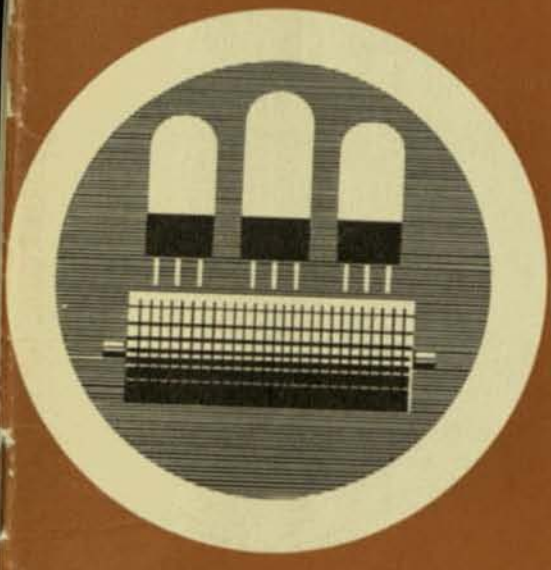
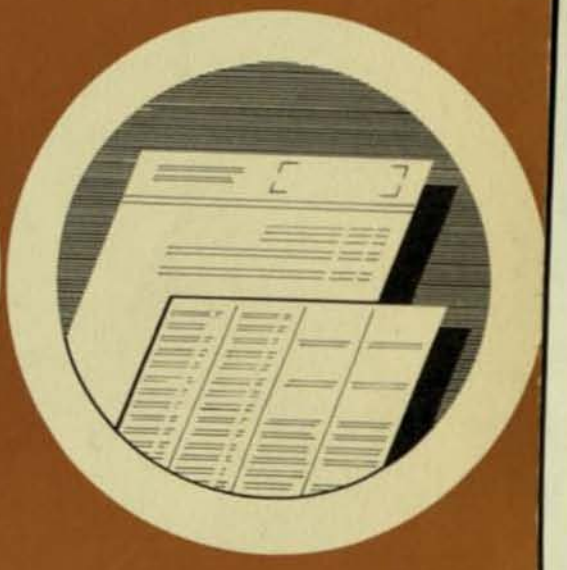
ERMA

ELECTRONIC RECORDING MACHINE–ACCOUNTING





The information presented in the following pages describes the prototype ERMA now in the laboratories of Stanford Research Institute.

Production units will have greater capacity and will be smaller in size thus reducing space, power, cooling and other requirements.

It is anticipated that automatic input will also be available, which in turn will reduce the number of operators and input stations required.

PRESENTING ERMA

WHAT IS ERMA?

ERMA (Electronic Recording Machine-Accounting) is an electronic bookkeeping machine which will handle all of the bookkeeping details for 50,000 checking accounts every working day.

WHAT ERMA DOES

Credits and debits individual checking accounts with the checks and deposits received, remembers the details of all these transactions, maintains depositors' current balances, and accepts stop payment and hold orders. If a check would create an overdraft, or exceed the free balance if there is a hold, or if there is a stop payment for the check, or if the item is not for one of the accounts handled by ERMA, ERMA flashes a warning light and will not accept the entry. Checks may be paid against overdrafts or holds only when the appropriate key is depressed by the operator.

Answers requests for depositors' current balances, prepares an activity list for all daily transactions (this activity list includes all current balances regardless of whether the account moved that day or not, and shows the date the last time the account had any activity) and totals current balances, making this list the daily proof of all of her current balances to the established controls, as well as a daily proof for all debits and credits.

Sorts the checks and deposits into account number order at a speed of 600 items a minute on an auxiliary machine.

Automatically calculates the service charges at the press of a button.

Turns out a complete printed statement for the depositors at the rate of 900 lines a minute at the end of the month, or whenever called upon to do so.

ACCURACY

ERMA cannot make mistakes arithmetically. Each item undergoes automatic acceptance tests and virtually any error is immediately apparent. Parallel or double processes insure accuracy and each step must be correct before the next step begins.

ERMA's STAFF REQUIREMENTS

ERMA needs a staff of nine operators and clerks to keep her operating at an average gait on a two-shift basis. Six operators are required on the first shift and three on the second shift. This staff includes a Supervisor-Technician who is trained to take care of all but major repairs.

TO ENABLE ERMA TO READ

Checks and deposits must be coded on the reverse side with the account number in magnetic ink. Deposit slips have an extra coded digit to indicate a credit.

ERMA'S MAIN PARTS

1. *Input Machine*—Consists of a keyboard, an electronic reading device, and sorting pockets.

The first eight columns of the specially designed keyboard are used to enter the depositor's account number manually where required. The next column is the symbol keys column to designate special types of entries. The last ten columns are used to enter the amount of the items, or for the entering of holds, or stop payments.

The sorting pockets are used for the charging of items other than depositor's checks and deposits (i.e., bank drafts, clearing checks, etc.).

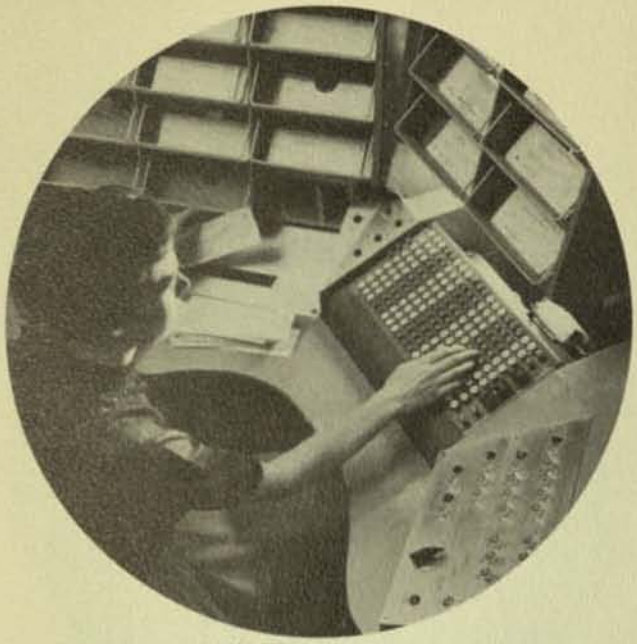
ERMA has five of these input stations which are connected to the electronic racks. All five stations can be operated simultaneously.

2. *Electronic Racks*—Consists of 24 racks arranged in 2 parallel rows, 35 feet long, 6 feet high, and 2 feet deep. One row contains the magnetic memory drums, the arithmetic units, the cross-bars and relay switching for access to the particular drum tracks, the circuits required for making entries on the drums, and the coding and decoding equipment. The other row contains circuits and switching equipment for transporting data to and from magnetic tapes and to the high speed printer. Space between the two rows of racks permits movement of maintenance and service equipment and provides access to cooling and wiring systems under the floor.

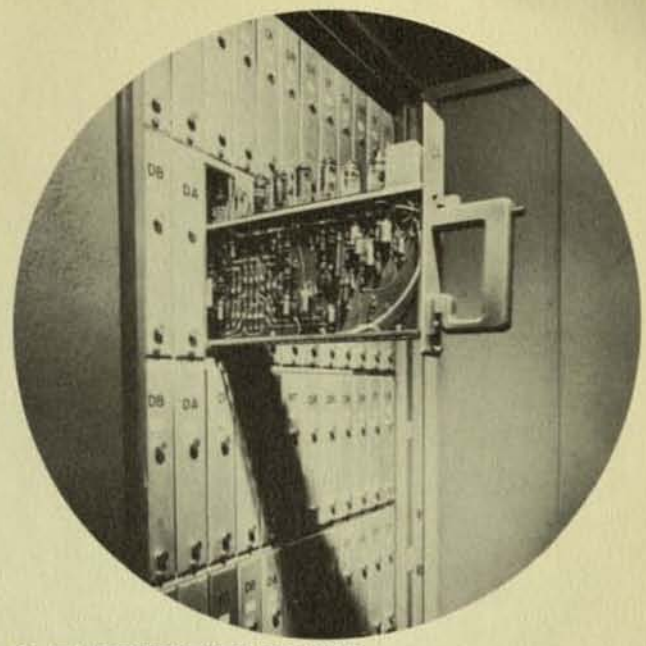
Each of the 24 racks contains an average of 84 "packages" of electronic component units.

3. *Magnetic Memory Drum*—Consists of two drums which are used to store the account numbers and current balances for all accounts, a record of the holds and stop payments, the service charge tables, and items waiting to be transferred to the magnetic tapes concerned for permanent record. The records on these drums are immediately available via the keyboards of any of the five input stations.

4. *Magnetic Tape Transports*—ERMA has twelve tape transports arranged in two rows of six each, back to back. Each transport handles 3,600 feet of magnetic tape on reels ¾ inch wide and includes all of the equipment required for operation as a separate unit. These transports are air-conditioned and humidity-controlled.

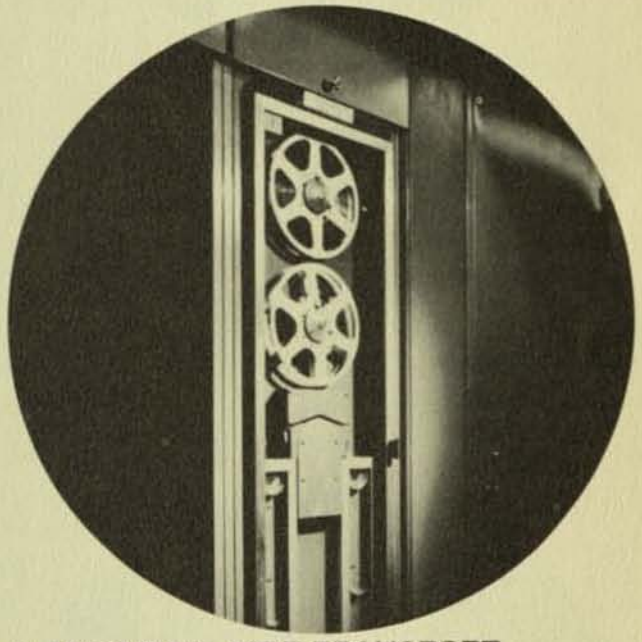


1. INPUT MACHINE

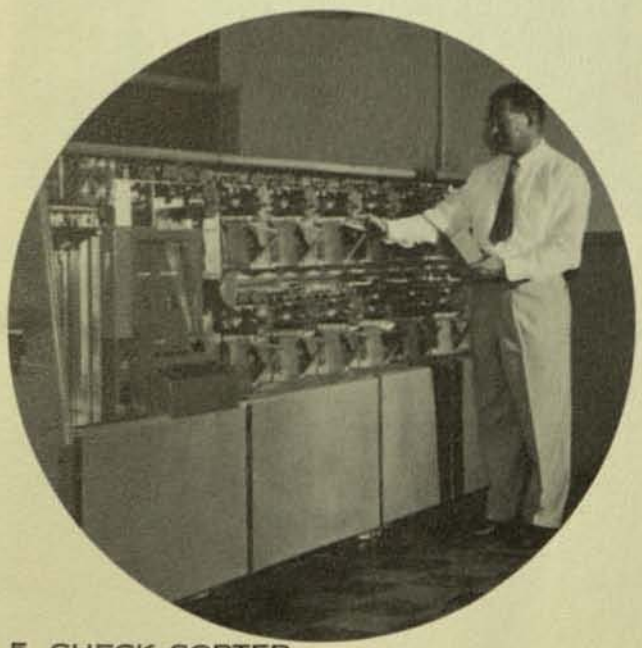


2. ELECTRONIC RACKS

3. MAGNETIC MEMORY DRUMS



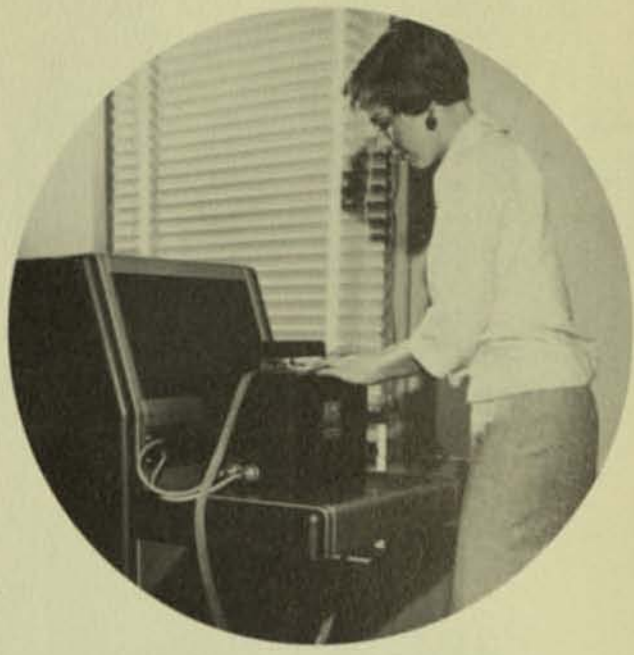
4. MAGNETIC TAPE TRANSPORT



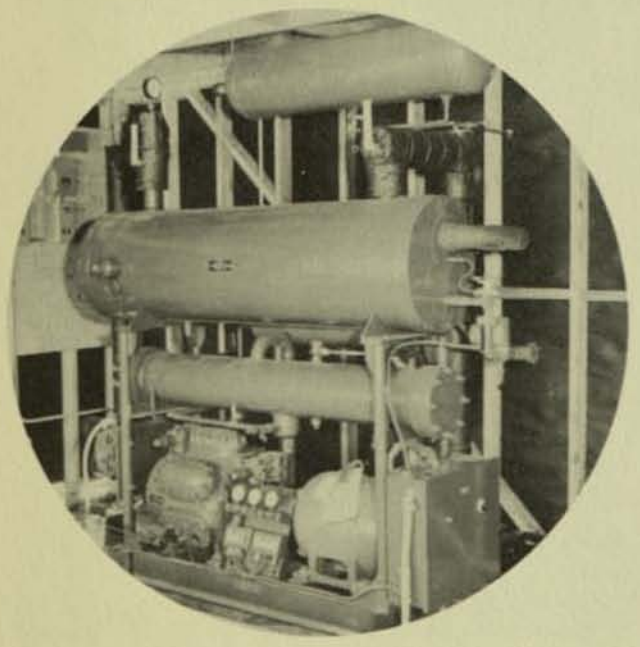
5. CHECK SORTER

6. HIGH SPEED PRINTER

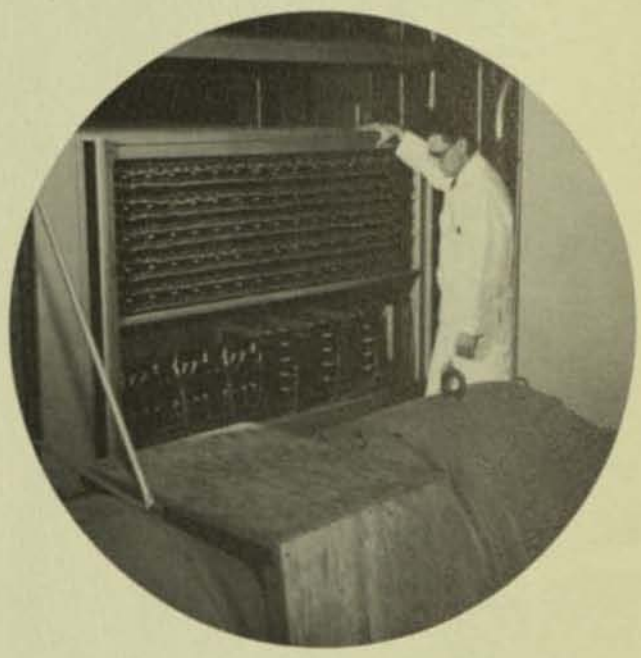
7. CONTROL CONSOLE



8. PAPER TAPE READER



9. COOLING SYSTEM



10. POWER SUPPLY

Ten of these transports are required to hold the records for all of ERMA's accounts. These records consist of the account number, the category code (type of account—commercial, "special," or dormant—and whether the account is subject to a service charge or not), name and address, as well as the current balances and all of the daily transactions for the month. These daily transactions are transferred to the tape automatically when the drum track for any one individual tape becomes full. The other two transports are used to operate the printer and for tape transfer purposes.

5. *Check Sorter*—ERMA requires one electronic sorter for her 50,000 accounts. It operates at a speed of 600 checks per minute and it is necessary to pass the checks through this sorter five times to arrange them in numerical sequence after posting.

6. *High Speed Printer*—ERMA requires only one such unit to produce her daily activity lists and to prepare the monthly statements. It will print at the rate of 900 lines per minute. An operator is required only when more paper is needed.

7. *Control Console*—This console serves as ERMA's functional center for maintenance and has lights which immediately indicate where the trouble is located in case ERMA becomes inoperative. It also provides for systematic checking of the over-all machine for preventive maintenance programs.

8. *Flexowriter and Paper Tape Reader*—

A standard Flexowriter typewriter is used for the preparation of punched paper tapes for ERMA's following operations:

Setting up names, addresses, account numbers and category codes to be inserted on the original magnetic tapes at time of branch changeover.

Daily changes in names, addresses, or category codes.

A high speed punched paper tape reader is used to transfer the information from the punched paper tapes to the magnetic tapes.

9. *Cooling System*—ERMA requires a cooling system of 25 tons to keep her innards at a tolerable temperature since she puts out heat at the rate of 278,000 Btu's per hour.

