FLIGHT-CONTROL SYSTEMS

DUPLEX, triplex, quadruplex—or something different? This is the control-system conundrum to be answered in the quest for the complete and fail-proof aircraft control system. Examples of each were shown at Farnborough in 1962. The first, duplex, system as presently installed in the Trident, is a sort of two-thirds-way house to the full triplex system for which provision has already been made, and which Smiths Aviation Division are now working up to operational level in Varsity G-ARFP.

The decision eventually to equip Tridents to triplex level rests with BEA, who for the time being are forgoing the additional weight and expense involved in the three-channel arrangement until experience with the duplex system has been obtained. With the duplex system, it will be recalled, autopilot authority is exercised equally in each of the two channels serving the Fairey hydraulic actuators. Output from each autopilot servo is compared with that of its neighbour by means of torque switches, any torque discrepancy between the pair causing both autopilots to be switched out. Approach and automatic flare may then be continued by means of the paravisual director information which is an integral part of the system. In the triplex system, three-way comparison is made at the torque switches, any failure in one channel being sensed as a torque difference between one switch and the pair which continue to function normally; majority rule prevails, and the faulty autopilot is switched out. Flight control continues as a duplex system.

A simulator for familiarizing pilots and training servicing personnel in Smiths flight control system equipment for the Trident is now being constructed at Cheltenham. Part of this—the cockpit—was mocked up on the company's stand. The simulator reproduces all the functions of the multiplex SFP 5 autopilot and systems associated with the integrated flight-control system which in developed form include, in addition to "normal" autopilot pitch-channel facilities: barometric height lock; Mach lock with datum trim; IAS lock and trim; descent rate selection up to 6,000 ft/min; flare to preselected height; and manual or automatic acquisition of ILS glide-slope. The remaining elements of the system, which provide the facility for autoflare, are automatic throttle control of airspeed (with a means of adjusting the datum) and coupling of the autopilot and automatic throttle to radio altimeter information to control flare out. Drift is automatically corrected by means of Doppler signals. The final stage of automatic landing is completed by coupling-in low-altitude azimuth from ground sources.

Meanwhile, practical study of the triplex-type system is being hastened with the aid of the Division's recently converted Varsity, described in our "Flight Systems" pages last week. To recap briefly, this is the first aircraft in the world to be fitted with an automatic landing system at triplex level (in pitch and roll; yaw is at duplex level). Using production-powered Belfast components fully representative of this aircraft's control systems. The programme has been commissioned by the Ministry of Aviation and is intended to provide practical proof of a three-channel system with automatic landing capability under actual operating conditions. As installed in the Varsity, investigation of the system naturally must apply to a slow-speed operating envelope, and for research into the high-speed and high-altitude functions, such as height and Mach hold, Comet 2E G-AMXX is being converted to triplex equipment for automatic landing. It has previously been flying at duplex level. This pair of aircraft will give further unique opportunities for assessment of triplex-system operation, and for trial automatic landings at as many airfields as possible. Though the aircraft are equipped for leader-cable operation, the majority of landings away from Bedford are likely to be made on localizer equipment, and it is certain that London Airport, with its STAN 7/8 localizer/glide slope ILS installation, will figure in these trials. This programme may also hasten the implementation of the recently promulgated ICAO standard for high-grade ILS localizer installations.

Next stage in the programme is likely to be further work on Trident autolanding—be it duplex or triplex—and investigations of the automatic approach, flare and landing problems associated with sweep-wing aircraft. A constant proviso to all this is the continuation of Ministry support for automatic landing research. There have been rumblings recently that uncertainties exist about the support which the MoA are prepared to give to full automatic systems following the Varsity and Comet programmes. And unlike the VC10, the Trident has no application to military autolanding requirements. At Elliott Brothers (London) Ltd word is awaited for the go-ahead on VC10 autoflare for all BOAC aircraft. As flown in the prototype at present, the flight control system stops short of autoflare capability, though the selector facilities are there, as evidenced by the pilot's control panel on the manufacturer's stand. Development work on components has been intense during the past year, and the company are preparing to move into production when the decision to equip the corporation's aircraft is reached. A year hence the radio altimeter system, which represents the change-over to the autoflare facility, could be fully developed. Automatic landing is much further away, and the choice between leader cable and ILS localizer is still, in Elliott's view, an open question. Whichever system is chosen (and the basis of probability is towards localizer information) the company has ready necessary techniques, having developed ideas, for example, on how to produce monitored leader-cable receivers. An autthrottle system is already in the hardware stage, and an example of the working VC10 was shown on the Elliott stand. This is a dual-control device for operating the four levers of the pilot's throttle from either of two auto-control systems. Engagement is through electronic magnetic clutches which serve also to isolate control runs associated with a failed engine.

One of the year's most interesting developments in VC10 automatic landing equipment is Elliotts' Approach and Landing Indicator. Even in a perfect approach and autoflare or automatic landing under autopilot control, it is needed to show the pilot that all is going well. As an example, a high wind shear encountered during the approach may be corrected under autopilot authority at a rate far more gradual than the pilot would employ himself, and reassurance must be given by, say, indicators of performance of the automatics and the aircraft's operating state that the autopilot complex is continuing to function correctly. This can be done by a combination of "head-up" and "head-down" instrumentation displays, but a simplified presentation of essential knowledge is preferable provided it indicates the...