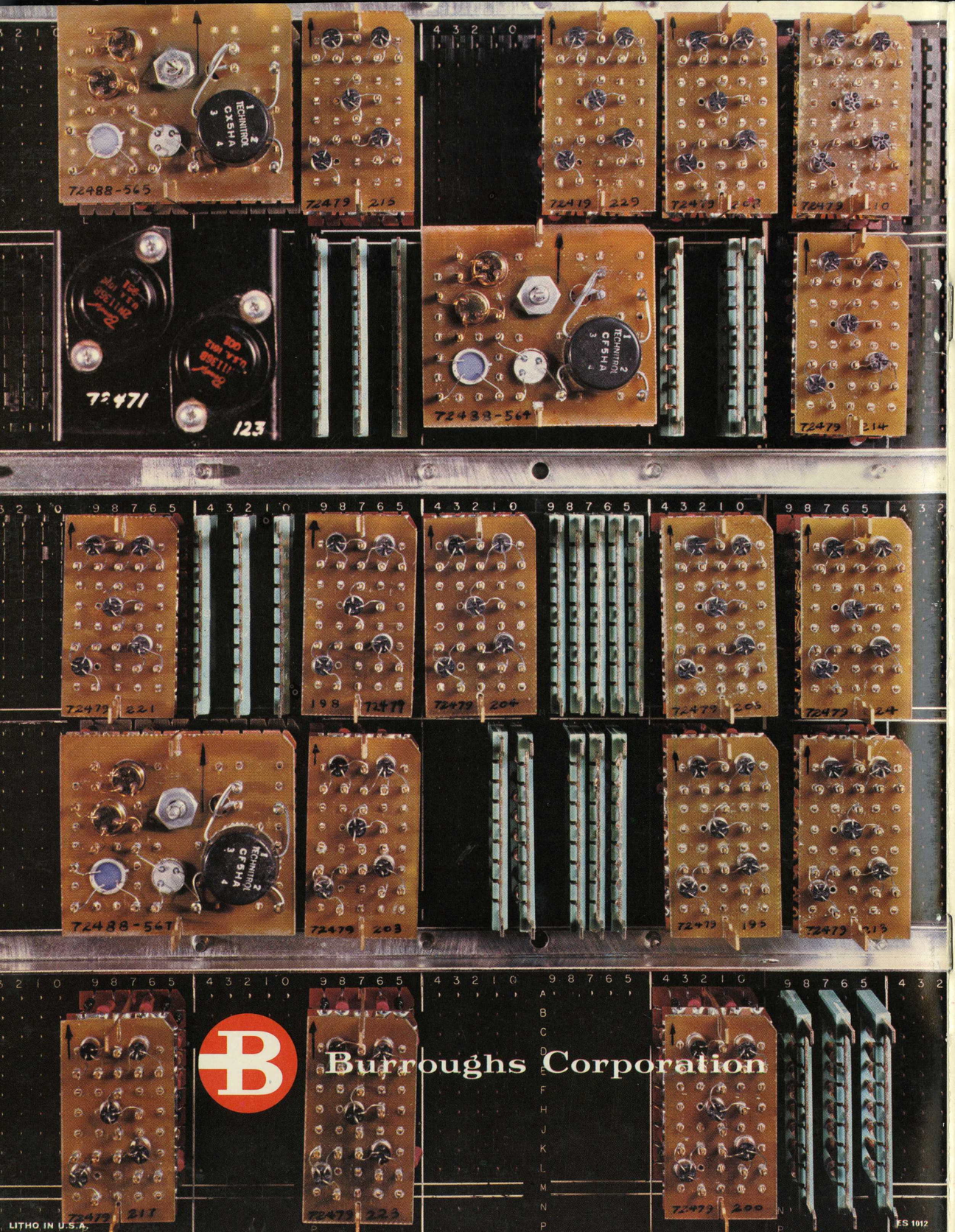
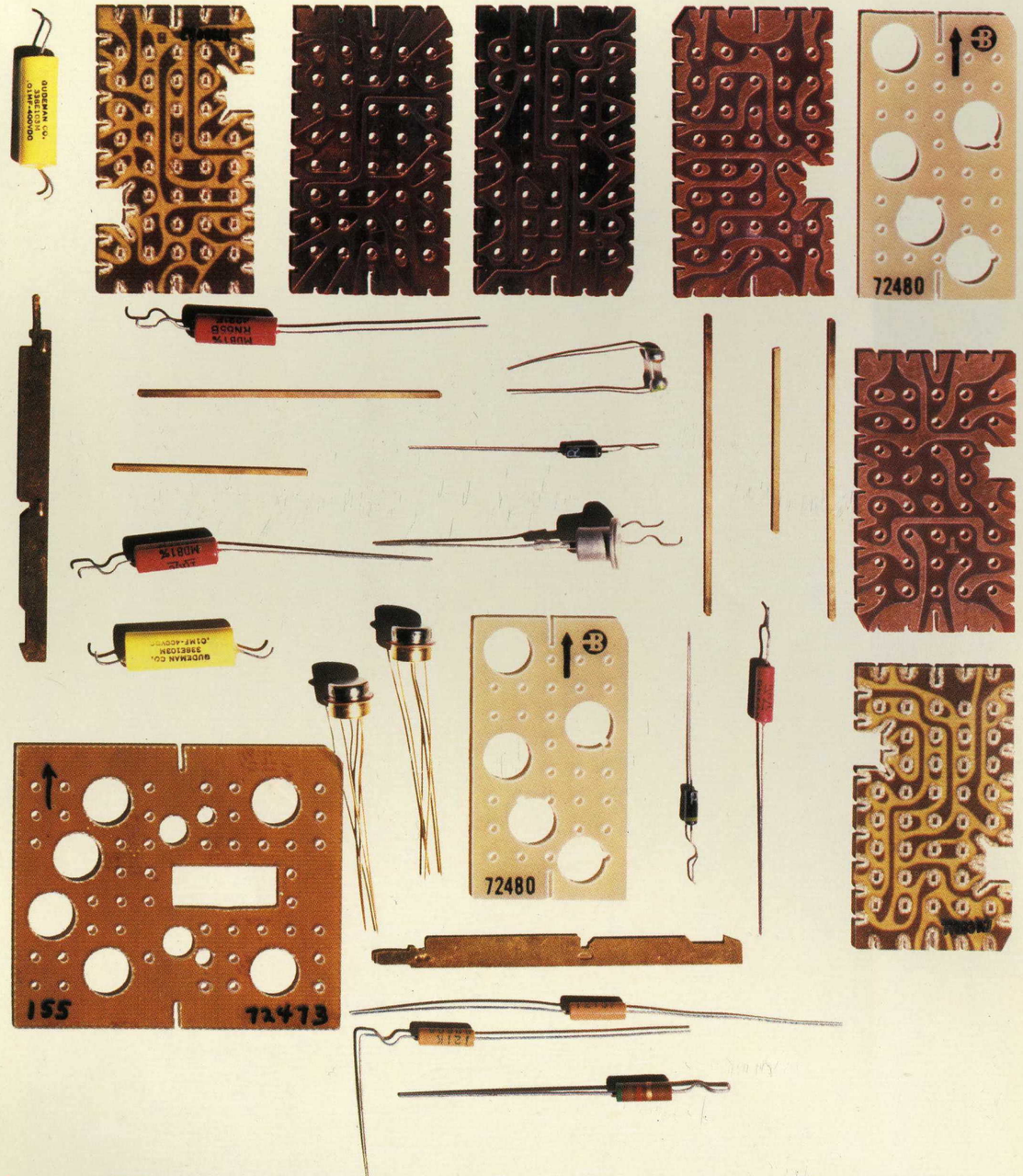
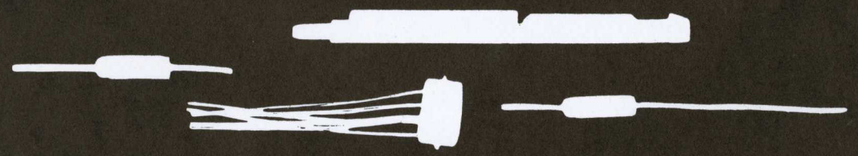




