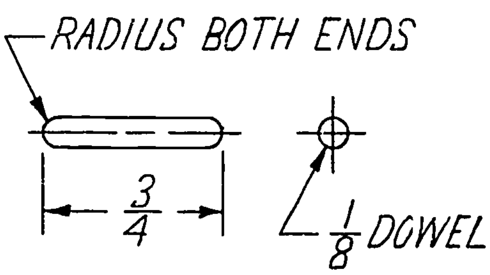
(8) BRACE — 8 REQ'D
SCALE: 2/1



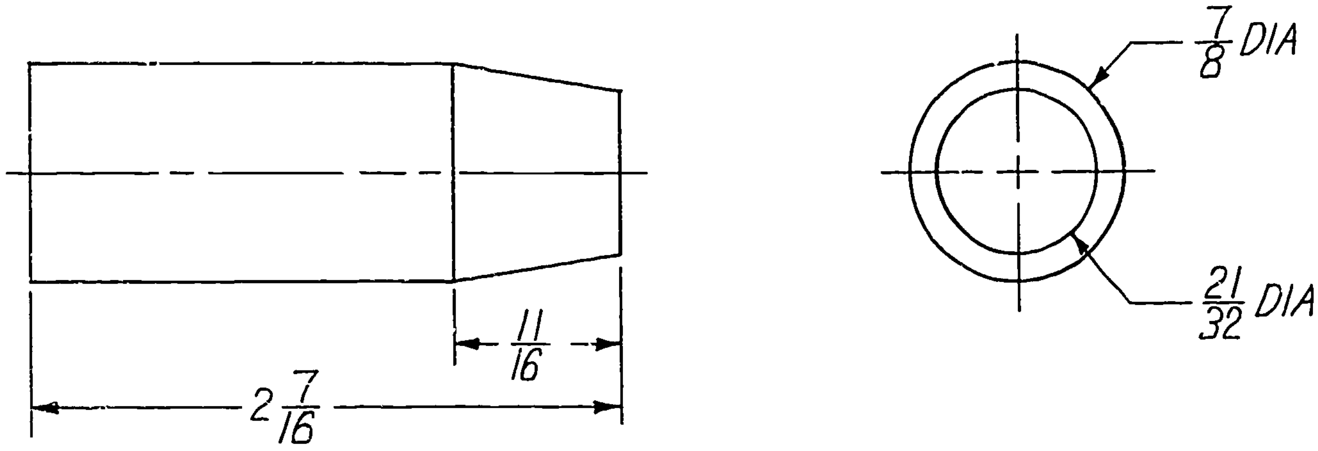
(9) 2ND STAGE MOTOR — 1 REQ'D
SCALE: 2/1



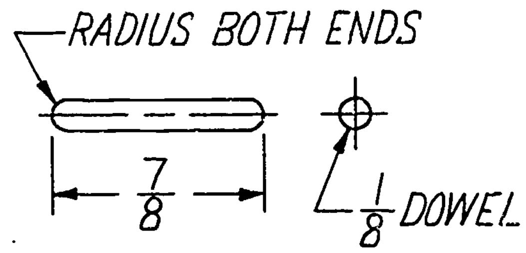
(10) MOTOR BASE — 1 REQ'D
SCALE: 1/1



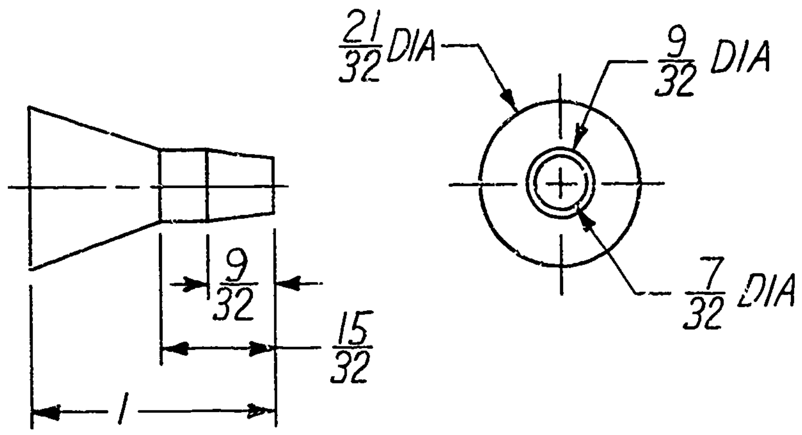
(11) FUEL LINE-LOWER — 1 REQ'D
SCALE: 1/1



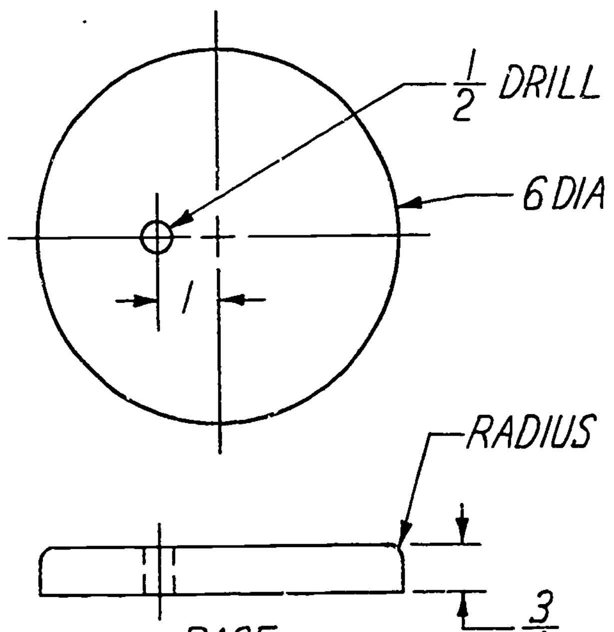
(12) 2ND STAGE BODY -- 1 REQ'D
SCALE: 1/1



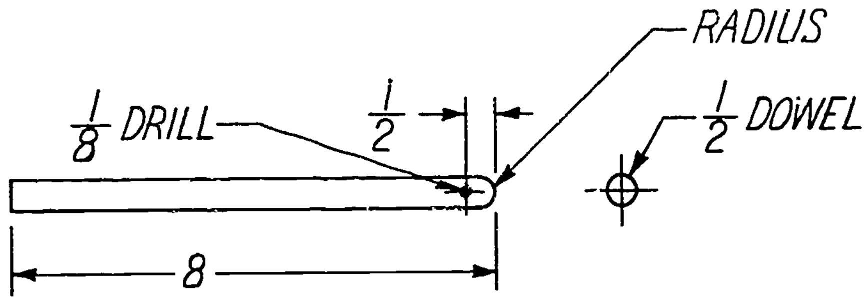
(13) FUEL LINE-UPPER — 1 REQ'D
SCALE: 1/1



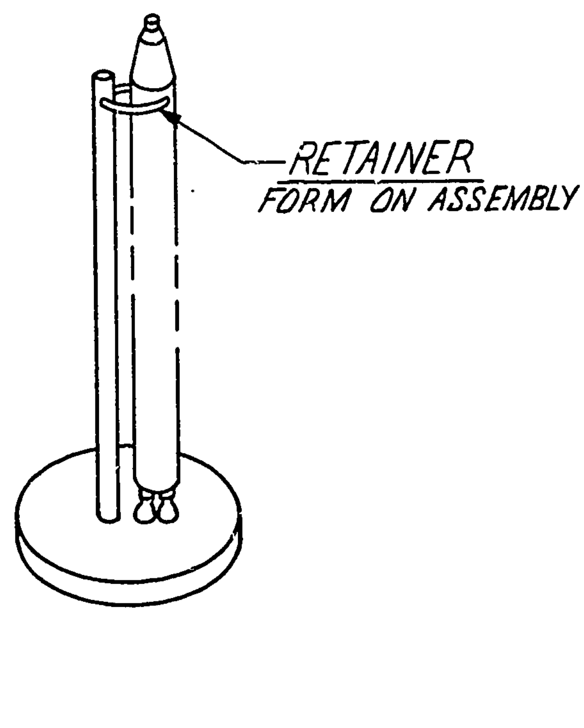
(14) SPACE CAPSULE — 1 REQ'D
SCALE: 1/1



BASE



DOWEL



MODEL STAND — HAS THREE PARTS
SCALE: 1/4

1. BASE
2. DOWEL
3. RETAINER (CLIP)

RECOMMENDED MATERIALS FOR CONSTRUCTION

GEMINI VII - TITAN II

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	2	Wood - Pine	Silver
2 Assy	1	Wood - Dowel	Silver
3	2	Metal Brazing Rod	Silver
4	4	Wood - Pine	White
5	1	Wood - Pine	White
6	1	Wood - Dowel	White
7	1	Wood - Dowel	White
8	8	Wood - Dowel	White
9	1	Wood - Pine	Silver
10	1	Wood - Pine	Silver
11	1	Wood - Dowel	White
12	1	Wood - Pine	White
13	1	Wood - Dowel	White
14	1	Wood - Pine	Black

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI VII - TITAN II

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - Pine	Cut to length. Turn to specified dimensions. Drill hole.	Finish sand.	
2 Assy	Wood - Dowel	Cut 1/8 dowel to length and taper one end to specified dimensions. Cut base from 7/16 dowel and drill holes.	Finish sand.	Glue 1/8 doweling in holes of 7/16 dowel with epoxy resin.
3	Brass Rod	Cut to length.	Clean.	Glue parts no. 1 and 2 to part no. 3 with epoxy resin. Paint assembly silver.
4	Wood - Pine	Cut to length.	Finish sand.	
5	Wood - Pine	Cut to length. Turn on lathe to specified dimensions. Drill 5/8 diameter X 1-1/8 deep hole. Cut slots to specified dimensions. Drill (2) 1/16 diameter holes for part no. 3 per dimensions.	Finish sand.	
6	Wood - Dowel	Cut to length.	Finish sand.	
7	Wood - Dowel	Cut to length.	Finish sand.	

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI VII - TITAN II

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8	Wood - Dowel	Cut to length.	Finish sand.	Glue parts no. 4, 6, 7, and 8 to part no. 5 with epoxy resin. Paint assembly white.
9	Wood - Pine	Cut to length. Turn on lathe to specified dimensions.	Finish sand.	
10	Wood - Pine	Turn on lathe to specified dimensions. Cut to length. Radius one edge per detail.	Finish sand.	Glue part no. 9 to part no. 10 with epoxy resin. Paint silver.
11	Wood - Dowel	Cut to length.	Finish sand.	
12	Wood - Pine	Cut to length. Turn on lathe to specified dimensions.	Finish sand.	
13	Wood - Dowel	Cut to length.	Finish sand.	Glue parts no. 11 and 13 to part no. 12. Paint White.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI VII - TITAN II

PART NUMBER	SUGGESTED MATERIAL	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
14	Wood - Pine	Cut to length. Turn on lathe to specified dimensions.	Finish sand.	Paint black. Glue part no. 12 to part no. 14 Glue parts no. 1, 2, and 3 to part no. 5. Apply surface details to parts no. 5 and 14 using appropriate paint or India ink.
Model Stand	Wood - Dowel Wire (solder)	See detail sheet for specified dimensions. Drill hole in dowel for wire clip.	Finish sand wood surfaces.	Glue dowel to base. Paint black. Form wire clip.

GEMINI

"It's a wonderful spacecraft but it's not much of a boat. It's got pitch, heave, and roll." These were the words of astronaut Young upon completion of the spacetrip in March 1965.

The Gemini flight program was started on April 8, 1964 and will continue through a scheduled number of operations. This series of experiments is the most sophisticated space venture that has ever been undertaken by man.

The Gemini spacecraft is similar to the Mercury spacecraft but is considerably larger. This project was designed as an intermediate step between the Mercury and Apollo projects as there was a definite need for more research data. It could also be made operatable with a minimum amount of time and expense.

The Gemini mission had several prime objectives which it needed to accomplish if future space ventures were to be successful. These are:

To subject two men and supporting equipment to long duration flights, a research and experience requirement for projected later trips to the moon or deeper space.

To effect rendezvous and docking with another orbiting vehicle; and to maneuver the combined spacecraft in space, utilizing the propulsion system of the target vehicle for such maneuvers.

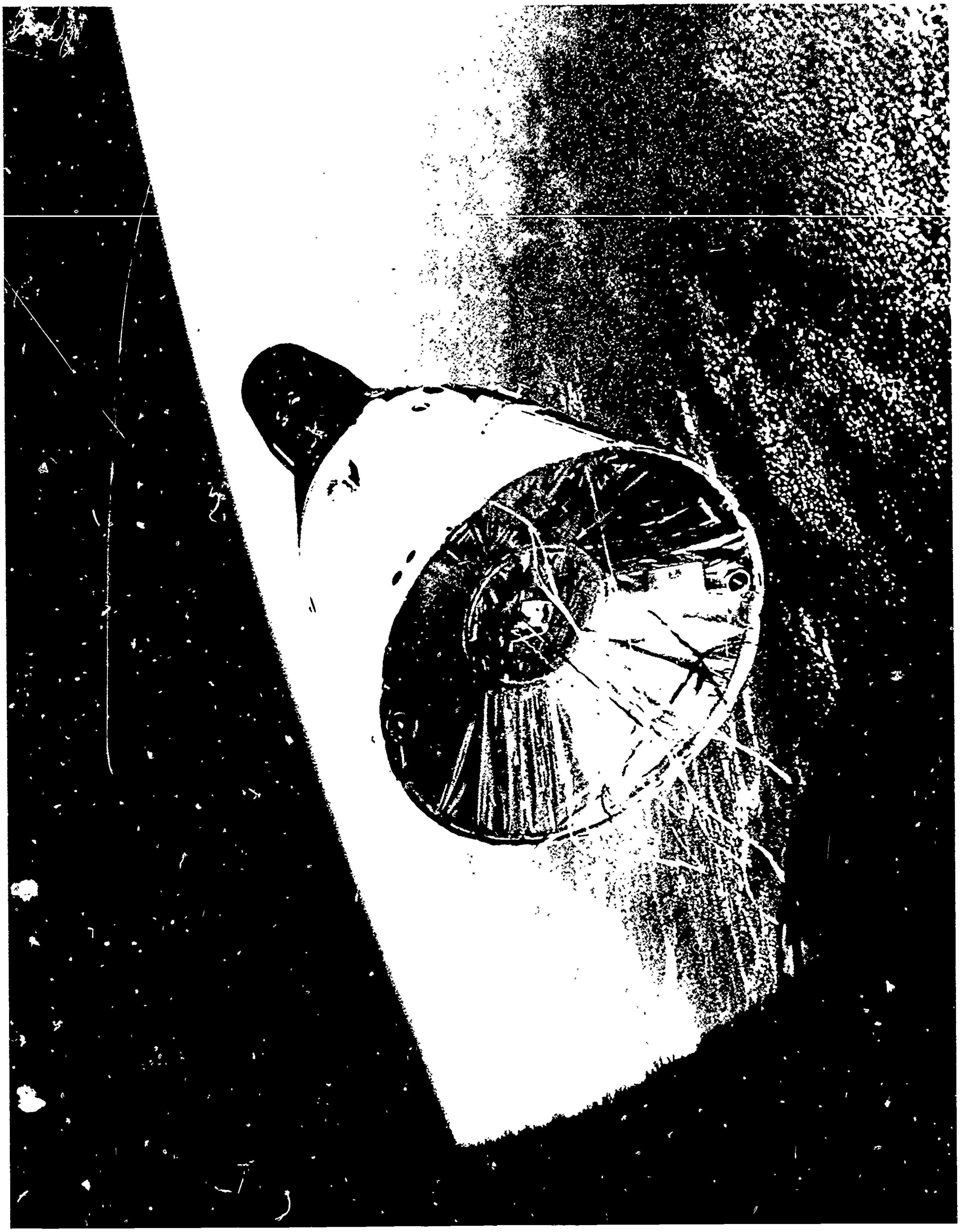
To experiment with astronauts leaving the Gemini spacecraft while in orbit and determining their ability to perform extravehicular activities such as mechanical or other type tasks.

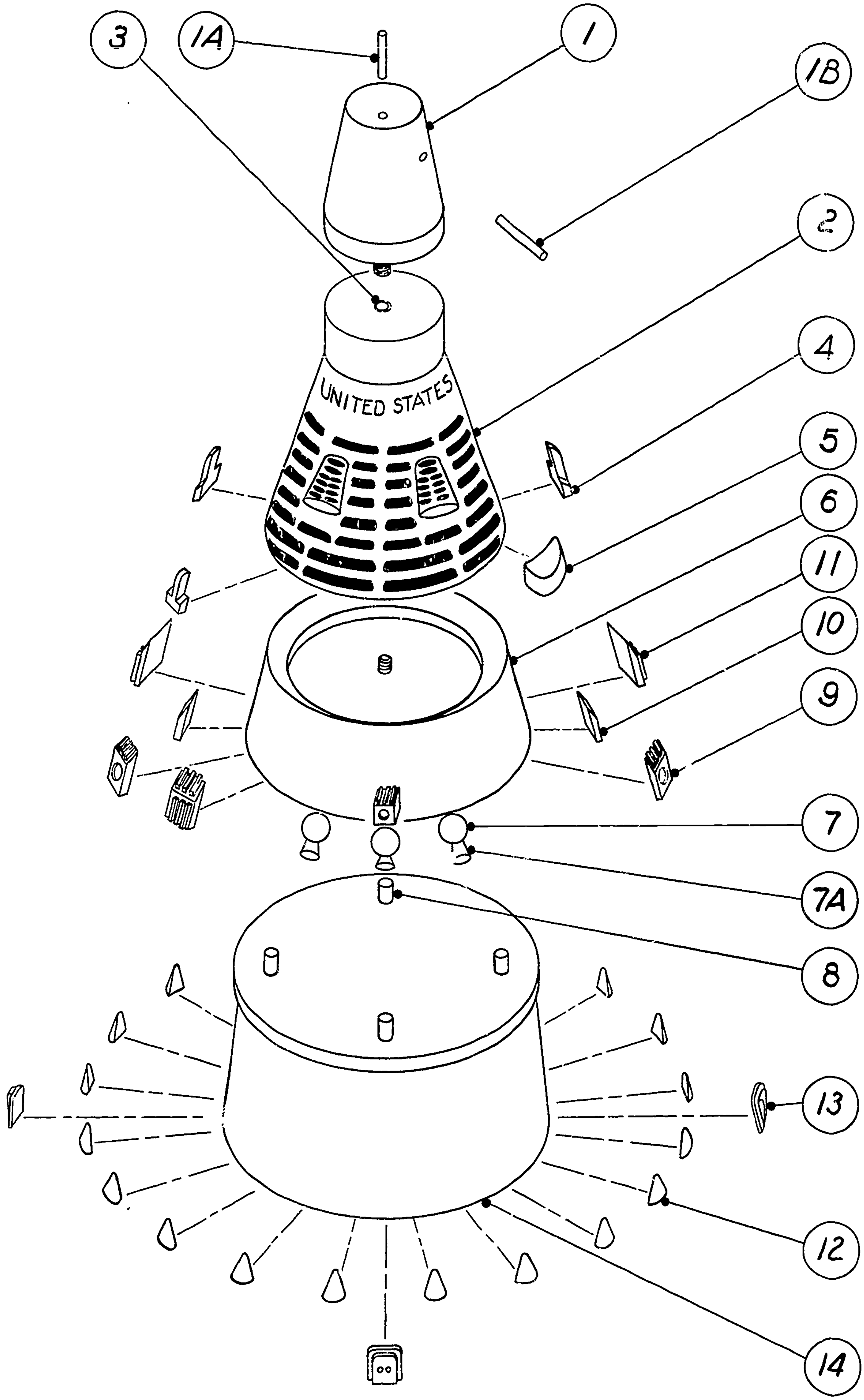
To perfect methods of reentry and landing the spacecraft at a preselected landing area.

To gain additional information concerning the effects of weightlessness, and physiological reactions of crew members during long duration missions, and other medical data required in preparation for the lunar mission of the Apollo Program.

To provide the astronauts with required zero-gravity and rendezvous and docking experiences.

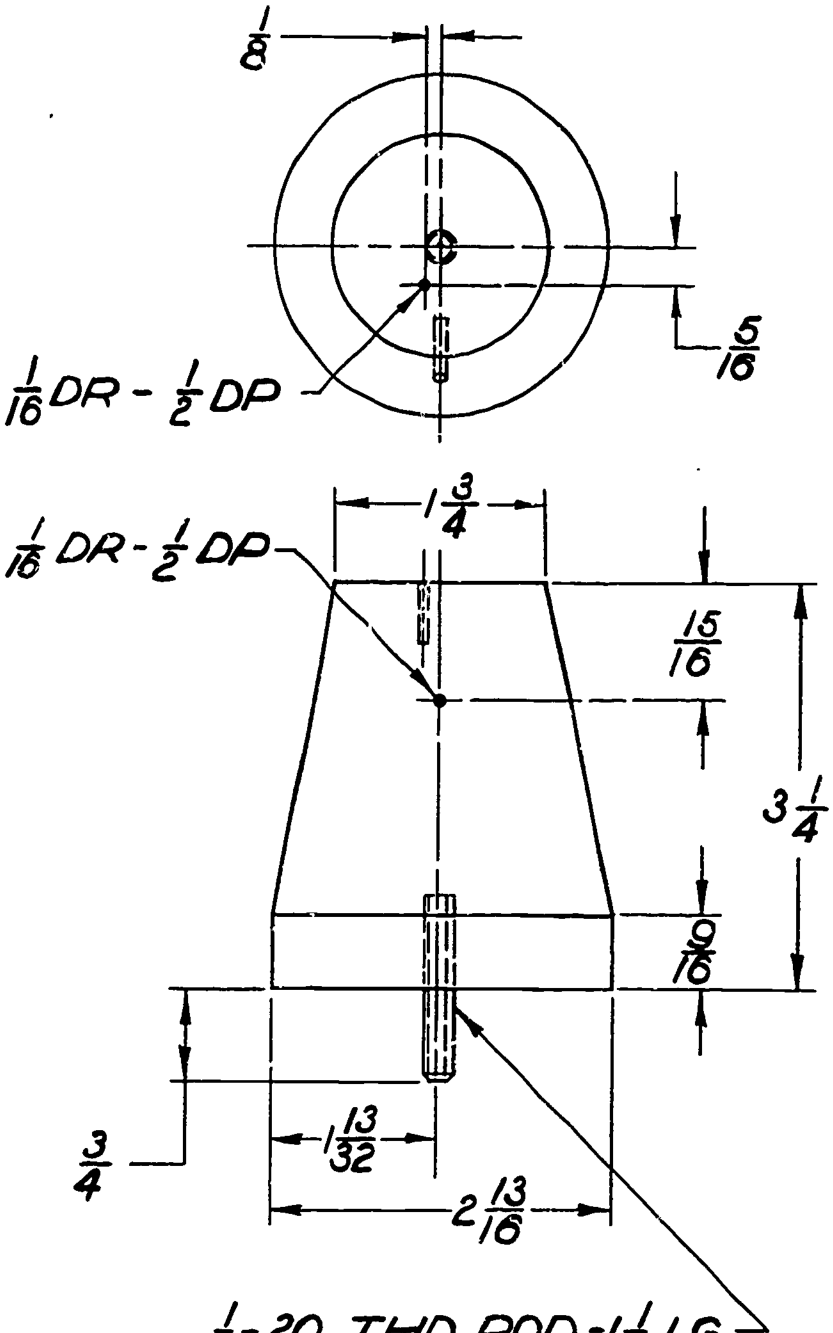
The Gemini Program will carry man one step closer to the moon and Mars and opens the starry heavens to future exploration and adventure.





