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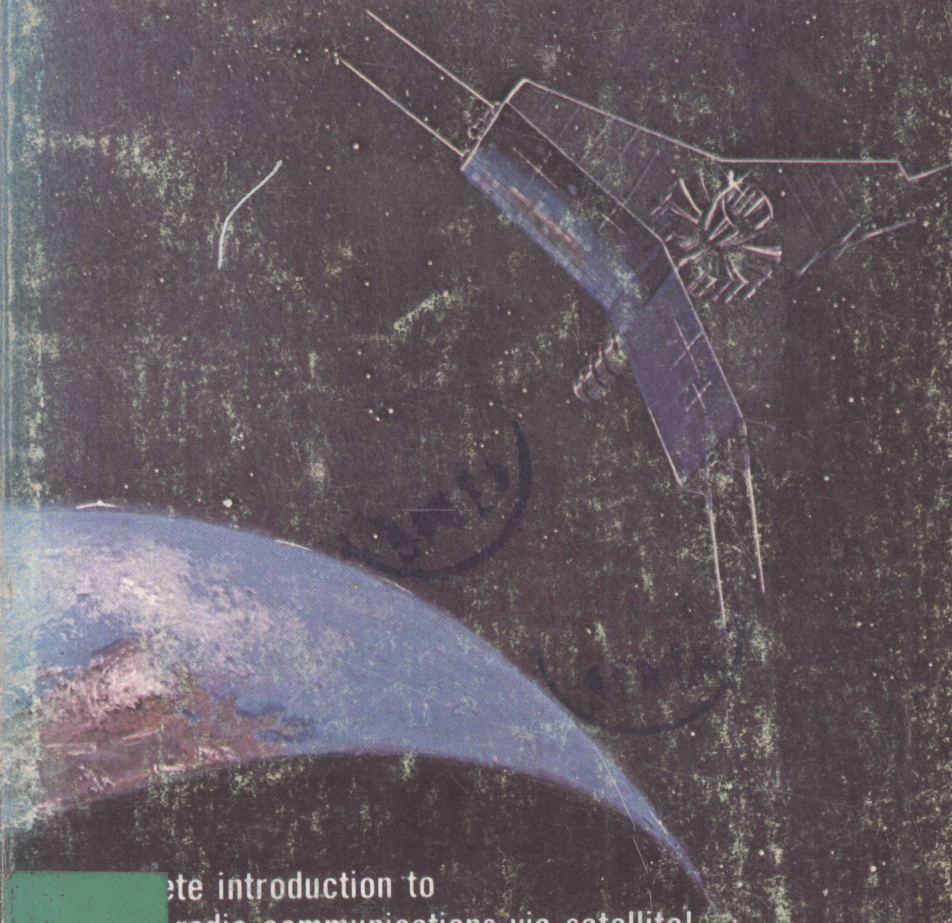

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radio communications via satellite!

ave Ingram, K4TWJ

OSCAR:
The Ham Radio Satellites

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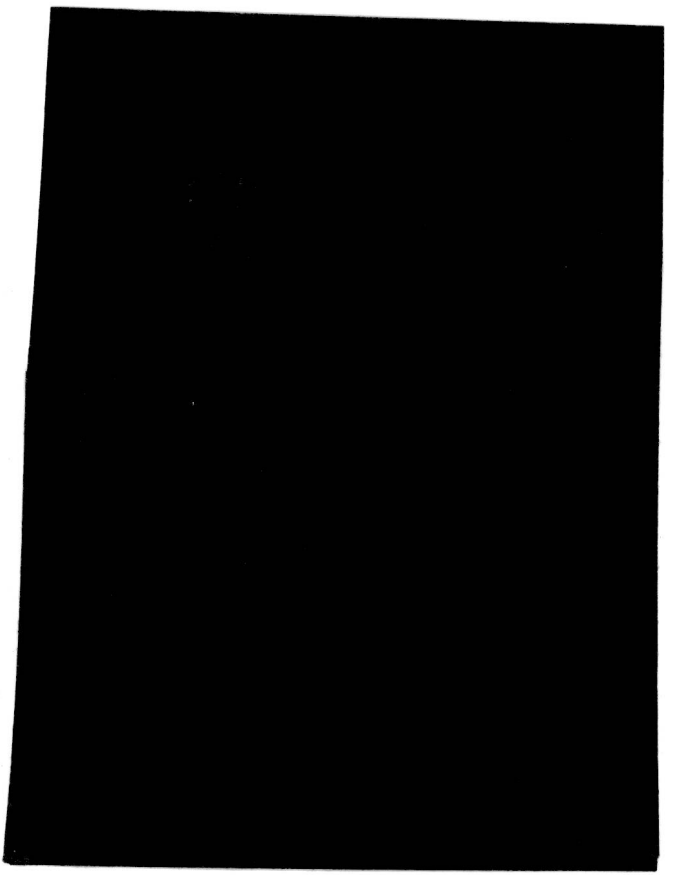