FROM COMPONENTS TO COMPUTATION

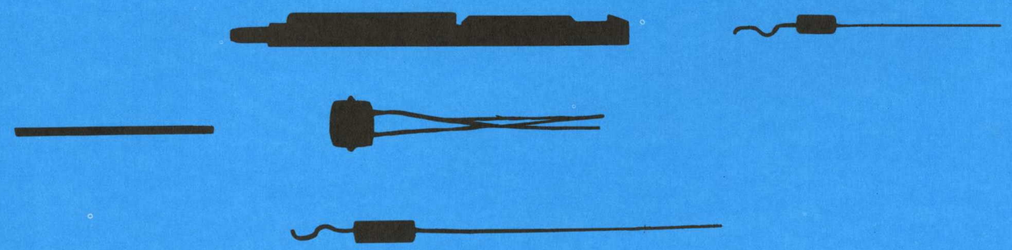
Burroughs Corporation

FROM COMPONENTS TO COMPUTATION

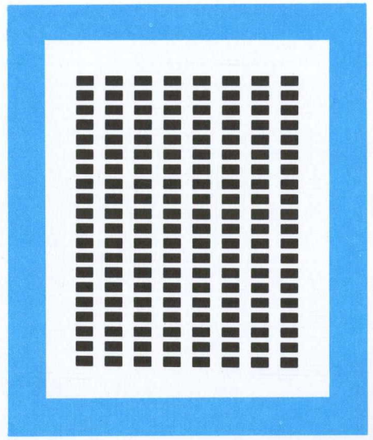


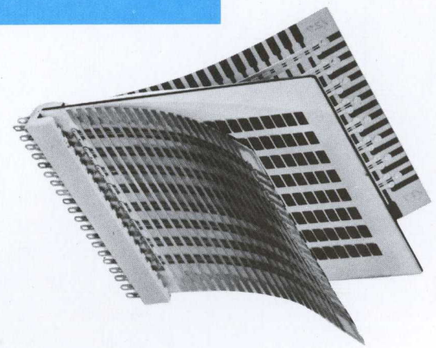
This is the story of the research, engineering, automated design, manufacturing, quality control, automatic programming, and customer services that are necessary to transform components into computation in your office.

It is also the story of how Burroughs Corporation has combined its experience and capabilities in commercial electronic data processing with advanced techniques developed in its military computer programs to produce new commercial information processing systems designed to meet the specifications demanded by experienced computer users at prices that provide new highs in productivity per dollar.

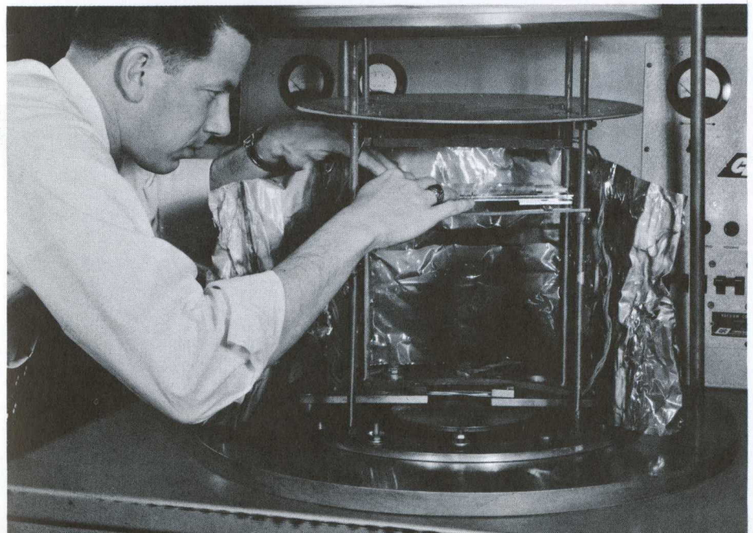


ATLAS GUIDANCE COMPUTER SYSTEM, developed and produced by Burroughs Corporation for the U. S. Air Force, provides automatic inflight guidance for the ATLAS intercontinental ballistic missile through the powered portion of its flight. This highly accurate, automatic, large-scale, real-time solid-state, general-purpose digital computer was initiated in 1955 and has been used in more than 150 missile flights and other major tasks including MIDAS, ATLAS-ABLE, THOR-ABLE, Project SCORE and is scheduled for use in Project MERCURY. It is also used in a range safety capacity for ATLAS and TITAN firings. This is just one of more than a dozen military computers and data processing systems developed by Burroughs engineers.