10. *Power Supply*—ERMA requires 80 kilowatts of power. A motor-alternator is used to govern the flow of power and to protect ERMA from line voltage variations. ERMA must use DC power, and special converters are used to break down the power into six different ratings for ERMA's differing functions.

ERMA'S STATISTICS

TECHNICAL HIGHLIGHTS

ERMA has approximately 8,000 tubes, 34,000 diodes, and 1,000,000 feet of wire. She has 1500 electronic "packages" of 25 different styles.

The number of decimal digits stored on the drums is 600,000—300,000 on each drum. Each tape has a storage capacity of 4,500,000 decimal or alphabetical digits and there are 10 active tapes per ERMA.

SPACE AND HOUSING REQUIREMENTS

ERMA requires an area of approximately 4,100 square feet.

ERMA is no lightweight, the floor must be able to support 100 pounds per square foot. Under the floor is a honeycomb of ducts and conduits, of wireways and pipes for the cooling system (which must maintain the "packages" of electronic circuits in the racks at stable temperatures) and for the main power distribution and inter-rack wiring.

HOW MANY ERMAs?

The Bank of America's program contemplates 37 ERMAs to be located in selected areas throughout California, each to serve the group of branches in that area.

The first ERMA is to be installed in San Jose after all of her tests have been made in her temporary home at the Stanford Research Institute, Menlo Park, California.

WHO DEVELOPED ERMA?

The research work and actual construction of ERMA was done by the Stanford Research Institute, Menlo Park, California, under an agreement with the Bank of America who drew up the specifications of what ERMA should do. The program started five years ago.

WHO IS TO MANUFACTURE ERMAs?

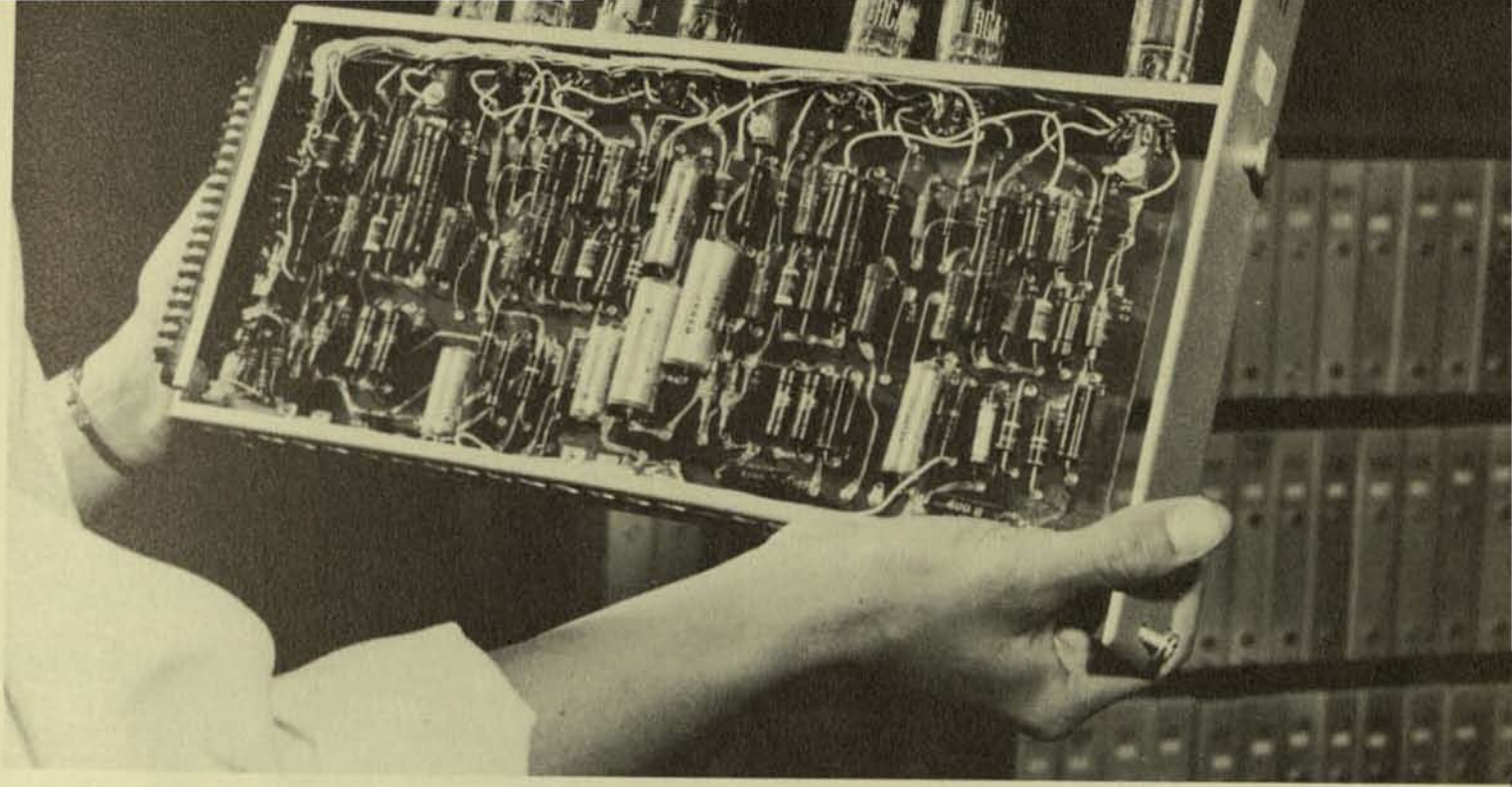
This question has not yet been settled. Negotiations are now in process with several manufacturers.

WHAT WILL FUTURE ERMAs COST?

This question will have to be answered by the ultimate manufacturer.

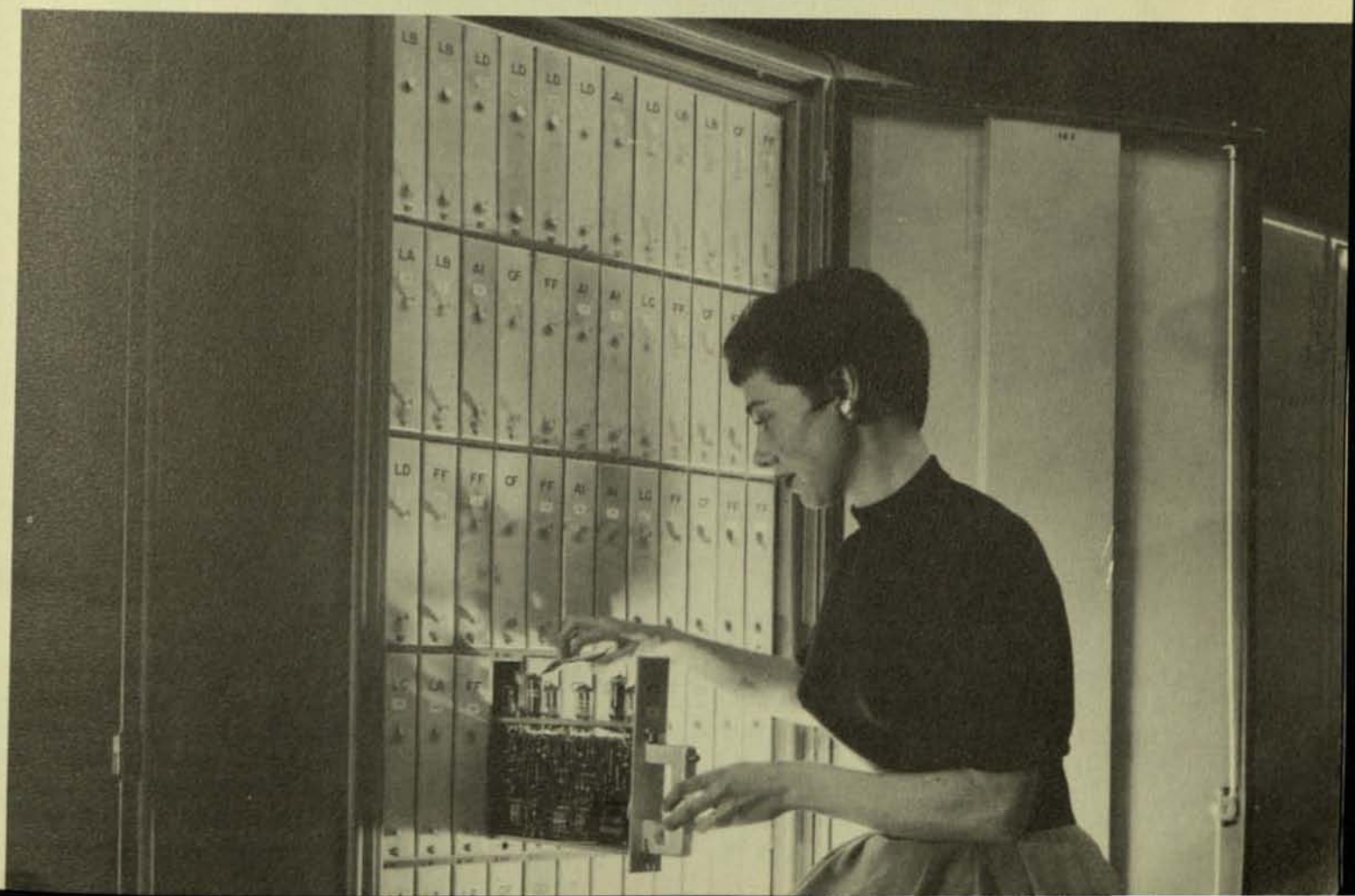
WHAT WILL ERMA SAVE?

This cannot be determined until the sales price has been set by the manufacturer, and will vary from bank to bank as individual costs vary according to present systems used and other factors.

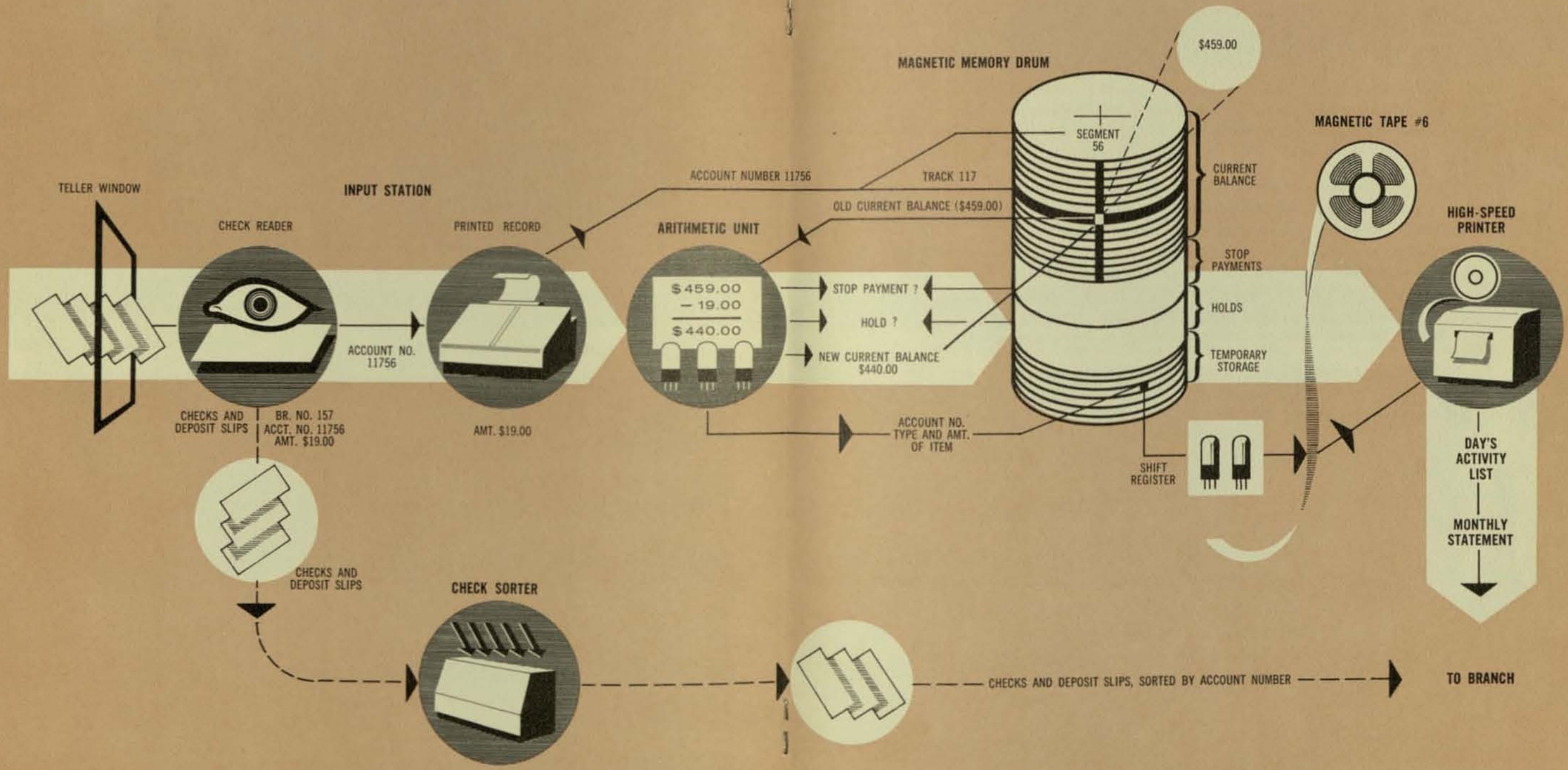


ELECTRONIC PACKAGE

ELECTRONIC RACKS



HOW ERMA FUNCTIONS



This chart illustrates the processing of checks and deposits by ERMA. The physical check or deposit takes the path of the dotted line; the information from it follows the solid lines. Checks and deposits are received in the normal manner by the ERMA operators. Assume, as a typical case, a check for $19.00 issued by A. Brown, whose account number is 157 11756. The first three numbers (157) identify the branch where Mr. Brown has his account. To perform the bookkeeping for this check the operator simply enters the amount of the check in the input machine keyboard, drops the item into the reader slot (where the account number is read electronically), and depresses the entry bar. ERMA thereupon looks up the old current balance for this account number, and delivers that sum to the arithmetic unit. ERMA also determines at this same time if there is a stop payment order against this check, or any holds against funds in this account; if none, the subtraction of the amount of the check is made from the old current balance by the arithmetic unit. The new current balance is then recorded on the current balance section of the magnetic drum and the item details are stored in the temporary storage section of the drum. Later these details are automatically transferred via the shift register to the magnetic tape concerned where all information for this account for the current month is held in sequence in the space assigned on the magnetic tape. At the end of each day an activity list for all accounts is printed on the high speed printer which will show Mr. Brown's account reduced by $19.00 as well as the listing of the item itself. At the end of the month the account details for Mr. Brown's account are read from the magnetic tape by the high speed printer which prepares his monthly statement.

These activity lists and statements as well as the checks and deposits which have been sorted into account number order are returned to the branch for preparation and delivery to the depositors.

OPERATING DETAILS

CHANGE-OVER

Before the actual change-over date for the branch or bank, all accounts must be assigned an account number. No endeavor is made to keep the accounts in alpha-numerical order. As the accounts are opened they are assigned the next available number. An eight-digit account number is used, with the first three digits representing the branch number.

Checks and deposits imprinted with the depositor's name, address, and account number on the face, and coded with the account number in magnetic ink on the reverse, must be issued to all depositors before the change-over date.

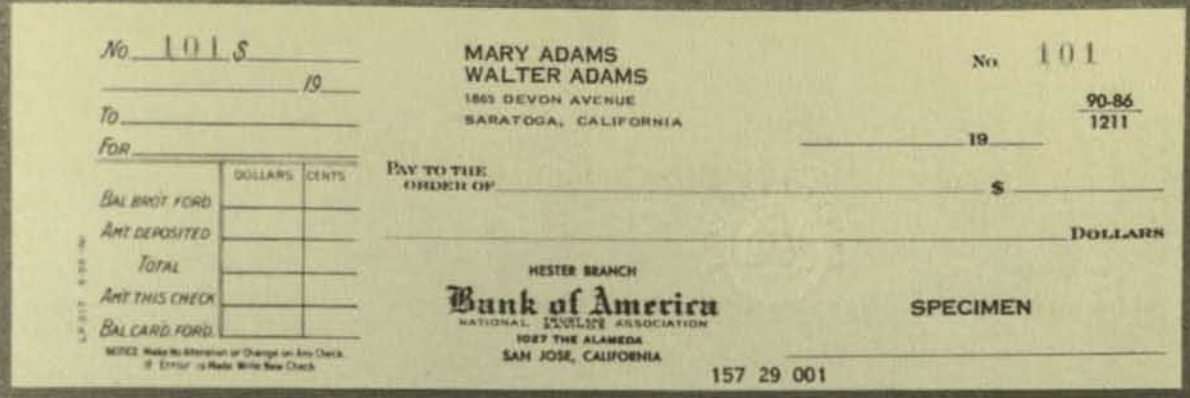
A Flexowriter punched paper tape is prepared for all accounts, before the change-over date, showing the account number, name, address, category code, and approximate number of entries monthly for each account. This information is transferred to the magnetic tape by the high speed, punched paper tape reader. Address changes, category code, and changes in names must then be kept up to date on the magnetic tape so prepared. These changes are made through the Flexowriter punched paper tapes to the magnetic tapes.