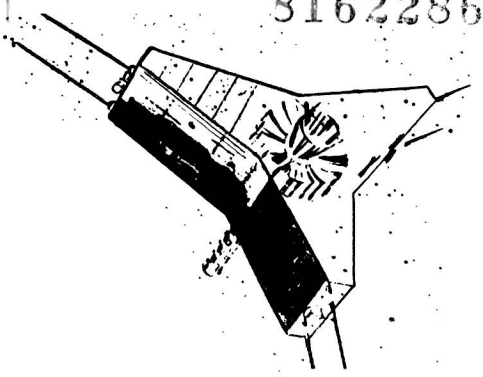

OSCAR: The Ham Radio Satellites

by Dave Ingram, K4TWJ

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The cover photo is a conception by artist William R. Findley WA6TUF of OSCAR 8 in orbit.

Writing a book of this nature is not a simple task, and I would like to express sincere gratitude to the following individuals for their outstanding assistance and support in producing this OSCAR satellite book: The Radio Amateur Satellite Corporation (AMSAT), and its U.S. president, Dr. Perry Klien, W3PK; Dr. Norman Chalfin, K6PGX; Mike Smithwick, WA6TUF; Roy Welch, WØSL; and Fred Merry, W2GN. Thanks also to the following companies for their assistance with information supplied in Chapter 7 of this book: ARCOS, Cushcraft, Hamtronics Inc., Spectrum International and Yaesu Electronics.

Finally, my deepest appreciation and gratitude to my XYL, Sandy, WB4OEE, for typing this manuscript and standing by me while writing this book.

As with any state of the art book which deals with pioneering frontiers, timeliness is a problem. Operational parameters and schedules are always open for modification; thus, late issue periodicals should supplement information presented in this publication.

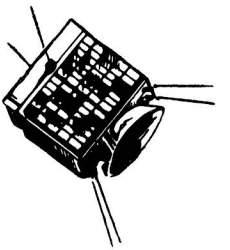
Dave Ingram, K4TWJ

Preface

Space communication is one of the hottest new frontiers in amateur radio, and its popularity is rapidly increasing. Each day, amateurs around the world are experiencing the enjoyment of this new era and realizing the fascination in personal communication via OSCAR satellites. There are a number of unique aspects associated with satellite communication, and these features have given many amateurs a renewed enthusiasm for ham radio. If you're searching for more than the usual pleasures in amateur radio, I'm sure you, too, will find OSCAR activities an absolute blast.

Although amateur satellites have been flying since 1961, their use hasn't become widespread until recent times. This enthusiasm has obviously been escalated by our latest satellite, OSCAR 8, and the upcoming Phase III spacecrafts. The construction cost of amateur radio satellites has been borne entirely by the amateur fraternity. Fortunately, these satellite costs have been significantly less than their commercial counterparts. As an example, OSCAR 7 costs totalled approximately $64,000 whereas a similar unit built under industrial auspices would have cost $2 million. The American Radio Relay League (ARRL) has made a substantial financial contribution to AMSAT in support of OSCAR 8. Education materials for OSCAR users also are being widely distributed by the ARRL.

This book is intended as an introduction and guideline for amateurs investigating or joining the fun of satellite operations. It is purposely *enjoyment* oriented rather than technically oriented, so settle back in an easy chair with a Coke and start dreaming of your own satellite earth station.