THIN FILM MEMORY development has progressed from basic physics research through materials research into circuits and systems. The result is an operational four-megacycle thin-film memory. Continuing development in this field will result in memories with cycle times of .2 microseconds requiring little driving power. Other advanced techniques under development include cryogenics studies and circuit deposition.



RESEARCH AND ENGINEERING

A continuous, expanding, computer-oriented research program has been in operation since the opening of Burroughs Laboratories in 1950. Basic techniques and products developed in Burroughs Laboratories include bimag cores, thin film memory planes, FLUXLOK non-destructive core memories, deposited circuits, electrostatic recording, ultra-high frequency circuit design and many others. Military products developed by Burroughs Laboratories include NADAC (Naval Digital Airborne Computer), SAGE Radar Data Processing Systems, ATLAS Ground Guidance Computer, POLARIS Submarine Stabilization Computer, ALRI Data Processor and the MAULER Computer. Building on this long record of positive accomplishment, the talented engineers and scientists at Burroughs Laboratories are currently involved in the development of new techniques which will assure Burroughs computer users of the latest hardware both now and in the future.

The responsibility of the engineering team is to transform the philosophical objectives of product planning groups into hardware that will be economical, efficient, reliable and easy to maintain, taking advantage of new techniques as they become practical.

Burroughs Corporation's computer engineering team has devoted over nine years to the design and development of commercial electronic data processing systems. This team has been first with a high-speed printer and magnetic tape on a medium-scale computer, and first with bulk random-access memory. This engineering team has total system responsibility, and approaches each component as a part of a system. Its reliability responsibilities include reliability prediction and establishing specifications for performance testing and environmental tests using the same equipment and techniques used to test the military computers.

AUTOMATED DESIGN

It is only natural that engineers designing a computer should turn to a computer to automate the detail of design.

The Burroughs engineering team uses a Burroughs 220 Computer System to automate the laborious detail of design and to check the logical and electronic consistency of the designer's work.

The picture at the left illustrates an engineer with design data coded for computer input. This data is fed into the computer where it is merged with other design data, checked for consistency and processed to produce circuit lists, wire lists and printed schematics. Punched cards for automatic input into automated wire-wrap equipment in the manufacturing operation are also produced by the computer.

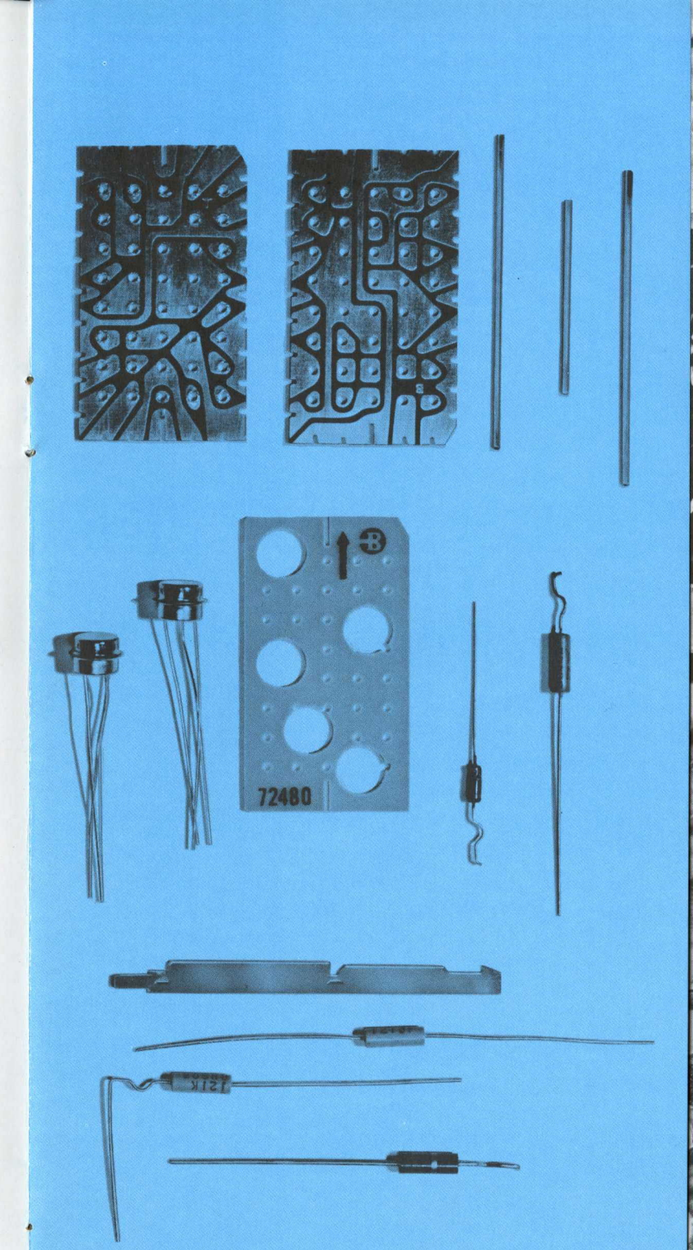
These automated design techniques free the engineer from a maze of detail and provide him with more time for creative design; eliminate changes that might occur later because of marginal electronic or logical design; assure consistency of design; assure accuracy of circuit lists, wire lists, schematics and control cards; slash the time between logical design and final specifications; assure reliability of design; and reduce engineering, manufacturing and maintenance costs.