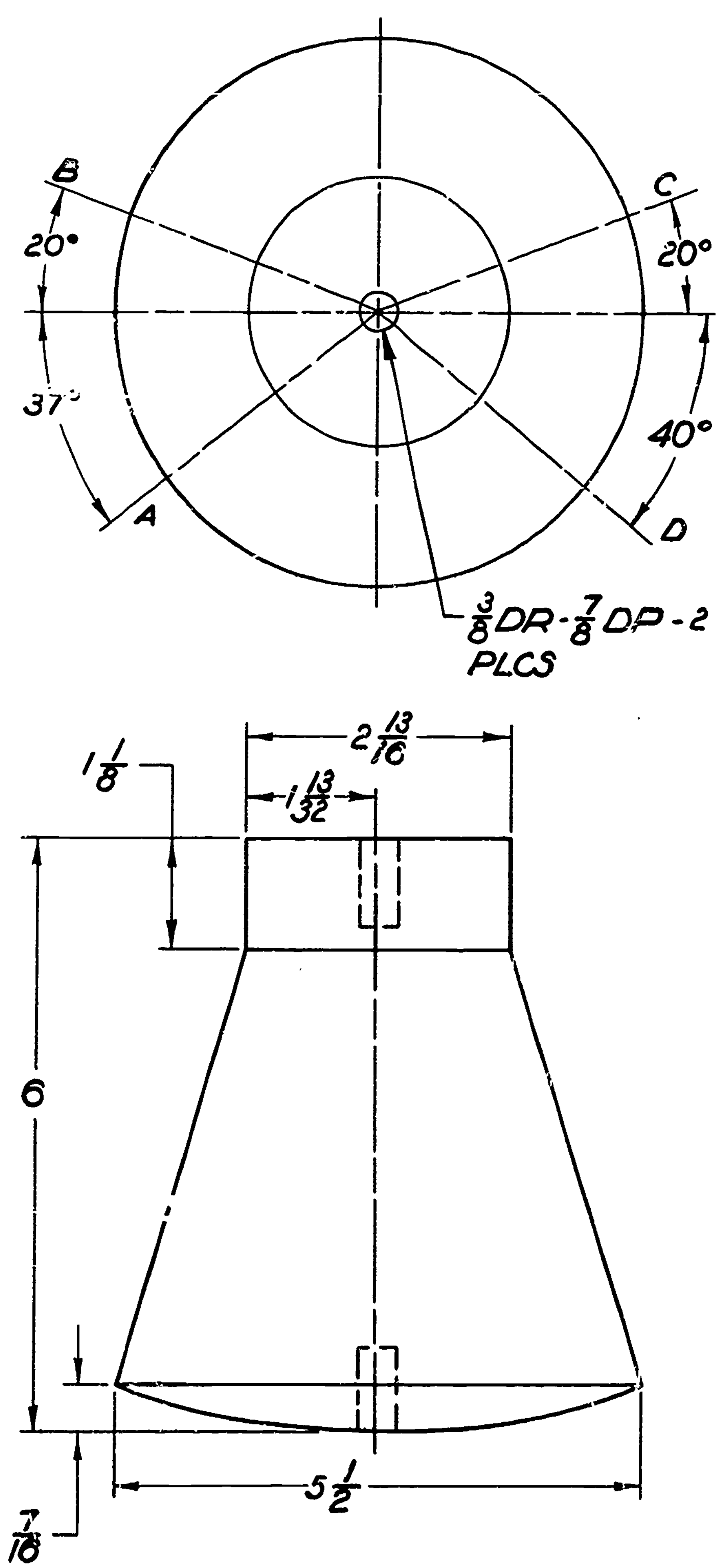
GEMINI

DETAIL NO. 1
SCALE 1"=1"

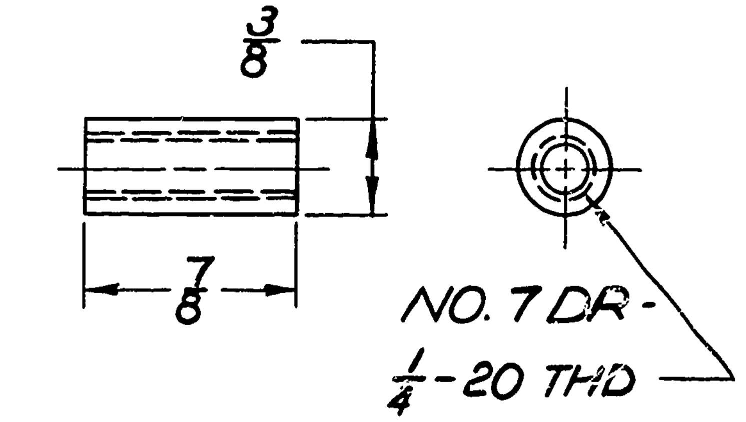


DETAIL NO. 2
SCALE 1"=1"

NOTE
1:-PART 4 LOCATED AT A-B-C.
2:-PART 5 LOCATED AT D.

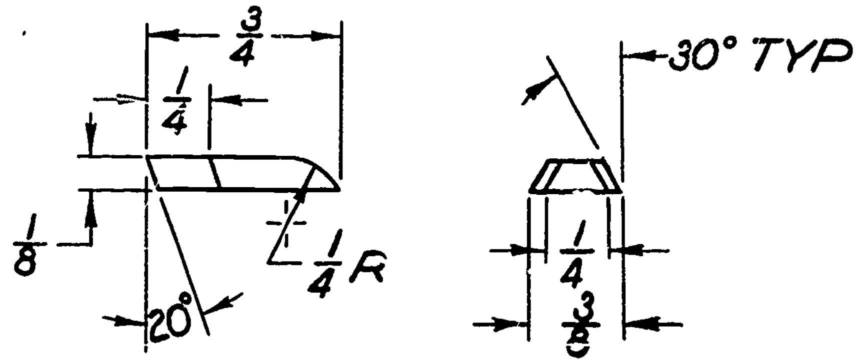


DETAIL NO. 3
SCALE 2/1

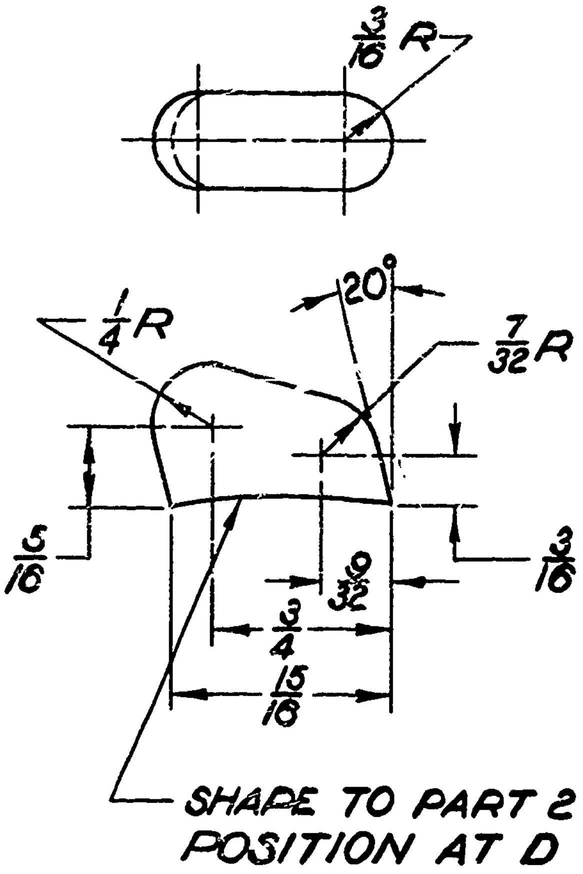


NOTE
SECURE PART 3 TO PART 2

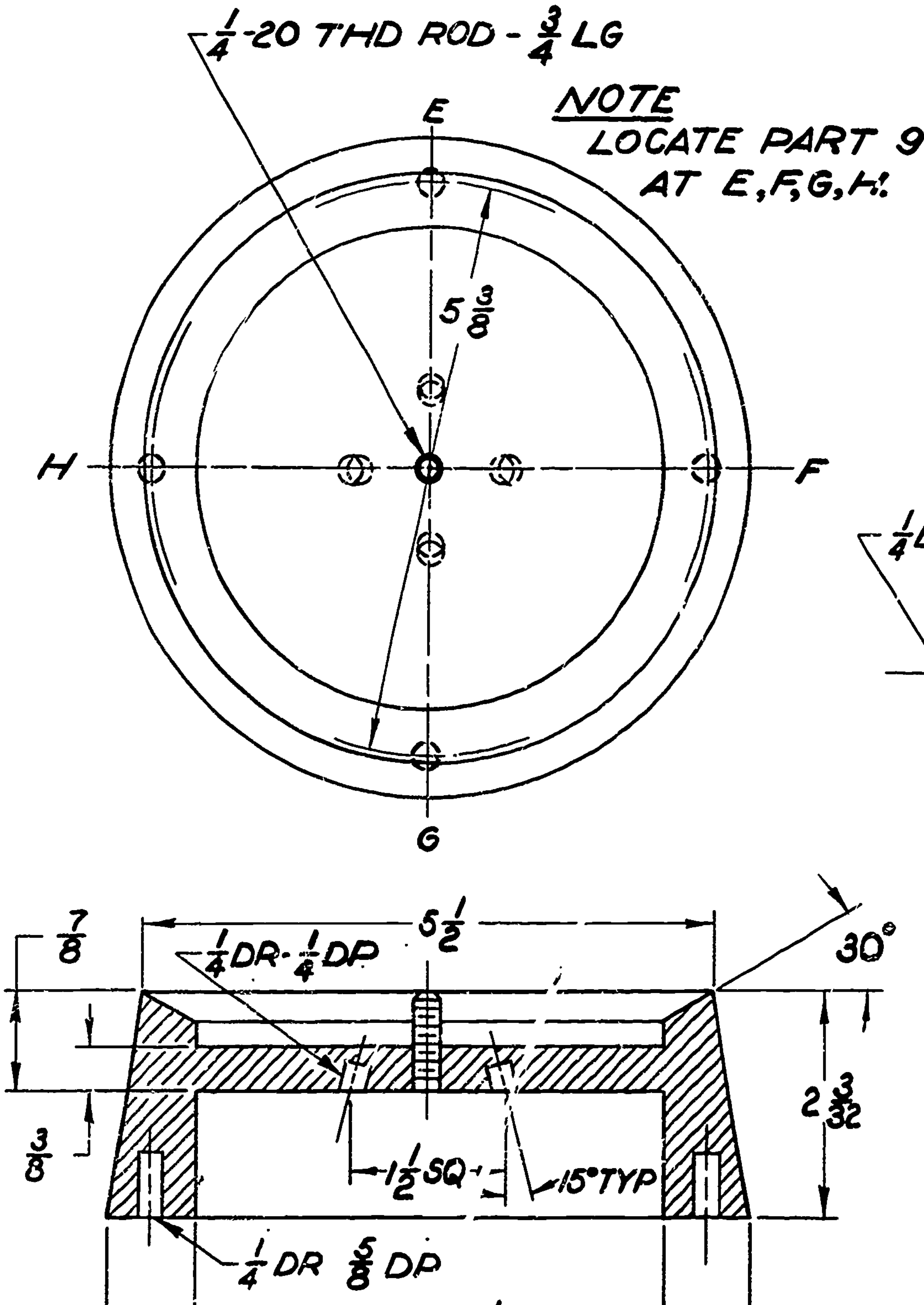
DETAIL NO. 4
SCALE 2/1



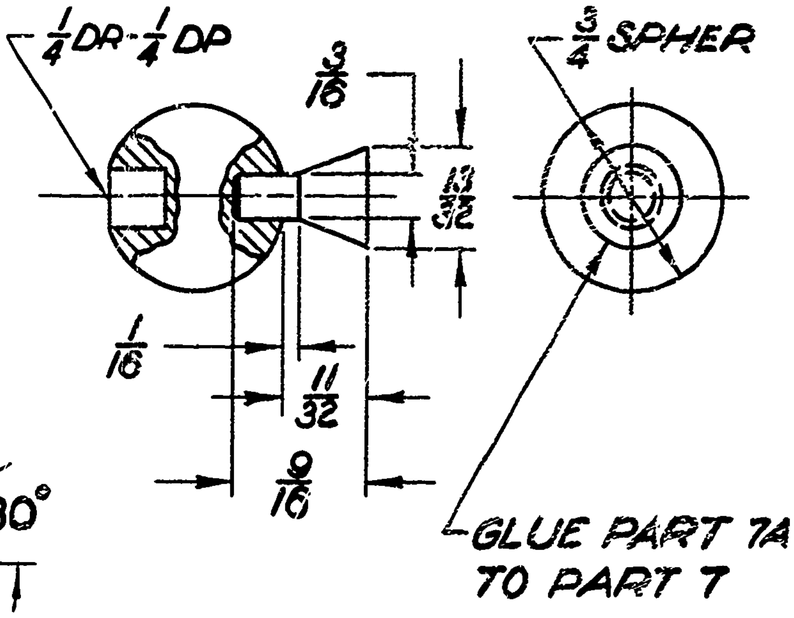
DETAIL NO. 5
SCALE 2/1



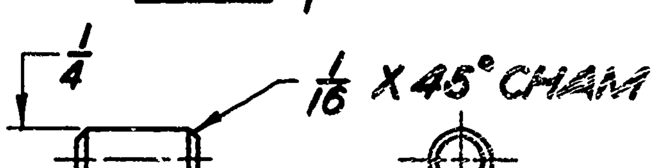
DETAIL NO. 6
SCALE 1" = 1"



