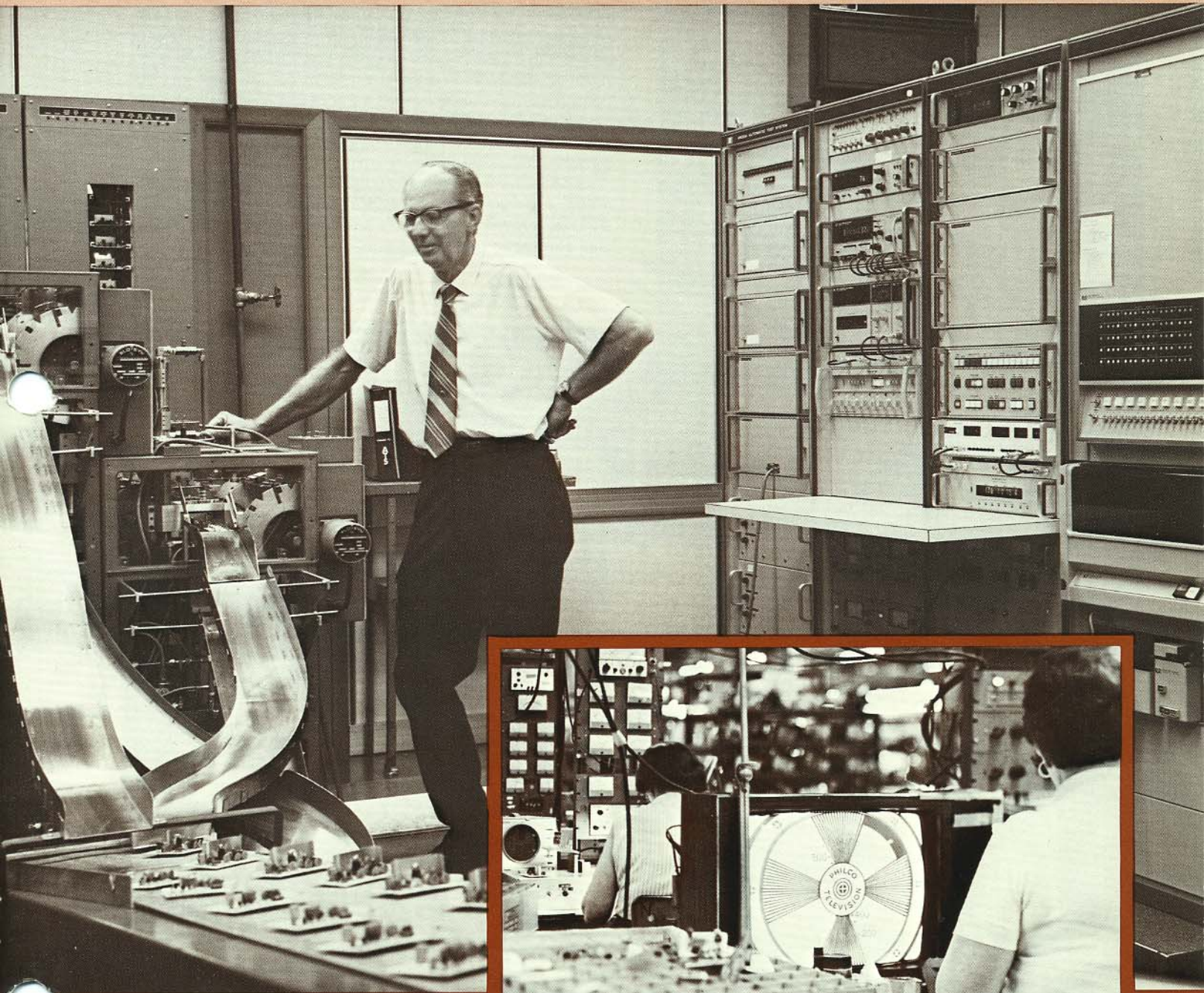# Television Set Production
Revolutionized by Automatic Alignment and Test

*Philco Color TV Modules are aligned and checked
by automatic handler and HP 9500 Series System.*