AUTOMATED MANUFACTURING

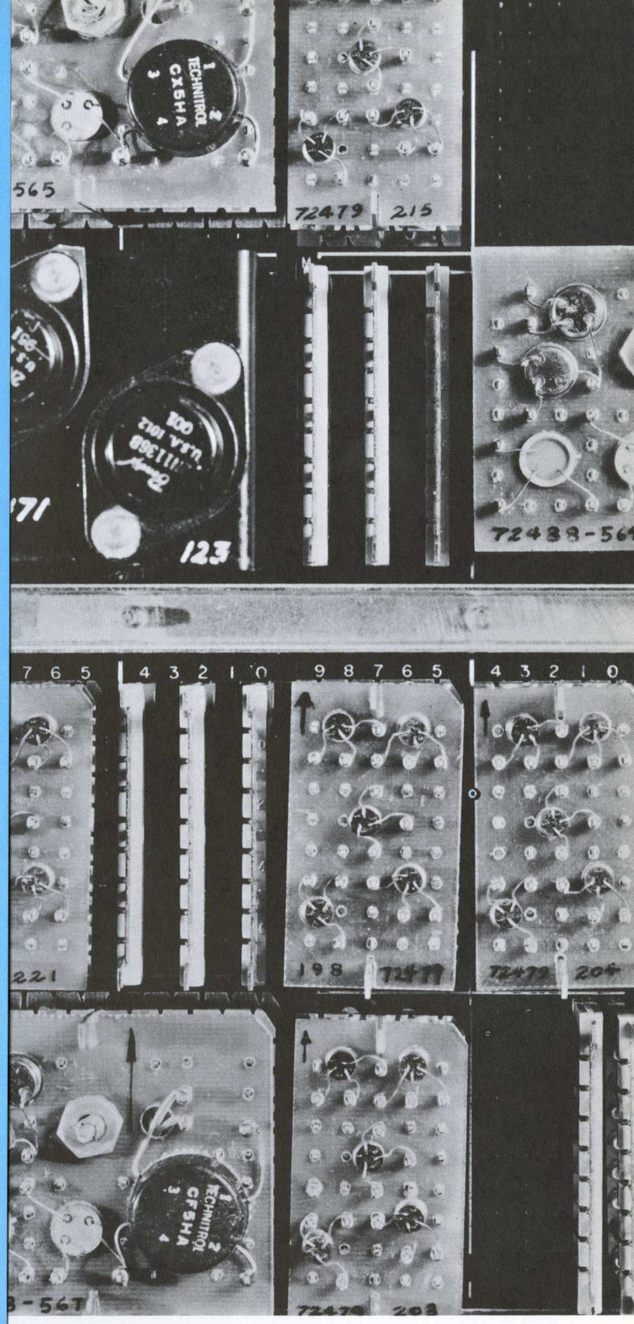
One of the major breakthroughs in the new Burroughs computers is the reduction in cost and improvement in quality achieved through automated mass-production techniques. The entire computer line has been designed to use a large volume of a relatively small number of electronic packages. This has made it possible to automate many manufacturing operations, resulting in drastically lower production costs.

But automation, alone, does not build a computer. It still takes a large number of highly-skilled experienced people to build quality computers. Burroughs Corporation has these skilled people with both commercial and military computer manufacturing experience. We also have the experience in computer manufacturing to know which jobs can be improved through automation and which cannot. As a result of this experience, we have achieved a blending of automation with hand craftsmanship to assure our customers of quality products at economy prices.

The next few pages illustrate and describe a few of these new automated techniques. The equipment you will see has been designed by Burroughs engineers or designed and built to Burroughs specifications. While it is not the complete story of computer manufacturing, it illustrates the kind of automation that results in lower cost and higher quality.

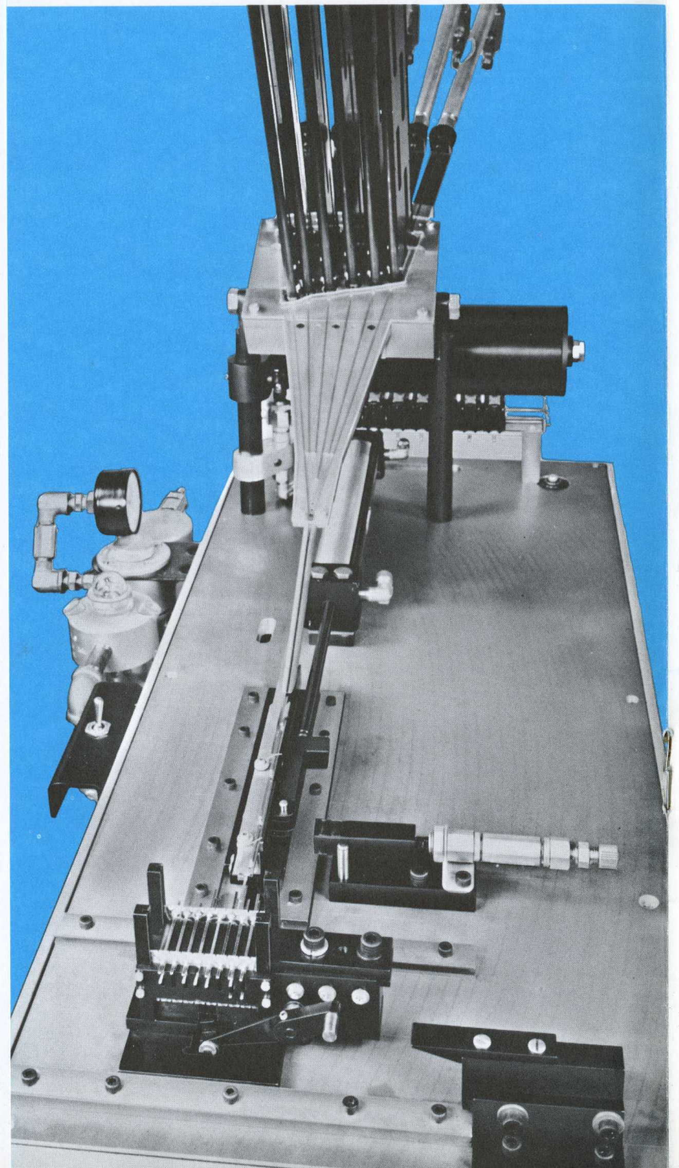


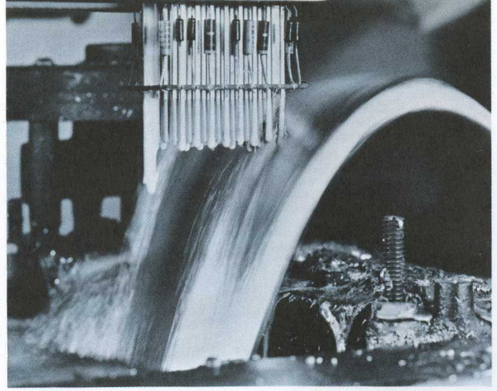
COMPONENTS AND PARTS used to manufacture typical electronic parallel-plate packages are standard, off-the-shelf transistors, resistors, etched circuit boards, contact pins, capacitors and a component card.