On change-over date the account numbers and current balances are entered on the drum through ERMA's input stations. At the press of a button ERMA then posts the balances recorded on the drums to the appropriate accounts on the magnetic tapes, and the conversion is completed. All holds and stop payments existing on the accounts when transferred must also be inserted on the drum through ERMA's input stations. This operation is performed as follows:

Holds: The account number and amount is inserted on ERMA's input machine keyboard and the "Enter Hold" key depressed.

Stop Payments: The account number, check number, or date of the check if the check has no number, and the amount, are inserted on ERMA's input machine keyboard and the "Enter Stop Payment" key is depressed.

This same procedure applies for new holds or stop payments received. When a release of a hold or stop payment is desired, the same procedure as above is followed except that the "Remove Hold" or or "Remove Stop Payment" key is depressed.



CHECKS (FRONT AND BACK) FLEXOWRITER

DAILY ENTRIES

Items received from branches or from other banks will be entered through any of the input stations in random order as received. The amount is set up manually on the input machine keyboard, the item (credit or debit) dropped into the reader slot where the account number is read automatically, and the item is charged or credited to the account concerned.

If there is a hold on the account and the check would exceed the free balance, or if there is a hold for the amount of the check, a stop payment for the check, or the check would overdraw the account, a warning light notifies the operator of the exact condition and ERMA will not accept the entry. If, for any reason, the item is to be paid, the operator will depress a special "Override" key.

An item will also be rejected if the branch number, as shown by the first three digits of the account number, is not one assigned to ERMA.

If the item does not bear a coded account number, the account number is entered manually on the input machine keyboard and the item dropped in the reader slot. A symbol is set up on the magnetic tape automatically for a manually entered account number, so that when the branch receives the daily activity list, this account number can be checked for the item concerned to see that it was entered correctly by the input machine operator.

The input machine has a master paper tape (in duplicate) which shows the account number, a symbol (if any), and the amount of each entry.

Clearing items, cashiers checks, money orders, etc., received in the in-mail or in-clearings will be handled in the same manner, except that they will be put in the "rack" pocket concerned and will be charged automatically to the pocket in which they are placed. Rejected items will be handled in this manner also.

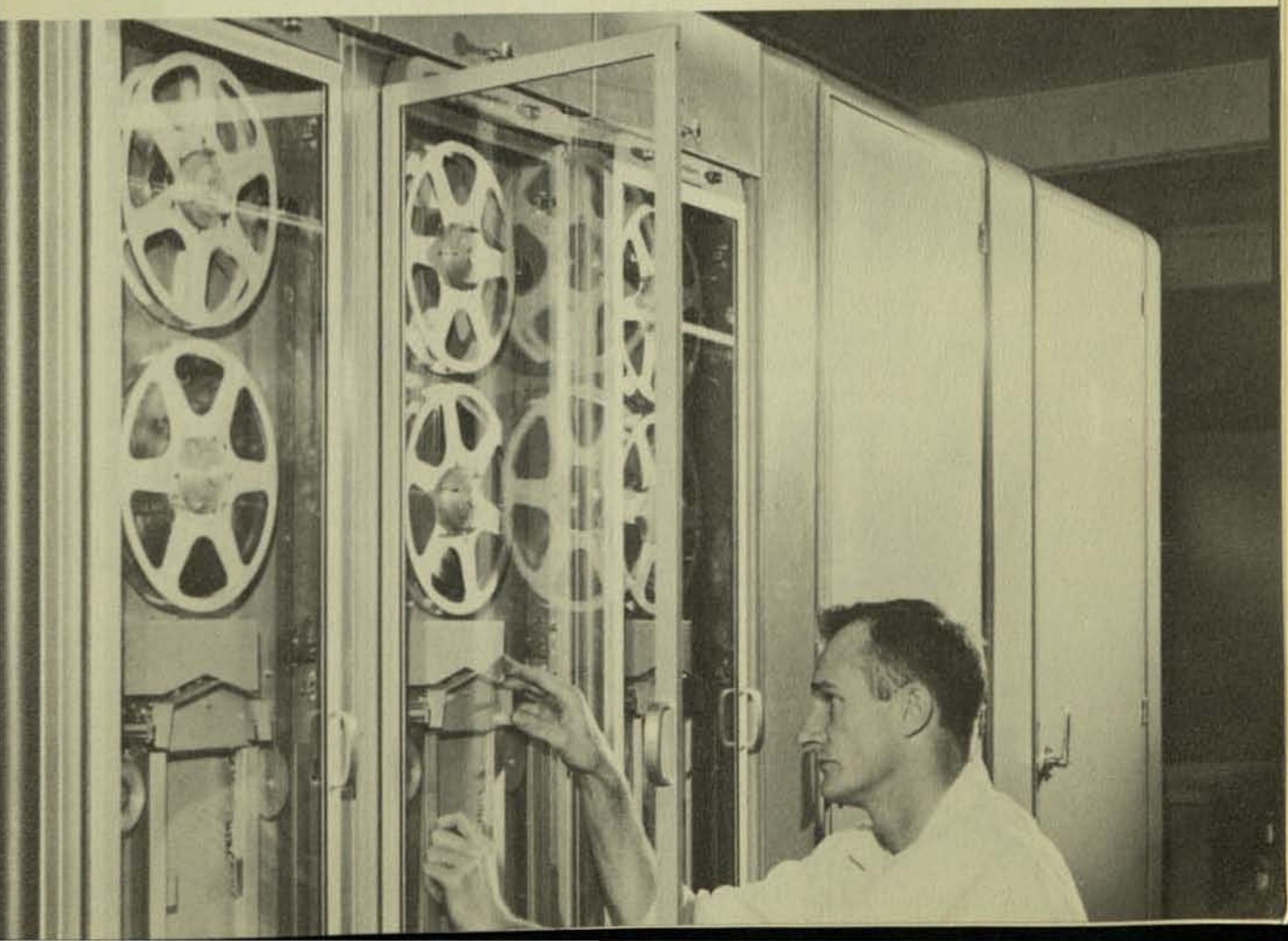
The items entered into the input machines must balance with the tape totals received from other branches or banks. If an error in amount is made by the input operator, the item is reversed, using a special symbol to so indicate. The item is then handled for the correct amount as a new entry.

FLOW OF DAILY ENTRIES

The amount which has been inserted on the keyboard, and the account number which has been read electronically, or entered manually, are referred to the drum where the corresponding account number is locted; the amount is checked with the current balance to be sure that an overdraft is not created, and is checked for a hold or stop payment. If no such limiting condition exists, the amount of the item and the current balance are then taken to the arithmetic unit where the check is subtracted from (or if a deposit, added to) the current balance. At this point a new current balance is obtained, and this new balance is substituted for the old current balance on the drum.

INPUT KEYBOARD

MAGNETIC TAPE TRANSPORTS



The amount of the item itself is sent to a temporary storage section of the drum where it is stored in random order on the "track" for the magnetic tape to which the account number belongs. When this track becomes full, a spare track is called upon while the entries on the full track are being transferred to the magnetic tape concerned. This transfer is done automatically, and does not interfere with the normal machine operation. The magnetic tape concerned starts with the first account number on its tape, and as the drum spins around, the tape asks the drum, "Do you have any items for account number 1?" If the drum says, "No," the tape moves to the next account, repeats this question and if the drum says, "Yes," the items are transferred from the drum to the tape and the operation continues until completed.

At the end of the day, after all of the items have been entered into the input stations and all of the items transferred from the temporary storage on the drums to the tapes, a proof operation is begun. ERMA's arithmetic unit picks up the old balance from the magnetic tape for each account that moved that day, adds and subtracts the deposits and checks, and arrives at a new current balance. The current balance for each account is transferred from the drum to the tape and this balance is checked against the new one.

Also during this proof operation, tape lists are run for the items charged to the input machine's rack pockets. Similarly an activity list is run for all the day's transactions, showing the account number, items (debits and credits), and the new current balances. If an account did not have any transactions on this day, the date of the last movement is shown as well as the current balance.

Subtotals are taken after each 100 accounts, and totals are taken after each 1,000 accounts for the checks, deposits, and current balances. A grand total is taken for each branch, which becomes a daily proof of the items and balances.

This list is run in duplicate and the original is forwarded to the branches concerned with the checks and deposits. The branches pay the signatures, cancel, and file the checks. The list is retained by the branches for their records and is also used for checking of depositors' balances where necessary.

An overdraft and zero balance (closed account) list is also run daily, for each branch, and forwarded to the branches concerned.

The items themselves are removed from the input machine's reader pockets (other than those which are stored in the rack pockets) periodically during the day. At the end of the day they are processed through the sorter and returned to the branches with the daily activity lists, as previously stated, in account number order.

All items for each account are kept on the magnetic tapes for a month. On the close-off date for the branch concerned, service charges are calculated automatically for each account, the amount so calculated is posted to and deducted from the current balance, and a new current balance is inserted on the tape. A list is run of the service charge amounts and the account numbers so charged and is returned to the branch.

Statements are then prepared in duplicate. These statements and ledgers are printed from the magnetic tapes on the high speed printer. At the time the statements are run on the printer, ERMA also counts the number of debit items and prints this number on the statemen and ledger copy for comparison with the number of items in the check files. The statements and ledgers are then mechanically separated and returned to the branch. The branch prepares the statements for delivery to the depositors and retains the ledger copies for their permanent records.

SPECIAL STATEMENTS

If a depositor wishes a statement at any time other than at the branch's regular statement close-off date, a special request is forwarded by the branch, the statement is prepared on the high speed printer, and is returned to the branch the next day. Where this is a weekly or monthly occurrence, a file is maintained at the ERMA office and statements prepared as called for. When a special statement is prepared, the magnetic tape is automatically marked to this point, and the next statement is prepared from this point only to the regular closing date.

CURRENT BALANCES

A current balance can be obtained at any of ERMA's input stations by depressing the account number and the current balance key. The balance will be shown on the input machine's paper tape or on a slip inserted into the input machine.

TYPES OF LISTS AND RECORDS OBTAINABLE FROM ERMA

1. Daily activity list (items and current balances)
2. Daily list of items for "rack" pockets
3. List of daily changes in names or addresses
4. Daily overdraft and closed account list
5. List of holds and stop payments by account or by branch
6. List of account names and addresses by branch
7. List of service charges by branch
8. Monthly statements
9. Special statements
10. List of unassigned account numbers by branch
11. List of dormant accounts
12. List of accounts where service charges are waived
13. List of activated account numbers ready for assignment
14. Current balances
15. Tape maintenance print-out
16. Drum maintenance print-out

SERVICE CHARGES

Up to five service charge rate tables can be set up in ERMA's memory. The appropriate table will be selected as indicated by the account category code when the service charges are calculated.

In calculating the service charge, ERMA checks the category code, finds the minimum balance, selects the table concerned, counts the number of items applicable to charge, calculates the charge, inserts the amount on the magnetic tape, and changes the current balance on tape and drum. At the same time she runs a list of the charges showing the account number and amount of charge.

CLOSED ACCOUNTS

Each branch receives a closed-account list daily, and if the branch wishes the account number to be de-activated (closed), it will so notify the ERMA office.

OVERDRAFTS

The items which would cause an overdraft are returned to the branches by the ERMA office with the daily activity list for approval or rejection by the branch officers. Attached to these items is a slip showing the current balance and a list of the holds (if a hold was the reason the item would create an overdraft).

The items rejected are returned by the branch in the regular manner.

The items to be paid are approved by an officer and returned in a special envelope to the ERMA office with a cash letter attached. Upon receipt of these items by the supervisor at the ERMA office they are posted to the accounts in the regular manner, except that the overdraft override key must be depressed before ERMA will accept the entry.

DORMANT ACCOUNTS

The transfer of accounts to dormants is handled in the same manner as at present.

When the entry is received at the ERMA office, the account is closed, and a Flexowriter entry is made. This Flexowriter entry puts a special category code after the account number to show that this account number is dormant. If an item should be entered for this account number, ERMA will notify the operator by a warning light that the item should be returned to the branch for entries to be made to activate this account number.

TAPE TRANSFERS

At the end of the month after the statements are run for each tape, the following information is transferred to a new tape:

1. Account number
2. Category code
3. Name and address
4. Current balance
5. Date of last movement

During this transfer operation, the amount of space needed on the new tape for each account is calculated automatically from the space used for the account on the old tape, plus a safety factor. The old tape is filed for a given period, and then the information is erased therefrom and the tape reused.

Provision is made for automatic transfer to a new tape if, at any time during the month, more space is needed for any account on the tapes.

TENPLAN ACCOUNTS

SPECIAL CHECKING ACCOUNTS

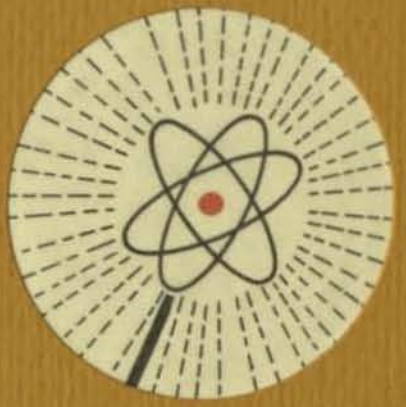
These accounts carry a special account category code because the charge for the checkbook is collected at the time the book is sold to the depositor. Therefore, no service charge is to be calculated on these accounts.

A supply of checkbooks is imprinted for each account and is kept in a special file by account number at the branch, for sale to the depositors when requested.

January 1956.

BANK OF AMERICA
NATIONAL TRUST AND SAVINGS ASSOCIATION
CALIFORNIA

Welcome To ERMA



Welcome To ERMA

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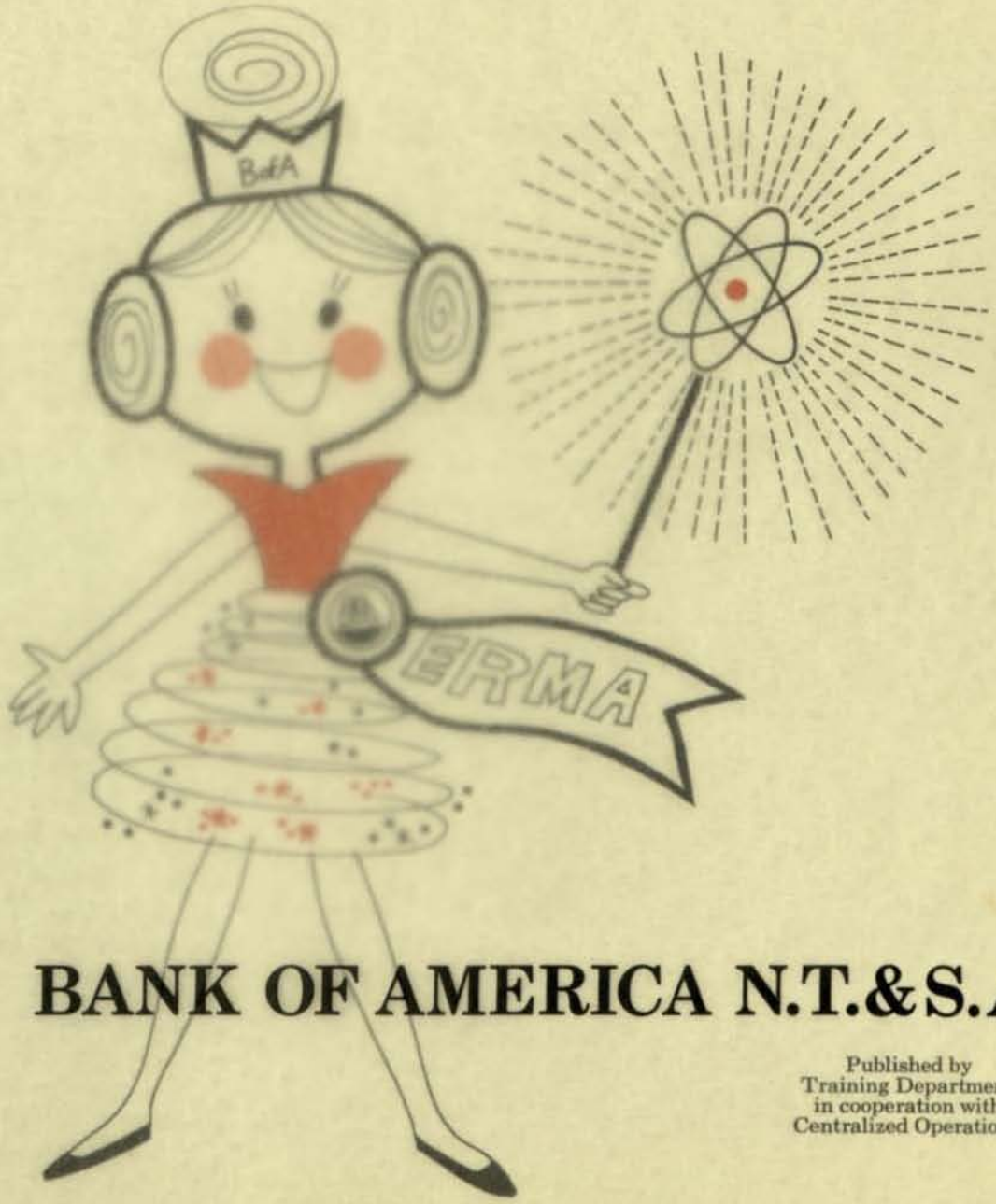
As a BankAmerican, you are part of a total team of more than 27,000 employes of the largest bank in the world...a bank built by A. P. Giannini for the many, rather than the few.