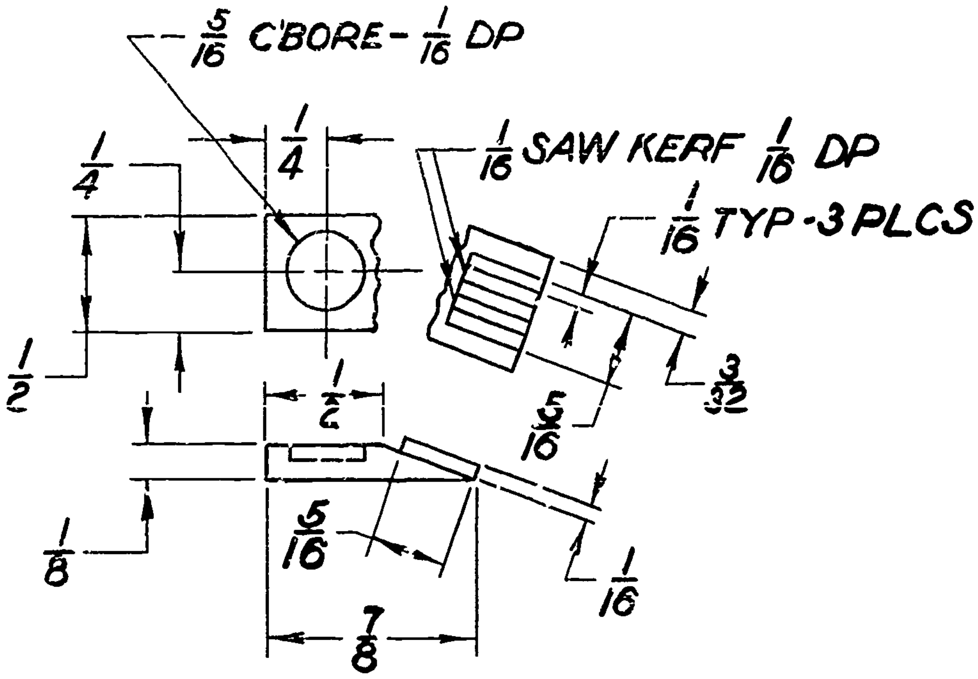
DETAIL NO. 7 & 7A
SCALE 2/1



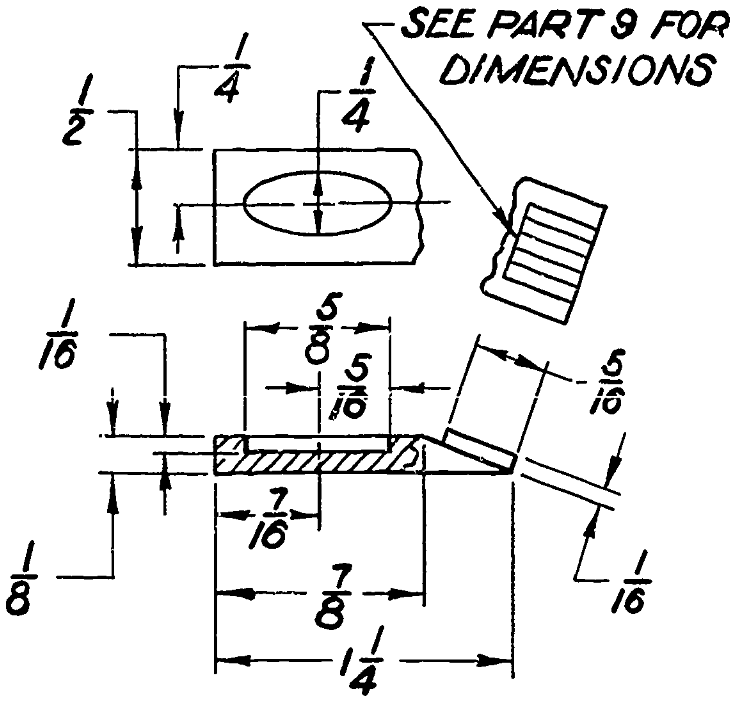
DETAIL NO. 8
SCALE 2/1



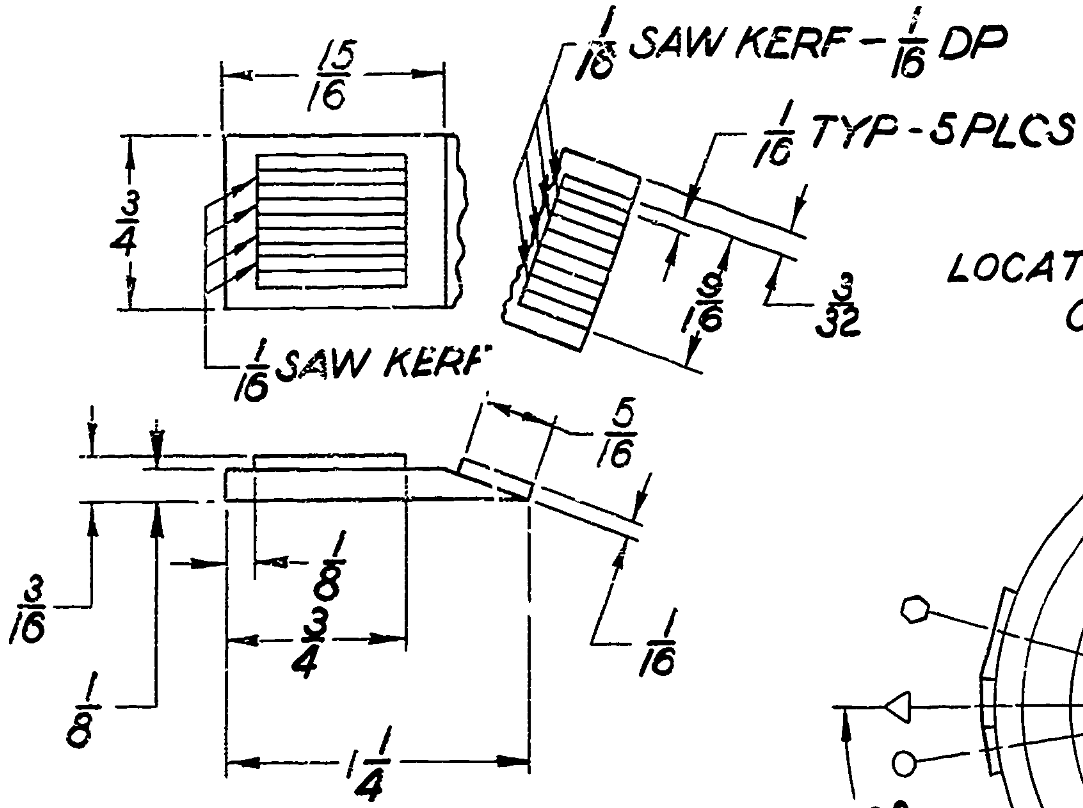
DETAIL NO. 9
SCALE 2/1



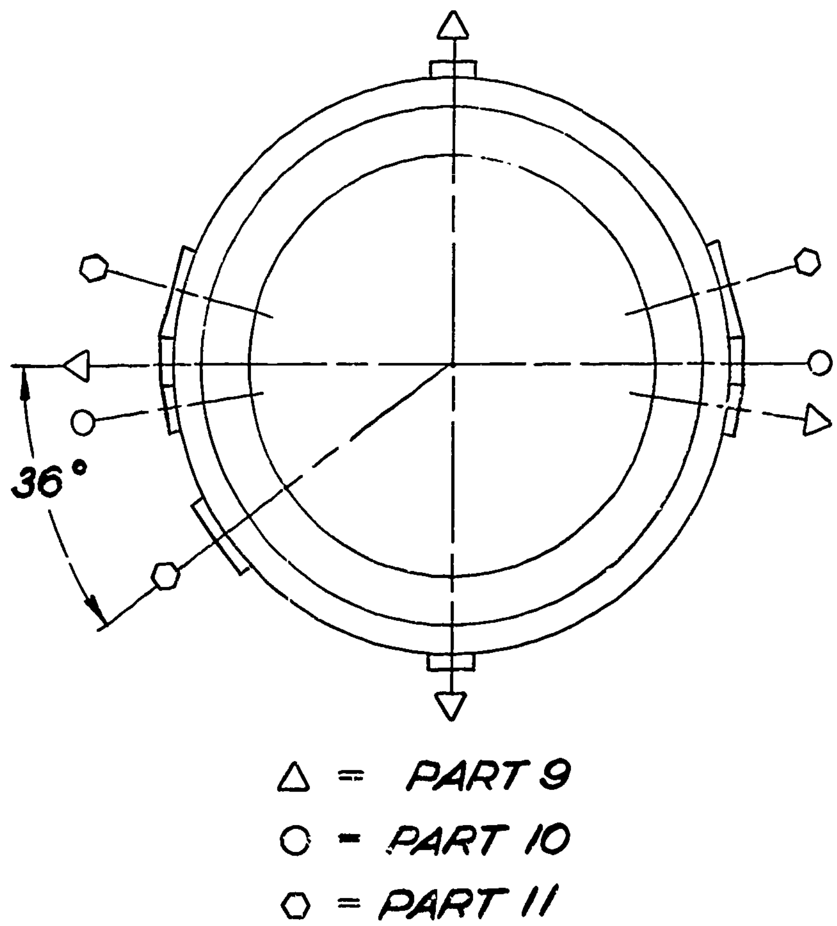
DETAIL NO. 10
SCALE 2/1



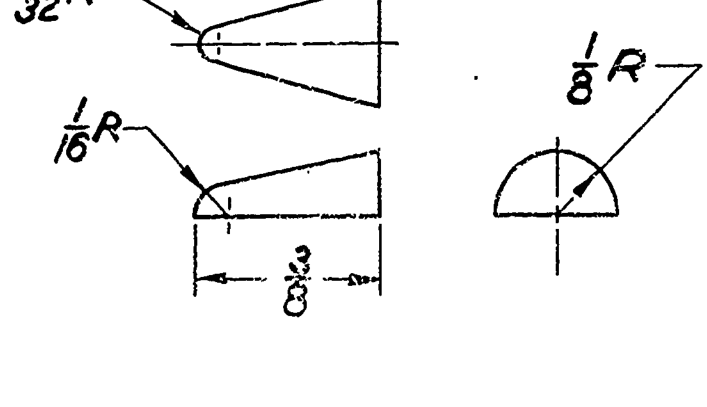
DETAIL NO. 11
SCALE 2/1



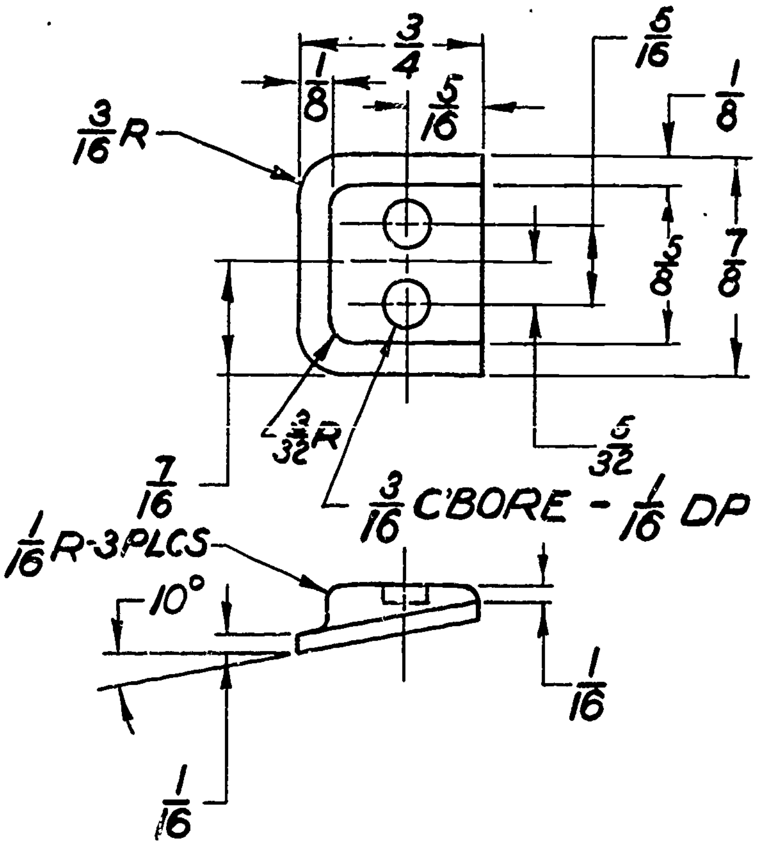
LOCATION OF PARTS 9, 10, & 11
ON PART 6



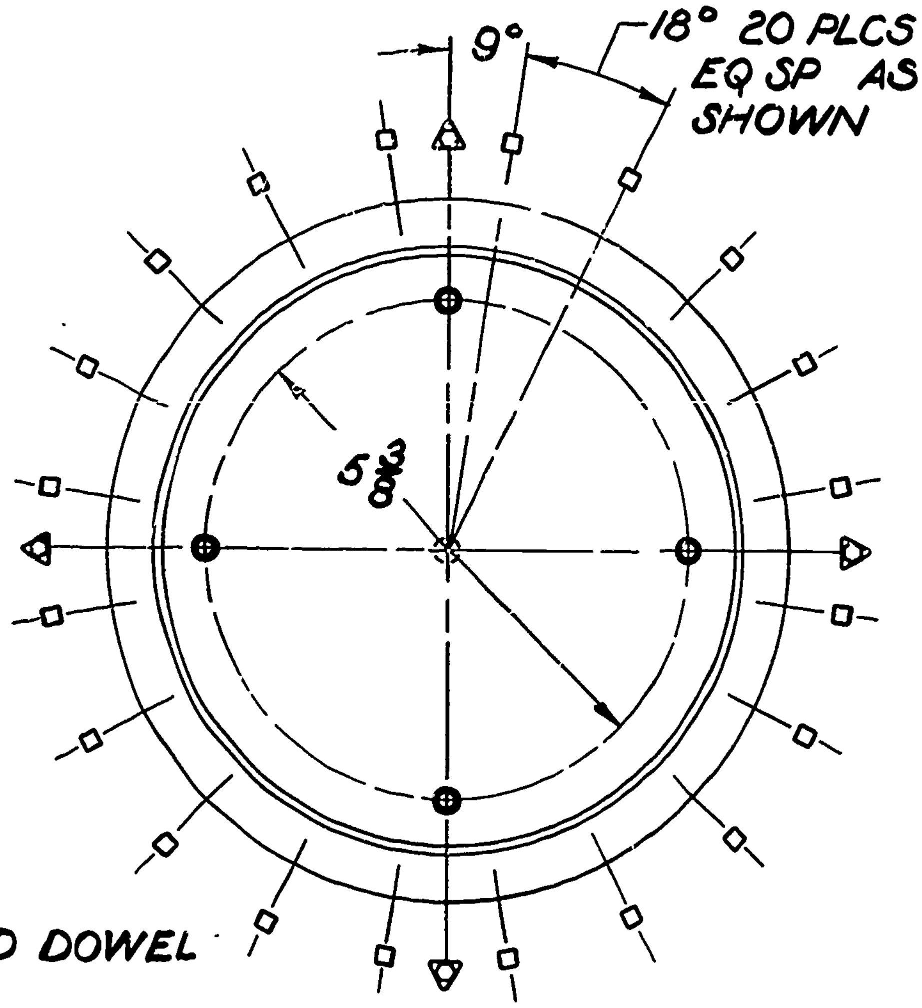
DETAIL NO. 12
SCALE 4/1



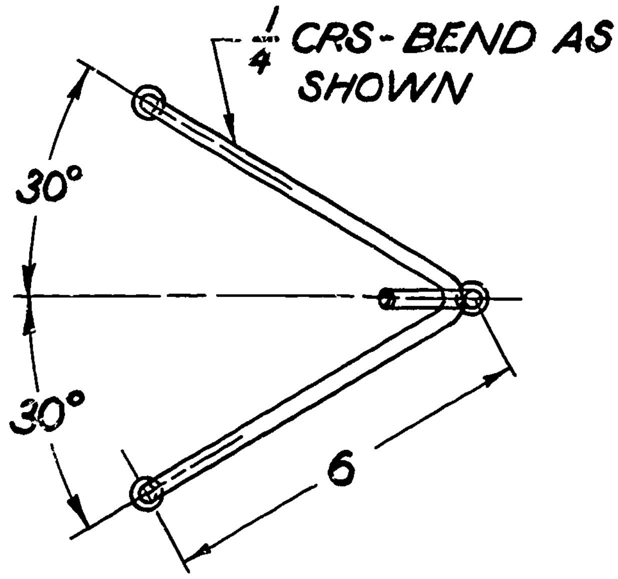
DETAIL NO. 13
SCALE 2/1

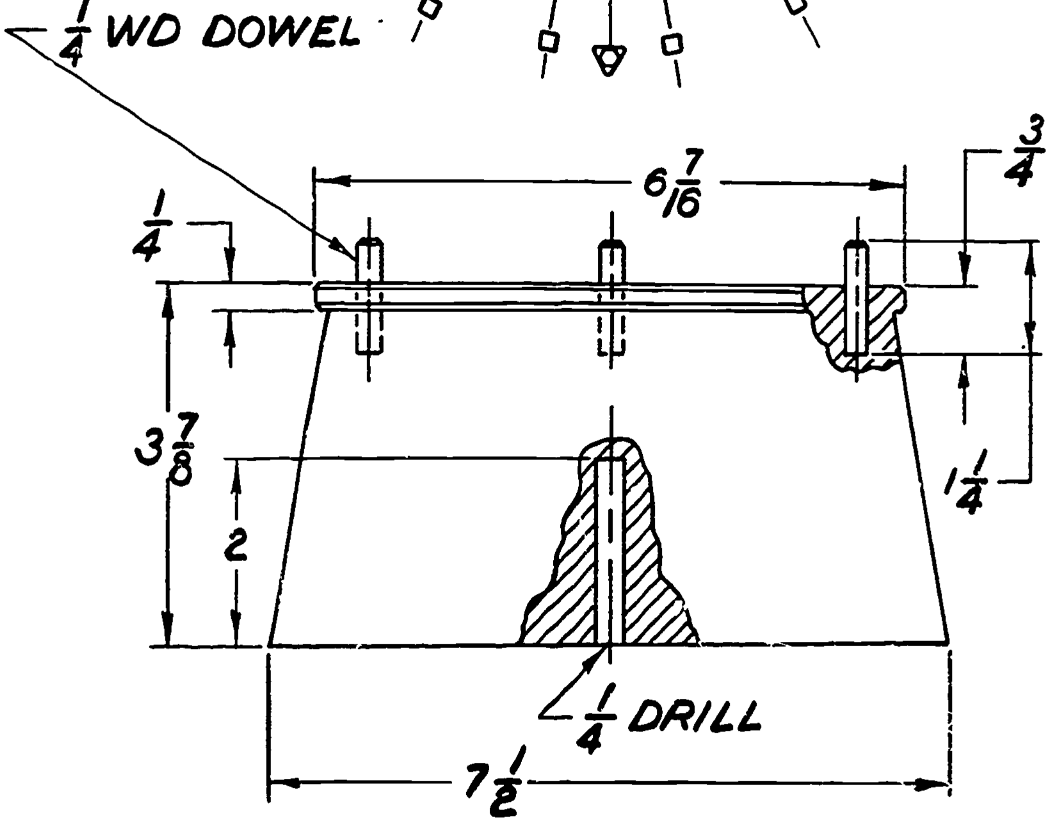


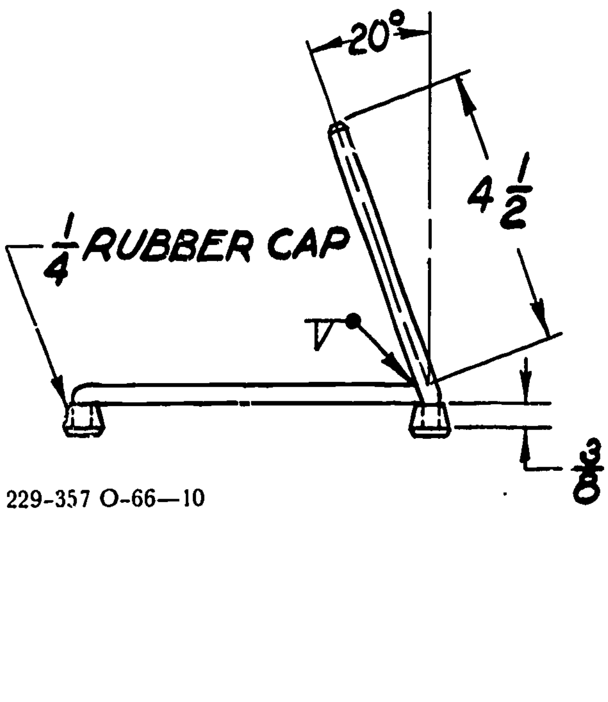
DETAIL NO. 14
SCALE 3/4" = 1"



GEMINI STAND
SCALE 1/2" = 1"

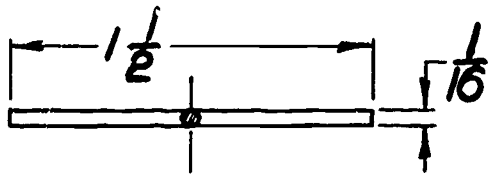




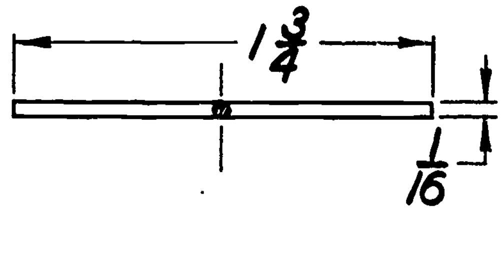


□ = PART 12
△ = PART 13

DETAIL NO. 1A



DETAIL NO. 1B



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RECOMMENDED MATERIALS FOR CONSTRUCTION

GEMINI

PART NUMBER	DESCRIPTION	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	Rendezvous and Recovery Section	One	Wood - Pine	Black
1A	Antenna	One	1/16" Brazing Rod	Polish & Lacquer
1B	Antenna	One	1/16" Brazing Rod	Polish & Lacquer
2	Cabin Section	One	Wood - Pine	White with Black surface details
3	Cabin Fastener (threaded Bushing)	Two	Steel	
4	Separation Adapter	Three	Wood - Maple	Black
5	Scanner	One	Wood - Maple	Black
6	Retrograde Section	One	Wood - Maple	White
7	Retrograde Motors Rockets	Four	Wood - Maple	Black
7A	Retrograde Chamber Sleeves	Four	Wood - Maple	Black

RECOMMENDED MATERIALS FOR CONSTRUCTION

GEMINI

PART NUMBER	DESCRIPTION	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
8	Separation Dowels	Four	Wood - Dowel	
9		Four	Wood - Maple	Black
10		Two	Wood - Maple	Black
11		Three	Wood - Maple	Black
12	Tie-Down Lugs	Twenty	Wood - Maple	Black
13	Attitude Control Chambers	Four	Wood - Maple	Black
14	Adapter Section	One	Wood - Pine	White
	Gemini Stand	One	Steel	White
	Stand Caps	Three	Rubber Caps	Black

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - Pine	Turn on lathe to specified dimensions. Drill as specified on detail drawing.	Finish sand all surfaces. Paint black.	Place threaded rod in position and secure with epoxy resin.
1A	1/16" Brazing Rod	Cut to specified dimensions.	Polish and lacquer.	Insert part 1A. (See pictorial assembly) Secure with epoxy resin.
1B	1/16" Brazing Rod	Cut to specified dimensions.	Polish and lacquer.	Insert part 1B (See pictorial assembly) Secure with epoxy resin.
2	Wood - Pine	Turn on lathe to specified dimensions. Drill as indicated on detail drawing.	Finish sand all surfaces. Paint white. Mask and paint surface details as shown on pictorial assembly.	
3	Cold Rolled Steel	Cut to specified dimensions. Drill and tap as indicated on the detail drawing.		Glue part 3 (Threaded Bushing) into part 2 -- Secure with epoxy resin.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
4	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 2.	Glue part 4 to part 2 -- Secure with epoxy resin.
5	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 2.	Glue part 5 to part 2 -- Secure with epoxy resin.
6	Wood - Pine	Turn on lathe to specified dimensions. Drill as indicated on detail drawing.	Finish sand all surfaces--paint white.	Place threaded rod in position. Secure with epoxy resin.
7	Hardwood	Turn on lathe to specified dimensions. Drill as indicated. May be purchased commercially.	Finish sand surface.	
7A	Hardwood	Turn on lathe to specified dimensions.	Finish sand all surfaces--glue to part 7, paint unit assembly (parts 7-7A)black.	Glue part 7A to part 7 -- Glue unit assembly to part 6.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8	Hardwood Dowel	Cut to specified dimensions.		Glue part 8 to part 14. (See detail drawing).
9	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 6.	Glue part 9 to part 6 -- Secure with epoxy resin.
10	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 6.	Glue part 10 to part 6 -- Secure with epoxy resin.
11	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 6.	Glue part 11 to part 6 -- Secure with epoxy resin.
12	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 14.	Glue part 12 to part 14 -- Secure with epoxy resin.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

GEMINI

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
13	Wood - Maple	Cut, shape, and drill to specified dimensions.	Finish sand all surfaces--paint black prior to cementing to part 14.	Glue part 13 to part 14 -- Secure with epoxy resin.
14	Gemini Stand	Cut, bend, and weld as indicated on detail drawing.	Prepare metal surfaces for painting (one coat metal primer and two coats of white enamel.)	Weld or braze steel stand as indicated on detail drawing. Attach rubber caps to legs.

TIROS

Carla . . . Donna . . . Esther . . . Flora . . .

These were destructive hurricanes which took thousands of lives and caused millions of dollars in damage.

Future counterparts, with other feminine names, will surely be as severe, but their destructive results will be minimized because people will be forewarned through information gathered by meteorological satellites in space, taking pictures of the earth's surface and cloud cover. Such warnings have enabled people in the hurricane belt to prepare themselves for high winds and water, and thus spare lives and property. Such was the case with Carla.

TIROS is the satellite which provides the information so necessary to meteorologists for studying weather and predicting what will happen. This name is an acronym for Television Infrared Observation Satellite.

The first meteorological satellite, TIROS I, was launched from Cape Kennedy on April 1, 1960, and from the beginning was very successful. The orbit was nearly a perfect circle and was about 450 miles from the surface of the earth. This satellite remained operative for approximately three months and took close to 23,000 pictures.

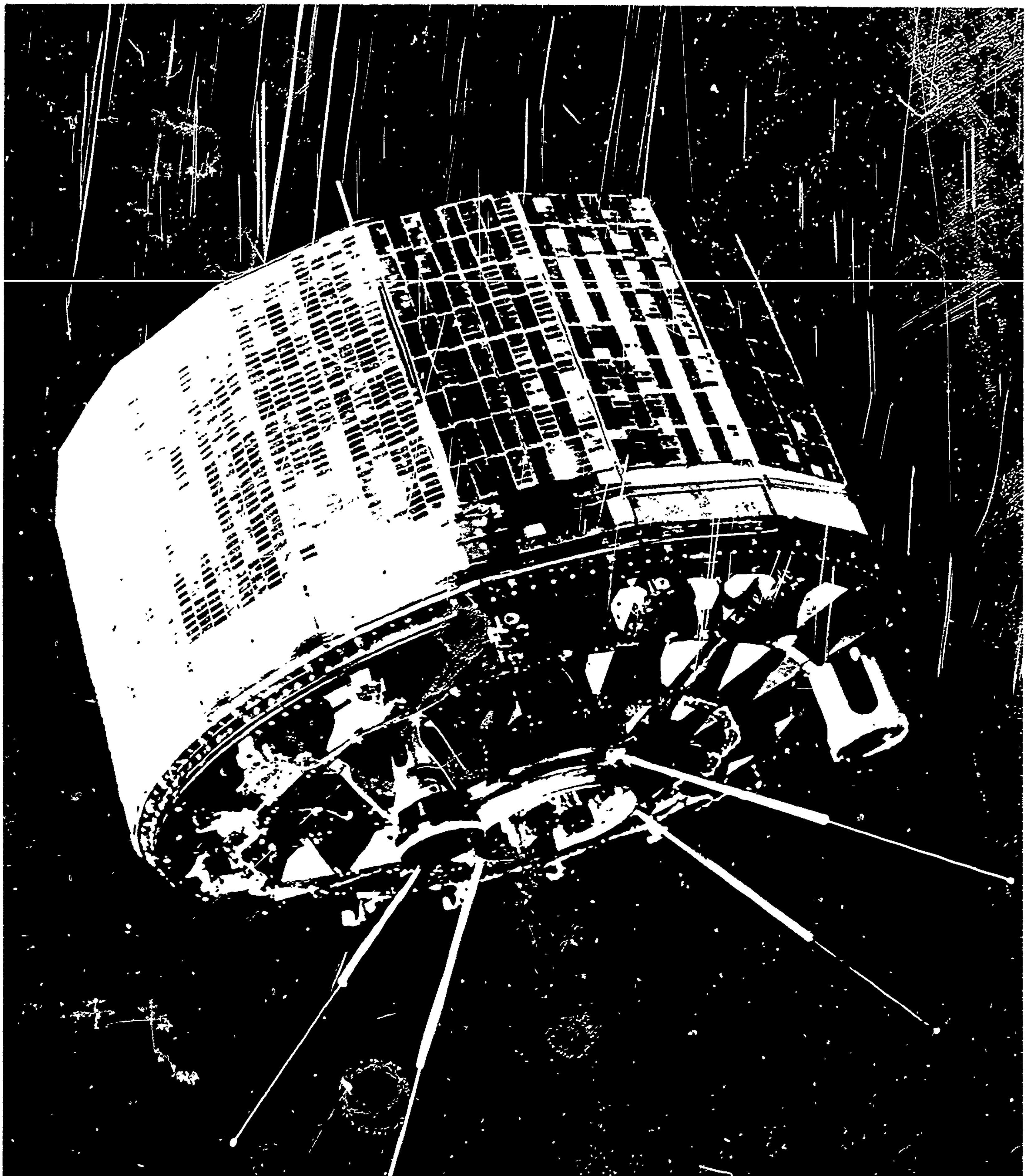
TIROS uses solar energy to power its operation and has 9,000 solar cells which convert the sun's rays to electricity. These also operate all the equipment on the craft and recharge the nickel-cadmium batteries which power the satellite when it is in the earth's shadow.

The utilization of the TIROS has many implications for the future. This method of scanning for weather fronts with a space satellite such as the TIROS is only the beginning of a new and wonderful adventure in space. New vistas have been opened and the clouds can no longer keep its secrets hidden from mankind.