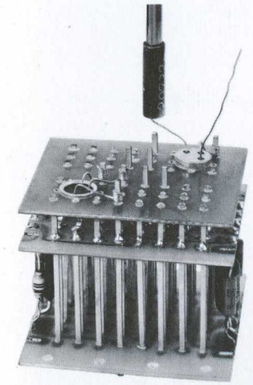
AUTOMATED MANUFACTURING

INSERTING THE CONTACT PINS into the etched circuit boards is the first step in manufacturing these electronic packages. This is accomplished automatically by the machine illustrated below. The machine automatically positions the jig and inserts the proper pins into the proper positions. Average elapsed time for the total operation is 90 seconds per package. The next step is to position the components in proper notches around the periphery of the etched circuit boards. These components are reel-fed into the component insertion machine which automatically cuts, forms and inserts the components into their proper positions. Average elapsed time is 45 seconds per package.

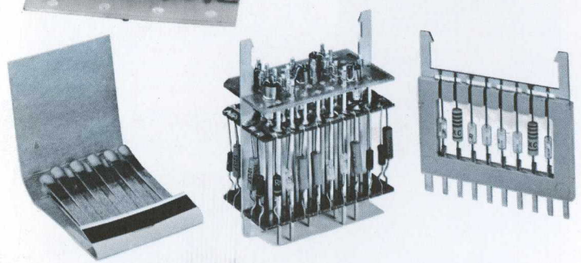




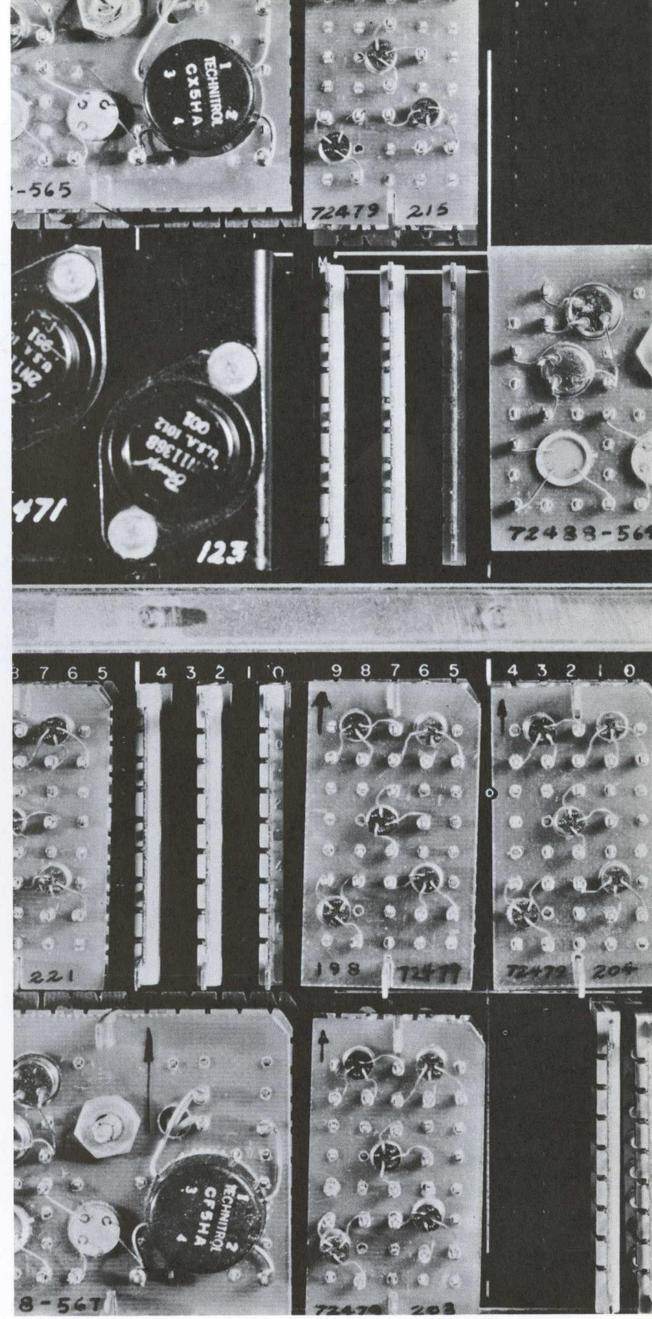
SOLDERING CONTACT PINS AND COMPONENT LEADS to the etched circuit boards is accomplished on an integrated flow solder line which performs the soldering by passing the etched circuit board into a constant action wave of solder, as pictured above. It is an automatic conveyor line operation, which performs masking, fluxing, soldering, mask removal and cleaning for both top and bottom circuit boards. This is an evolutionary step from dip soldering, offering more assurance of positive solder joints. The integrated flow solder line completes the soldering operations at a rate of 30 seconds per package.