You are now a banker—and while you won't be in direct contact with customers, your position is as important to good customer relations as a branch manager, a lending officer or a teller.

WELCOME ABOARD!



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Like any girl, ERMA is somewhat mysterious. Sometimes she is baffling – particularly when we don't know all her capabilities.

What is ERMA?

In general, ERMA is a system of electronically connected units which automatically process all bookkeeping details to post and balance checking and savings accounts.

Specifically, the ERMA system is a combination of people and electronic equipment. Over *600* BankAmericans are working together in thirteeen Centers every night to help ERMA perform her bookkeeping chores. And, she performs these duties at the rate of 33,000 accounts per hour.

ERMA means *E*lectronic *R*ecording *M*ethod of *A*ccounting.

ERMA is manufactured by the General Electric Corporation for the Bank of America. She is an electronically efficient bookkeeper who has learned her three R's...reading, 'riting, and 'rithmetic. The first ERMA Center was established in San Jose early in February, 1959. There are now twelve other regional Centers, so located that they serve all but 22 of our bank's more than 830 branches.

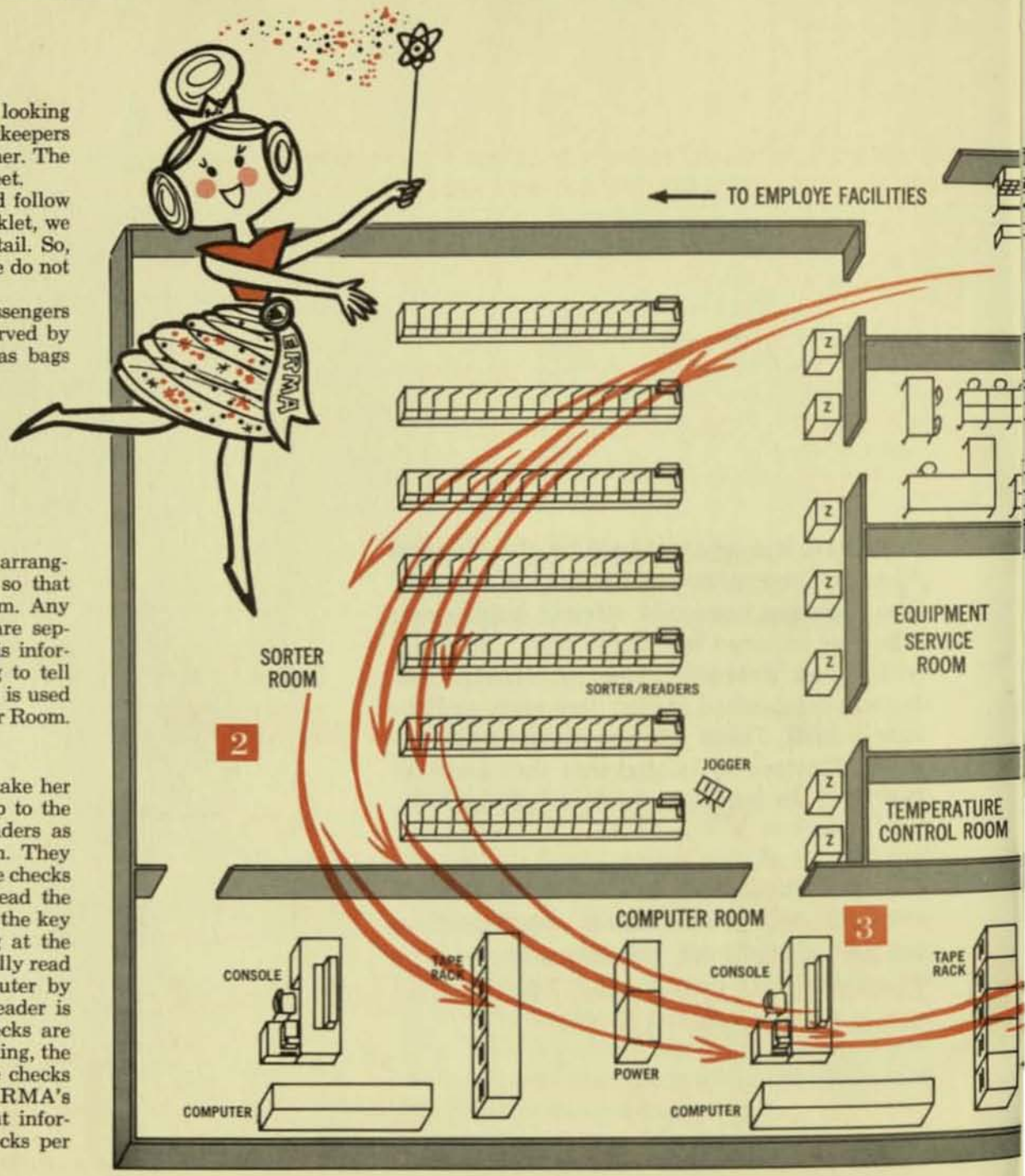
ERMA needs only 32 millionths of one second for each step in processing an account. If we could take steps as fast as ERMA, we would be around the world in 23½ minutes.

Fasten your safety belt...here is ERMA

This is a typical ERMA Center. You are now looking into the home of one of the world's fastest bookkeepers which has been custom-designed especially for her. The average Center occupies about 10,000 square feet.

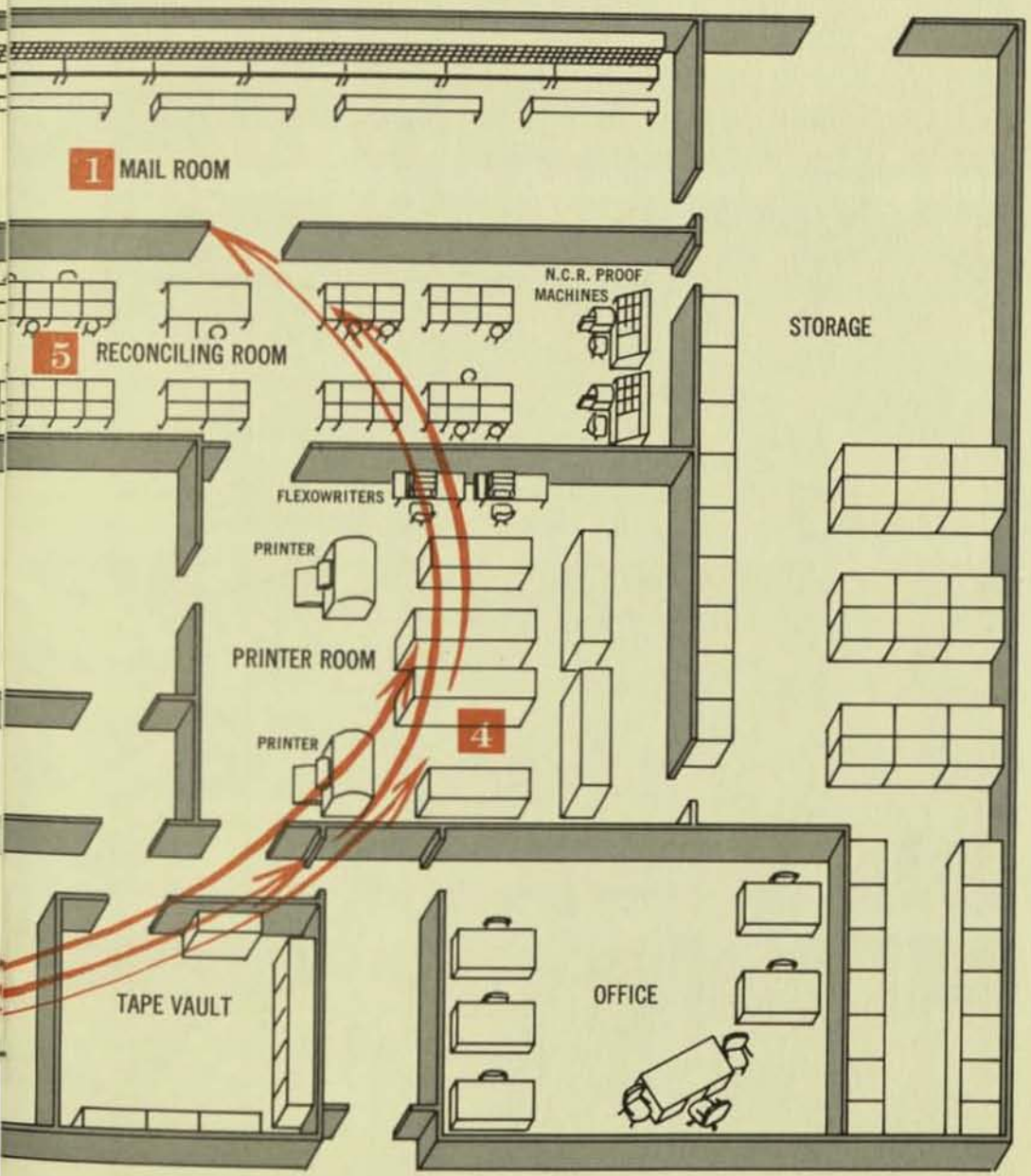
We are going to do a little eavesdropping and follow ERMA through her paces. Later on in this booklet, we will re-trace these same steps—but, in more detail. So, on this first tour, let's not be too concerned if we do not fully understand all of our lady's capabilities.

It is early evening of any banking day. Messengers are arriving from all of the bank's branches served by your ERMA Center. They are carrying canvas bags filled with checks and deposits.



1 Here, in the *Mail Room*, Center Clerks are arranging the checks and deposits in portable racks so that they can easily be wheeled to the Sorter Room. Any change of address, new account names, etc., are separated and sent to flexo-typists who convert this information into punched paper tape. We are going to tell you more about punched paper tape and how it is used later. The racked checks are wheeled to the Sorter Room.

2 In the *Sorter Room*, ERMA is waiting to take her first electronic step. The checks are wheeled up to the Sorter/Readers. Let's think of the Sorter/Readers as the "eyes" and "hands" of the ERMA System. They have mechanical "hands" that physically sort the checks and deposits, and the electronic "eyes" that read the information. This brings us to what is probably the key to the whole system; the magnetic ink coding at the bottom of each check. The Sorter/Readers actually read this information and transmit it to the Computer by electric cable. At the same time, the Sorter/Reader is reading and relaying this information, the checks are sorted into specific pockets. Later on in the evening, the Sorter/Reader operators will re-sort these same checks in branch and account number sequence. ERMA's Sorter/Readers read and transmit all important information about the check at the rate of 750 checks per minute!



3 You are now in the *Computer Room*. The Computer components appear to be merely a series of metal cabinets with tiny, flickering lights and an electric hum ...but here is the real heart and brain of ERMA.

The Computer has all of the qualities of the mechanical calculator (adding, subtracting, multiplying and dividing) *but*, far more important, it can "*decide*" and "*memorize*." She is given instructions on how to do her job by trained Computer "programmers." The *real* "thinking" must be done by people before her "on-button" is pushed.

The information that the Sorter/Readers have captured is now stored on the Computer's magnetic tape (similar to your home recording tape). The figures that the Computer works on come from this entry tape; the instructions as to what to do with the figures are contained in the Computer's "memory." The results are stored on other reels of magnetic tape.

In pre-ERMA days, we expected an efficient bookkeeper with a year's experience to do the sorting and posting for 245 accounts in one hour. But, ERMA can do the sorting and posting for 550 accounts in ONE MINUTE!

4 ERMA's last electronic step is in the *Printer Room*. Here, her High Speed Printers spell out the results of her nightly efforts. Customer statements and other reports are printed from tapes prepared by her Computer. These reports speed through her Printers at 900 lines per minute.

5 There are always busy people in the *Reconciling Room*. In a way, it is ERMA's nerve center where out-of-balance checks and deposits are brought into balance by staff Reconcilers.

Armed only with a simple adding machine and a sharp pencil, capable figure-skilled Reconcilers check, trace back, locate human errors, re-encode in ERMA language, correct and eventually balance all of the debit and credit items the branches sent to your ERMA Center.

It is early morning now, and the Mail Room is again the busy place it was last evening. Sorted checks, branch reports, forms, deposits, customer statements, etc., are locked in canvas bags for return to the branches.

ERMA has completed another 24-hour day.

THAT TECHNICAL LOOK

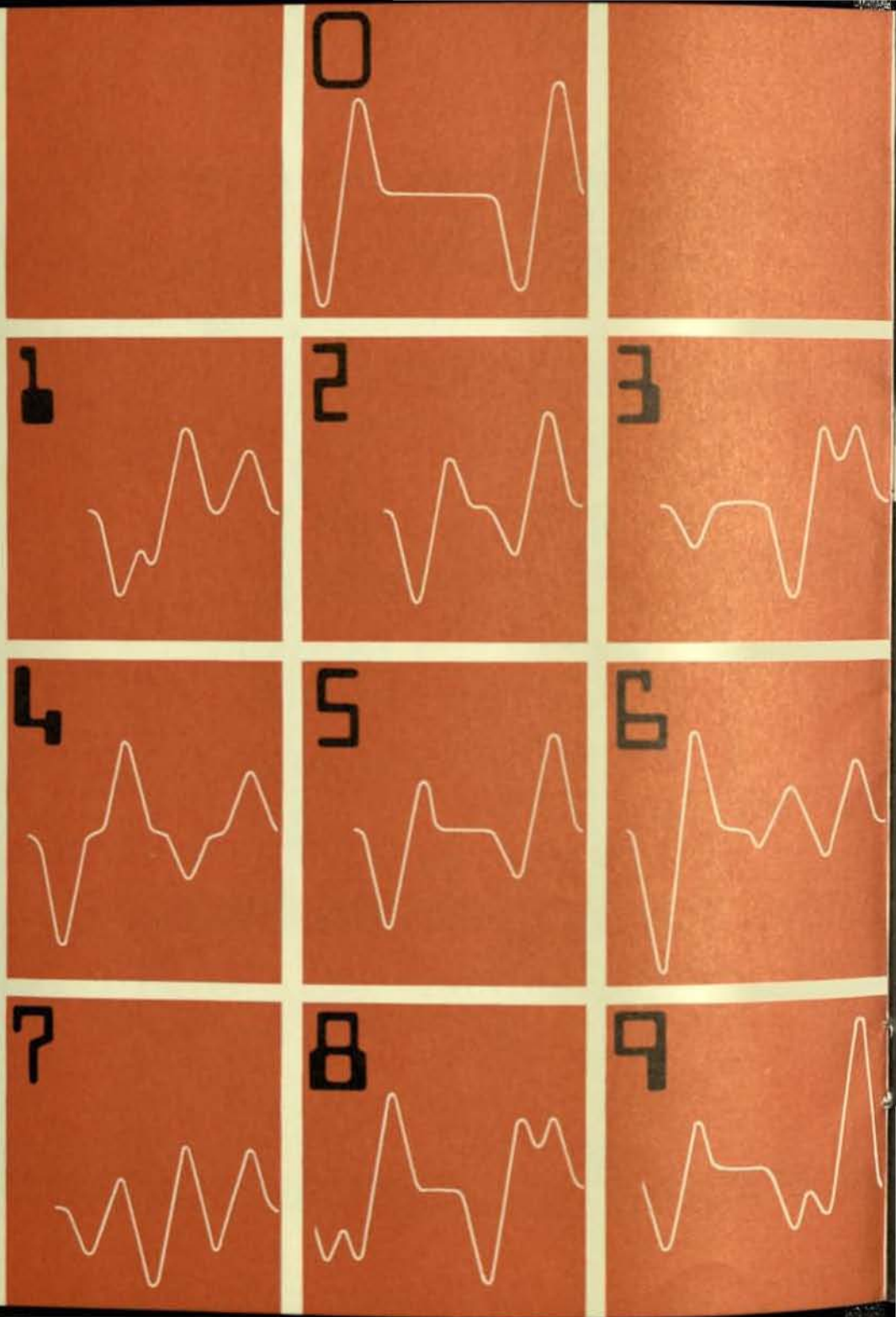
ERMA's electronic equipment does look formidable and complex—*and, it is.* But, don't let ERMA "throw you" with her technical look. In the beginning, it's best to simply accept the fact that human "know-how" has taken magnets, wires, diodes, and transistors and *taught them* how to read, write and perform mathematical computations.

