Sound and Television Society, Academy of Television Arts and Sciences, Photographic Society of America, American Television Society (of which he was Vice-President), American Society of Cinematographers and Academy of Motion Picture Arts and Sciences. He is also a member, and served on the Board, of the Theater Equipment Manufacturers Assn.

Apollo 11 — Television and Photography

Since 1961, when President Kennedy announced a decision to place a man on the moon by the end of the decade, until the Moon-Walk on July 21, 1969, the resources of many of the nation's great industrial organizations were directed toward getting men on the moon safely and getting them back without disaster.

Communications techniques and equipments reached an incredibly advanced stage of development. One of the most impressive culminations of the research and development activities of a number of firms was the vicarious walk on the moon experienced by the millions who watched the first live telecast from the moon.

Among the firms who have developed and adapted cameras and other equipments, or otherwise taken part in Moon-Earth communications and photography are included: Data Memory, CBS Laboratories, Eastman Kodak, Edgerton, Germeshausen and Grier, General Electric, J. A. Maurer, Inc., Paillard, Inc. (distributors of Hasselblad cameras manufactured in Sweden), Philips Broadcast Equipment Corp., RCA Corp. and Westinghouse.

Videodisc Recorders, produced by Data Memory, were used to reconstitute the slow TV signals from the moon for world broadcast use. Compared with standard TV pictures, Apollo transmissions provided only one-third the usual number of electronic picture frames. The Videodisc Recorder was adapted to record each active frame containing a picture and repeat it three times before moving on to the next active picture.

Norelco color cameras, produced by Philips Broadcast Equipment Corp., were used extensively in the worldwide broadcast and the little Norelco Multi-Purpose Plumbicon (monochrome) (used in closed-circuit television systems) was attached to the 36-in telescope at Fernbank Science Center in Atlanta, GA, and coupled to an image intensifier capable of multiplying light from space 100,000 times on the reflector telescope. This unusual system was used to transmit pictures of the Apollo 11 capsule for NBC network during the eight-day journey to and from the moon.

Two Westinghouse television cameras, one color camera and one black-and-white camera, were used for coverage of the journey to and from the moon and the moon landing. The color camera, based on the field-sequential system developed some 28 years ago by Peter C. Goldmark, President of CBS Laboratories (*Journal*, p. 574, July 1969), was carried in the command module to televise astronaut activity on the long journey. A black-and-white camera weighing 7.25 lb (earth weight) and containing more than 250 components was used to photograph the moon landing and activity on the moon. That camera was left on the moon. The color TV camera weighs 13 lb. Both cameras were designed around the SEC (secondary electron conduction) tube.

Equipments developed by RCA Corp. were used to assure a safe journey and arrival to the moon travellers and to bring visual news of their adventures to home TV viewers. A radar to enable the astronauts in the lunar module to track the command/service module was one of the factors enabling the safely accomplished rendezvous following the moon landing. The radar and other control electronics on the lunar module were manufactured by RCA Corp. for Grumman Corp.

It has been frequently pointed out that the key to successful space explora-

tion is miniaturization. For example, the assembly that throttled the lunar module descent engine to make a gentle touchdown on the moon could fit into a shoebox. An RCA antenna, designed to spring open like an umbrella, was carried to the moon to beam signals (including live TV) from the moon to the earth. The antenna was carried as a cylinder 10 in in diameter and 29 in long with an earth-weight of 14 lb.

Two RCA systems were also installed in Australia to enable home TV viewers to watch the moon broadcast. One of the systems, which converts slow-scan TV signals to commercial standards for rebroadcast, was located at the NASA Manned Space Flight Network station at Honeysuckle Creek. The second was installed at Sidney for use with the Australian National Radio Observatory in Parkes. Similar systems were located at Goldstone, CA, and Madrid, Spain.

Among the cameras carried for motion-picture and special photography to the moon was a Maurer sequential camera. Eastman Kodak developed a special-purpose stereo camera for taking close-ups of the lunar surface. Designed to be used by astronauts in pressure suits with heavy gloves, the camera has a collapsible handle that looks like a walking stick. A trigger in the handle enabled the astronaut-photographer to take the pictures without bending over (an impossibility in a space suit). The camera (about the size of a cigar box) held the film some 10 in away from the surface and the photographs will enable scientists to study pictures of particles smaller than 2/1,000 in. The camera has a fixed shutter speed of 1/100 s and aperture of $f/22.6$ The electronic flash unit to light the surface was supplied by Edgerton, Germeshausen & Grier, Inc. The miniaturized unit measures $1\frac{1}{2}$ by 4 by $4\frac{3}{4}$ in. The camera and flash system were designed especially for use with 35mm Kodak Ektachrome MS film SO368 (thin Estar base). The camera holds about 30 ft of 35mm film (enough for 112 pairs of stereo photographs).

Still photographs were made with three Hasselblad cameras. One of the cameras was designed especially for moon photography. The specially designed camera incorporated a new Zeiss Biogon 60mm lens and reseau grid plate for accurate measurements of the areas photographed. Adaptation of the reseau plate to the $2\frac{1}{4}$ size format was made at the Hasselblad factory. According to Paillard, Inc., distributors of Hasselblad cameras, this is the first time a photogrammetric device has been adapted successfully to a single-lens reflex camera.

The success of Apollo 11 depended on the solution to many and various problems on the ground, on the sea, in the air and in space and on the moon. One of these problems was that of providing adequate lighting at the launch pad to as-