A Solution to Production Test Problems for PHILCO-FORD HOME PRODUCTS DIVISION

TV Modules Aligned and Tested - Automatically

Old style "tweak and measure" TV testing by technicians has gone by the board at Philco-Ford. Over a half-million modules were tested on their Automatic TV-Production Tester in less than four months operation with outstanding success. Quoting Ralph Booker, Philco-Ford Television Engineer* speaking of the overall results. "We have achieved better control over production and a more uniform product tested to greater accuracy." The automatic test system has allowed Philco-Ford to include about 20% more tests to specifications than previously and yet remain cost competitive. These improvements are behind Philco's new eleven word warranty for its solid-state console color television line – "For two years after delivery we'll fix anything that's our fault."

MAJOR DEVELOPMENT PROGRAM*

Philco-Ford launched the automatic testing project simultaneously with the other innovations: the redesigned circuitry, using ICs wherever practical for lower production costs and higher reliability; 100% modular PC card construction for reduced repair and warranty costs through quick replacement of modules in the home; and circuit design by module for individual updating in future sets.

The test-adapter/module-handler was designed and built by the Philco-Ford Home Products Division and the test system was furnished by Hewlett-Packard. The Hewlett-Packard system was chosen by Philco-Ford as the basis of the test hardware and software. It offered a powerful minicomputer with a large core memory plus auxiliary disc memory, a wide selection of standard modular subsystems for DC, AF, and RF requirements, a design which allowed other additions to satisfy the unique TV test requirements, and the Automatic Test System BASIC programming language.

The test-adapter/module-handler design included three stations to reduce "dead time" for loading and warmup, a test adapter providing interfaces between system and modules, and automatic tools for alignment.

For members of Philco's Test System Task Force, see back panel.
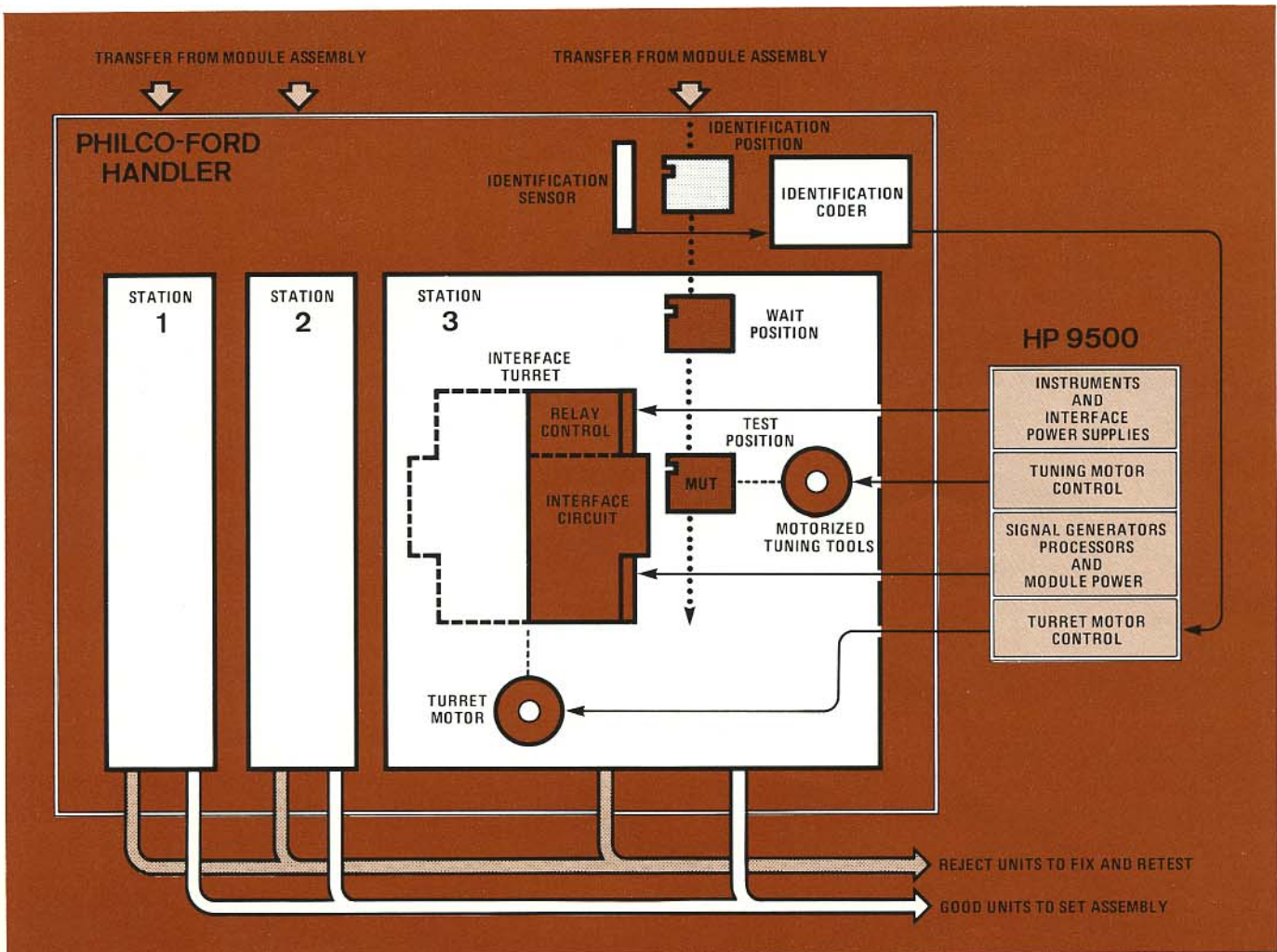
Pushbutton operated automatic test line does the work of many technicians, better.