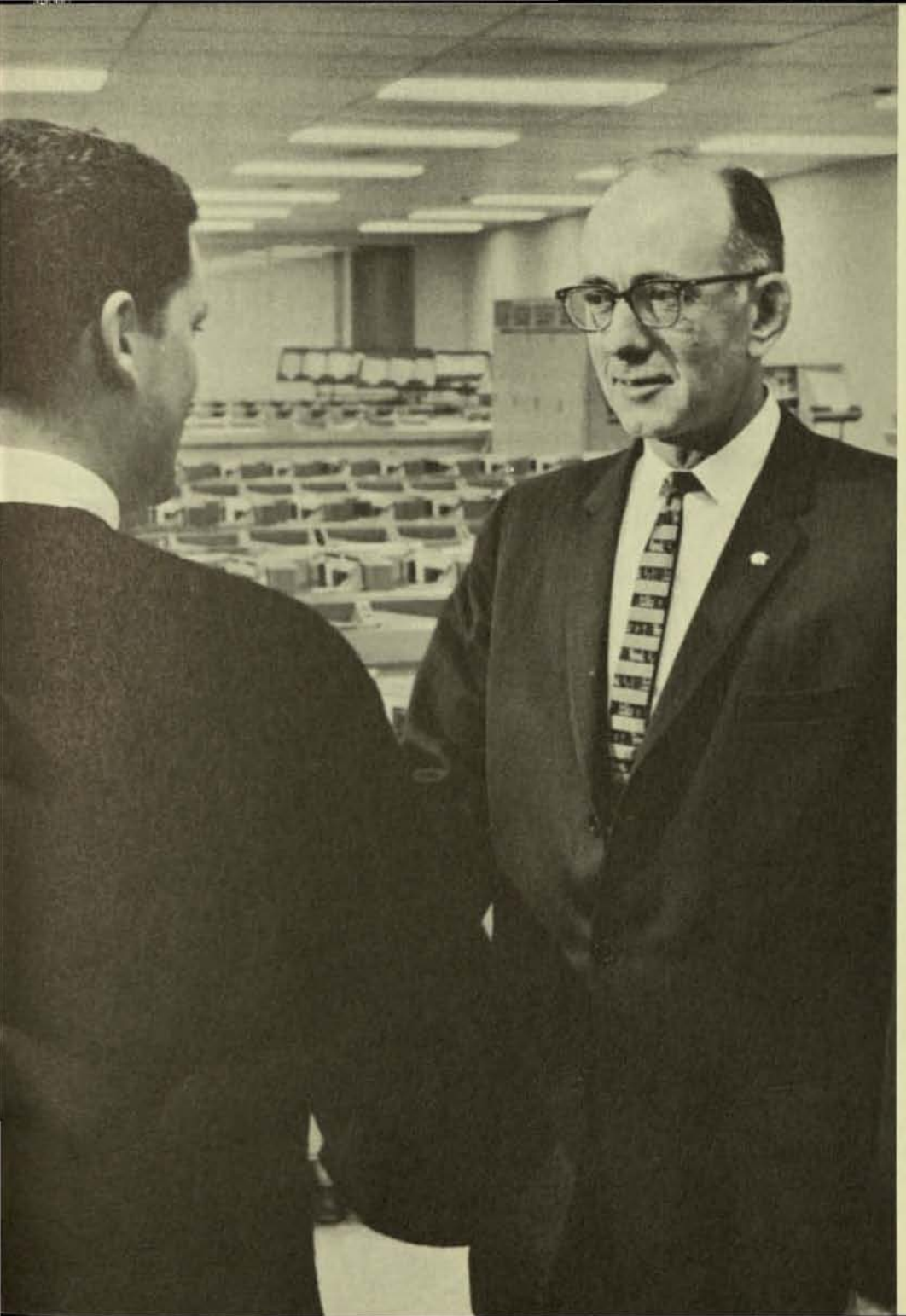
As you grow on your ERMA job, you will develop more understanding of the *how* and *why*. It is our hope that as you make your second journey through the pages of this guide, *you* will become more knowledgeable on your job and how it relates to other work in the Center. There is additional material on specific ERMA functions available to you—simply ask your supervisor.

THAT TECHNICAL SOUND

You'll hear a lot of "different" words used in your Center: "Hardware, Junk-List, Scratch, Document, Peripheral"...sound mysterious? Right now, they are strange. But, you'll be using these terms before you know it. However, to help you get started, take a look at the ERMA DICTIONARY on page 23. It contains most of the words you'll hear.

As you read through the following pages, you'll see some of these "words." If you are in doubt, probably your best bet would be to look them up—so the next time you see or run across them, you'll know what they mean. You won't find actual banking terms, such as commercial account, overdraft, posting, etc. Ask your supervisor for a copy of "Bank Terminology" covering this information.





YOUR SPONSOR AND YOU

Our job in helping you learn your job is going to be a little easier, now. After you've made your quick tour of your Center and met Phil, George and Betty (names are all just names at first, aren't they?), you'll be introduced to your Sponsor. A Sponsor—as the name implies—is the person you will be working *with* during your training period. Your Sponsor may be a skilled Sorter/Reader operator, a first level Reconciler... regardless, he is responsible for *you* and *you* to *him*. A Sponsor explains all of the little and big details about your job—and works right with you until you fully understand *everything*.

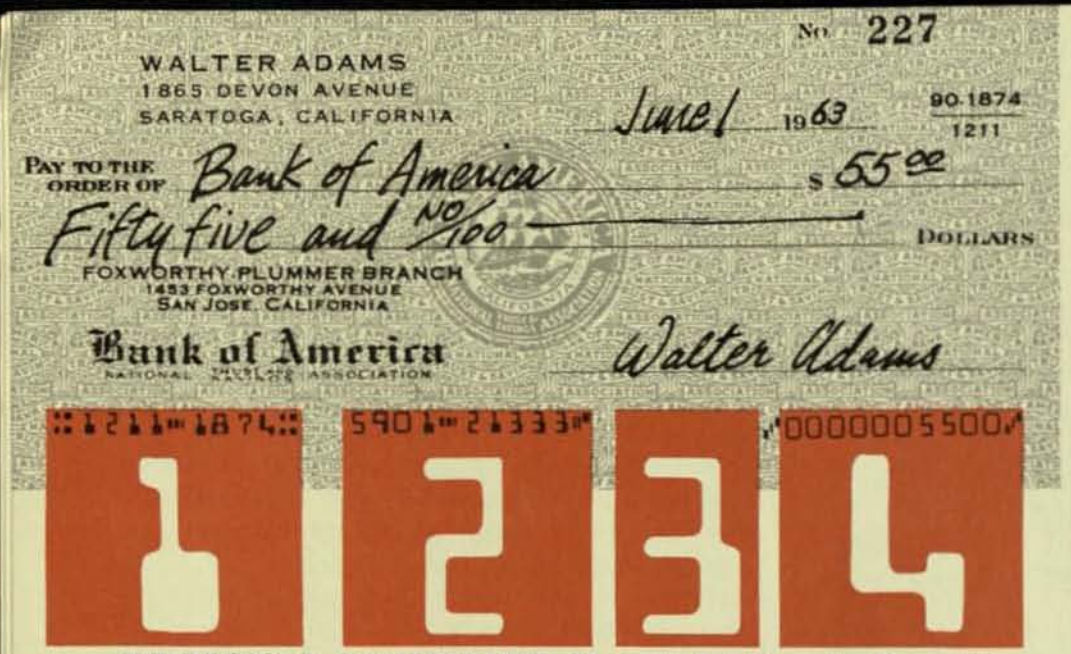
His is a job of indoctrination on the specifics. He is not "checking" on you. His job is to teach you all of the fundamentals of your specific job until you have thoroughly learned all the techniques necessary to perform them by yourself.

YOUR SUPERVISORS AND YOU

But, who am I working for? You are working for Bank of America under the direction of your Center Manager who has a personal interest in *everyone* and a professional interest in *everything* connected with the Center.

Because all Centers operate around the clock—but are primarily an after dark operation—there are three shifts: (1) day, (2) evening, (3) late. During the evening and late shifts an Assistant Manager is in charge. They, in turn, each have an assistant: the Chief Reconciler on the evening shift and the Senior Reconciler on the late shift. You will probably work more closely with either of these supervisors.

An ERMA Center Manager is responsible for the overall operation of your Center – both personnel and equipment. In most instances, he has been with ERMA since its inception back in 1958. He is both knowledgeable and understanding...he is your friend, supervisor, counselor and leader.



ERMA'S LANGUAGE—Magnetic Ink Character Recognition

If ERMA is going to process information for us, obviously we have to have some way to get information into ERMA. ERMA can't read handwriting—or tell the difference between pink and green slips of paper. She has her own "language": it is known as *M*agnetic *I*nk *C*haracter *R*ecognition.

M.I.C.R. is made up of ten arabic numbers which are recognized by ERMA and humans alike. These numbers are printed in a special ink which has tiny specks of iron oxide in it. When a document passes through ERMA's Sorter/Readers, the little pieces of iron oxide, become magnetized and send out a tiny electric impulse. Each number sends out a *different shape* of impulse. ERMA's Sorter/Readers pick up these tiny impulses and "input" is solved. The numbers are now in electronic form—and the computer can work on them.

A typical check looks like the one illustrated. Note the line of numbers along the bottom of the check. Some are pre-printed—the rest being quickly "post-printed" after the check or deposit reaches the branch. This line of information is divided into four separate areas—which are referred to as "Fields." The four fields are:

1. The Transit Field
2. Account Number Field
3. Transaction Code Field
4. Dollar Amount Field

Note also on the sample check the tiny "cue" characters appearing before and after each of the fields. While they contain no information, they have a most important function. They separate the fields so that when ERMA's Sorter/Readers are scanning along the line and pick up one of these cues, it is alerted that one kind of information is about to start, or is finished, and in a fraction of a second sets itself to receive the next parcel of information or data.

1 THE TRANSIT FIELD

Starting at the extreme left of Walter Adams' check is the transit field. 1211 is the Federal Reserve Check Routing Number and 1874 is the American Bankers Association (ABA) number identifying individual banks and branches on a nationwide basis.

2 ACCOUNT NUMBER FIELD

In the account number 5901-21333, 590 is our internal number for the Foxworthy Plummer branch in San Jose. This indicates to ERMA to sort the check to that branch. The 1 immediately following 590 is a check digit used as a safeguard against possible number copying or reading errors. This is known as a T.C.D.—or transposition check digit. Following the cue character is the number assigned to Walter Adams' checking account—21333.

3 TRANSACTION CODE FIELD

Every time we send an entry to ERMA, we must tell her Computer exactly what the item *is* and *what* to do with it. The absence of a number in the transaction code field indicates that this *is* a check and the amount should be subtracted from the balance of the account of Walter Adams. In other words, a debit. A number 5 in this field indicates a deposit or credit to the account. The ERMA system has the capacity to act on any of 100 different transaction codes that may be encoded in this field.

4 DOLLAR AMOUNT FIELD

The last group of numbers on the right side is known as the dollar amount field. This field simply contains the dollar amount of the entry (in our example $55.00) omitting decimals and the dollar sign. This field has space for ten digits. Notice that *all* the digit positions must be filled when an item goes into ERMA. In other words, the spaces to the *left* of the actual dollar amount must be filled with zeroes until all ten spaces are filled.

At this point ERMA has all the necessary information to post the check to the proper account. And ERMA can do this with any item, as long as we put the *right* information in the code line.

MEANWHILE, BACK AT THE BRANCH...

The banking day is just starting. ERMA messengers have delivered the previous day's work and the processed checks and deposits are being filed. There's lots of *other* activity, too. ERMA produced customer statements to mail, ledgers to be checked and many customer services to be performed.

Walter Adams—like any B of A customer—on opening his account is provided with pre-printed checks showing his name and address. Also pre-printed with magnetic ink are the transit and account number fields. As long as he maintains his account at a particular branch, these encoded numbers remain the same—hence they are pre-printed. If he should forget to bring his pre-printed checks, he can use a counter check. These first two fields are then encoded on the Account Number Encoder—about the size of an ordinary adding machine.

All that remains after a check or deposit slip is presented to the Teller is to add the transaction code and dollar amount. This is done on the Dollar Amount Encoder—an attachment to the N.C.R. Proof Machine, illustrated here. We call this post-printing.

Branch Proof Machine operators simply depress the keys, the document is fully encoded and automatically pocketed. Walter Adams' check is now ready for ERMA. After a pocket has a maximum of 150 items, this group of checks, deposits or special entries becomes a "batch."

She then prepares a Batch Header Card showing in ERMA language the branch number, whether these are debit or credit batches, and total dollar amount of the group. The entries are then banded together with the proper Batch Header Card and a Batch Listing Tape, produced by the N.C.R. Proof Machine. Balancing of batches is done on this machine before the items are sent to ERMA. A master tape is also prepared—which remains at the branch.

Non-encoded forms are also sent to ERMA—such as new accounts, change of name, address, etc., and are typed on special forms. The separated and bundled items are placed in heavy canvas mail bags, stenciled with the name and number of the sending branch, and picked up by ERMA motor messengers.

The responsibilities of your Center's branches are many. Documents must be correctly encoded—all batches must be ready to go to ERMA when the messenger arrives. This is where teamwork is important—at both the branch and your ERMA Center.

IN THE MAIL ROOM...

As the locked canvas mail bags arrive at your ERMA Center, they are opened and processed individually by an assigned ERMA Center mail clerk. He separates the banded batches of work into four basic groups: debit, credit, special entries and record changes.

The incoming checks and deposits are unbanded and Batch Header Cards are checked against the batch tapes. Staples, paper clips, gummed stickers, and other foreign material are removed as they could cause damage to a Sorter/Reader. Mail clerks in "fanning" through the documents occasionally find items that are upside down—or backwards. ERMA just can't read them this way...so the checks and deposits are "faced" in order that they can be read.

After Center mail clerks examine the batches and Header Cards, a set of 12 "batch separator" cards are inserted at the end of each batch. These cards carry a special batch separator identification number and tran code.

He delivers the record change entries to the Flexowriter operators...special entry batches are held until all branches work is in...and debit and credit batches are placed in portable racks containing metal trays. The checks and deposits are then wheeled to the Sorter Room.

The empty bags are racked, as illustrated, in their respective branch order. A label on the rack corresponds with branch name and number on the bag. Then the bags are ready to be filled with outgoing mail. For return of processed items the correct bag is then easily selected.

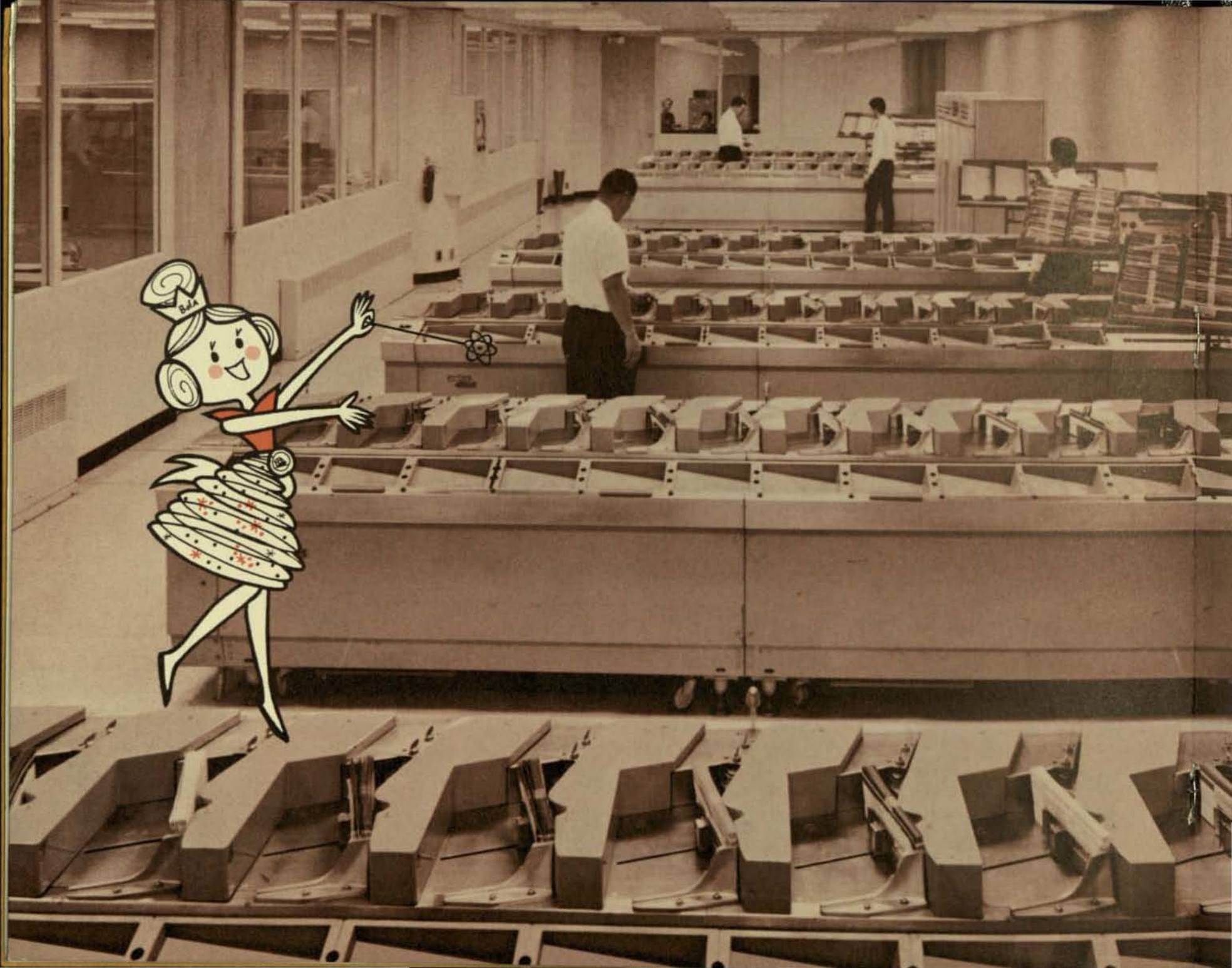
NEW ACCOUNTS AND RECORD CHANGES– THE FLEXOWRITER

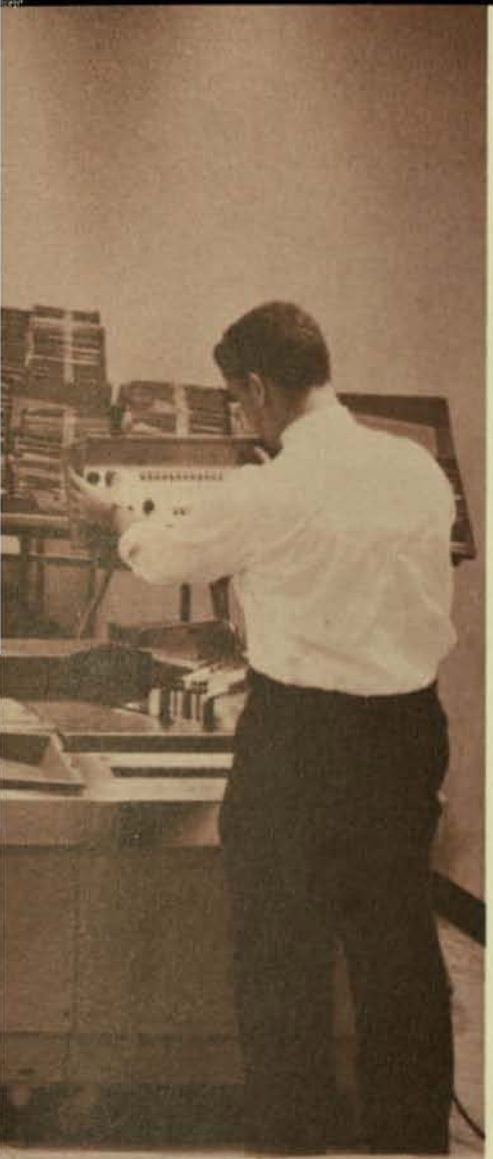
Since the Sorter/Readers can only read encoded numbers we must have another means of introducing names, addresses and alphabetical information into the Computer.