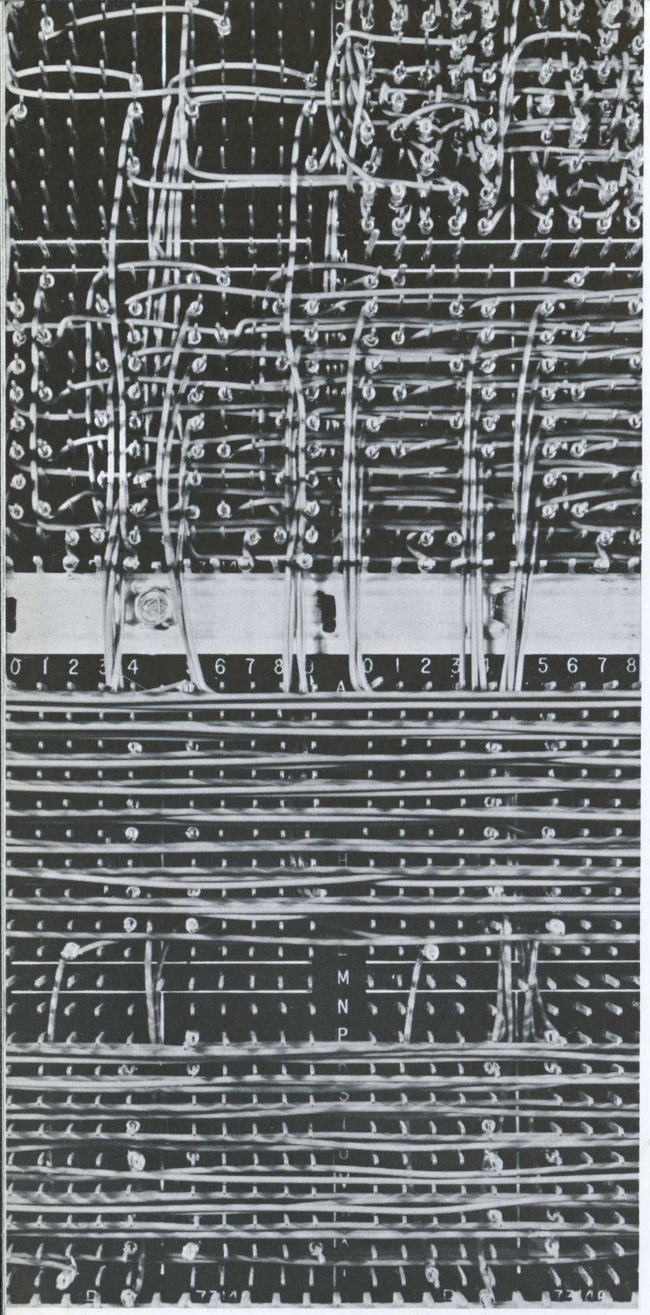


WIRE WRAPPING TRANSISTORS onto contact pins assures positive electrical connections and prevents heat damage to the transistors.



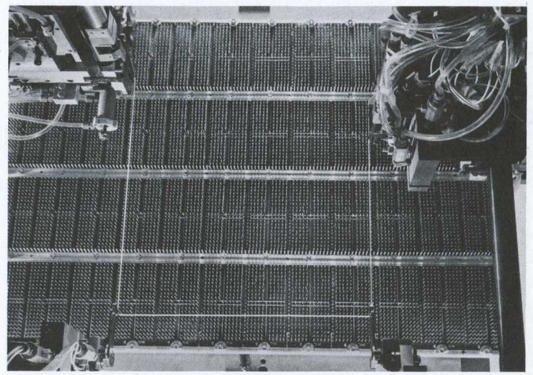
THE FINISHED PACKAGES are now ready for inspection. Each is plugged into automatic test equipment which provides complete electronic quality control. Diodes and resistors are assembled into diode and resistor sticks in a similar automatic manner and are also checked for performance with automatic electronic test equipment. The inspected packages are then sent into stock. Parallel-plate packages, diode sticks and resistor sticks are then called from stock and inserted into position on the panel as illustrated at the right.



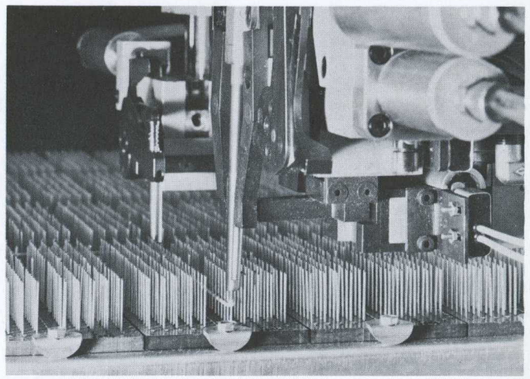


BACK PLANE WIRING, historically a manual job, involving high cost, frequent errors and slow production, is now a highly-automated operation. Part of the automated design operation produced a deck of punched cards. The data on these cards contains the path for each wire and the pin positions to which it is to be connected. These cards are fed into a specially designed, numerically controlled wire-wrap machine which automatically routes the wire into the proper path, and wraps it around the proper pins. The result is a low cost, accurate, consistent, high-speed wiring operation. *(Reverse side of this page shows the front of panel.)*

This combination of automated design and automatic wire wrapping means not only better original wiring, but provides accurate instructions for wiring changes in existing equipment.



ROUTING THE WIRE in accordance with the instructions on the punched card is accomplished automatically by a rotating turntable, two moving wire-wrap heads and two positioning fingers.



WRAPPING THE WIRE is another high-speed automatic operation. Both ends of the wire are wrapped simultaneously. Average time for routing and wrapping is six seconds per wire.

QUALITY CONTROL

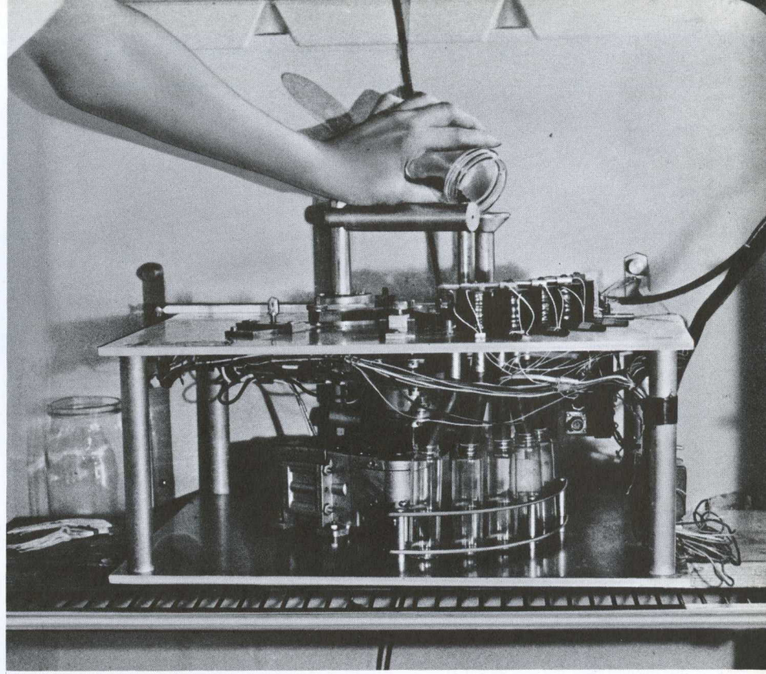
Quality control starts before manufacturing begins by monitoring the design of equipment to see that multiple sources are available for procurement of purchased components. The quality control group also works with manufacturing and engineering to aid purchasing in vendor selection. A careful and continuing process of vendor evaluation is the first step in the assurance of quality of purchased components. The second step is the testing of components to assure that they meet specifications.

The next step in quality control is visual inspection at prescribed stages of assembly. The monitoring of manufacturing continues with the use of automatic electronic equipment to test performance of electronic packages.

Another responsibility of the quality control group is a careful inspection of finished system components, plus performance testing of these components and of the total system against engineering specifications.