Philco-Ford Handler

The test-adapter/module-handler, an unusual piece of equipment designed and built by Philco-Ford engineers, is a self-contained automatic test line operated under computer control from the HP system. It provides TV module-to-system interfaces as well as automatic alignment screwdrivers. In operation, randomly mixed modules coming down the line are recognized by the computer through sensing of a coded slot cut along the card edge. The computer controls station and interface selection to match the module. All interfaces, except for the video IF, are on a rotating turret. The module to be tested is automatically pushed into one of three stations — station one is for the video IF and is the only one with a fixed interface, station two is for modules having no adjustments, and station three is for all other modules having adjustments.

The interface cards contain special test circuitry which complements the test system's stimulus and measurement instruments. AC and DC Stimulus signals from the system go through the interface card to the TV module while outputs from the TV module are routed through or detected on the card. Wherever practical for higher speed, AC voltages from the module under test are detected for DC measurement.

The three station handler has no waiting for loading, unloading, and warm-up.

The automatic tuning tools are arranged so that when the program calls a motor number, that tool moves up to the component to be adjusted and a preset routine seats the tool. If not seated, an error code is generated. Tuning an IF transformer by this method takes only a few seconds, total. Good tested cards are ejected from the handler into a chute and onto an outgoing conveyor belt. Faulty cards are ejected into other chutes to be returned for manual checkout and repair.

INSTANT TEST DATA

Statistical Analysis programs help keep track of characteristic trends of the modules — an invaluable by-product of having a computer system with an auxiliary disc memory. These programs are available instantly on pushing control panel switches: Status Report, Module Test Results Tabulation, Wrap-Up Report (summary of run), Start-Up Program to set up system for the day's run, and Statistical Analysis from 100 samples for Mean, Mean Error, Skew, Standard deviation, etc.