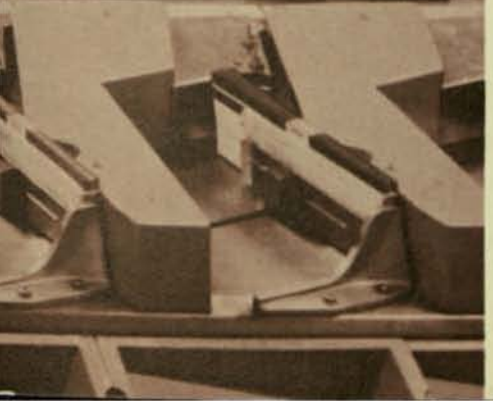
You'll recall that the branches type *special forms* for these record changes. From incoming mail, they are delivered to the Flexowriter operators. The Flexowriter is a special kind of typewriter that produces a punched paper tape. The Flexotypist checks the accuracy of her work by running the tape through the Flexowriter producing a typewritten facsimile of the punched paper tape.

Each Computer Console is equipped with a special device – known as a Photo/Reader. The new accounts, names, addresses and other statistical information prepared on punched paper tape can now be placed on magnetic tape reels through this machine.

Reading through the Photo/Reader is at 200 characters per second. Another method of input has been solved.







SORTER/READERS

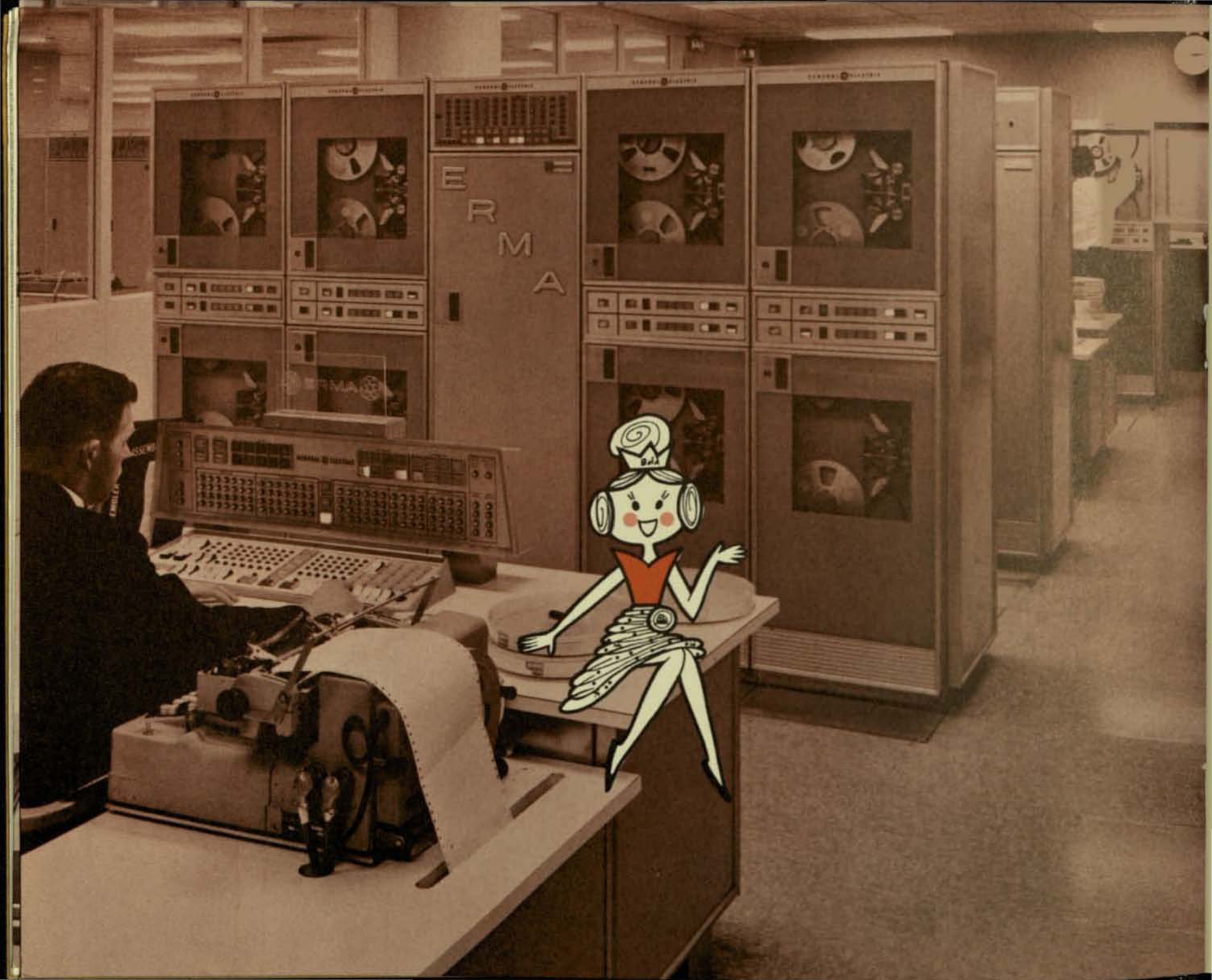
The Document Sorter/Readers, earlier described as the "eyes" and "hands" of the ERMA system, are capable of being operated in two ways. These are known as "on-line" or "off-line."

When operating "on-line" the Sorter/Readers are under direct control of the Computer. As the magnetic ink characters on each check are transmitted to the Computer, information is being captured on magnetic tape. Simultaneously, the Computer supplies the sort mechanism on the Sorter/Readers with a pocket decision. There are 12 pockets on a Sorter/Reader. In the flash of a millisecond, a gate will open on any one of the pockets, and the item has been sorted.

The initial entry of documents "on line" with the Computer is referred to as the *entry run*. Items that cannot be "read" automatically go to the end pocket as an ERMA reject. This may be due to faulty magnetic ink printing, misaligned documents, etc. Sorter operators will make re-entry runs for reprocessing of items rejected on the entry run. The sort on the *entry run* is a broad sort with pre-determined pocket assignments according to geographic areas and other ERMA Centers throughout the state of California.

During "off-line" document sorting runs, the Sorter/Readers operate independently of the Computer. Pocket decisions are supplied by the Sorter electronics—located in the "Z-Rack." Off-line is a fine-sort operation requiring the Sorter operators to make several passes in order to place the checks in branch and account number sequence. Off-line, fine sorting takes place after the Computer has received all coded information and during the time the actual bookkeeping, posting, etc., is taking place.

Sorter/Reader operators doing fine sorting make digit selections through the Control Panel, illustrated above. The Feed Hopper is directly below the Control Panel and the documents are "fanned" by an overhead air jet to facilitate single feeding of items. A Jogger —which vibrates and adjusts documents—is used prior to the items being placed in the feed hopper.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THE COMPUTER

The "heart" and "brain" of the ERMA system is the Computer, which actually does the bookkeeping. The Computer operator is seated at the Console, left. Directly in front of him is the display panel of lights and buttons that allow him to monitor the processing operation. Beyond the panel are the eight magnetic tape servos. In the photograph above, note that arithmetic circuitry and memory storage are contained in the cabinets shown in the background. Communication with the Computer, starting and stopping runs, etc., is made through the Flexowriter, on the Console.

ERMA Computer operators are trained to initiate the steps and sequence of the actual bookkeeping processes for both checking and savings accounts. They must at all times use the *full capacity* of the Computer. There are nine basic runs each night. These are the entry, editing, sorting, splitout, merging, posting, record changes, branch journal report and the main ledger runs. Each is important; each must be done in proper sequence.

Aside from operating and directing the Computer, the Console operator has many important responsibilities. He selects the programs and causes them to be inserted in memory. He recognizes and analyzes errors. Logs must be kept of operating times, lost times and equipment failures. Tapes must be labeled and routed properly to assure that no records are inadvertently destroyed. His is a tremendously big job... and a very important one.

General Electric Corporation was awarded the contract to build the ERMA System for Bank of America. Their highly trained technicians maintain a twenty-four hour vigil to assure that ERMA meets the deadlines. General Electric service personnel are provided an Equipment Service Room in each Center. They regularly follow preventive maintenance programs and make diagnostic tests to avoid possible emergencies during critical operating times. Theirs is a vital and important role.

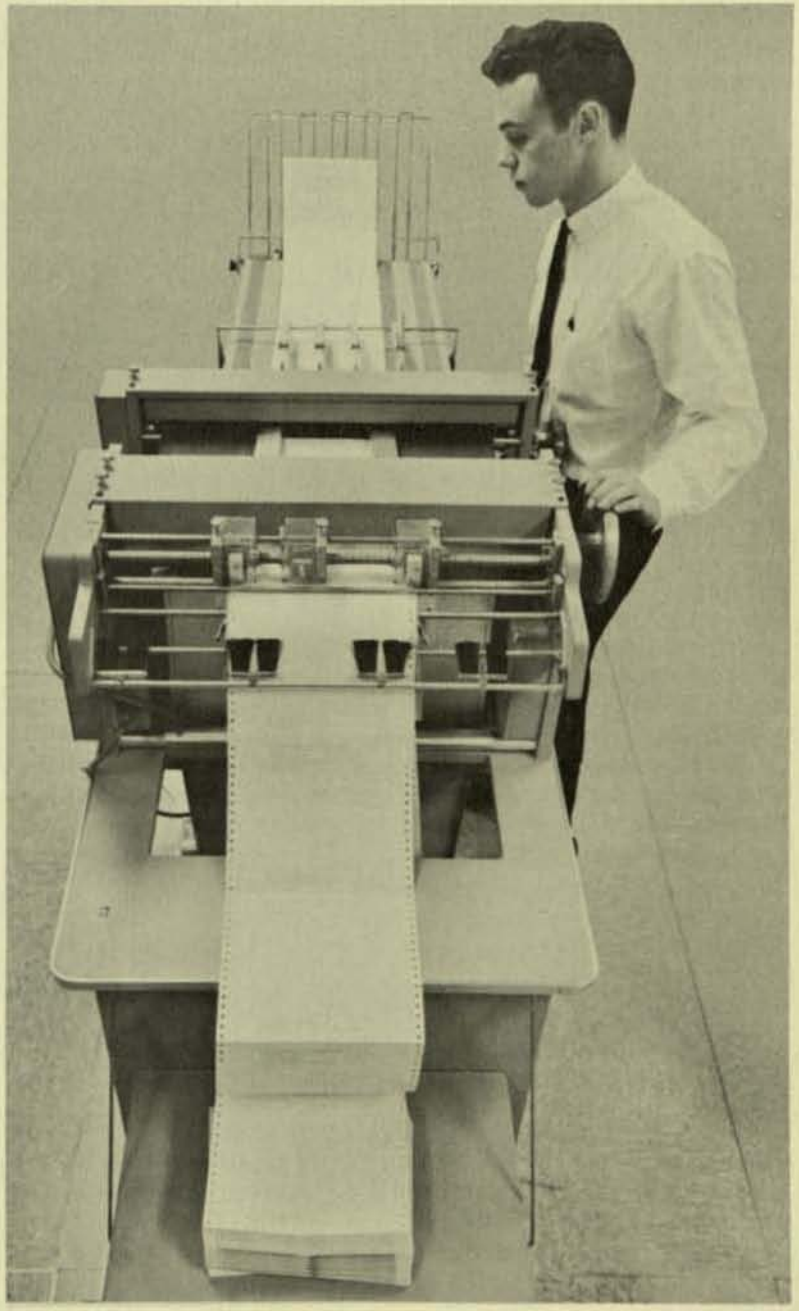
THE PRINTER

We must translate *out* the results that the Computer has compiled. This is done by skilled Printer operators on the High-Speed Printer. They prepare printed reports "off-line" from the ERMA processed magnetic tape reels.

A number of these reports are for Center use—others are for your branches—still others for our customers. Daily reports include: a *status* report containing the account number, correct up-dated balance, and the date of last activity; a *rejected items* register; and a *journal* which reflects *all* transaction details. There is a *large items* report—an *overdrawn accounts* report—accounts reaching zero balances during the night posting activity.

Reconcilers need "trace lists"... customers need monthly statements. ERMA and her capable Printer operators spell all of these out on continuous multi-copy forms. He separates originals and carbons on the "*deleaver*"; continuous forms are snapped-apart on the "burster," illustrated above.

Fast...you bet! Fifty *complete* customer statements a *minute*.

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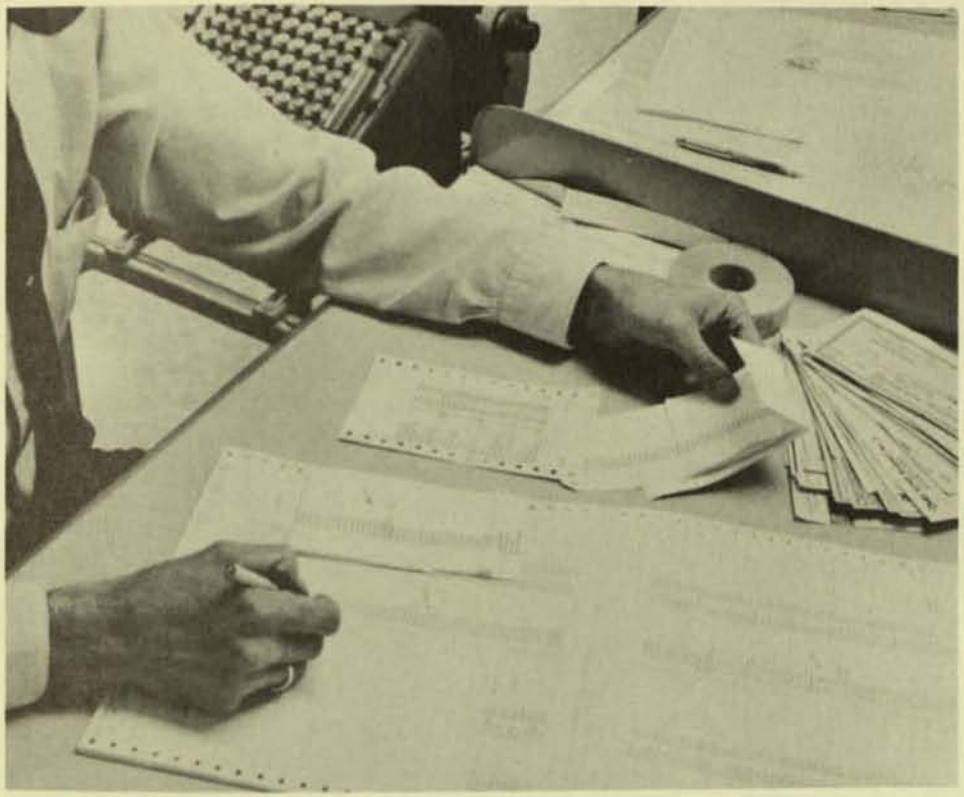
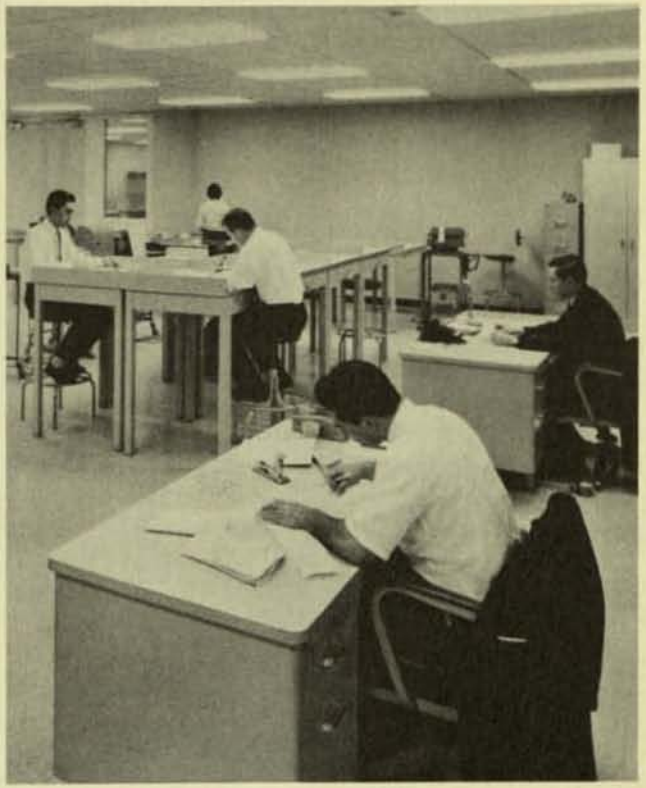