Burroughs Corporation's reputation for quality control has been established in over 300 commercial computer installations and 200 military installations. The ATLAS Guidance Computer, for example, has achieved a reliability of .9985, which is 450% in excess of contractural requirements. One of the ATLAS computers has over 12,400 operating hours without a single failure. Most important, there has been not one in-line component failure during ATLAS flights or in simulation and integration tests.

The same quality control techniques that have made this performance record possible have been incorporated in the new Burroughs computers.



AUTOMATED QUALITY CONTROL cannot be overestimated because in magnetic core memory production, for example, one-third of total production time is devoted to testing. Without automation, testing would take an even higher percentage of time and would be subject to the possibility of human errors.

The picture above illustrates an automatic core handler used to test individual cores. The core handler is contained in a special chamber to provide a carefully controlled environment for the cores while they are being tested to learn if their electrical characteristics are exactly as required. This automatic core handler was developed by Burroughs engineers to fill a need that could not be met by existing test instrumentation. A plane testing fixture, also designed by Burroughs engineers, checks each leaf and memory plane for broken cores and reveals any leakage between wires. It also verifies that the wires are of the correct resistance. This device can check a memory plane in 3 minutes.

SOFTWARE

Thus far in this booklet we have reviewed Burroughs Corporation's capabilities to produce superior hardware. But this is just one part of the story. Another important part of the story lies in Burroughs Corporation's capabilities for the development of programming and operating systems, such as compilers, assemblers, translators and master control programs. These systems we refer to as "software."

The first examples of software consisted of libraries of routines and subroutines developed by computer manufacturers to simplify the programming jobs of their users. Today's concept of software differs from this past concept to an even greater degree than today's hardware differs from the hardware of the early days of computers. Today's software enables the computer to accept programs in a universal problem-oriented language (ALGOL or COBOL, for example) and from these programs to generate its own machine language programs.

ALGOL (Algorithmic Language) was formulated in Switzerland in 1958 by a distinguished group of logicians, mathematicians and computer experts. Burroughs Corporation quickly saw the customer benefits that would result from implementing ALGOL with an advanced compiling system. By April of 1960, Burroughs 220 users could communicate with the computer in the algebraic notation of ALGOL. The results reported by users show dramatic reductions in programming time and cost with a high degree of program efficiency.

However, this was only the beginning. Burroughs automatic programming staff was ready to move on to faster, more efficient software techniques. But to do this they needed hardware that would be compatible with software advances. The decision was made to develop such hardware, and a team consisting of product planners, automatic programmers, design engineers and logicians was assigned to this project. The result: new computer systems which provide users with all the benefits of software techniques including increased operating efficiency and slashed programming time and cost without loss of program efficiency.

THE PROBLEM

$$X = \frac{AY^3 + BY^2 + CY + D}{LM^2 + 2N}$$

MACHINE LANGUAGE PROGRAM

LOCATION	OPERATION	ADDRESS
0500	CAD	1250
0501	FMU	1340
0502	FMU	1340
0503	STA	1665
0504	CAD	1018
0505	FMU	2316
0506	FAD	1665
0507	STA	1018
0508	CAD	1421
0509	FMU	1610
0510	FMU	1610
0511	FMU	1610

LOCATION	OPERATION	ADDRESS
0512	STA	1665
0513	CAD	2430
0514	FMU	1610
0515	FMU	1610
0516	STA	2632
0517	CAD	3100
0518	FMU	1610
0519	FAD	1542
0520	FAD	2632
0521	FAD	1665
0522	FDV	1018
0523	STA	1000