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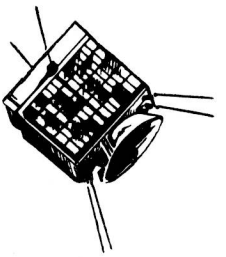

Communication via satellite is a frontier of unlimited opportunity and enjoyment that's open to amateurs around the world on a daily basis. This exciting new era of amateur radio is gaining momentum at a fantastic rate, and some revolutionary developments are due to evolve in the near future. A superb new amateur radio satellite recently was placed in orbit around our world (Fig. 1-1), and another highly sophisticated amateur satellite capable of direct worldwide communication on a multi-hour basis is scheduled for launch during early 1980. Now's the ideal time to hop on the bandwagon and join in the fun of this new aspect of amateur communications. This book is intended as a guideline toward that end, and it provides all the necessary details you need to become involved with today's space age communications. I trust you'll find the information useful, entertaining and enjoyable.

It has been said that our Golden Age of Communications has, like many aspects of the exciting yesteryears, passed in the annals of time. When we consider that situation from a different standpoint, however, we find the Golden Age is still very much alive in the special frontiers of advanced communication techniques. OSCAR (Orbital Satellite Carrying Amateur Radio) satellite communications are a perfect example of such boundless horizons. If you're looking for a refreshing change in amateur radio activities, this mode will surely provide such new life and return that excitement you felt during those first days as a ham radio operator.

The launch of U.S.S.R's Sputnik I in late 1957 sparked interest and enthusiasm among radio amateurs throughout the world. Soon

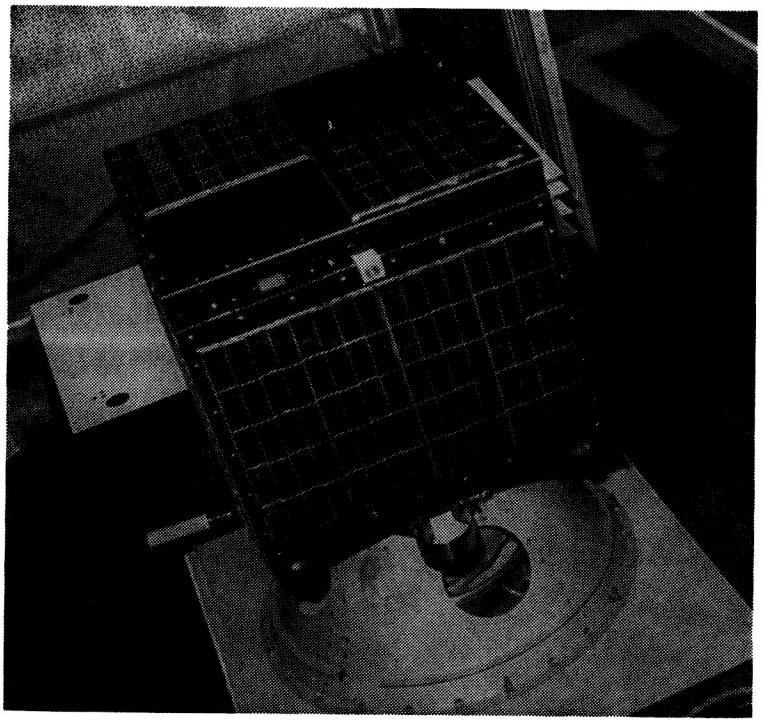

Fig. 1-1. The newest star performer in amateur radio's satellite program, OSCAR 8, sits on its mount baseplate awaiting final checkout at Vandenburg Air Force Base laboratories. Outer perimeter of satellite is covered with high quality photocells. White blocks at top center of craft is outlet for 10 meter antenna.

thereafter, a relatively small group of amateurs began building a space satellite of their own. This "weekend project," which was informally accomplished in basements and garages, became our first orbital amateur radio satellite in late 1961. The satellite program immediately acquired acceptance and soon became too large for a single, small group to handle. AMSAT, the Amateur Satellite Corporation, was thus established and large scale progress began. Today, AMSAT continues the design, development and launch aspects of amateur satellites, while the American Radio Relay League assists with many administration and public relation duties of the spacecrafts. Our satellite program is now moving forward, and its possibilities for the future are absolutely unlimited.