A digital clock records the day of the year and the time of day at start-up and at shutdown of the system. It may be used to record when a run starts and when reports are taken. It is also used when preparing high-speed programs, to measure the length of time for execution of program segments.
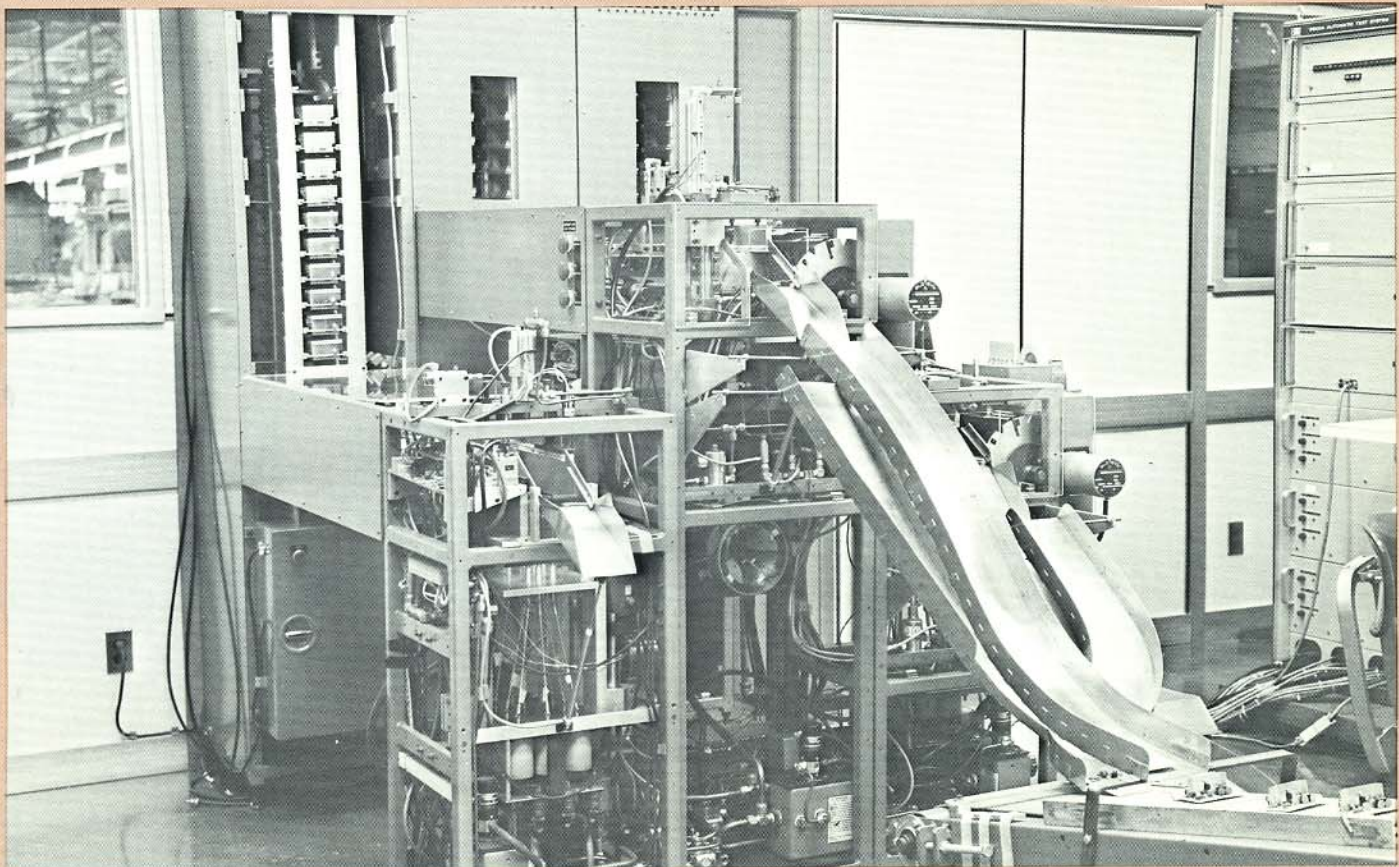
Hewlett-Packard 9500 Tester
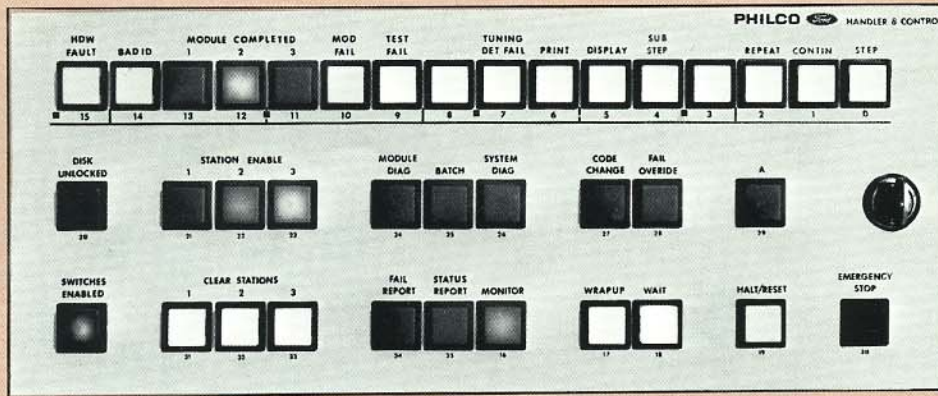
Pushbutton operation with Control Panel.