RECONCILING

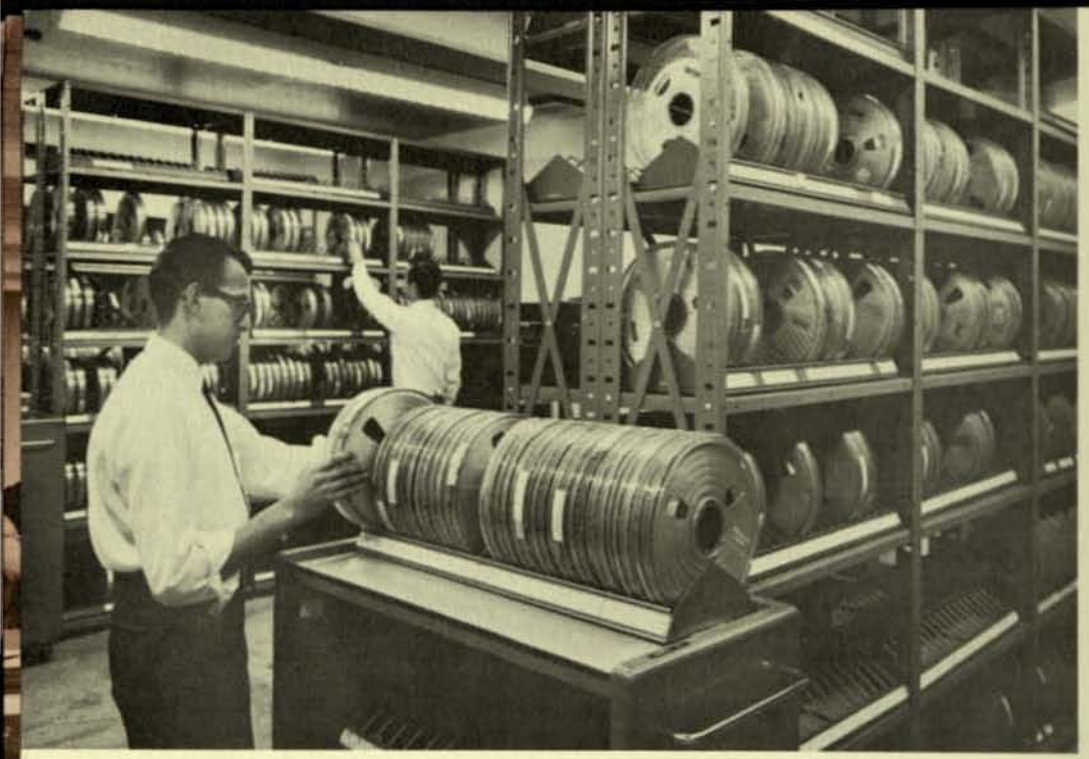
With the thousands of checks and deposits that pour into your ERMA Center each evening, it would be wonderful if they all balanced... but they don't. That is the *why* of Reconciling. Double feeds. Misreads. Nonreads. (These are all *too* familiar terms to our skilled Reconcilers.) Their's is one of the most difficult jobs of all.

You'll recall back at the branch, a Proof Machine tape total and Header Card is included with each batch of 150 debits or credits. You may also recall that Pocket "12" along with two other pockets on the Sorter/Readers are reject pockets. ERMA simply could not *read* these documents and could not, as a result, proceed with processing.

Periodically during the evening, rejected documents are returned from the Sorters to the Reconcilers. Also periodically, the Computer has noted the errors through print-outs in batch and superbatch special lists.

Our figure-skilled Reconcilers proceed to trace the path of "out-of-balance" batches. They check branch Proof Lists and ERMA Trace Lists. With adding machines and sharp pencils, batches of work are brought into agreement. Some checks and deposits are re-encoded. Some corrections and substitutions made. Eventually, items that can be re-entered are sent to the Sorter/Reader operators—and a final "on-line" re-entry run is made.

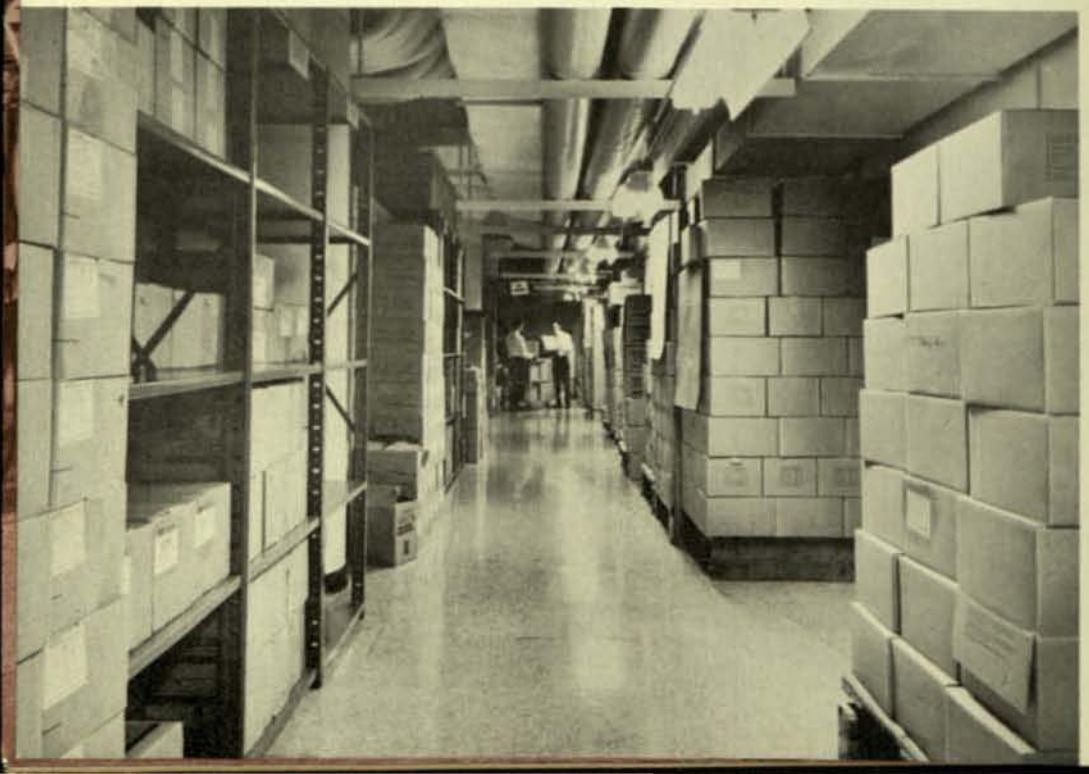
Experienced Reconcilers have acquired a unique skill, arithmetical "know-how," unlimited patience and problem-solving minds.



TAPE VAULT

Supply and storage of Magnetic tape is extremely important to the proper functioning of your ERMA System. A tape librarian is in charge of the fire-proofed and temperature-humidity controlled vault —on each shift. He is responsible for proper shelving, storing and rotating of both *data* and *blank* tapes.

All ERMA Centers are on the off-premises tape rotation plan which insures reconstruction of account records in the event of disaster. Tapes are messenger delivered in special crash boxes to vaults outside a 50 mile radius of the Center. Other Center activity tapes are air-shipped between San Francisco and Los Angeles, nightly.



PAPER STOCK STORAGE

With some 36 different ERMA continuous paper forms to keep track of, Center housekeeping *must* be neat and orderly. Many of these forms have two or more multiple copies. Paper stock storage is located adjacent to the Printer Room so that the proper multi-copy forms are readily available. The forms are in cartons and neatly labeled so that Printer operators have the right form at the right time. The paper storage room—like other ERMA Center working space—must be kept spic and span. Won't you do your part to help us keep it that way?

ON TAKING A BREATHER...

You'll find your ERMA Center employe facilities modern, clean and comfortable. The employe lounge has a refrigerator for keeping milk and other foods chilled. Soup and coffee are always available. There is ample room for your personal belongings—hats, coats, etc. Because ERMA Centers are 'round the clock operations, we do our very best to keep our restrooms and other employe facilities spotless... please help us keep them that way.

Your Supervisor will explain the keeping of Time Sheets and provide you with a little folder called "It's The Law." As a B of A employe, you'll receive all the same benefits our branch and administrative people do. We'll mail to your home a copy of our monthly publication "The Bankamerican." You'll hear about softball tournaments, picnics and other recreational activities.

SHHH!
IT'S CONFIDENTIAL...

Everybody keeps something under their hat. Magicians keep rabbits. Bachelors keep phone numbers. But Bankers keep SECRETS. The very nature of banking is confidential. We don't talk about the fact we saw a check for $10,000.00—or that Mr. Brown *must* be "loaded" because you happened to see his monthly statement. Being friends with people outside Bank of America is fine but tipping your hand about information that isn't yours to give in the first place is strictly taboo. Make sure that your hat is "leakproof."

AND, YOU MIGHT LIKE TO KNOW...

That Stanford Research Institute of Palo Alto, California, in conjunction with Bank of America developed ERMA.

That the first handmade ERMA prototype was publicly demonstrated before representatives of the press and banking profession in September 1955.

That in 1956, General Electric Computer Division, Phoenix, Arizona was awarded a contract to build 30 Computer Systems for our 13 B of A ERMA Centers.

That Magnetic Ink Character Recognition—now in use nationwide—was a joint effort of Stanford Research Institute and Bank of America.

The 13 ERMA Centers handle and process over *52 million* checks and deposits per month.

That the American public is now writing checks at the rate of 15 billion a year—by 1970 (just 7 years) we will be writing close to 22 billion.

That our 13 Centers handle 2,500,000 Customer Checking Accounts and 3,000,000 Savings Accounts.

Your ERMA Dictionary

BATCH SEPARATOR CARDS—A set of 12 colored cards numerically encoded to separate batches within a superbatch. The colors assist in quick identification of material being processed.

BLANK TAPES—Magnetic tapes that are available for reuse. These tapes will have the identifying label removed.

BRANCH BREAKOUT—Initial sorting of documents processed by the Computer on an off-line condition based on a single digit of the branch number.

C.D.A.—Commercial Deposit Accounting.

COMPUTER—Electronic equipment components capable of memory storing, input reading, logic-sorting and classifying, arithmetical computating and out-put writing all under program control.

CONSOLE—A Computer operator's monitoring desk through which he can send or receive instructions and information to and from the Computer.

CONTROL DESK—Where processed material for reconciling purposes is assembled and controlled.

COPY—To transfer information from one magnetic tape to another.

CUE CHARACTERS—Four M.I.C.R. symbols not containing information used to separate one field of information from another.

CUT-OFF CARDS—Cards which indicate the end of a superbatch group.

DATA TAPES—Magnetic tapes which contain vital information after processing. These tapes will carry an identifying label.

DELEAVER—A mechanical device used to separate originals from copies from carbon paper that are printed on continuous form paper stock.

DIGIT SELECTORS—Upper row of buttons on the Sorter Control Panel used to select individual digits within fields.

DOCUMENT—In ERMA language any encoded item such as a check, deposit slip, special entry, etc.

DOCUMENT HANDLER—A Sorter/Reader.

DOWN TIME—The elapsed time when equipment is not operating due to malfunction or equipment failure.

ENCODED—The numeric and cue characters printed in magnetic ink along the lower edge of checks and deposits.

ENTRY RUN—Initial input of information through a Sorter/Reader on-line with the Computer.

ERMA—Electronic Recording Method of Accounting.

FEED—Items flowing through a Sorter/Reader.

FIELD-A/C NUMBER—Contains the Branch number, Transposition Check Digit and the Account number identifying the particular customer account.

FIELD-DOLLAR AMOUNT—The last group of numbers on the right side of the encoded line. It contains the dollar amount of the entry and will accommodate up to ten digits.

FIELD SELECTORS—Lower row of buttons on the Sorter Control Panel used to select fields.

FIELD-TRANSACTION CODE—By the use of authorized number codes, this field instructs the Computer to handle the item in a specific manner.

FIELD TRANSIT—Contains the Federal Reserve routing symbol and the American Bankers Association transit number.

FILES—An accumulation of branch work necessary to aid receipt and distribution of work flow, such as files I, II, or III.

FIRST LEVEL—Working description of the people responsible for the initial balancing of item dollars entered into the Computer in relation to the dollars charged by the branches.

GENERAL PURPOSE SORTER—A Sorter/Reader with a specially wired plug board capable of making decisions on an entire field of information.

HARDWARE—Any electronic equipment in an ERMA Center. Also referred to as "gear."

ITEM—Any **one** of the checks, deposits or other documents.

JOGGER—A vibrator used to align the leading edge of checks and other documents so the Sorter/Reader will accept them properly.

LISTING—A manual adding machine listing of items rejected from an entry run in batch separator order.

MAGNETIC TAPE—A plastic or mylar tape with similar qualities to home recording tape on which information can be stored.

M.I.C.R.—Magnetic Ink Character Recognition.

OFF-LINE—The operation of input-output peripheral equipment not under direct control of a Computer.

ON-LINE—The operation of input-output peripheral equipment under direct control of a Computer.

PAPER TAPE LOOP—A punched paper tape which controls vertical alignment and format of forms—such as customer statements.

PERIPHERAL EQUIPMENT—Equipment separate or separable from the main Computer which is used to enter information into the Computer and translate information from the Computer—such as Sorter/Readers, Printers, etc.

PLUG BOARD—A wired panel which controls the horizontal alignment and format of forms—such as customer statements.

POCKETS—Twelve storage compartments on a Sorter/Reader into which documents are sorted.

PROGRAM—A series of coded instructions which tell the Computer what to do in order to complete a specific job.

RE-ENTRY RUN—Reprocessing of items that were rejected on the entry run.

RUN—Actually using program in processing—such as sorting, posting, etc.

SCRATCH, OR SCRATCHING—Removing an external label from a Magnetic tape reel after the information it contains is no longer needed.

S.D.A.—Savings Deposit Accounting.

SECOND LEVEL—Working description of the people responsible for balancing dollar items which could not be brought into balance by the First Level people.

STRIPPED ITEMS—Those documents that have been corrected for re-entry through the use of a gummed strip attached to the bottom of a document.

SUPER BATCH—A consolidation of one or more batches, received from one or more branches, for convenience of reconciling.

TAPE CARTS—Mobile units used for transporting Magnetic tape reels to and from the Computer.

TAPE RACKS—Shelves for storing of Magnetic tape.

TAPE RETENTION—Data tapes placed in storage on or off premises and labeled and stored for purposes of reconstruction of records. (As in a case of disaster where it is necessary to return tapes to recover information.)

TAPE UNITS, OR SERVOS—Magnetic tape transport that houses and passes the tape over a read-write head—similar to a home tape recorder.