If you've never experienced operation via OSCAR, you're in for a tremendous experience. The ability to operated *duplex* fashion (simultaneous transmit and receive using separate rigs on separate bands) is truly unique. You hear your own signal exactly as others

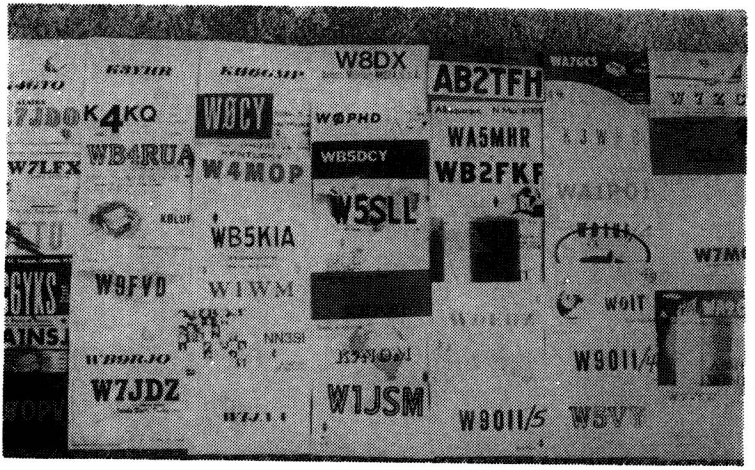

Fig. 1-2. These QSL cards represent the outstanding achievement of Worked All States via OSCAR satellite. The proud owner of this WAS certificate #14 is Mike Smithwick, WA6TUF.

hear it. Additionally, several satellite stations can simultaneously operate from one site on a reliable basis. Such capabilities can prove highly beneficial during emergency or contest activities (Fig. 1-2).

Our amateur satellites are quite unique in nature—they do not recognize social, political or economic barriers. Their communication capabilities inspire international friendship, peace and understanding. This aspect allows the spirit of amateur radio to flourish,

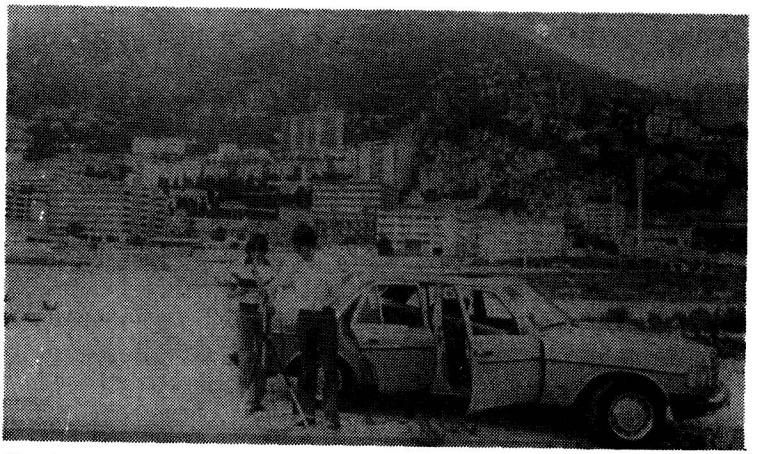

Fig. 1-3. WA6TUF as 3A0JB operating portable/mobile near Monaco. 28 different stations were contacted during these activities. Antennas mounted on a tripod followed the satellite's path, which paralleled the mountain in the background.

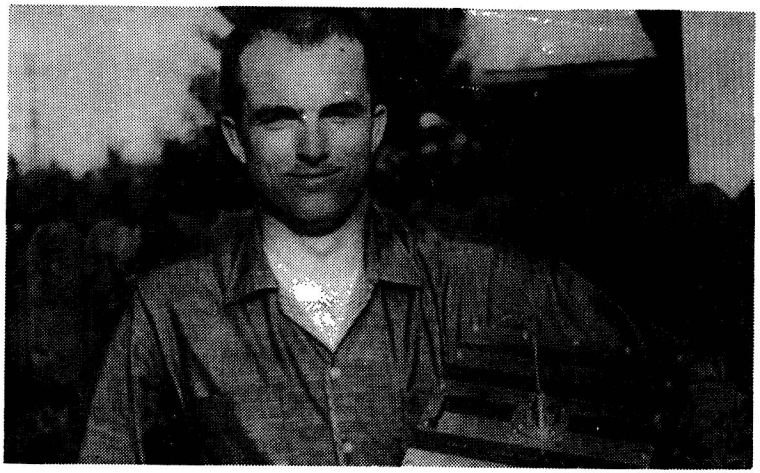

Fig. 1-4. One of the prime designers and builders of OSCAR 1, Lance Ginner, K6GSJ, holds the spacecraft under his arm before launch day arrives. The successor, OSCAR 2, was identical in appearance to OSCAR 1 (courtesy Project OSCAR).

and sets it apart from all other similar communications media (Fig. 1-3).