The Automatic Test System (ATS) used at Philco-Ford is typical of Hewlett-Packard 9500 series systems. HP 9500 ATS is noted for its general-purpose capability. It may be expanded and modified by adding or replacing capabilities with an extensive variety of compatible Hewlett-Packard modular subsystems. The controller portion of the ATS includes an HP minicomputer with 32,000 words of core memory backed up by a disc memory with 750,000 words of storage. Loading of programs is from the disc into the core under program control. For all practical purposes for Philco-Ford there are virtually no limitations on the program length, all current programs can be in the system, and ready to run in a moment without handling punched paper tape.

The system has a control panel, designed and fabricated by Philco-Ford to meet their particular needs. It provides full pushbutton control over testing without use of the teleprinter keyboard. Controls include: station enable, clear station, halt/reset, failure override, etc. One pushbutton switch turns the eleven-digit computing counter display into a control panel numerical display for station number, module number, test number, and good or fault location.

HP 9500 AUTOMATIC TEST SYSTEM
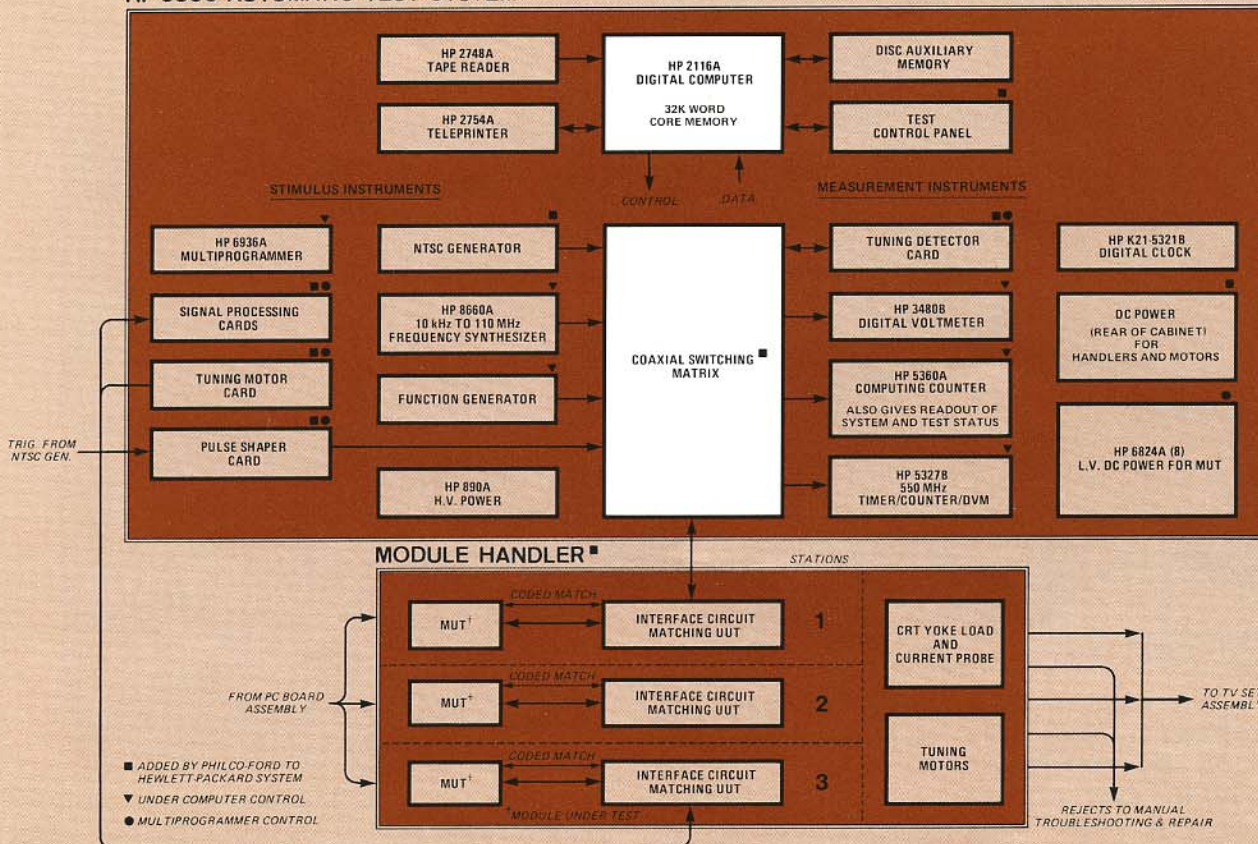
Programming – A Prime Concern