ALGOL PROGRAM

```
X := (A × Y*3 + B × Y*2 + C × Y + D) / (L × M*2 + 2 × N);
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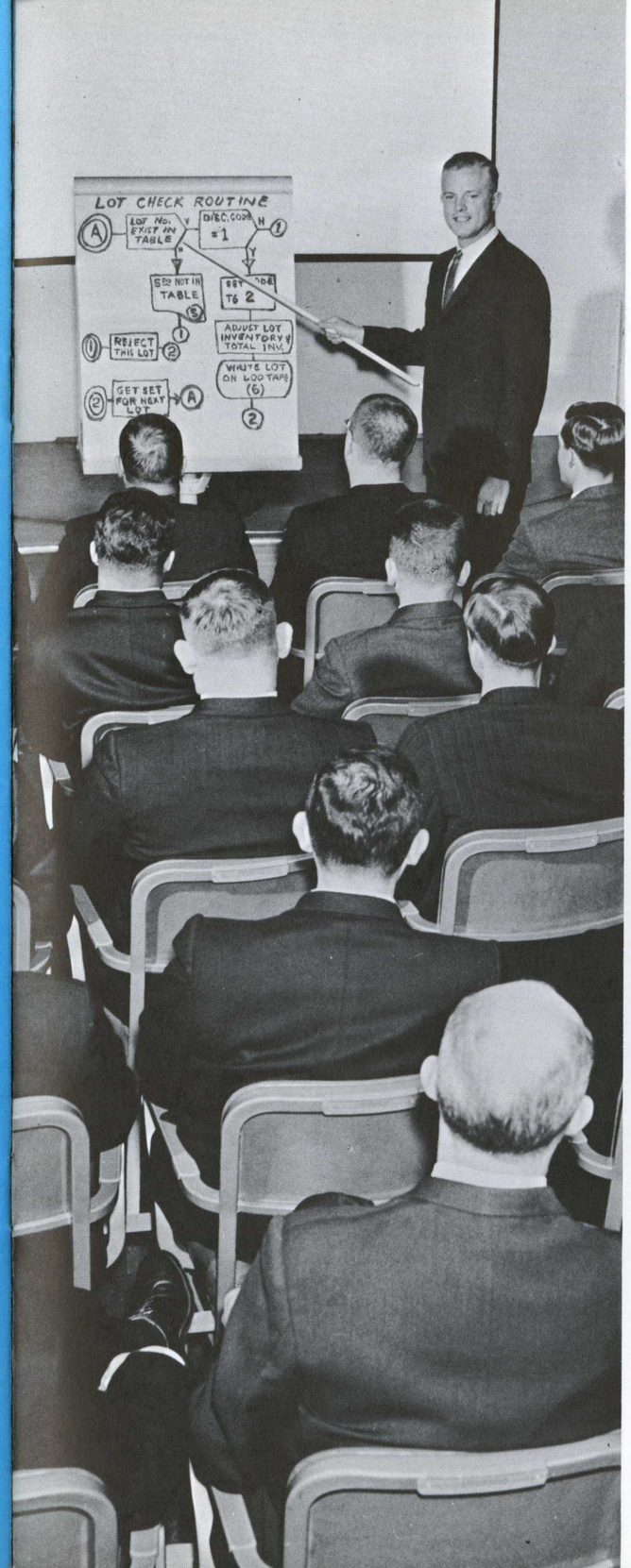


CUSTOMER SERVICES

Just as software is needed to augment hardware, so customer services are essential to translate the proper hardware-software combination into in-your-office computation.

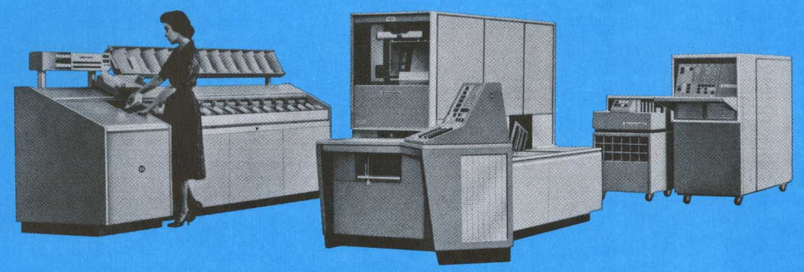
Burroughs Corporation's customer services are based on a knowledge and understanding of customer requirements gained in over 70 years' experience in serving the computational requirements of business and over 6 years' experience in the commercial computer field at over 300 commercial computer installations. The ability to provide services to meet these requirements has been acquired by experienced staffs, skilled in providing Programming Systems, Professional Services, Technical Support and Field Engineering. In fact, much of the design of the new Burroughs computers is based on the knowledge of customer requirements gained by these groups. Some of the services that these groups provide include: Program development, systems analysis, feasibility studies, applications analysis, programming assistance, customer training, installation and maintenance.

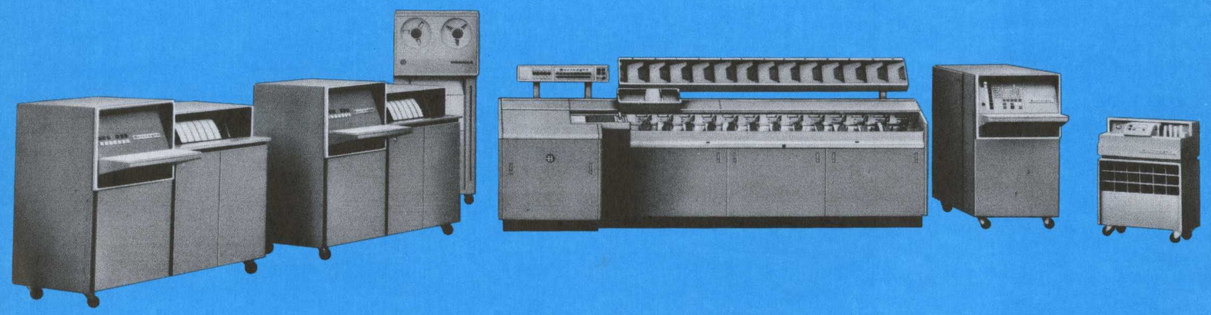
The capabilities described in this booklet have resulted in a number of new computer systems, including the B 5000, B 251 and B 272. These capabilities also form the foundation for maintaining Burroughs Corporation's position in the forefront of computer technology.

BURROUGHS B 5000 INFORMATION PROCESSING SYSTEM

The B 5000 is a medium to large scale, solid state, general purpose information processing system. It is designed from a total systems approach as a complete "hardware-software" package, incorporating the most advanced automatic programming techniques and a revolutionary approach to logic and language. The result, from a user's point of view, is a system that is easy to use and efficient in operation with maximum productivity per dollar.

B 251 VISIBLE RECORD COMPUTER A solid-state general purpose document and data processing system that combines the decision-making capabilities of a computer with the advantages of conventional hard copy records. Input can be from either magnetically encoded documents through the sorter-reader or from punched cards.





B 272 ITEM PROCESSOR Sorts magnetically encoded documents under programmed electronic control, provides a tape listing of the items in each pocket and captures data on magnetic tape for subsequent computer input. Sorts, lists and converts at speeds up to 1560 documents per minute.

BURROUGHS LEADERSHIP IN ELECTRONICS

Burroughs Corporation has led the electronics industry with many important "firsts"—revolutionary new developments that brought "space age" concepts down to earth and put them to practical use. Burroughs engineering and research have pointed particularly at smashing the cost barrier in electronic computation, to make it available to businesses in every field.

THE FIRST DESK-SIZE COMPUTER. The Burroughs E 103 was the first desk-size electronic digital computer. It was designed for use where workloads had outgrown conventional calculators but did not justify expenditure for larger computers. Unique external pinboard programming and simple input make it both highly versatile and easy to operate, and wide acceptance has resulted.

THE FIRST MEDIUM-SIZE MAGNETIC TAPE COMPUTER SYSTEM. The Burroughs 205 was the first medium-size magnetic tape computer system. More than 100 of these systems are now in use in a variety of scientific and business applications.

THE FIRST INTERMEDIATE RANGE COMPUTER SYSTEM. The Burroughs 220, a large capacity magnetic core memory computer, was the first electronic data processing system to offer the capabilities of the so-called "giants" in an intermediate price range. The reliability and high performance of the Burroughs 220 have been confirmed at many successful installations.

THE FIRST HIGH-SPEED MAGNETIC DOCUMENT PROCESSING SYSTEM. The Burroughs B 301 was the first system to employ computer speeds and automation in the processing of paper documents. It simultaneously sorts at speeds up to 1,560 items per minute, prints at speeds up to 3,000 lines per minute, records on magnetic tape at speeds up to 1,500,000 characters per minute, while simultaneously screening and evaluating the information on the documents.

COMP'UTENCE

Comp'utence is the term we use for total competence in computation and data processing. It is not a slogan but a pledge to which all efforts of Burroughs Corporation are dedicated. This pledge is possible because our entire business—past, present and future—is in the area of computation and data processing. The capabilities and equipment described in this booklet are products of Comp'utence. We invite you to investigate our Comp'utence in solving your computational or data processing requirements.

Burroughs Corporation Detroit 32, Michigan

offices in principal cities

In Canada: Burroughs Adding Machine of Canada, Limited, Windsor, Ontario