HOW IT ALL BEGAN

Amateur radio officially began its sojourn into the satellite program on Dec. 12, 1961, when a simple 10 pound package of electronics was placed in orbit around our planet. The package, known as **OSCAR 1,** transmitted information concerning its internal temperature back to earth in the form of a timed CW "HI" on the 2 meter amateur band. The satellite was home constructed by a small group of amateurs in the California area (Fig. 1-4) and its free ride into space was accomplished by replacing a satellite launch rocket's dead weight ballast with the tiny package (Fig. 1-5). The 100 milliwatt transmitter aboard OSCAR 1 lasted approximately three weeks before its internal batteries discharged, and the satellite fell to earth soon thereafter. Consequent reports of OSCAR 1 reception from over 600 amateurs in 25 countries indicated solid interest in amateur satellites, thus plans for another "bird" were begun.

OSCAR 2 was launched from Vandenburg Air Force Base in California on June 2, 1962. This satellite was identical to OSCAR 1, except its transmitter ran slightly higher output power. A simple spring mechanism separated the satellite from the launch vehicle, and another spring swung its antenna into position. OSCAR 2 lasted approximately 2½ weeks befor its non-rechargeable batteries died.

Fig. 1-5. The satellite that started it all—OSCAR 1. This small unit was designed and built by members of the Project OSCAR group organized at Foothills College in Los Altos, California and Lockeed Amateur Radio Club in Sunnyvale, California. OSCAR 1 was carried aloft by the Discoverer 36 rocket (courtesy Project OSCAR).

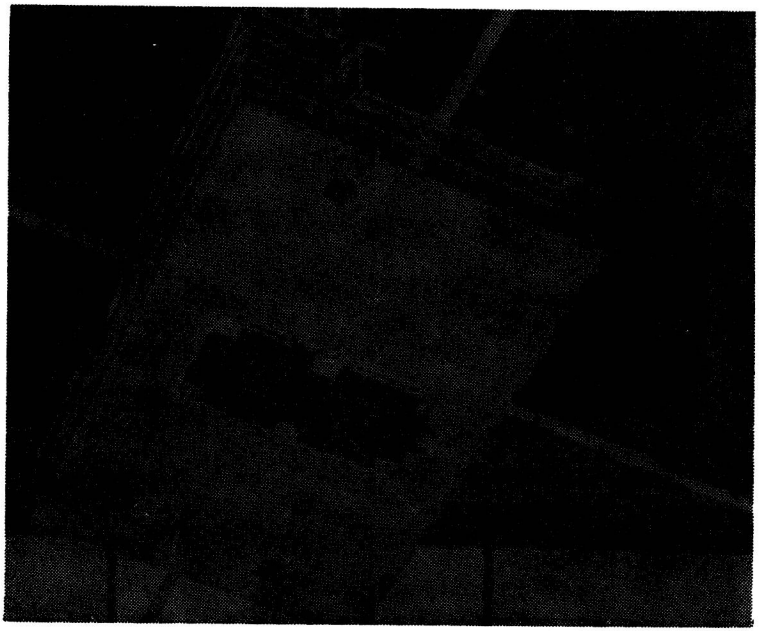

Fig. 1-6. OSCAR 3, amateur radio's first full communications satellite. The small group of photocells on each side of this craft were provided as battery backup rather than recharging.