Programming was a major part of the project because of the Philco-Ford test system additions and the automatic handler. The goals were high speed operation using software especially written for the requirements but using ATS BASIC language in the test programs for easy understanding. To prepare for writing the special operating system software, two engineers with programming experience attended the Hewlett-Packard computer training school.

In developing color TV module tests, the Philco-Ford Test System Task Force studied the design engineering tests for each module and decided which tests were important from the standpoint of both set reliability in the field and performance. The Task Force also decided which tests were compatible with the system and requested redesign of modules where necessary to meet system requirements. After specifying the test and parameters for the tests, each module program was written and debugged until the master program for all 14 modules was complete.

Program development, on-line. Ralph Booker (Philco-Ford) at the heavy-duty teleprinter console.
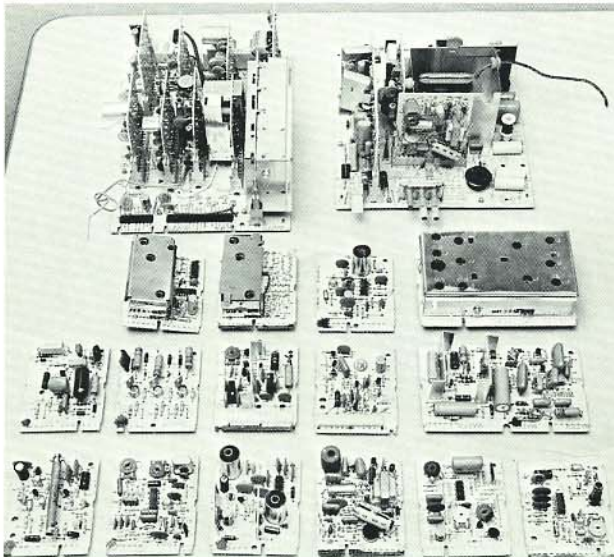
New Philco solid-state modules use eleven ICs. Modules plug into "boss" cards at top. Identifying slot on card edges passes light for photosensing.

VIDEO IF MODULE TESTS COVERED IN ONLY 800 PROGRAM STATEMENTS

- V_{CC} Current
- Detector Reference
- AGC Reference
- AGC Setup
- Tuning Adjustments (11)
- Trap Refinement Using AM
- Pic and Chroma Carrier Level
- Tilt Check
- Passband Response
- Sound Signal Level
- Video Level
- AFC Signal Level
- Picture Sensitivity

Long Term Planning: The Path to Success

Automatic testing for television receiver production has already proved to be successful — up to 6,000 modules pass through in a single day.

Computerized automatic testing will be used in Philco's manufacturing facility in Sao Paulo, Brazil, while engineering and tester programming will remain in the Home Products Division headquarters. Thus, control remains where it belongs while the hard-to-fill technical labor requirement is eliminated. Philco-Ford engineers anticipate that circuit design changes for future models will be easier to implement than before and less costly due to the modular design and test system versatility.