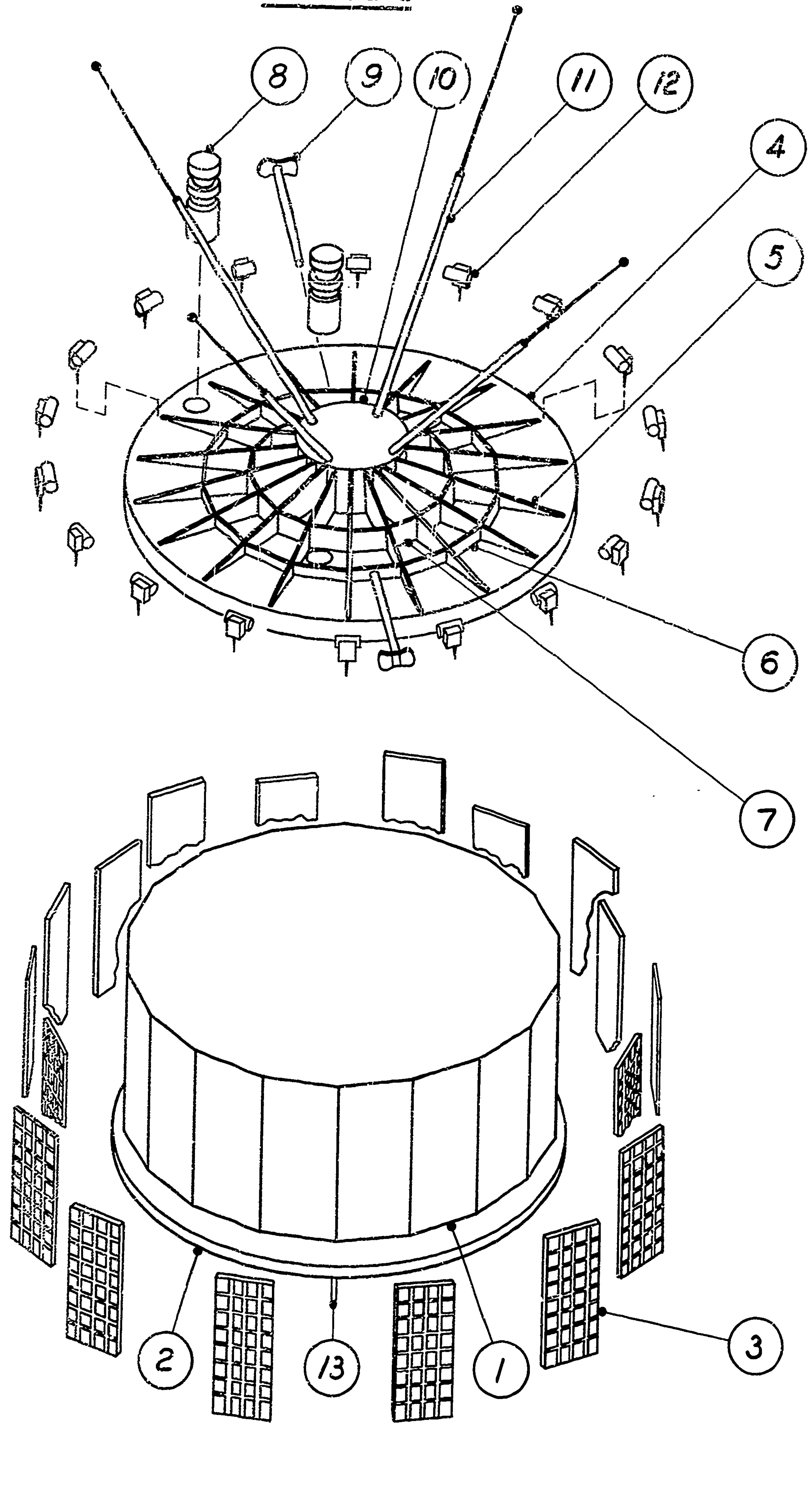
Ten TIROS spacecraft were launched; TIROS X on July 2, 1965. In 1966 two operational weather satellites, ESSA I and II, based upon NASA's research and development of the TIROS program, were placed in orbit to provide data for use in routine weather observation and forecasting.

The ESSA satellites are elements of the TIROS Operational System (TOS), the world's first operational weather satellite system, and provide forecasters with daily pictures of the cloud cover over the entire earth, except for those areas in polar darkness. Management of the system is the function of the Weather Bureau of the Environmental Science Services Administration, also designated by the acronym ESSA, and a part of the U. S. Department of Commerce. The satellites are launched for ESSA by the National Aeronautics and Space Administration.

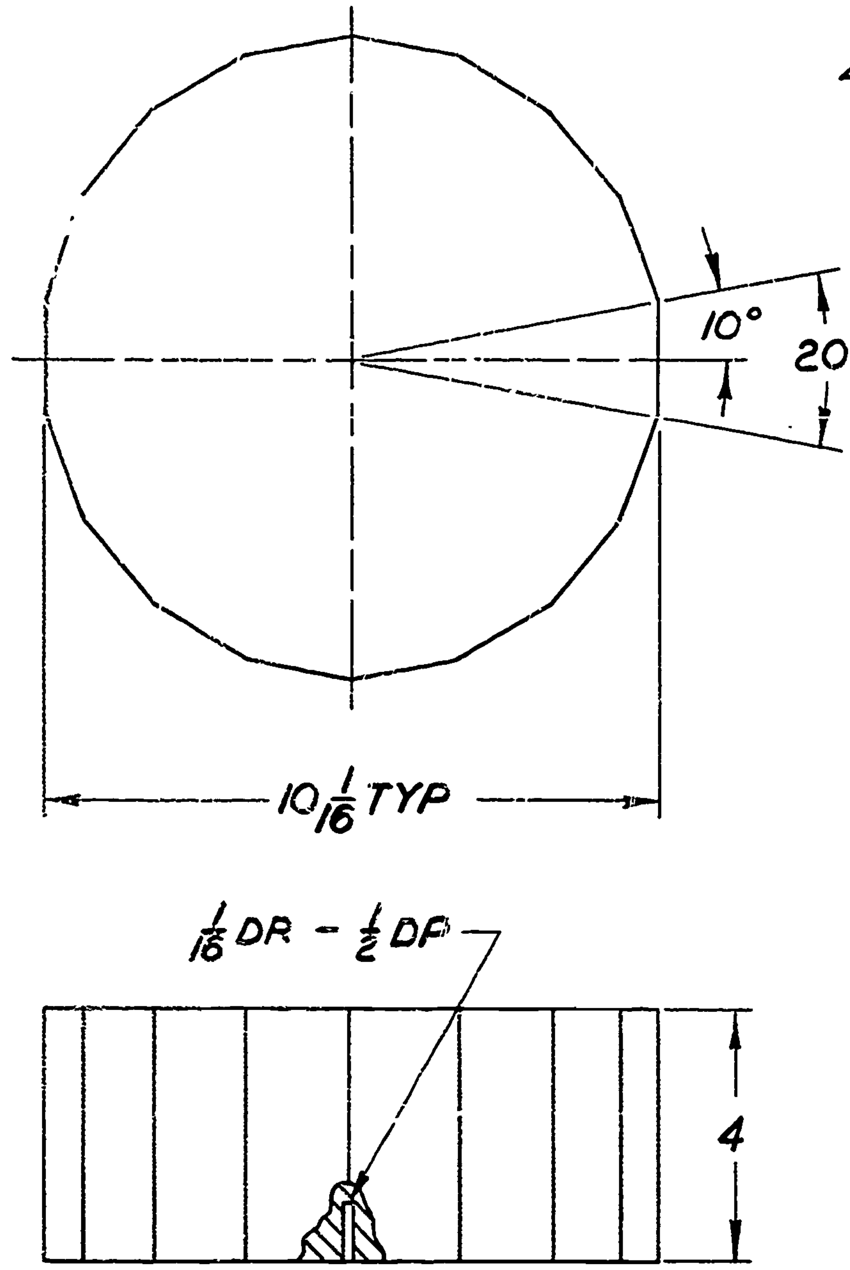
ESSA I and II are similar in appearance to the TIROS spacecraft, the pictures and plans of which are presented on the following pages. The ESSA craft differ from the TIROS model shown in that their cameras are on the spacecraft's rim, 180° apart (a configuration first used in TIROS IX). The ESSA spacecraft rolls along in orbit like a wheel, each camera pointing directly toward earth once during each revolution. In its nearly polar, sun-synchronous orbit, the ESSA views weather all over the world once every day, photographing a given area at the same local time each day.



TIROS



DETAIL NO. 1



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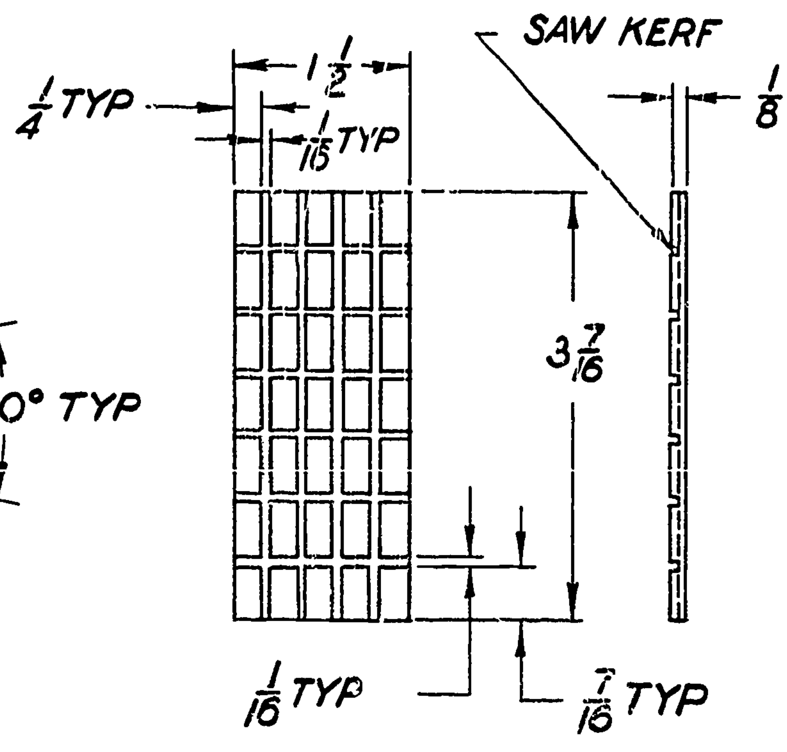

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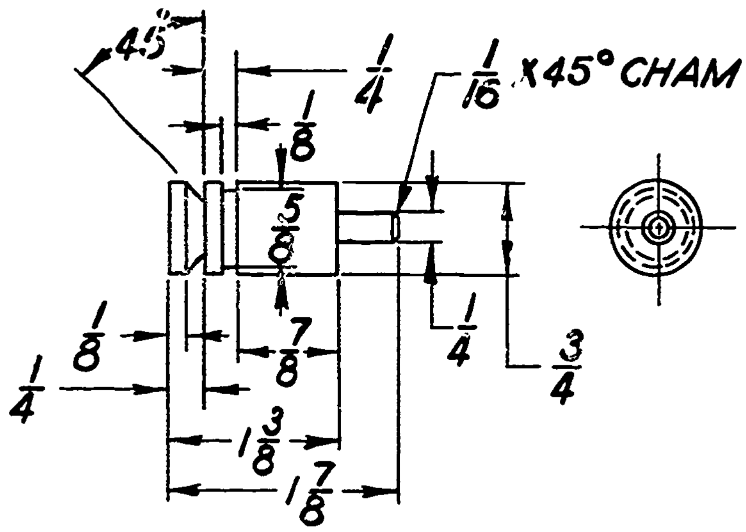

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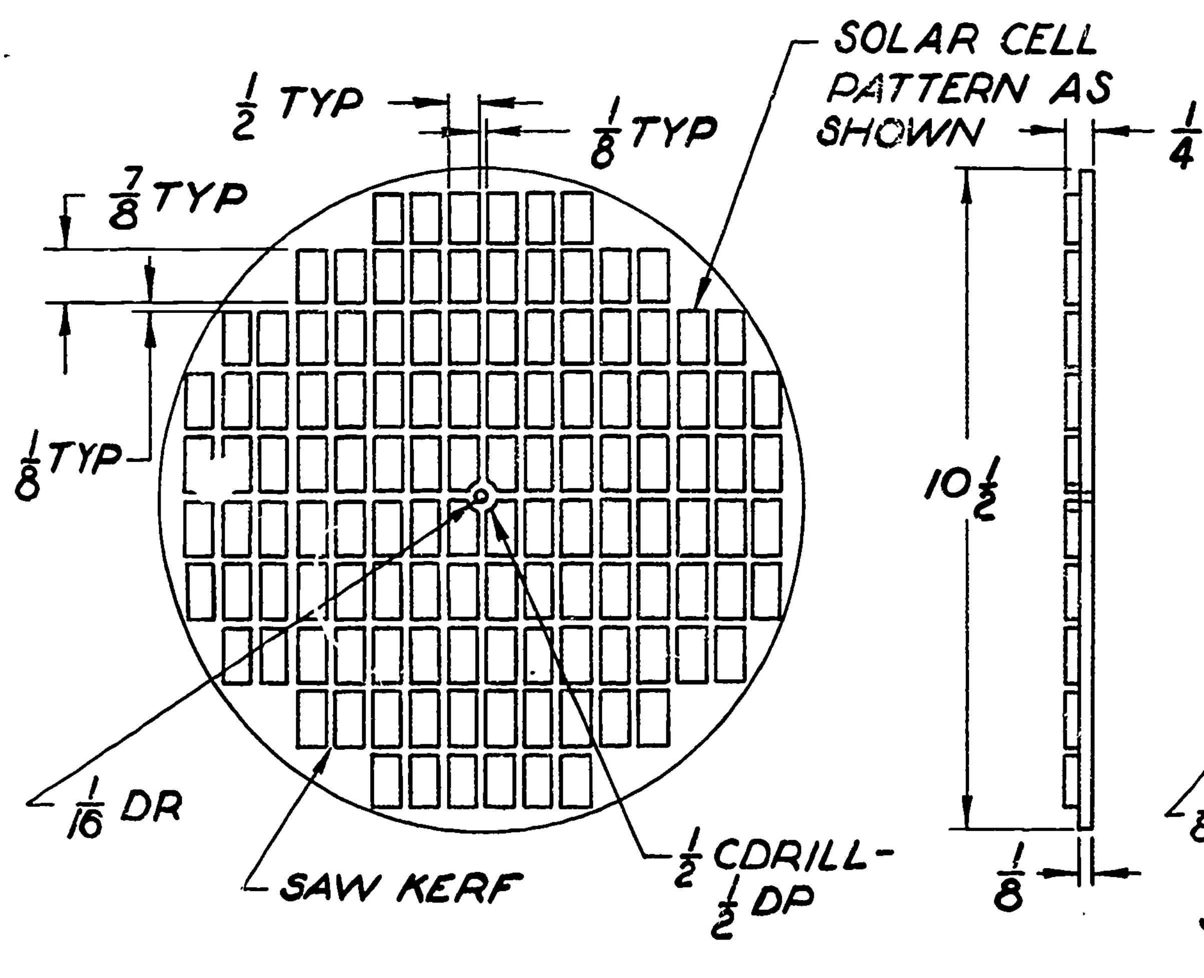

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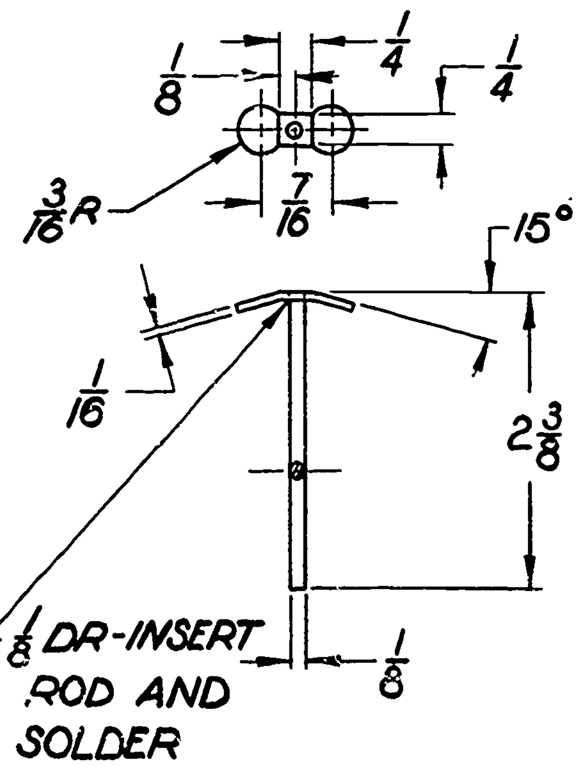

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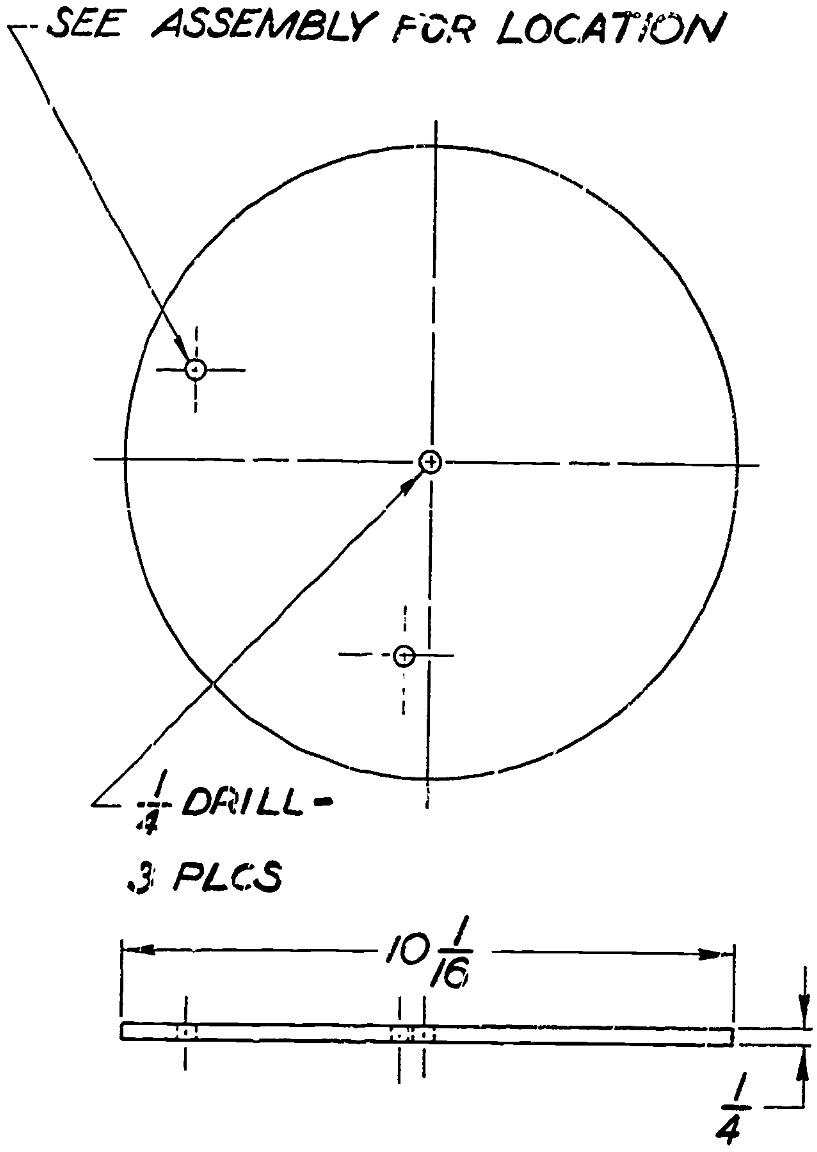

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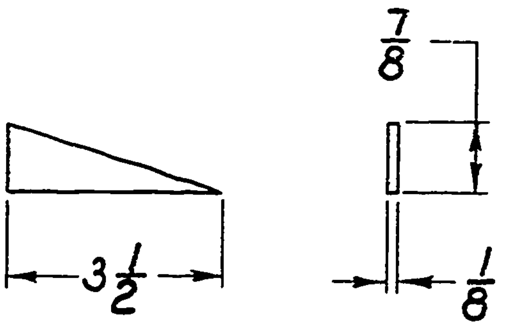

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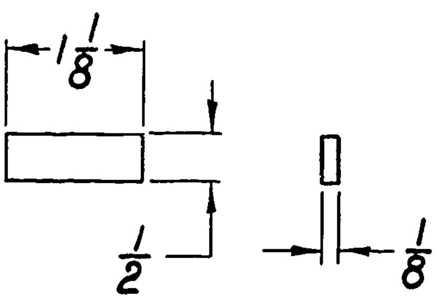

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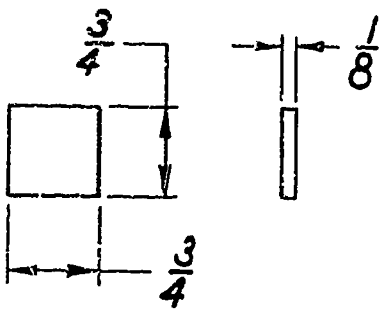

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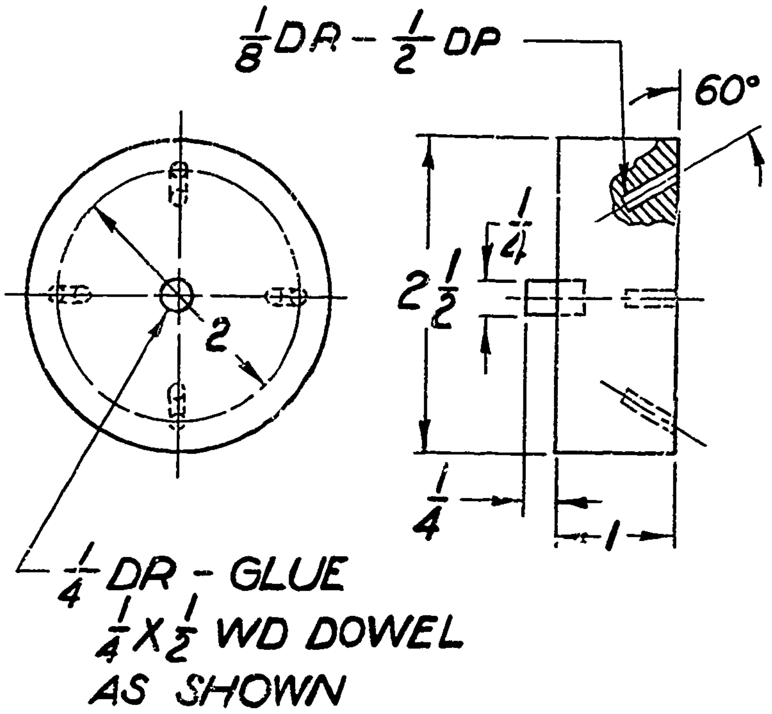
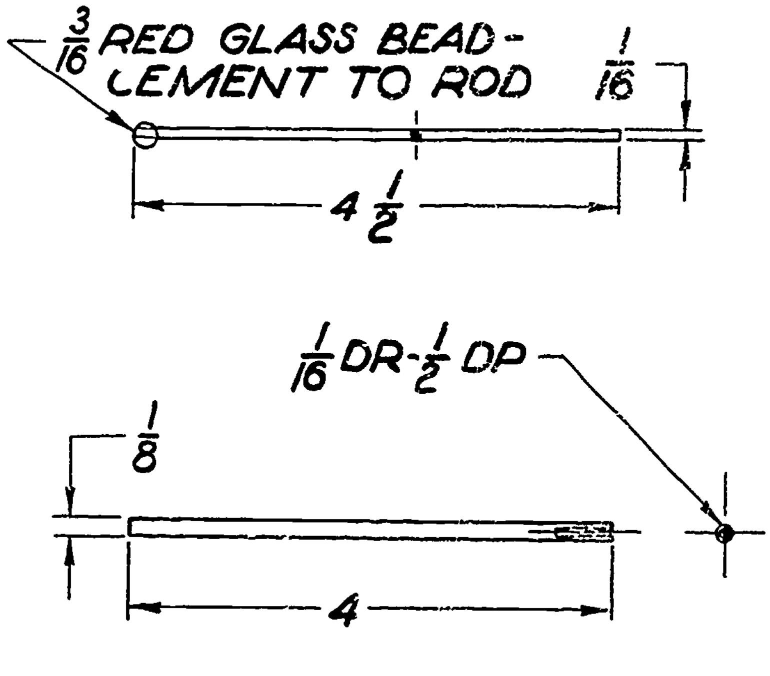