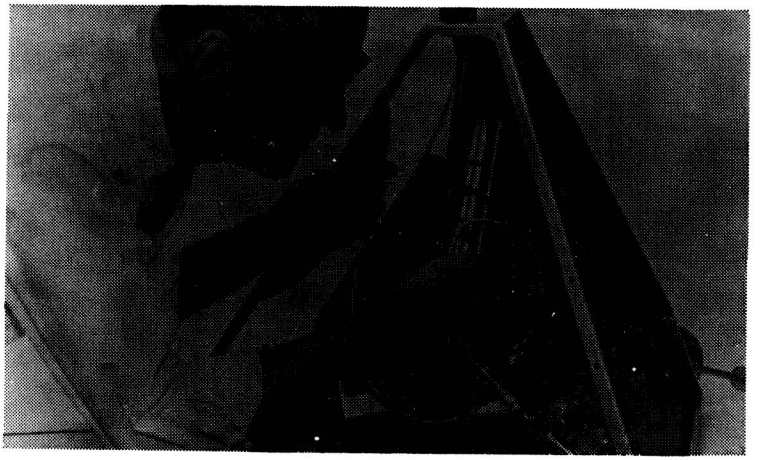

Fig. 1-7. OSCAR 4 undergoing construction during 1964. The following year, OSCAR 5 was launched and a rocket malfunction placed it in a highly elliptical orbit. The first U.S. to U.S.S.R. communications resulted from that mishap.

Over 700 reports of reception again proved support for amateur satellites, and additional plans were instigated.

OSCAR 3 was launched on March 9, 1965, and it made history as amateur radio's first full communications satellite (Fig. 1-6). The one watt, 2 meter linear transponder aboard this craft relayed CW, SSB and FM signals from amateurs around the world. Approximately two weeks after this satellite was placed in orbit, its internal batteries died, and the unit ceased to function. Although a bank of solar cells were incorporated in this satellite, they were strictly for battery back-up rather than for recharging. Over 100 amateurs in 15 countries report communicating via this short-lived satellite.

OSCAR 4 was launched from Cape Kennedy on Dec. 21, 1965. A defect of the launch vehicle caused this satellite to be placed in a highly elliptical orbit, however, the first U.S. to Russia communications was provided by this satellite (Fig. 1-7). The craft employed a 2 meter to 70 cm transponder capable of three watts ouput. A failure of the craft's solar cells caused this satellite to die in March, 1966. A significant lesson in satellite range/altitude was acquired through this bird's misfortune. This information will be used in the Phase III era of long distance satellite communications, which is scheduled to begin in early 1980.

OSCAR 5 was built by students at Melbourne University in Australia, and launched from the U.S. Western Test Range on Jan. 23, 1979 (Fig. 1-8). AMSAT completed extensive modifications, testing, launch arrangements, licensing and data collection for this

satellite project. This craft featured two elaborate telemetry systems for sending information concerning its health and well being back to earth. The information was used for planning future OSCAR satellites. One transmitter operated in the 2 meter band, and the other operated on 10 meters. Although this satellite lasted slightly over a month before its batteries discharged, over 200 reports for telemetry reception from amateurs in over 25 countries were received.