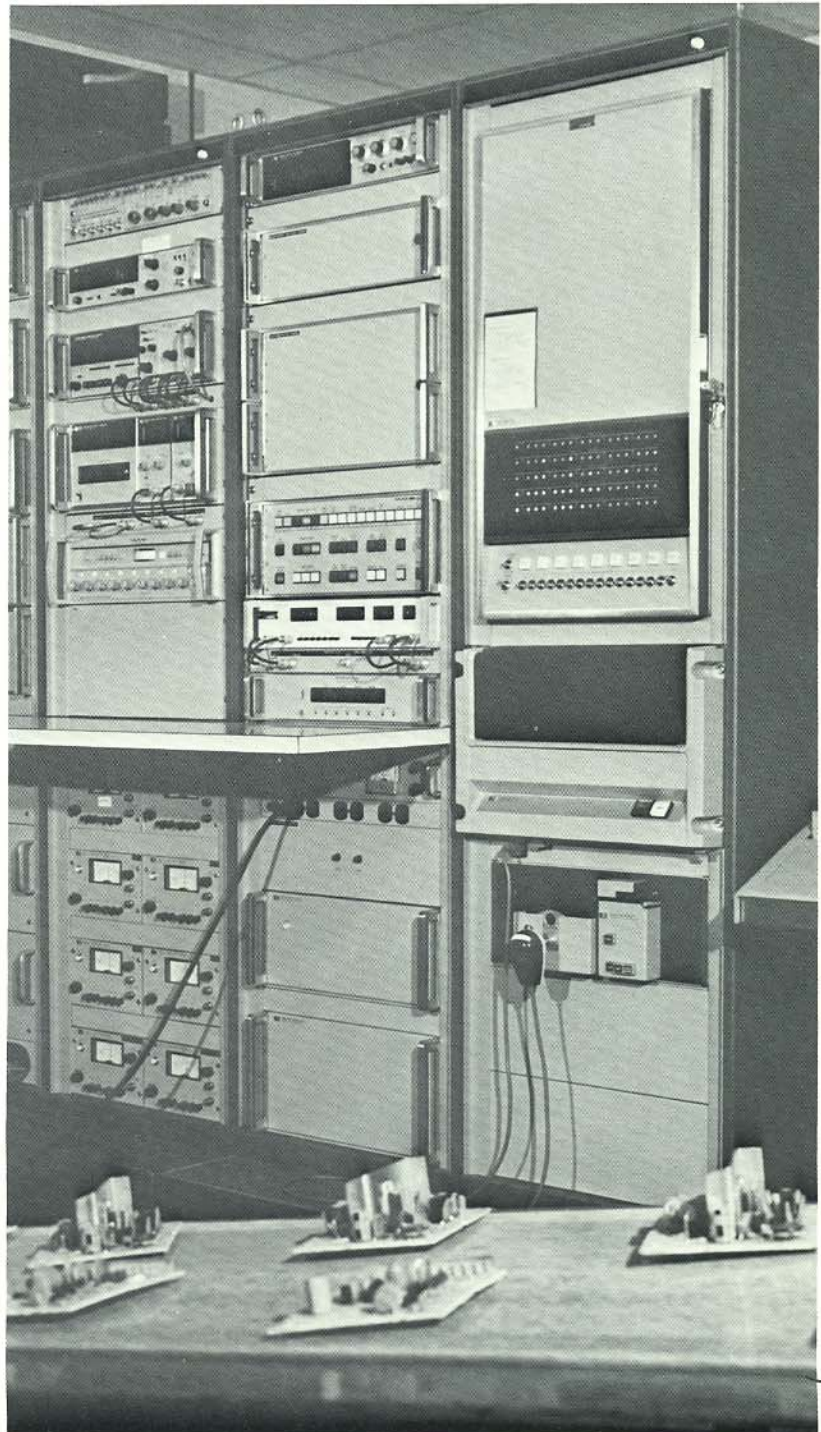**PHILCO—FORD TEST SYSTEM
TASK FORCE**

C.T. Eckert: Chief System Designer
J.L. Cicchinelli: System Designer
F. Frick: Mechanical Designer
R. Booker: Television Engineer
J.P. Pietrolewicz and M.M. Reinish:
System Analysts and Programmers

Good tested modules pass by the ATS on the way to set assembly.

HEWLETT **hp** PACKARD