Marconi-Elliott head-up display. The USMC's aircraft are to be equipped with the Hughes ARBS (Angular Rate Bombing System), which provides automatic tracking of ground targets and first-pass automatic acquisition of laser-designated objects. It will allow delivery of unguided rockets at night in close-support operations, is compatible with guided weapons and can direct gunfire and air-to-ground rockets. The ARBS dual-mode television/laser tracker locks on to a target, providing line-of-sight angle and angle-rate information to the IBM weapon-delivery computer (WDC). These figures, combined with true airspeed and altitude (from the air-data computer), are processed by the WDC to give the weapon-delivery solution. The target position, together with weapon-release and azimuth-steering information, is shown on the head-up display—a Marconi-Elliott AVQ-24 has been used in tests.

**A-6E Intruder**

A-6E has a different radar, computer and armament-control system from the A-6As used in South-East Asia. A Norden multi-mode Ku-band APQ-148 radar replaces the same company's shared-aperture APQ-92 (search and terrain avoidance/following) and APQ-112 (target tracking and ranging) used in the earlier variant. The APQ-148 can perform search, ground mapping, tracking and ranging of fixed or moving targets, terrain avoidance or terrain following, and beacon detection and tracking. Scanning in azimuth is mechanical and in elevation is electronic. In service the radar has picked up ships at 30 miles range from an A-6E flying at only 200ft.

IBM supplies the ASQ-153 solid-state digital attack and navigation computer, with Fairchild Camera and Instrument providing the signal data converter. The main display is a Kaiser Aerospace and Electronics AVA-1 vertical display indicator (VDI), an 8-in diameter cathode-ray tube which shows a synthetic landscape and sky and on which is superimposed steering and attack information.

The complete US Navy Intruder force will eventually carry Tram (Target Recognition and Attack Multisensor), which combines forward-looking infra-red equipment with laser tracker/illuminators (see Flight for October 16, 1975, page 565). A target is acquired on radar, transferred to infra-red tracking and identified using a 15° telescope. The laser range-finder pinpoints the target's position and an attack can be carried out with guided or unguided ordnance.

**LTV Aerospace A-7D/E Corsair**

The weapon-delivery system is based on an APQ-126 forward-looking radar used for air-to-ground ranging, ground mapping (for bad-weather bombing), manual terrain following and terrain avoidance. A Marconi-Elliott AVQ-7 head-up display is supplied with information by the ASN-91 digital bombing computer, as is a Computing Devices of Canada ASN-99 projected-map display.

A pod-mounted Tram installation (see A-6E entry) is planned for US Navy A-7Es and Pave Penny (see A-10 entry) is being installed in USAF A-7Ds.

**Fairchild A-10**

The A-10 carries no radar, but is being equipped with a Martin Orlando AAS-35(V)1 Penny laser search and tracking set which will allow laser-designated targets to be attacked during the day and at night. The illuminator can be airborne (for instance in an OV-10) or ground-based, reflected energy being picked up by the Penny pod and the target position appearing on the pilot's head-up display. Tracking is possible from -90° to +15° in elevation and between ±10° in azimuth.

**Rockwell International B-1**

The B-1's nav-attack system, which is being integrated by Boeing, includes twin Litton LN-15S inertial systems, Texas Instruments APQ-146 terrain-following radar (adapted from the F-111 equipment), General Electric APQ-144 forward-looking radar (adapted from the F-111's APQ-114 by increasing scan angle from 45° to 60°), electro-optical viewing system consisting of Hughes forward-looking infra-red and Dalmo Victor low-light television, and two Singer-Kearfott SKC-2070 computers. Raytheon's phased-array APQ-140 forward-looking radar may later be installed.

Also proposed for the B-1 and FB-111 is the Westinghouse electronically agile radar (EAR). It can change beam shape and position instantaneously to perform different functions. Radar data are processed digitally and the equipment will provide simultaneous high-resolution ground mapping and precise position and velocity information, allowing accurate terrain-following flight and weapon delivery to be accomplished in all weathers.

The RAF's Phantom FGR.2s are equipped with the Westinghouse AWG-12 radar. This aircraft mounts an EM1 reconnaissance pod and Sparrow air-to-air missiles.

**Boeing B-52 Stratofortress**

The capability of B-52Gs and Hs is being improved by incorporating a chin-mounted EVS (Electro-optical Viewing System), comprising Hughes AAQ-6 forward-looking infra-red and Westinghouse AVQ-22 low-light television.

**McDonnell Douglas F-4 Phantom**

Westinghouse supplies a range of radars for the Phantom series:—APQ-72 (F-4B), APQ-100 (F-4C), APQ-109 (F-4D), APQ-120 (F-4E) and AWG-10A (F-4J), AWG-11 (F-4K) and AWG-12 (F-4M). The APQ-120 (USAF and overseas customers) and AWG-10A (US Navy) remain in production. The former weighs 290kg and was designed to operate reliably in close proximity to the F-4E's nose-mounted M61 cannon. The Navy's AWG-10A has been developed from the AWG-10 by adding digital computing and built-in testing, plus a servoed optical sight. The operating modes remain the same: pulse-Doppler lock-down, pulse air-to-air search and tracking, high/low mapping, air-to-ground ranging and illumination for Sparrow air-to-air missiles. The Lear Siegler ARN-101 digital navigation/weapon-delivery/navigation system is being fitted in up to 262 USAF F-4Es and RF-4Cs, ARN-101 includes Pave Tack (see below) and modification for Maverick operations.

The Aeronutronic AVQ-10 Pave Knife (Dalmo Victor television/Westinghouse laser-designation) system used on F-4Ds in Vietnam is being replaced by the same company's Long Knife equipment, which has greater acquisition range (30 n.m.), twice the tracking accuracy and improved stabilisation. The International Laser Systems designator has five times the range of that in Pave Knife. Ball Bros Research supplies the low-light television camera.

Also developed from Pave Knife is Aeronutronic Ford's Pave Tack pod-mounted gyro-stabilised AAQ-9 forward-looking infra-red (FLIR) and laser target designator, which is part of the Pave Strike series of defence-suppression measures. It will allow F-4E/Fs to make night-time attacks and will also be fitted to F-111E/Fs.

Another part of Pave Strike is the Westinghouse ASQ-153 Pave Spike, a day-only television/laser-designator pod for F-4D/ES which is smaller, lighter and cheaper than Pave Knife.