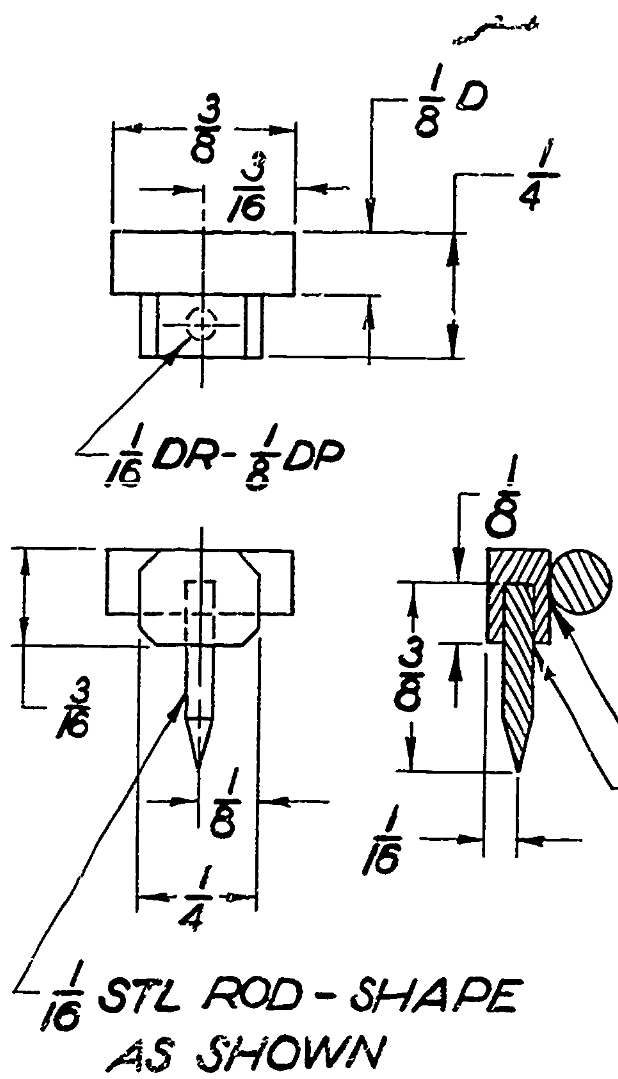
DETAIL NO. 11



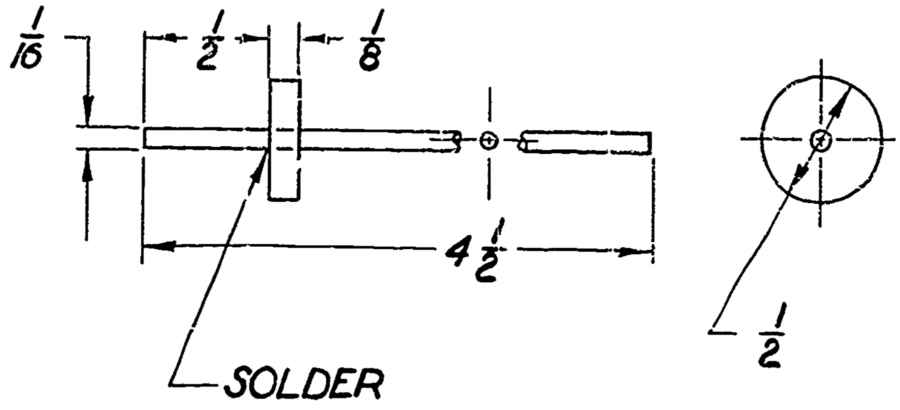
NOTE:

SOLDER PART 11
TOGETHER

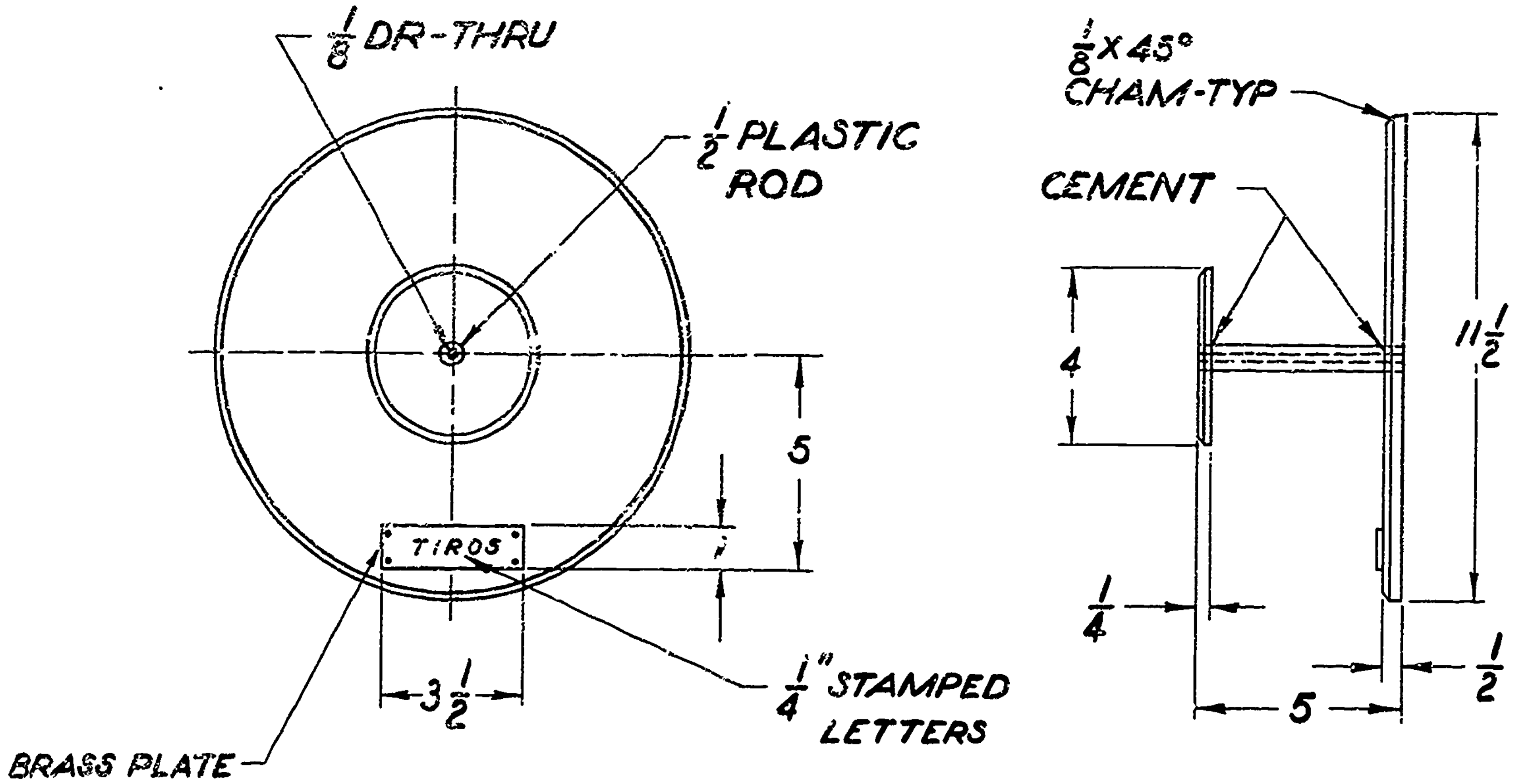
DETAIL NO. 12



DETAIL NO. 13



TIROS STAND



RECOMMENDED MATERIALS FOR CONSTRUCTION

TIROS - WEATHER SATELLITE

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	1	Wood - Pine	Silver
2	1	Wood - Maple	Body-Silver Cells-Black
3	18	Wood - Maple	Black
4	1	Wood - Maple	Silver
5	18	Wood - Balsa	Silver
6	18	Wood - Balsa	Silver
7	18	Wood - Balsa	Silver
8	2	Wood - Maple	Black
9	2	Brass	Polish
10	1	Wood - Maple	Silver
11	4	Brass Welding Rod	Polish
12	18	Steel, Mild	Black
13	1	Steel, Mild	Silver

Note:
Tiros stand to be made of plastic.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

TIROS - WEATHER SATELLITE

PART NUMBER	SUGGESTED MATERIAL	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - Pine	Turn on lathe to specified dimensions. Surface 18 flats.	Sand all surfaces. Paint exposed surfaces silver.	
2	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces.	Paint - Position and glue part 2 to part 1.
3	Wood - Maple	Cut and shape to specified dimensions.	Finish sand all surfaces.	Paint - Position and glue part 3 (18) to part 1.
4	Wood - Maple	Cut to specified dimensions.	Finish sand all surfaces.	Glue part 10 to part 4.
5	Wood - Balsa	Cut to specified dimensions.	Finish sand all surfaces.	Position and glue parts 5 (18) to parts 4 and 10.
6	Wood - Balsa	Cut to specified dimensions.	Finish sand all surfaces.	Position and glue part 6 (18) to part 4.
7	Wood - Balsa	Cut to specified dimensions.	Finish sand all surfaces.	Position and glue part 6 (18) to part 4. Paint parts 4, 5, 6, and 7 silver.

229-357 O-66—11

RECOMMENDED PROCEDURE FOR CONSTRUCTION

TIROS - WEATHER SATELLITE

PART NUMBER	SUGGESTED MATERIAL	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8	Wood - Maple	Turn on lathe to specified dimensions.	Finish sand all surfaces.	Paint black. Glue to part 4.
9	Brass	Cut to specified dimensions.	Polish and lacquer.	Solder two units of part 9 together. Position and secure with epoxy resin.
10	Wood - Maple	Turn on lathe to specified dimensions. Drill as indicated on detail drawing.	Finish sand all surfaces.	Glue to part 4 before securing parts 5, 6, and 7 to part 4.
11	Brass rod	Cut to specified dimensions.	Polish	Solder two units of part 11 together, and glue to part 10.
12	Steel - mild	Cut to specified dimensions.	Use file and emery cloth prior to painting black.	Solder parts of detail 12 together and secure to part 4 with epoxy resin.
13	Steel - mild	Cut to specified dimensions.	Use file and emery cloth prior to painting silver.	Solder two units of part 13 together and secure to part 2 with epoxy resin.

ORBITING ASTRONAUTICAL OBSERVATORY (OAO)

A stairway to the stars has long been a dream of scientists who have studied the heavenly bodies throughout the years. These men, now known as astronomers, had their origin with the first coming of mankind. From the earliest days man has raised his eyes to the skies and studied the twinkling bodies that seemed to hang loosely in space.

Few years pass without some new star, planet, or galaxy being discovered. Yet, even with this, the scientists realize that they are merely seeing the bare fringes of the total universe.

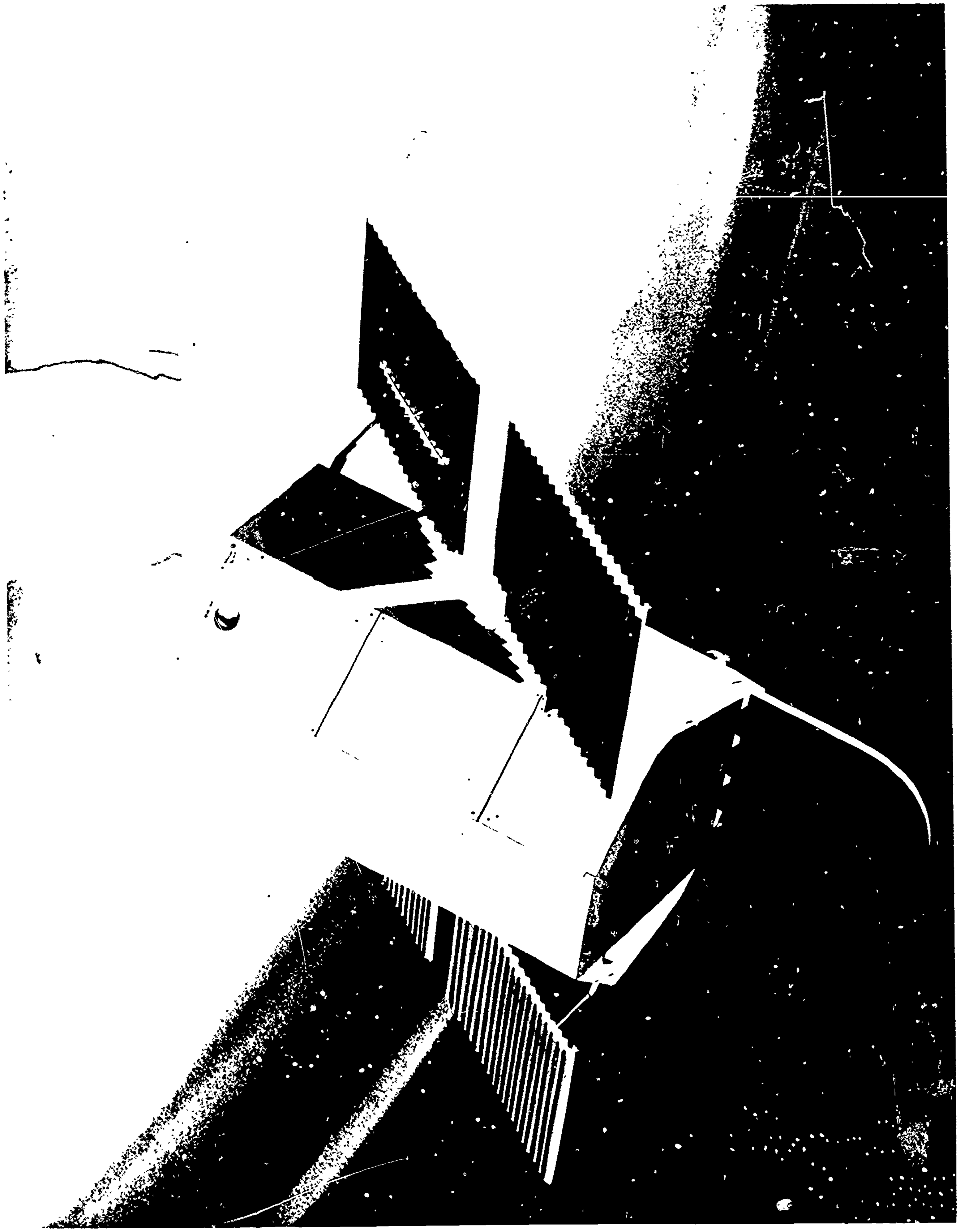
Years of research and development have resulted in a broad array of complex optical instruments designed specifically to study the unknowns of the skies. However, there are many obstacles which hinder man's attaining maximum results from the earth's surface.

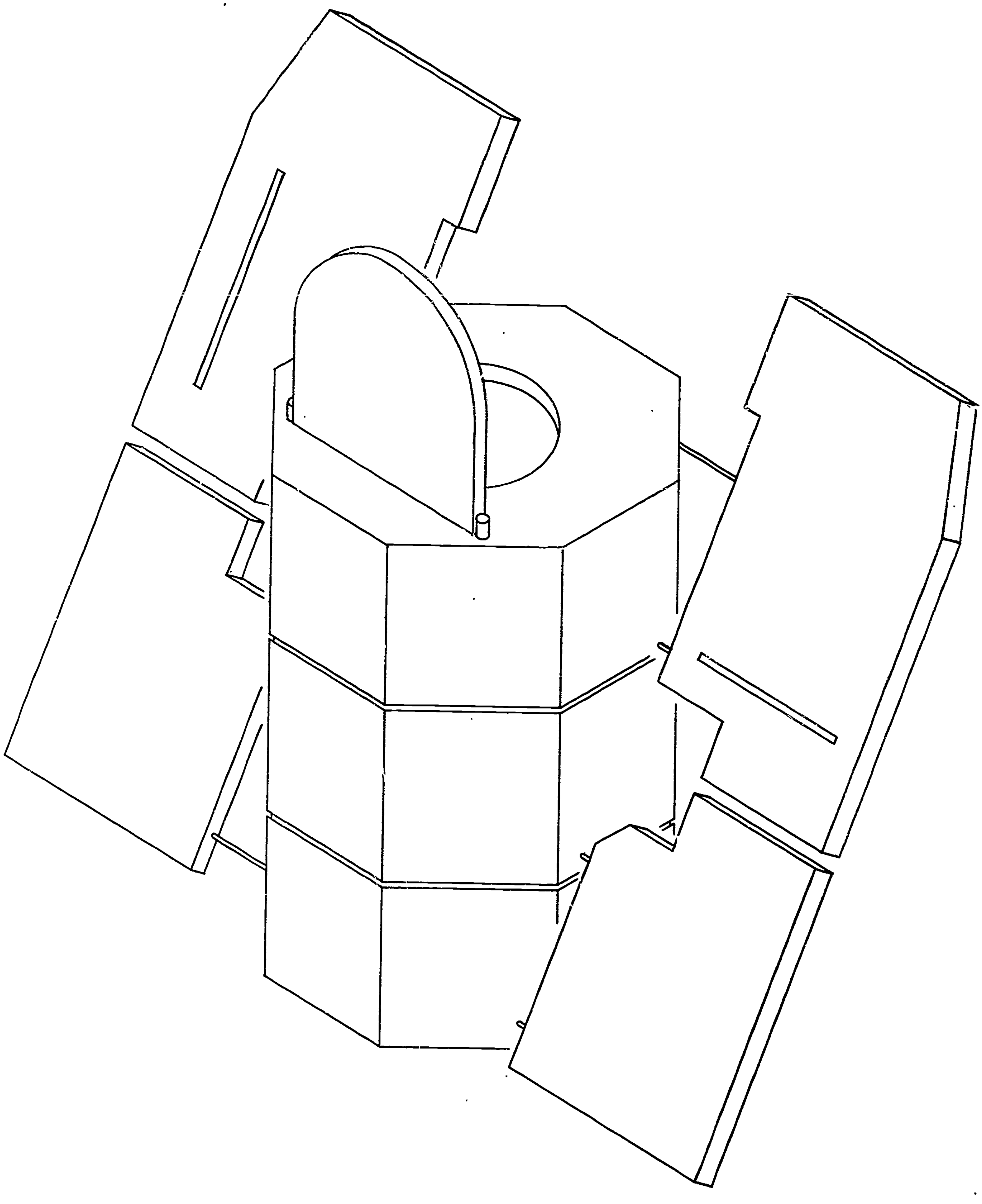
Shortly after the launching of Sputnik I by the Russians in 1957, Dr. Lloyd V. Berkner, Chairman of the Space Science Board of the National Acadamy of Science, requested 200 United States scientists to provide him with details of information to be procured by a satellite in space with a 100 pound payload. This was the origination of the idea that led to the development of the Orbiting Astronautical Observatory.

Some device had to be developed to permit mankind to look into the non-visible spectral regions. In 1960 final specifications were prepared and circulated to industry and a prime contractor was selected. At the present time several types of standardized satellites are being developed, including the orbiting solar, astronomical and geophysical observatories.

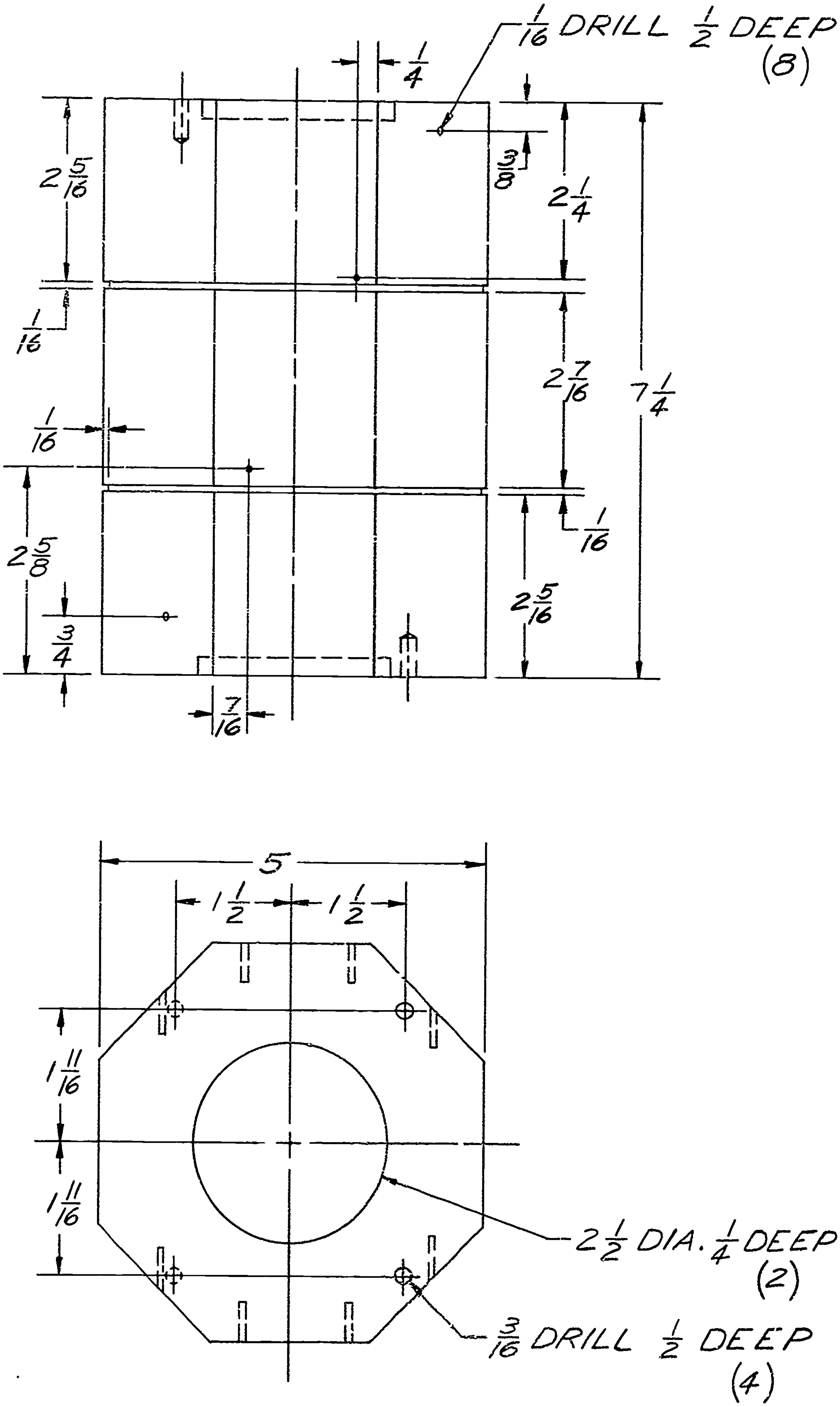
The Orbiting Astronomical Observatory will be a precisely stabilized 3900 pound satellite in a circular orbit about 475 miles above the earth's surface. It will carry about 1000 pounds of experimental equipment such as telescopes, spectrometers, and photometers. The specialized scientific equipment will be furnished by leading astronomers throughout the United States.

The twinkling stars and other heavenly bodies are soon to be brought much closer into man's realm for observation. The mere feat of developing a platform stable enough to scientifically study these bodies is a marvel of the age. Man is only beginning to touch the edges of this unknown portion of the universe and will only accomplish this through such space probes as will be made possible by the Orbiting Astronomical Observatory. In time the stars' secrets will also be man's secret. This information will enable man to better understand space and delve further into its mysteries.



