



Left to right: the Honeywell Golden Gnat miniature rate gyro and its rotor; wiring up the BG-158 computer in its "jeep can"; and testing the autopilot

control when his mind and hands may be considerably occupied by navigation and attack functions.

While attitude information is taken from the LN-3, the MH-97G has its own rate gyros, mounted in the APC system, in the roll rate and two-axis rate-gyro packages. In all cases the rate gyro used is the Honeywell Golden Gnat, a floated, single-axis unit weighing only 160gm and having a hysteresis rotor turning at 24,000 r.p.m. It can sense angular velocities from 0.01°/sec to 50°/sec. Super-clean rooms are used for assembly, and specially close quality-control is applied throughout the manufacturing process. Damper and autopilot computer circuitry, designated BG-158, is contained in a standard "jeep can." There are only 22 relays, solid-state switching being otherwise employed; and some electronic circuits are potted modules built up from three-dimensional clusters of components in which the leads from the components themselves are welded to form the interconnections.

Very extensive and specialized test equipment is used, here as elsewhere, to calibrate and check the autopilot before delivery. In addition, Honeywell have installed a sizeable analogue computer and control simulator at Dörligheim and are studying flight instrumentation and handling of typical VTOL aircraft, with a view to developing instrumentation for transition and landing. They supplied the stabilizer system for the German pre-VJ-101 VTOL "bedstead."

As already intimated, Honeywell are anxious to point out that, during 1,170 flights in Germany in the first ten months of 1962, 390 autopilot failures were claimed by pilots, but that only 21 of

these (5.4 per cent) were actually the fault of the autopilot itself. The other 369 were traced to one of the other systems. During 42,000hr of user operations in the USA and Europe the BG-158 computer has shown an MTBF of 368hr, equal to 141 per cent of the reliability specification. The three-axis damper has achieved 3,062hr against the specified 690hr, and the APC 2,043hr, which is no less than 252 per cent of that required. Late last year there had never been a failure in the normal accelerometer unit or APC gyro package.

#### UG-1000 Check-out

Honeywell in Germany are also responsible for testing and delivering, though not for manufacturing, the UG-1000 automatic check-out trolley, about 70 of which have been ordered for the four original air forces in the F-104G programme. This set is one of the series of Automatic System Analysers made by Honeywell and described in *Flight International* for October 18.\* It is designed to check the MH-97G in about four hours; without the UG-1000 this operation would take two days. The UG-1000 can also perform a rapid functional check in ten minutes. A2 and A3 models are being delivered now, but Honeywell are completing the design of the UG-1000G, which will be able to check not only the MH-97G but the LN-3, PHI-IVB, air-data computer and other systems.

\*—and, in greater detail, in our associated journal "Measurement and Control" for February 1962.

### F-104G ELECTRONICS PRODUCTION

System	Designer	European Source	Remarks
Radar fire-control Nasarr	NAA Autonetics, Downey, California	North American Aviation SpA, Turin Manufacture Belge de Lampes et de Matériel Electronique (MBLE),* Brussels  Ateliers de Constructions Electriques de Charleroi (ACEC), Belgium Hollandse Signaalapparaten* (HSA), Hengelo Telefunken, Ulm* Fabbrica Italiana Apparecchi Radio* (FIAR), Italy	overall support, training, modifications. indicator, low-voltage power supply, electronic control amplifier: sub-contract from HSA for computer. sub-contract from MBLE.  aerial assembly and computer. synchronizer, receiver. transmitter, waveguide coupler, radar set control, clearance-plane indicator. test and check-out. overall co-ordination and liaison.
Inertial system LN-3	Litton Industries, Beverly Hills, California	Cobelda, Belgium Litton Industries GmbH, Hamburg  C. Plath, Hamburg* Standard Elektrik Lorenz (SEL), Germany Bell Telephone Manufacturing Co, Belgium Fritz Hellige & Co, Freiburg Litton Italia, Rome Teldix, Heidelberg* Ottico Meccanica Italiana (OMI), Italy Honeywell GmbH, Frankfurt-Darligheim* Officine Toscane Elettromeccaniche (OTE), Florence OIP, Belgium Allgemeine Elektrizitäts Gesellschaft (AEG), Germany	manufacture and final assembly. navigation computer. navigation computer. inertial gyros. sub-contract. Telefunken/Bendix joint company.
Position and homing indicator IV B Autopilot MH-97G	Computing Devices of Canada, Toronto Minneapolis-Honeywell	Etro, Germany Optische Industrie de Oude-Delft, Holland	manufacture; also UG-1000 check-out system. sub-contract parts of APC and BG-158.
Optical sight and in-range computer	General Electric	Hollandse Signaalapparaten (HSA)	
Infra-red sight	Lockheed Aircraft (Lockheed-California Co), Burbank, Cal		
Bombing computer M-2	Mergenthaler Linotype		
Dual timer Air-data computer	Lear AirResearch Divn, Garrett Corp	Interaero, Germany Microtecnica, Turin van der Heem, Holland three companies: not yet decided	subsidiary of Garrett Corp. also makes J57 engine accessories.
UHF radio AN/ARC-552 UHF 3-channel emergency radio Tacan AN/ARN-52 IFF AN/APX-46	Collins Radio of Canada RCA  I.T. & T. Hazeltine Packard Bell Stewart Warner	Standard Elektrik Lorenz, Germany Siemens & Halske, Germany	

\* Final assembly, test and delivery of complete systems, as well as manufacture of certain portions of system.