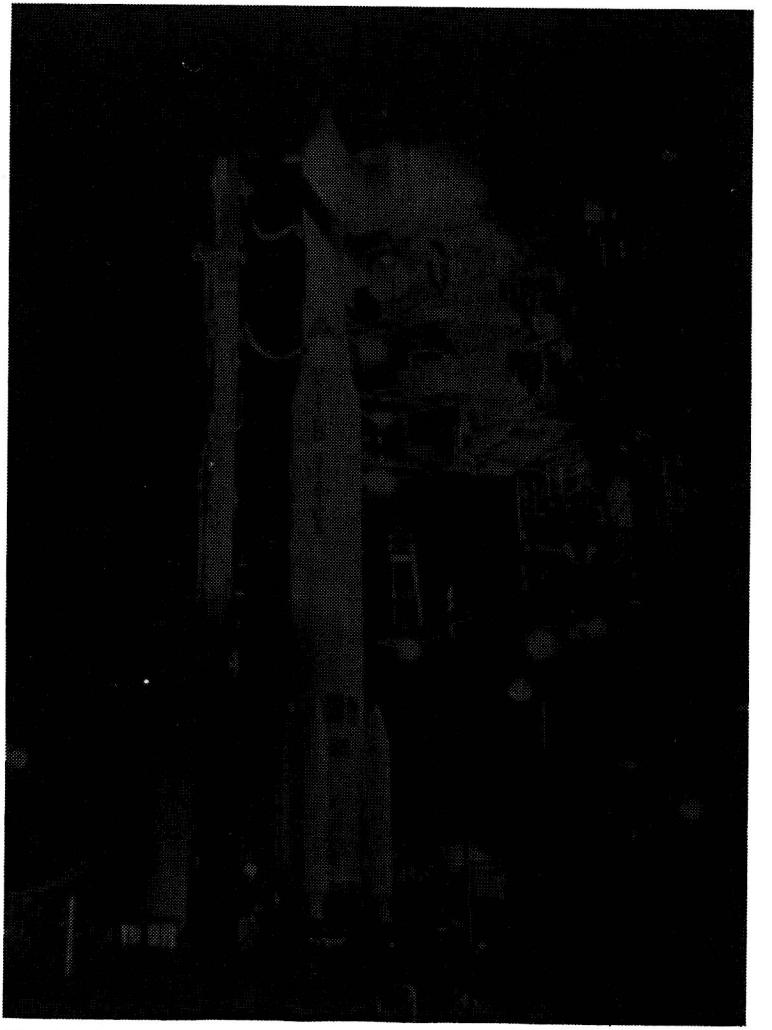

Fig. 1-8. A spectacular evening launch carried OSCAR 5 into orbit on Jan. 23, 1970. Performance of this outstanding satellite was something to remember.

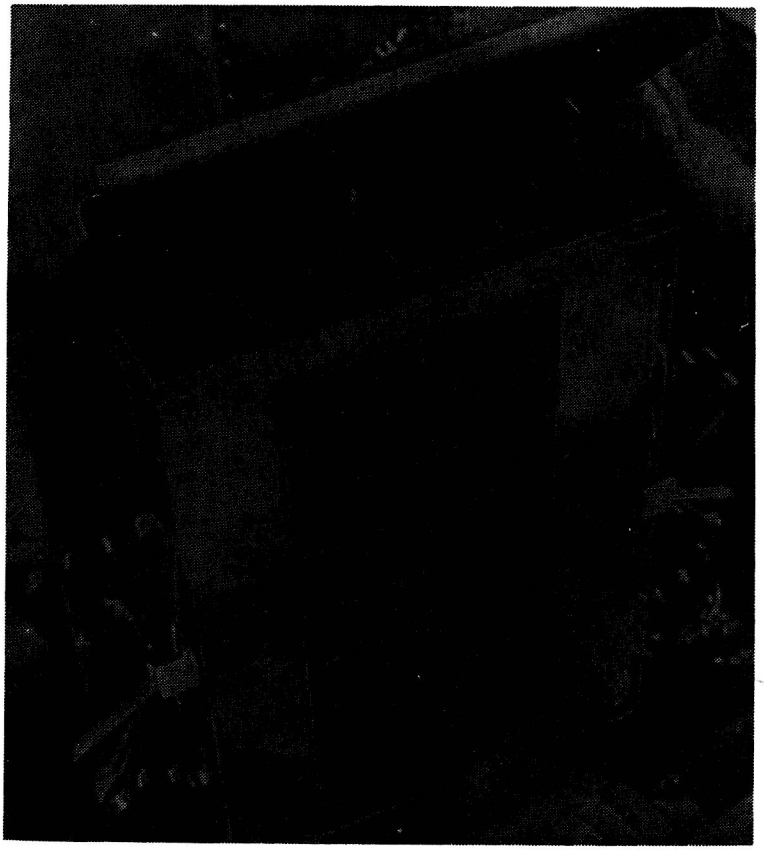

Fig. 1-9. OSCAR 6, the classic amateur satellite, mounted on side of Delta Rocket 91 and awaiting launch. The 10 meter antenna was a ribbon-looking folded flexible steel rule which was released when OSCAR was deployed from the rocket.

OSCAR 6, a highly outstanding amateur satellite, was launched from the U.S. Western Test Range on Oct. 15, 1972 (Fig. 1-9). This classic satellite featured a one watt 2 to 10 meter linear transponder which operated beautifully for over four years (Fig. 1-10). Magnetic stabilizing rods were used for accurately controlling satellite roll rate. OSCAR 6 was the first in a series of long-life satellites. Its internal Nicad battery package was continuously recharged by solar cells which covered the craft's outer perimeter. Thousands of reliable QSO's were accomplished by this perfectly operating satellite. Indeed, it seemed that OSCAR 6 could do no wrong. Each time the bird crossed your horizon, the 10 meter satellite band (29,450 to 29,550 kHz) sounded like contest time on