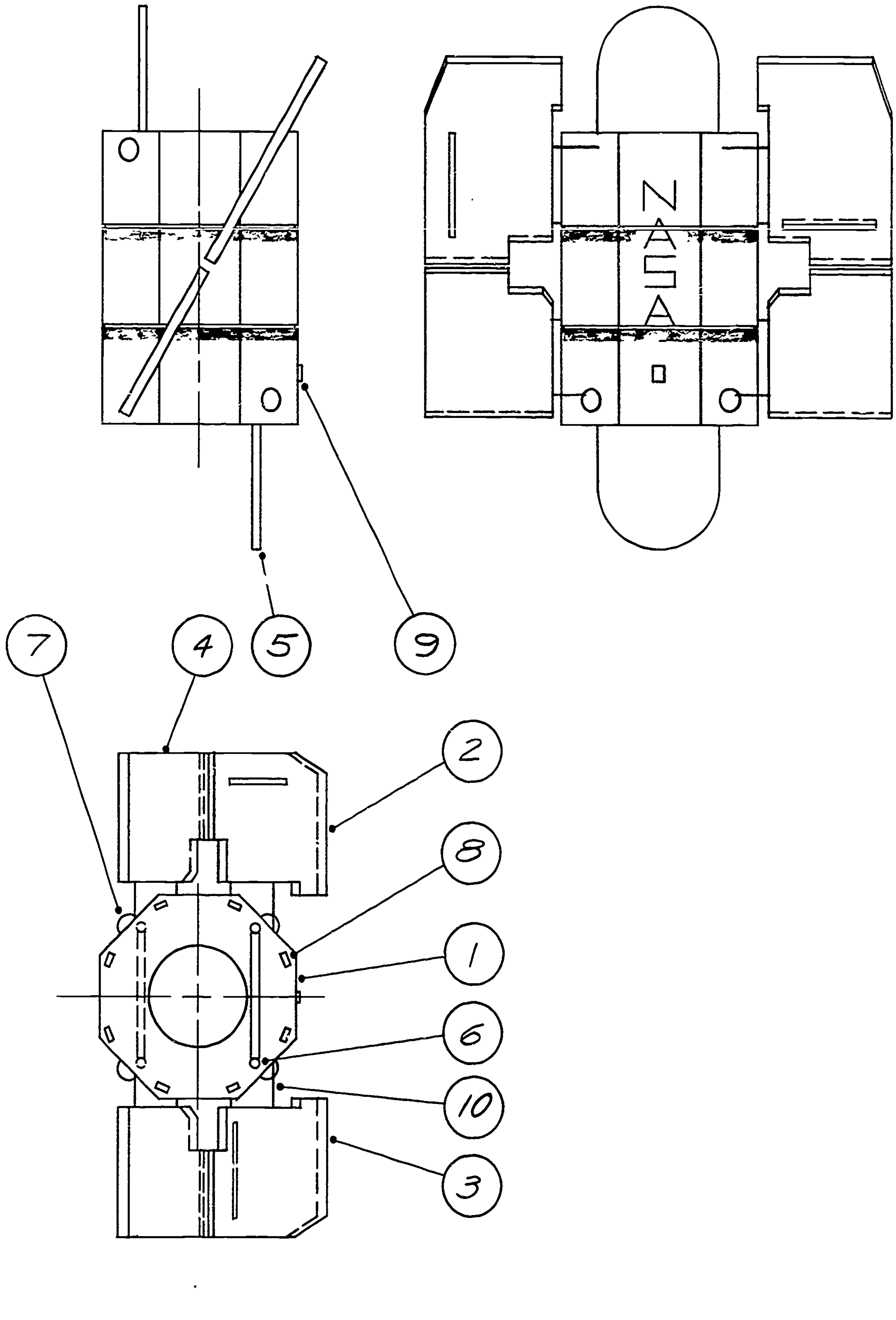


(1-A) ORBITING ASTRONOMICAL OBSERVATORY (OAO)

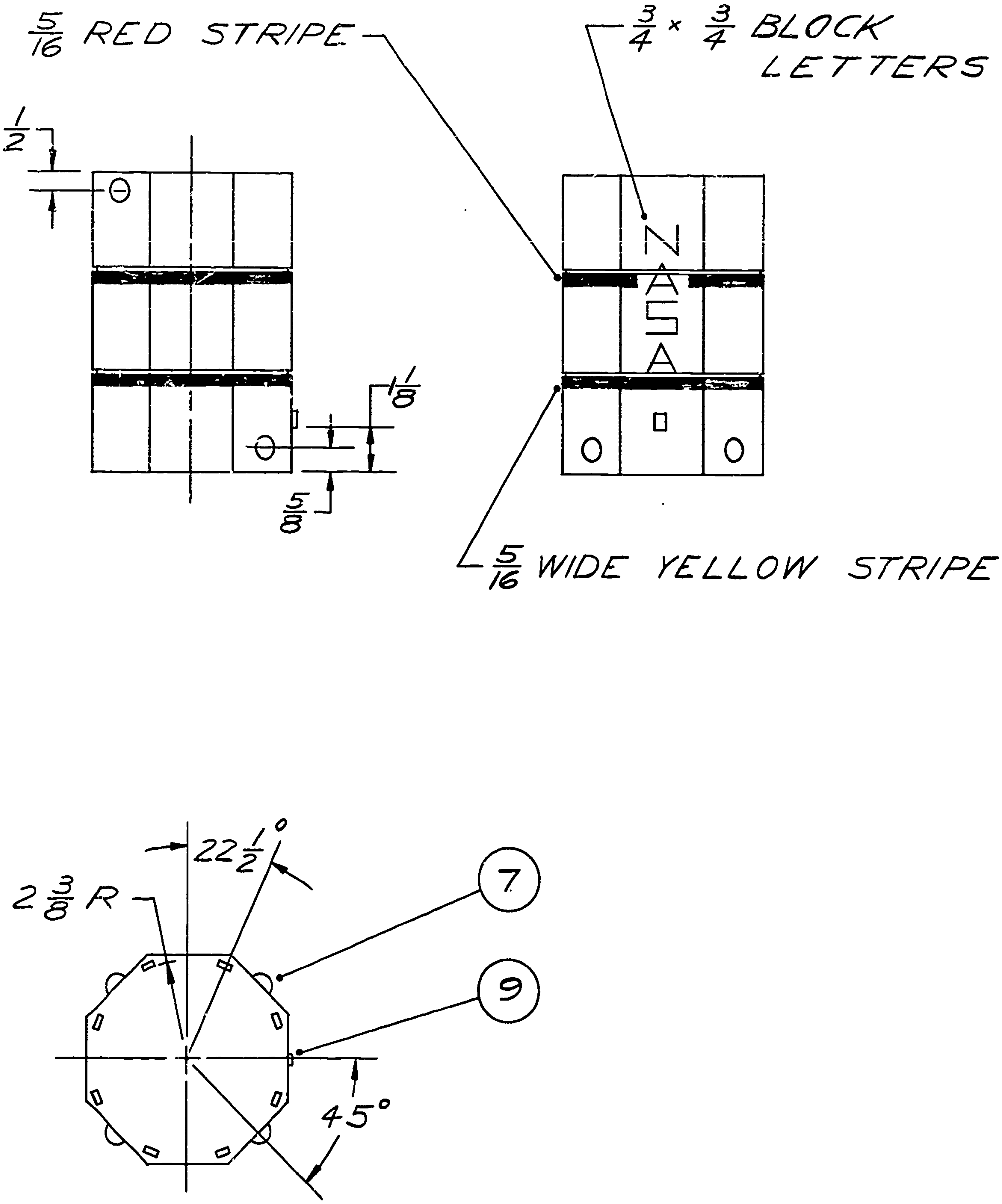


1/16 DRILL 1/2 DEEP (8)
1/4
2 5/16
3/8
2 1/4
1/16
2 7/16
7 1/4
1/16
2 5/8
1/16
2 5/16
3/4
7/16
5
1 1/2
1 1/2
1 11/16
1 11/16
2 1/2 DIA. 1/4 DEEP (2)
3/16 DRILL 1/2 DEEP (4)

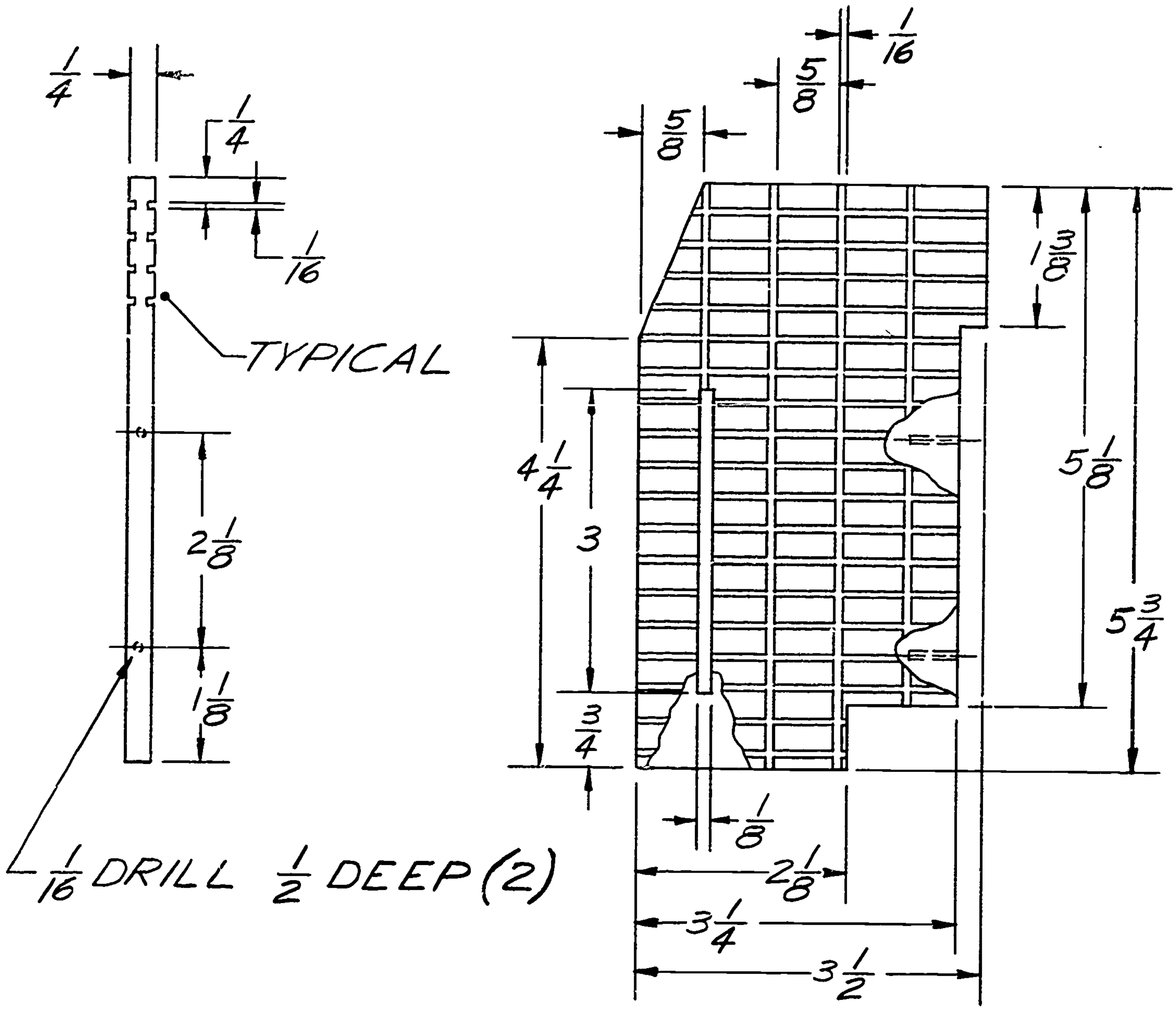
(1) 1-REQ'D.



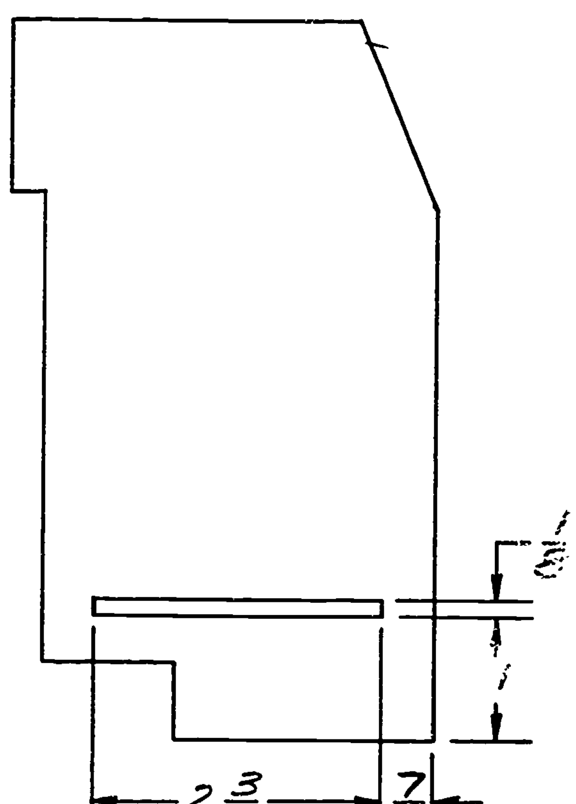
2-A OAO


5/16 RED STRIPE
3/4 × 3/4 BLOCK LETTERS
1/2
NASA
1 1/8
5/8
5/16 WIDE YELLOW STRIPE
22 1/2°
2 3/8 R
7
9
45°

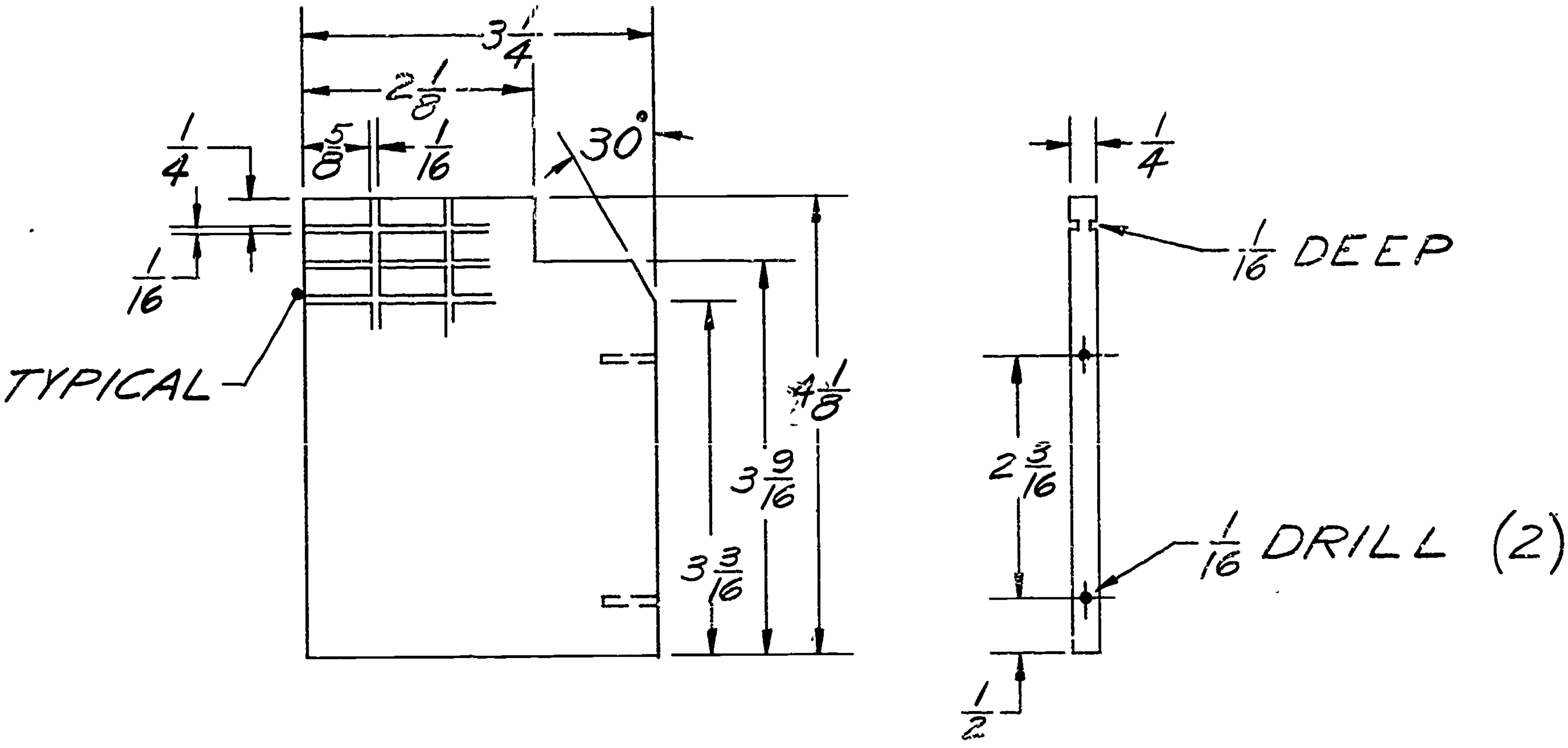
3-A



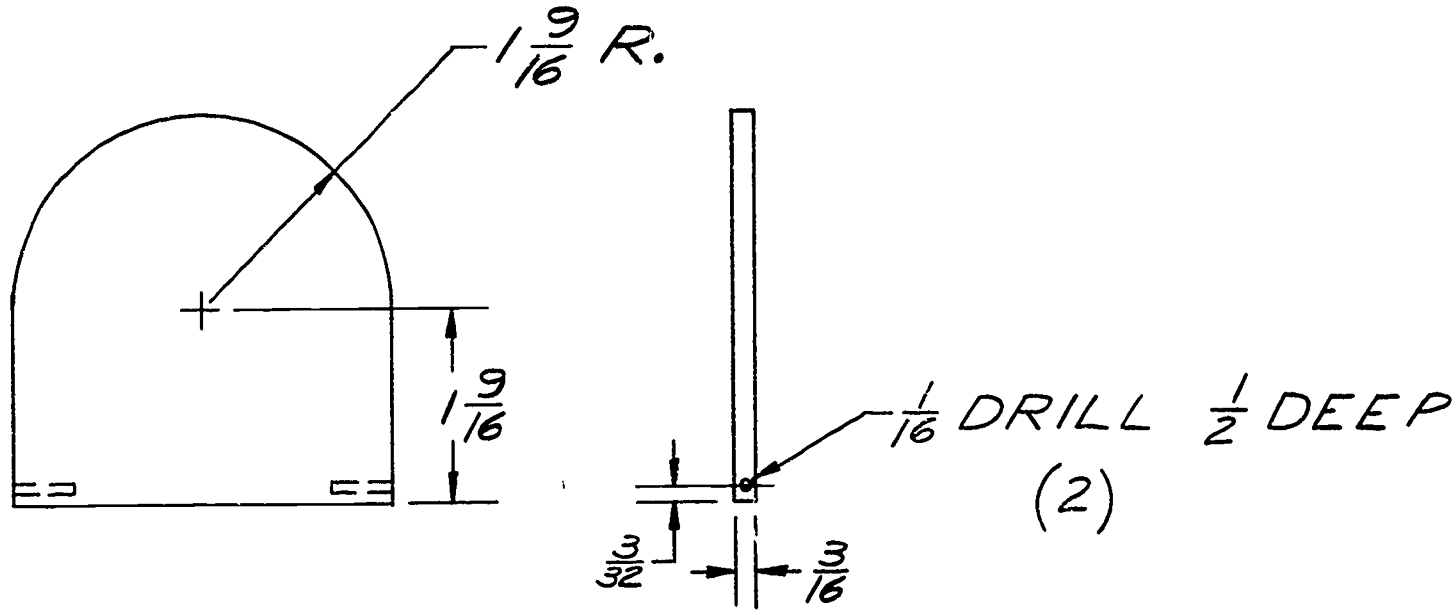
(2) 1-REQ'D.



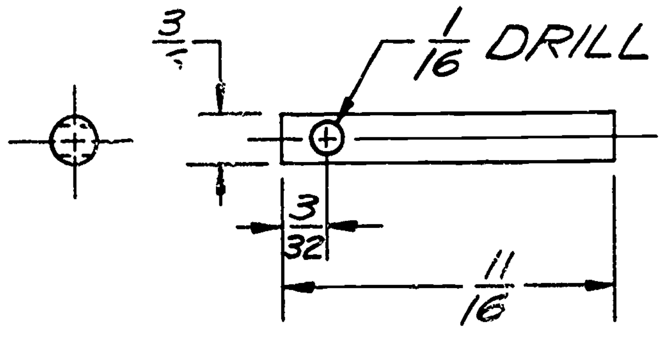
(3) 1-REQ'D. OTHERWISE THE SAME AS DETAIL #2



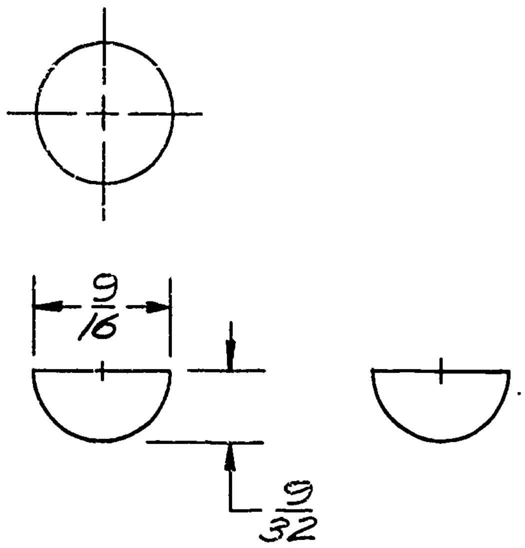
(4) 2-REQ'D.



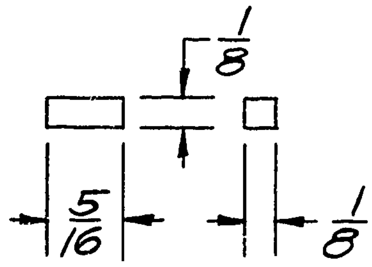
(5) 2-REQ'D.



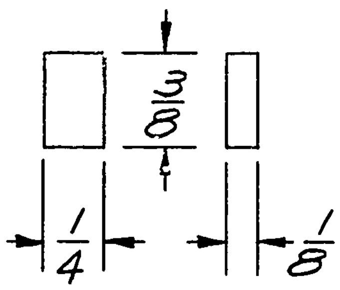
(6) 4-REQ'D. 4X



(7) 4-REQ'D 2X



(8) 8-REQ'D. 2X



(9) 1-REQ 2X

RECOMMENDED MATERIALS FOR CONSTRUCTION

ORBITING ASTRONOMICAL OBSERVATORY

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	1	Wood - pine	White
2	1	Wood - hard	Purple
3	1	Wood - hard	Purple
4	2	Wood - hard	Purple
5	2	Wood - hard	Silver
6	4	Drill Rod	Silver
7	4	Wood - balsa, fiber, or plastic	Light Blue
8	8	Wood - balsa, fiber, or plastic	Black
9	1	Wood - balsa, fiber, or plastic	Black
10	8	1/16 diameter brazing rod	Natural

RECOMMENDED PROCEDURE FOR CONSTRUCTION

ORBITING ASTRONOMICAL OBSERVATORY

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - pine	Construct octagon body to specified dimensions. Drill as per detailed drawing.	Finish sand all surfaces. Paint white.	
2	Wood - hard	Construct to specified dimensions.	Finish sand all surfaces and paint purple.	
3	Wood - hard	Construct to specified dimensions.	Finish sand all surfaces and paint purple.	
4	Wood - hard	Construct to specified dimensions.	Finish sand all surfaces and paint purple.	
5	Wood - hard	Construct to specified dimensions.	Finish sand all surfaces and paint silver.	
6	Drill Rod	Construct to specified dimensions.	Paint silver.	Assemble part no. 6 to part no. 1. Assemble part no. 5 between part no. 6 with 1/16 brazing rod.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

ORBITING ASTRONOMICAL OBSERVATORY

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
7	Wood - balsa, fiber, or plastic	Construct to specified dimensions.	Finish sand all surfaces and paint light blue.	Assemble part no. 7 to part no. 1 with epoxy resin.
8	Wood - balsa, fiber, or plastic	Construct to specified dimensions.	Finish sand all surfaces and paint black.	Assemble parts no. 8 to part no. 1 with epoxy resin.
9	Wood - balsa, fiber, or plastic	Construct to specified dimensions.	Finish sand all surfaces and paint black.	Assemble part no. 9 to part no. 1 with epoxy resin.
10	1/16 diameter brazing rod	Cut 8 pieces to desired length.	Lacquer all pieces.	Assemble two no. 10's in parts no. 2, 3, and 4 using epoxy resin. Assemble parts no. 2, 3, and 4 to part no. 1 using epoxy resin.

LUNAR MODULE (LM)

229-357 O-66—12

The initial giant step on the road to the moon was taken May 5, 1961, when Astronaut Alan Shepard was powered into a suborbital flight aboard a one-man Mercury spacecraft that took him into the fringes of space. This momentous flight was followed by other suborbital and orbital Mercury flights which set the stage for the two-man Gemini.

Flights in the Gemini program have been highlighted by such exploits as the 220 orbit mission; the "space walk" by Astronaut Ed White; the first rendezvous with another spacecraft, and the first docking in space. These accomplishments have done much to advance the next major space project which ill be the Apollo program.

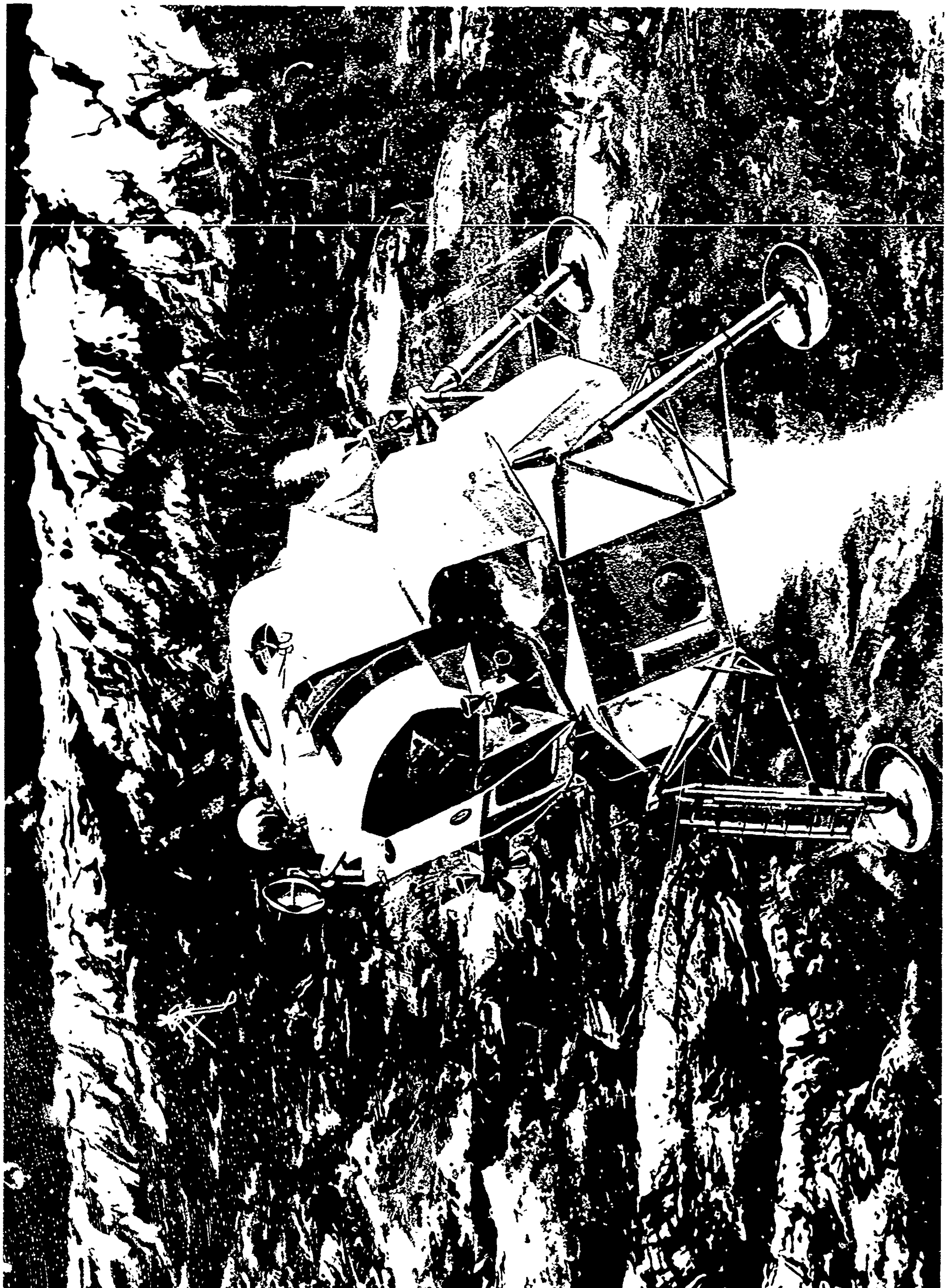
The Apollo project dates from 1963 and is one of the largest ventures ever undertaken by this country. Included within this giant government/aerospace industry team are more than 20,000 companies and 300,000 persons who are devoting their engineering and manufacturing skills to the successful completion of the moon mission.

The spacecraft designed to accomplish this mission consists of three modules which include the Apollo spacecraft's Command Module, a Service Module and the Lunar Module. The spacecraft will carry three astronauts in the Command Module; two of them will descend to the moon's surface.

Upon approaching the moon, the spacecraft must achieve a lunar orbit at which time two astronauts will transfer to the Lunar Module and detach from the Command Module. They will then use one of the two engines to land on the lunar surface.

The time has arrived to thoroughly disprove many of the original concepts regarding the moon's surface. Upon completion of their scientific investigation the two astronauts will return to the Lunar Module and launch themselves from the moon by using the second engine.

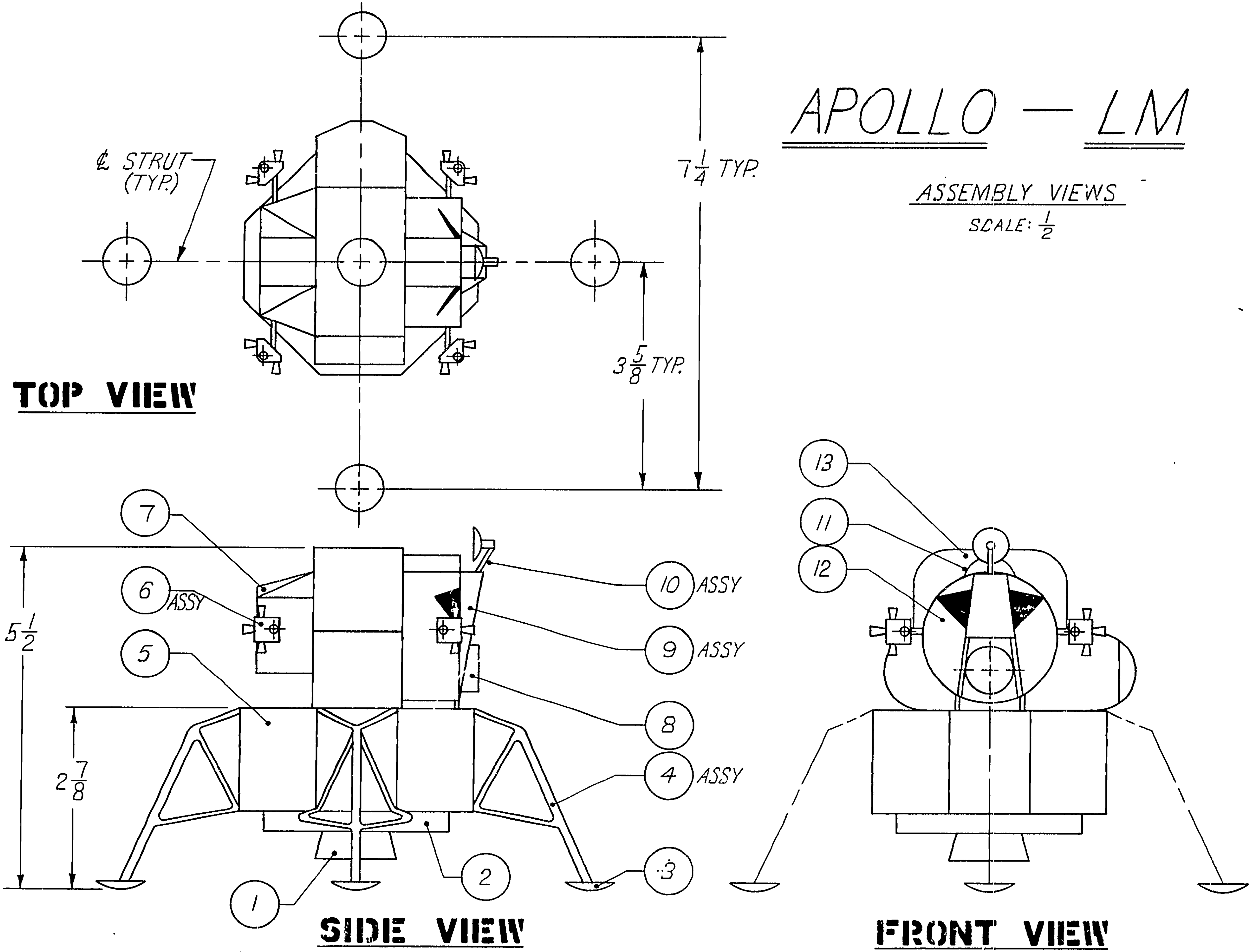
The LM will rendezvous with the Command Module which is still circling the moon about eighty miles above its surface. When the two vehicles are joined, the two men will rejoin the third in the Command Module. The Lunar Module will then be dropped off in the lunar orbit and the return to earth will begin in the Command Module.

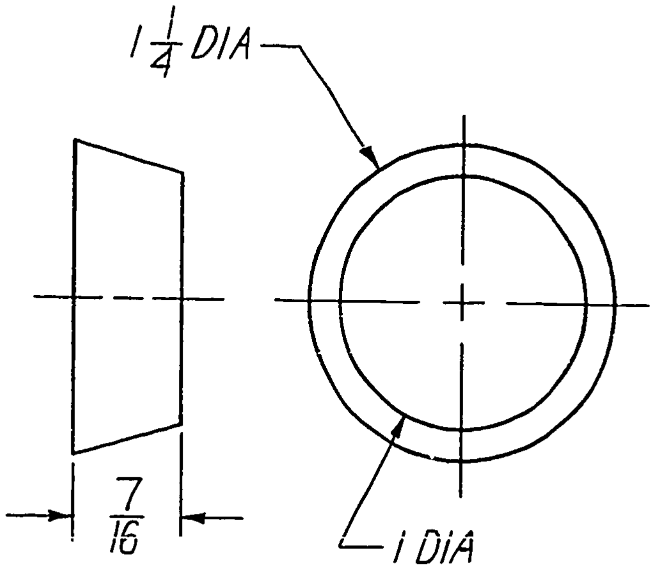


APOLLO — LM

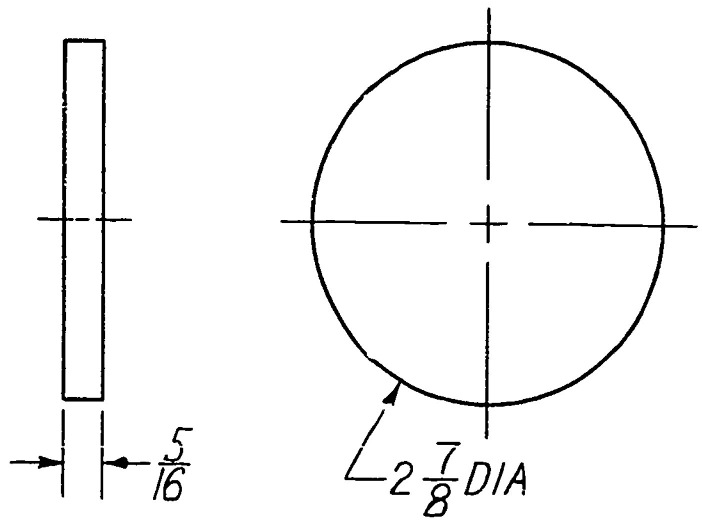
ASSEMBLY VIEWS

SCALE: 1/2

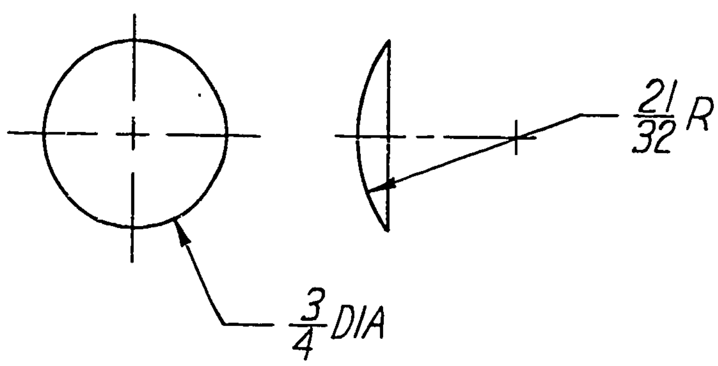




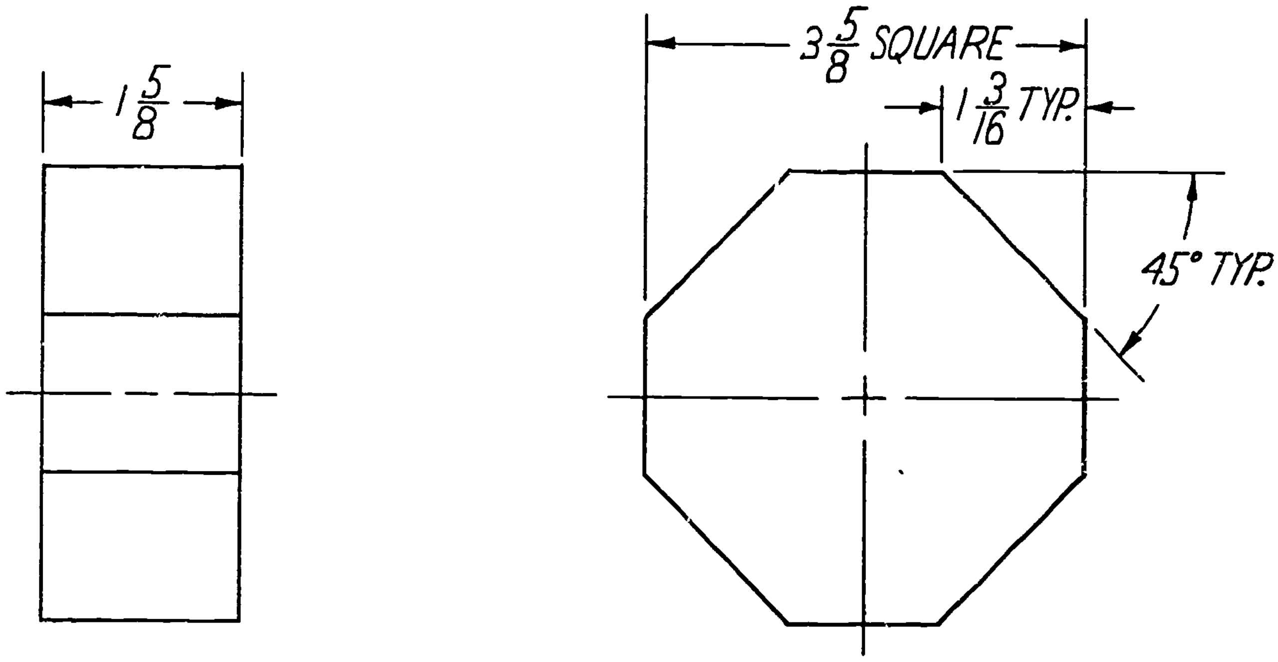
(1) ENGINE — 1 REQ'D
SCALE: 1/1



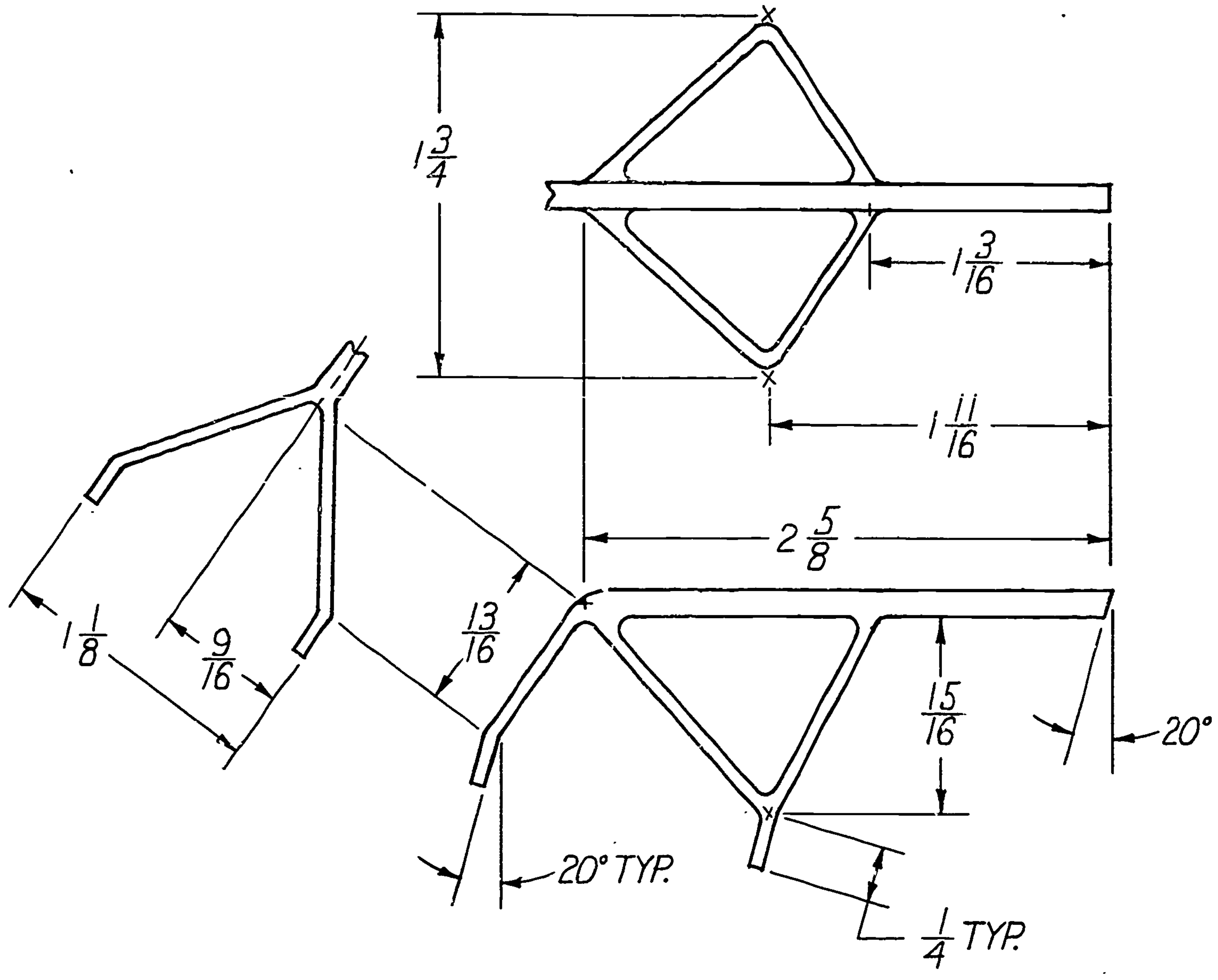
(2) HEAT SHIELD — 1 REQ'D
SCALE: 1/2



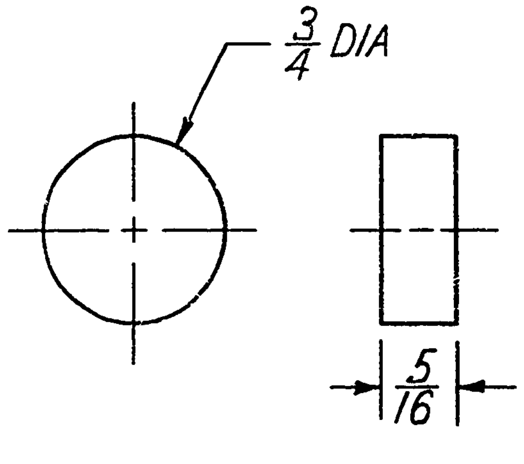
(3) LANDING PAD — 4 REQ'D
SCALE: 1/1



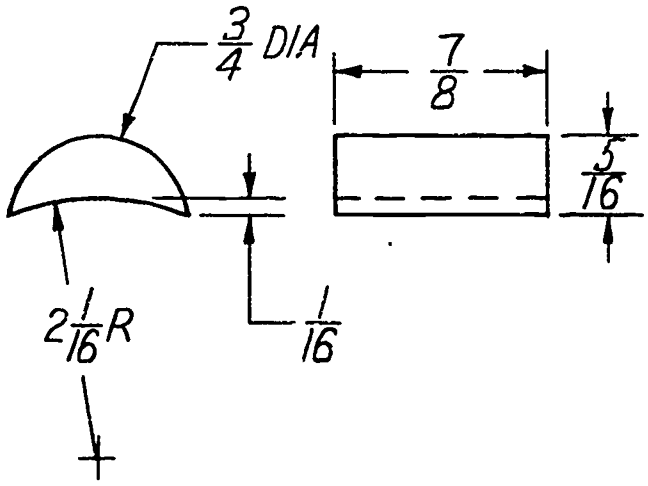
(5) ENGINE HOUSING — 1 REQ'D.
SCALE: 1/2



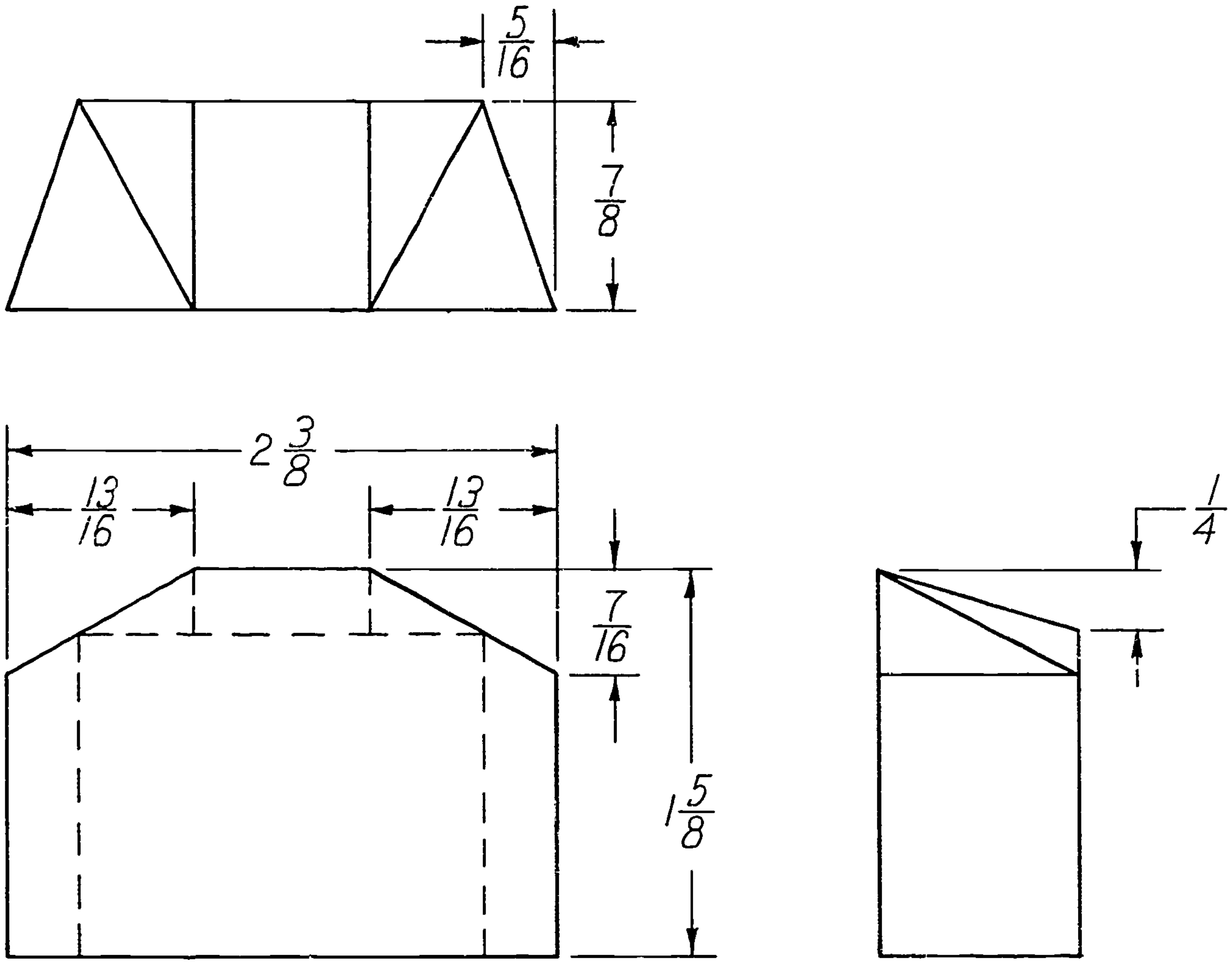
(4) ASSY — LANDING GEAR — 4 REQ'D
SCALE: 1/1



(8) DOCKING TUNNEL — 1 REQ'D
SCALE: 1/1

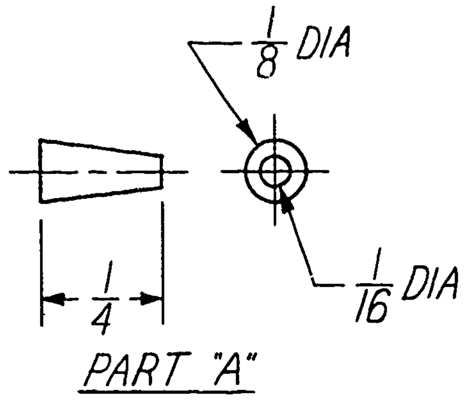


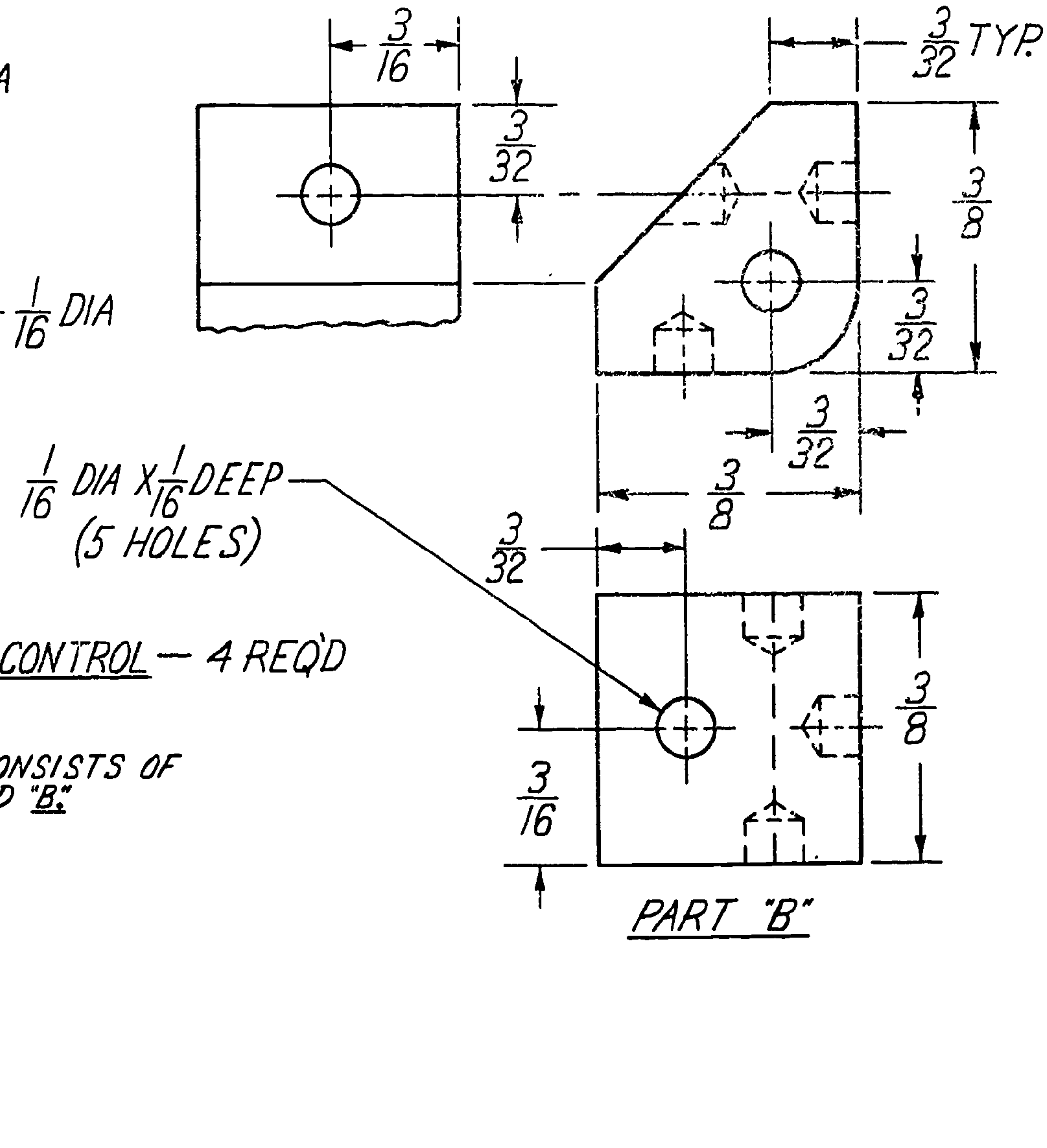
(11) HOUSING, RADAR EQUIPMENT— 1 REQ'D
SCALE: 1/1



(7) FUEL STORAGE COMPARTMENT — 1 REQ'D

SCALE: 1/1

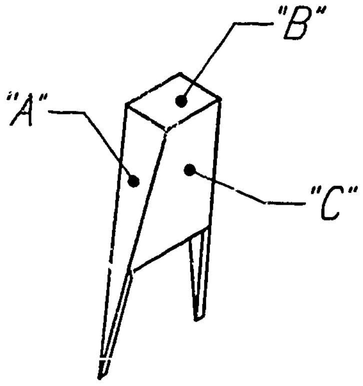


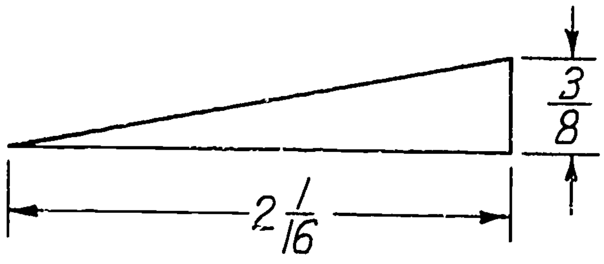


(6) ASSY — REACTOR CONTROL — 4 REQ'D

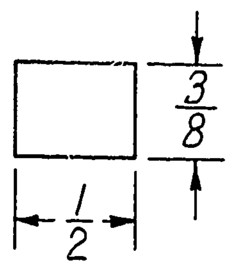
SCALE: NONE

NOTE: ASSEMBLY CONSISTS OF PARTS "A" AND "B."



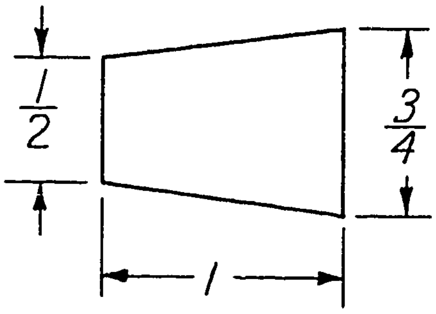


PART "A" — 2 REQ'D
SCALE: 1/1

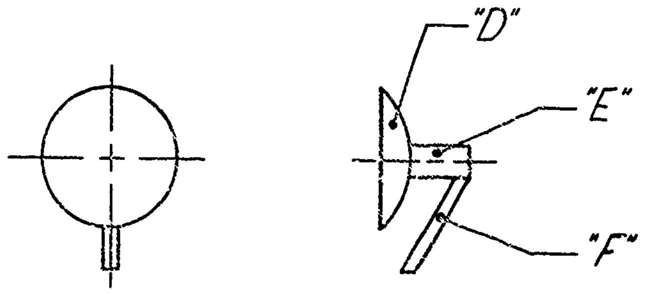


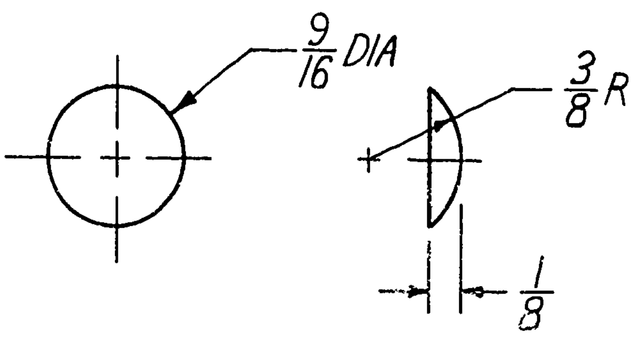
PART "B" — 1 REQ'D
SCALE: 1/1

(9) ASSY — EQUIPMENT SHIELD — 1 REQ'D
SCALE: NOTED
NOTE: ASSEMBLY CONSISTS OF:
PART "A"
PART "B" — SHOWN AT RIGHT
PART "C"
✳ ALL PARTS ARE 1/16 THICK



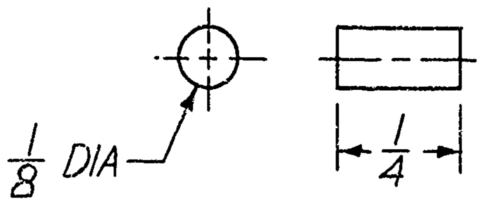
PART "C" — 1 REQ'D
SCALE: 1/1



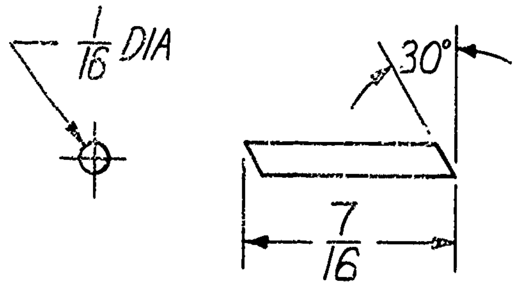


PART "D" — SCALE: 1/1

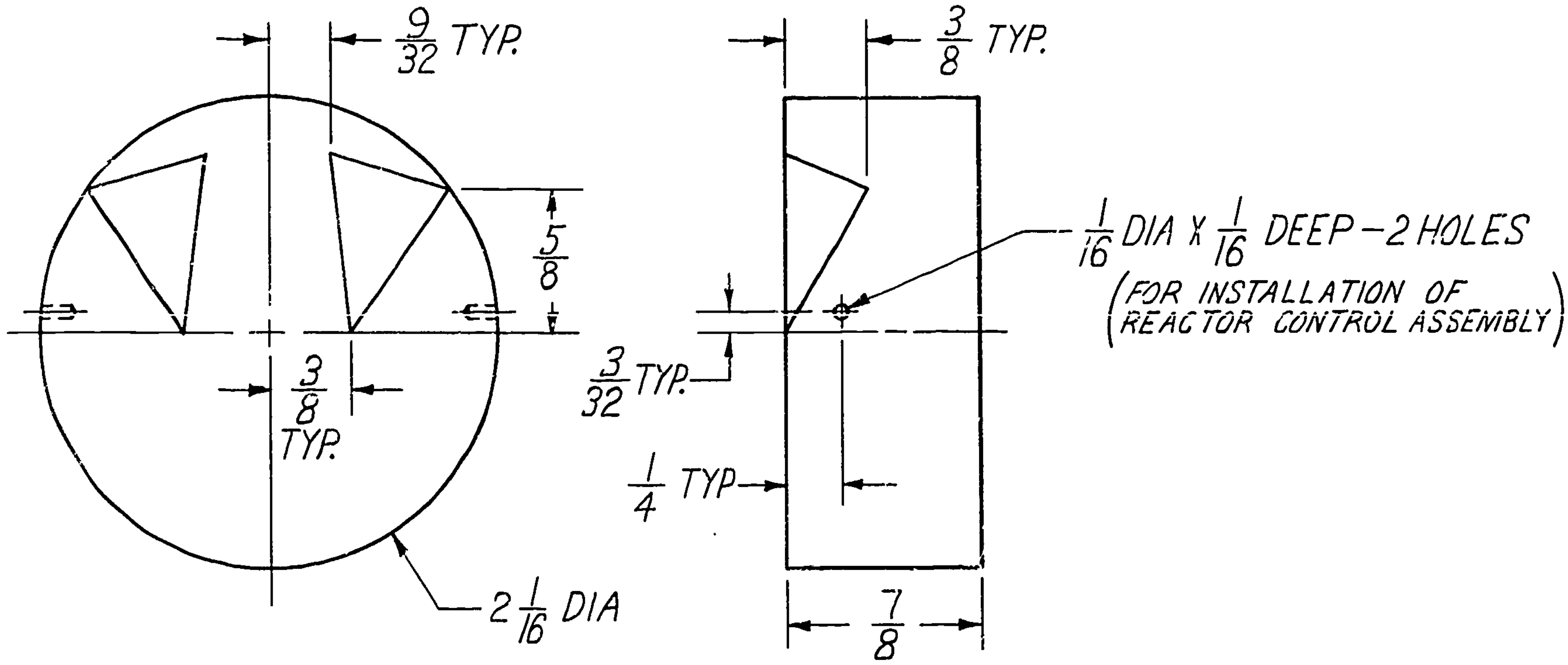
(10) ASSY — RADAR ANTENNA — 1 REQ'D
SCALE: NOTED
NOTE: ASSEMBLY CONSISTS OF:
PART "D"
PART "E" — SHOWN AT RIGHT
PART "F"



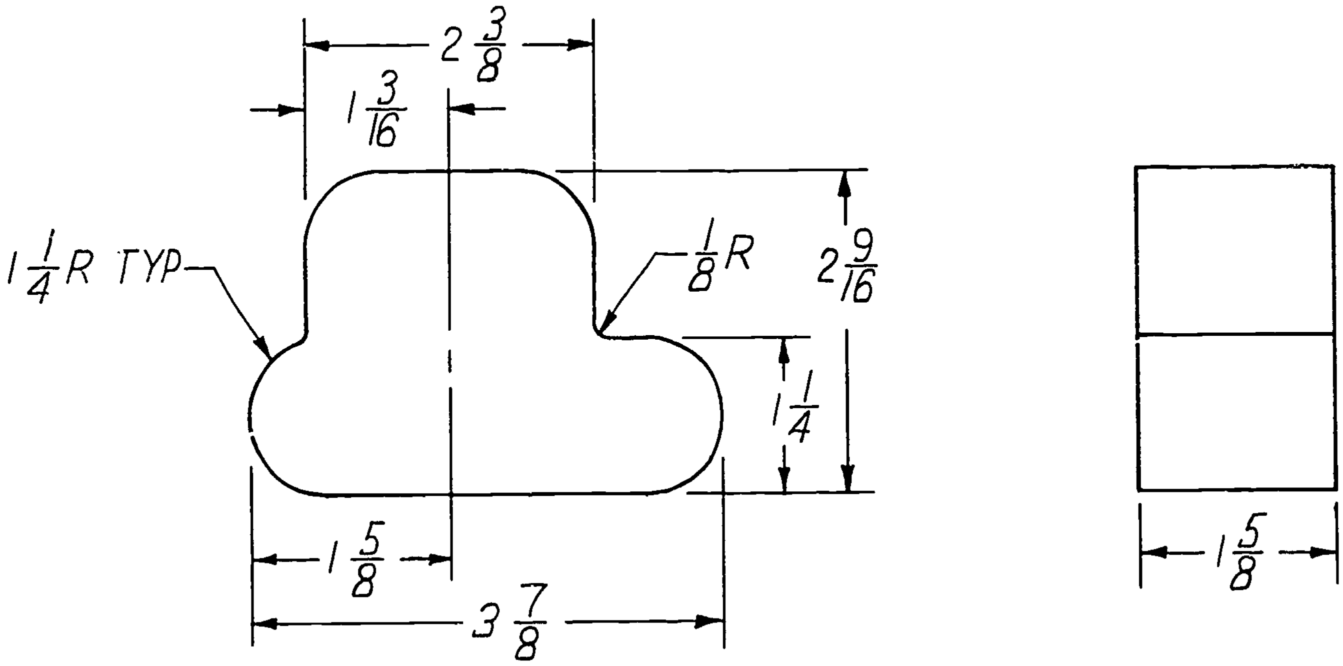
PART "E" — SCALE: 2/1



PART "F" — SCALE: 2/1



(12) CABIN — 1 REQ'D
SCALE: 1/1



(13) MAIN BODY — 1 REQ'D
SCALE: 1/2

RECOMMENDED MATERIALS FOR CONSTRUCTION

APOLLO - LUNAR MODULE

PART NUMBER	NUMBER REQUIRED	RECOMMENDED MATERIAL	COLOR
1	1	Wood - Pine	Black
2	1	Wood - Pine	Black
3	4	Wood - Pine	White
4 Assy	4	Metal brazing rod	Silver
5	1	Wood - Pine	White
6 Assy	4	Wood - Pine	Black
7	1	Wood - Pine	White
8	1	Wood - Doweling	White
9 Assy	1	Wood - Pine	White
10 Assy	1	Wood - Pine	Black
11	1	Wood - Pine	White
12	1	Wood - Pine	White
13	1	Wood - Pine	White

RECOMMENDED PROCEDURE FOR CONSTRUCTION

APOLLO - LUNAR MODULE

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
1	Wood - Pine	Cut to length and turn to specified dimensions.	Finish sand.	
2	Wood - Pine	Cut to thickness. File to specified diameter.	Finish sand.	Glue part 1 to part 2 with epoxy resin. Paint assembly black.
3	Wood - Pine	Cut to thickness. File to specified diameter.	Finish sand. Paint white.	
4 Assy	Metal, 1/8 and 1/16 diameter brazing rod.	Cut rods to lengths. Form necessary rods and braze together. Use detail drawing for pattern.	Clean. Paint Black.	
5	Wood - Pine	Cut to thickness. Shape to specified dimensions.	Finish sand. Paint white.	
6 Assy	Wood - Pine("B") Wood - 1/8 diameter dowel ("A")	Cut parts "A" and "B" to specified dimensions. Drill holes in "B"	Finish sand.	Glue part "A" to part "B" with epoxy cement. Paint assembly black.
7	Wood - Pine	Cut to specified dimensions.	Finish sand.	

RECOMMENDED PROCEDURE FOR CONSTRUCTION

APOLLO - LUNAR MODULE

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
8	Wood - 3/4 diameter dowel	Cut to length.	Finish sand.	
9 Assy	Wood - Pine	Cut all parts to specified dimensions.	Finish sand after assembly.	Glue parts "A", "B", and "C" together using epoxy cement.
10 Assy	Wood - Pine ("D") Wood - 1/8 diameter dowel ("E") Wood - 1/16 diameter dowel ("F")	Cut parts "D", "E", and "F" to specified dimensions.	Finish sand after assembly.	Glue parts "D", "E", and "F" together using epoxy cement. Paint assembly black.
11	Wood - Pine	Cut and radius to specified dimensions.	Finish sand.	
12	Wood - Pine	Cut to specified thickness and diameter. Make cut-outs (windows) with wood chisel.	Finish sand.	Glue parts 8, 9, and 11 to part 12 using epoxy cement.

RECOMMENDED PROCEDURE FOR CONSTRUCTION

APOLLO - LUNAR MODULE

PART NUMBER	SUGGESTED MATERIALS	FABRICATION TECHNIQUE	SURFACE TREATMENT	ASSEMBLY RECOMMENDATIONS
13	Wood - Pine	Cut to thickness and shape per specified dimensions.	Finish sand.	Glue parts 5, 7, and 12 to part 13. Paint assembly white.
				Drill 1/16 diameter holes in parts 7 and 12 and install part 6 assy with epoxy cement.
				Paint cutouts in part 12 black.
				Glue part 10 assy to part 9 assy with epoxy cement.
				Glue part 2 to bottom of part 5 with epoxy cement.
				Glue part 3 to part 4 assy with epoxy cement.
		**CAUTION - Check levelness of model prior to gluing of landing pads to landing struts.		Drill 1/16 diameter holes in part 5 and glue part 4 to part 5 with epoxy cement.

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