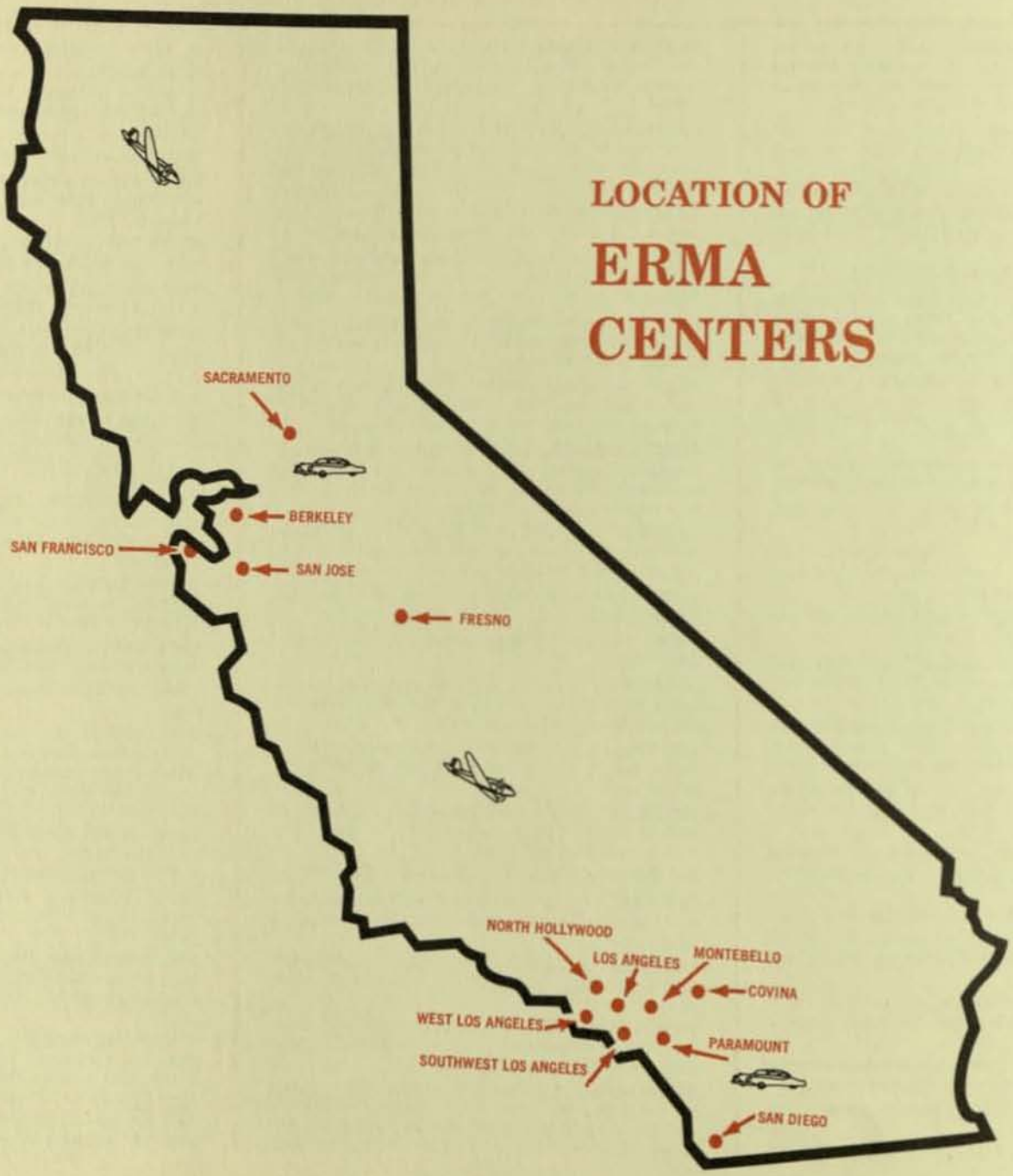
TAPE VAULT—A protected area used for the storage and retention of Magnetic tapes on premises.

TRANSPOSITION CHECK DIGIT—Is the number between the branch and account numbers. ERMA uses this digit to check against possible number errors.

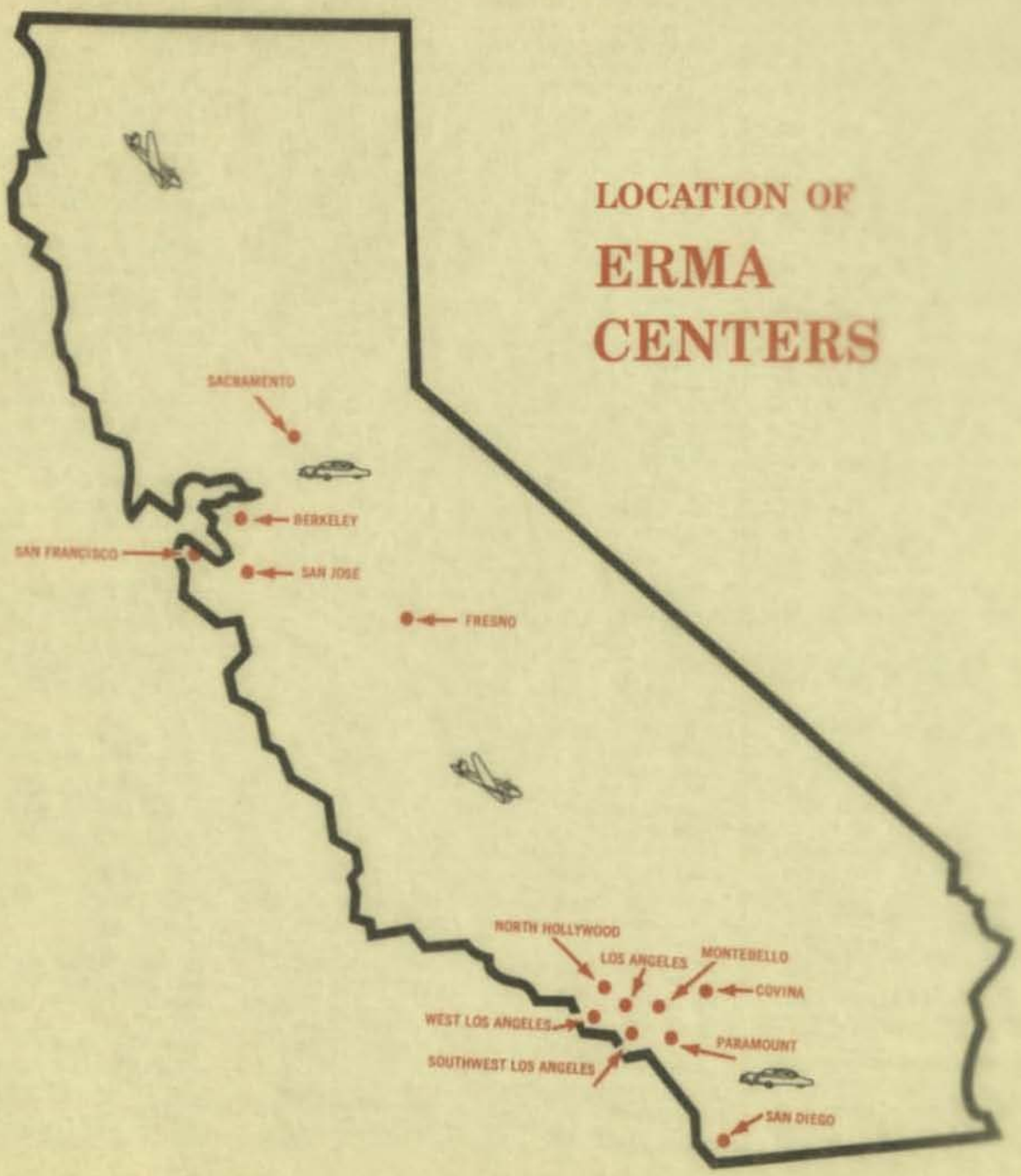
UTILITY ROUTINE—A standard program, or routine, not connected with the processing of documents that is used for copying, correcting, comparing or tape editing routines.

"Z" RACK—A cabinet containing the electronic gear of the Sorter/Reader.

LOCATION OF ERMA CENTERS



LOCATION OF ERMA CENTERS




BANK OF AMERICA
WORLDWIDE SCOPE—STATEWIDE SERVICE
CALIFORNIA
NATIONAL TRUST & SAVINGS ASSOCIATION

ERMA

Electronic Recording Machine, Accounting

BANK OF AMERICA

NATIONAL TRUST AND SAVINGS ASSOCIATION

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TO:

An important difference between this SRI prototype and the GE production models is that the GE computers were transitorized.

Teresa Hickey
Archivist

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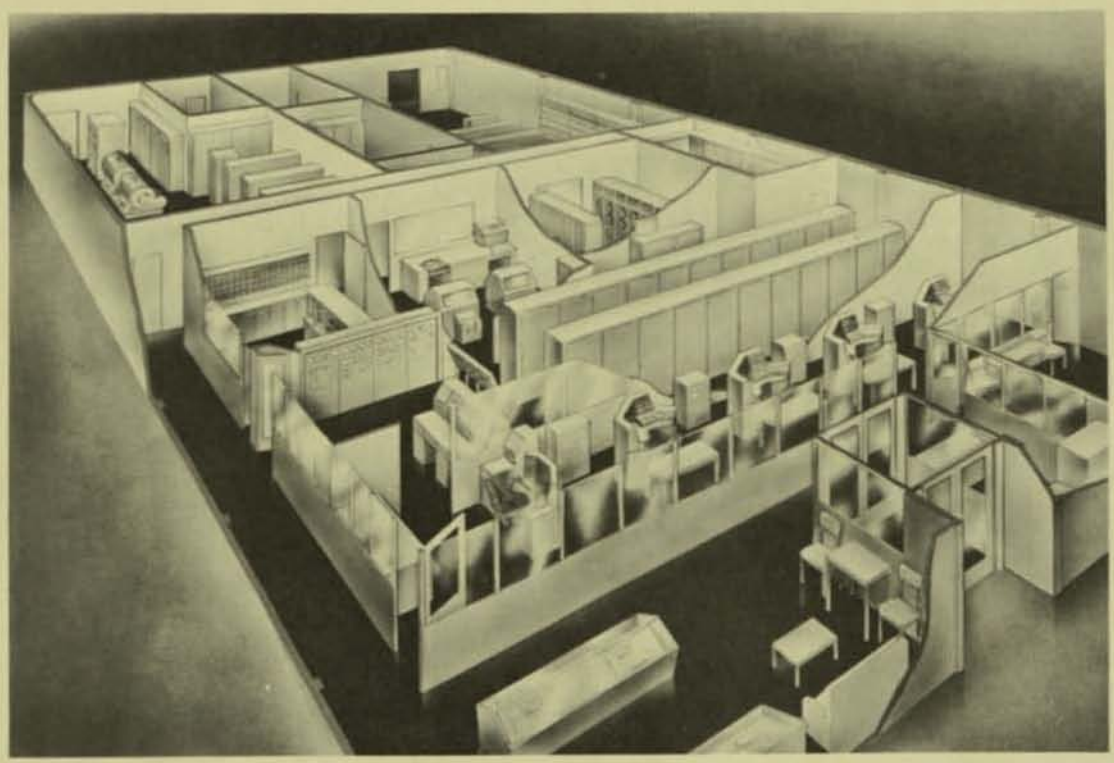
(415) 622-4997

BANK OF AMERICA

CORR-94

ERMA



Artist's drawing of first proposed ERMA installation.

ERMA

Electronic Recording Machine, Accounting

A MACHINE TO PERFORM THE BOOKKEEPING
OF CHECKING ACCOUNTS, DEVELOPED BY
STANFORD RESEARCH INSTITUTE FOR

BANK OF AMERICA
NATIONAL TRUST AND SAVINGS ASSOCIATION

SAN FRANCISCO • CALIFORNIA

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MACHINE BOOKKEEPING OF CHECKING ACCOUNTS

A machine to perform the necessary accounting for 50,000 commercial checking accounts has been developed for the Bank of America by Stanford Research Institute. In engineering language it is called Electronic Recording Machine, Accounting, which conveniently abbreviates to ERMA.

The prototype has been successfully tested at the Institute's laboratories in Menlo Park, California, and will be installed early in 1956 for operational use by the Bank of America at San Jose, California.

ERMA is a large, data-processing and paper-handling system designed specifically to handle checking-account bookkeeping. From its central position it will perform the accounting for checking accounts of all the branch banks in the San Jose area. The machine enters into individual accounts deposits and checks, remembers details of all transactions, maintains customers' correct balances, accepts stop-payments and hold orders, stops when an item would overdraw an account or when a hold item is presented, and sorts checks.

The electronic bookkeeper physically occupies about 4000 square feet of floor space, and weighs about 25 tons. Its 34,000 diodes, and 8200 vacuum tubes and associated electronic components are housed in two, 40 foot long rows of metal cabinets, six feet high. Sixty kilowatts of power at six d-c voltages are supplied by regulated selenium rectifiers. A 25-ton air-conditioning plant removes the heat from machine's electronic equipment.

The electronic bookkeeper was developed over a period of five years by SRI for the Bank of America. The numerous patents that have arisen from its development will be assigned to the Bank of America. The bank, likewise, will arrange with equipment builders for the construction of production models.

ERMA. . . . *Electronic Recording Machine, Accounting*

Operator at the input console. The amount of deposit or withdrawal is punched on the keyboard, the check or deposit slip is dropped in the automatic reader, then ERMA's work cycle begins.

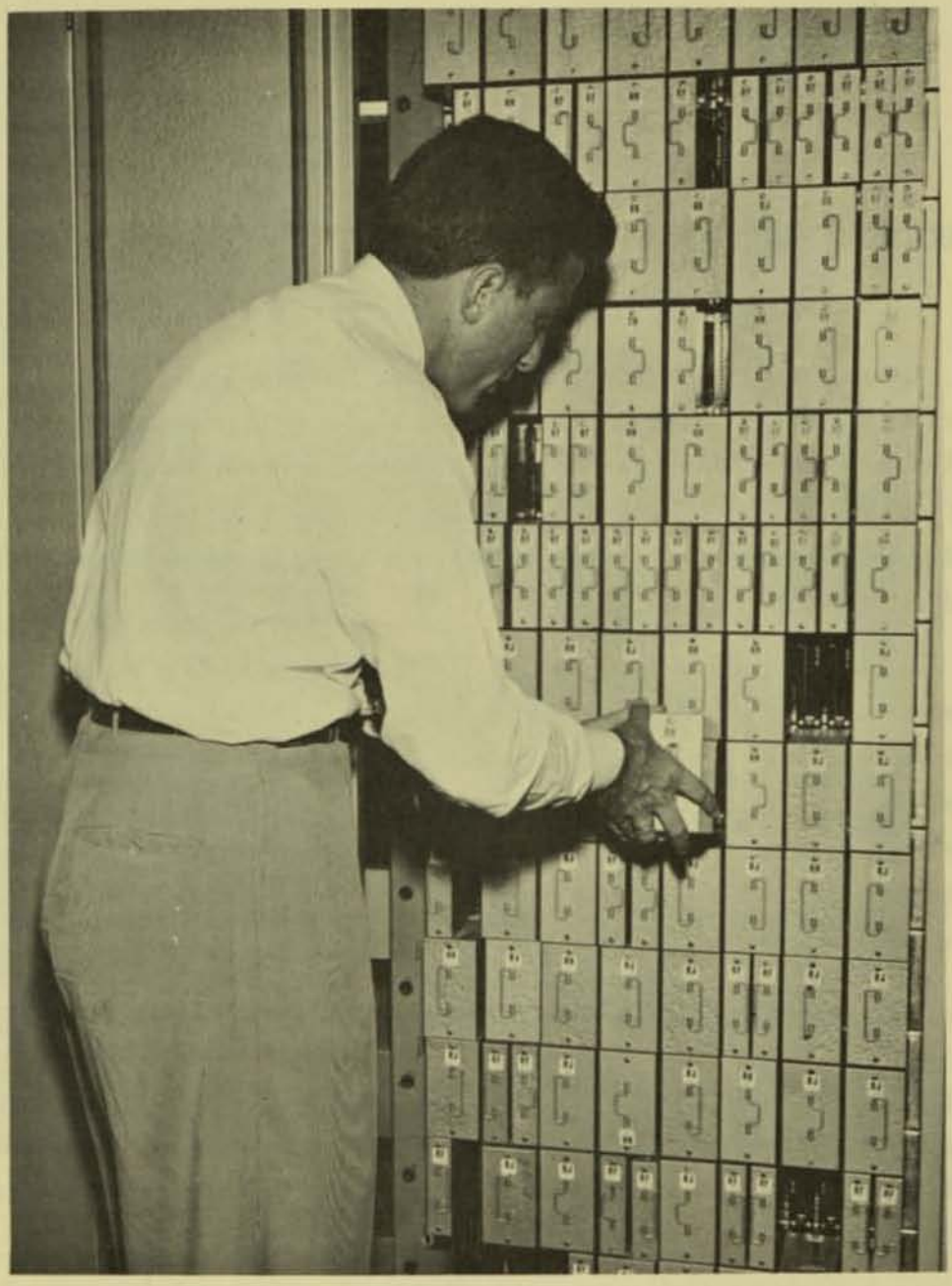
ELECTRONICS AND A BANK ACCOUNT

Consider how the electronic bookkeeping machine keeps track of a typical checking account. Assume it is the account of Harold Brown in the Hester Branch bank of the Bank of America at San Jose. Assume that in the Bank of America system this is branch number 157 and the hypothetical Mr. Brown has been assigned account number 11756 in that branch. Thus Mr. Brown is known to the bookkeeping system of Bank of America – and to ERMA – as 15711756.

Mr. Brown writes a check for, say $19.00 to a neighborhood merchant. Here is where the first but inconspicuous element of difference comes in. Each check of the book supplied to Mr. Brown carries his account number – 15711756. (How this number is put on we'll come to later. Just assume it is in some language intelligible to the electronic computer but not necessarily readable by you or me.) Except for the account number and it is further personalized with Mr. Brown's name and address, the check looks like any other Bank of America check.

The merchant deposits Mr. Brown's check to his own account, which may or may not be the same bank as serves Mr. Brown. In any case the check arrives via usual banking channels, such as clearinghouse transfer or directly from one of the branches' own tellers, to the desk of one of the five operators for ERMA the electronic bookkeeper. It is in one of the thick bundles of checks against the many accounts for which the machine is responsible.

The operator has before her, as do the other four, an array of keys that resembles the keyboard of a large adding machine. One section of the array applies to the branch-bank number and the account number and the other is for the dollars and cents amount of the item. Between the account-number section and the amount section is a single column of keys for various code purposes.



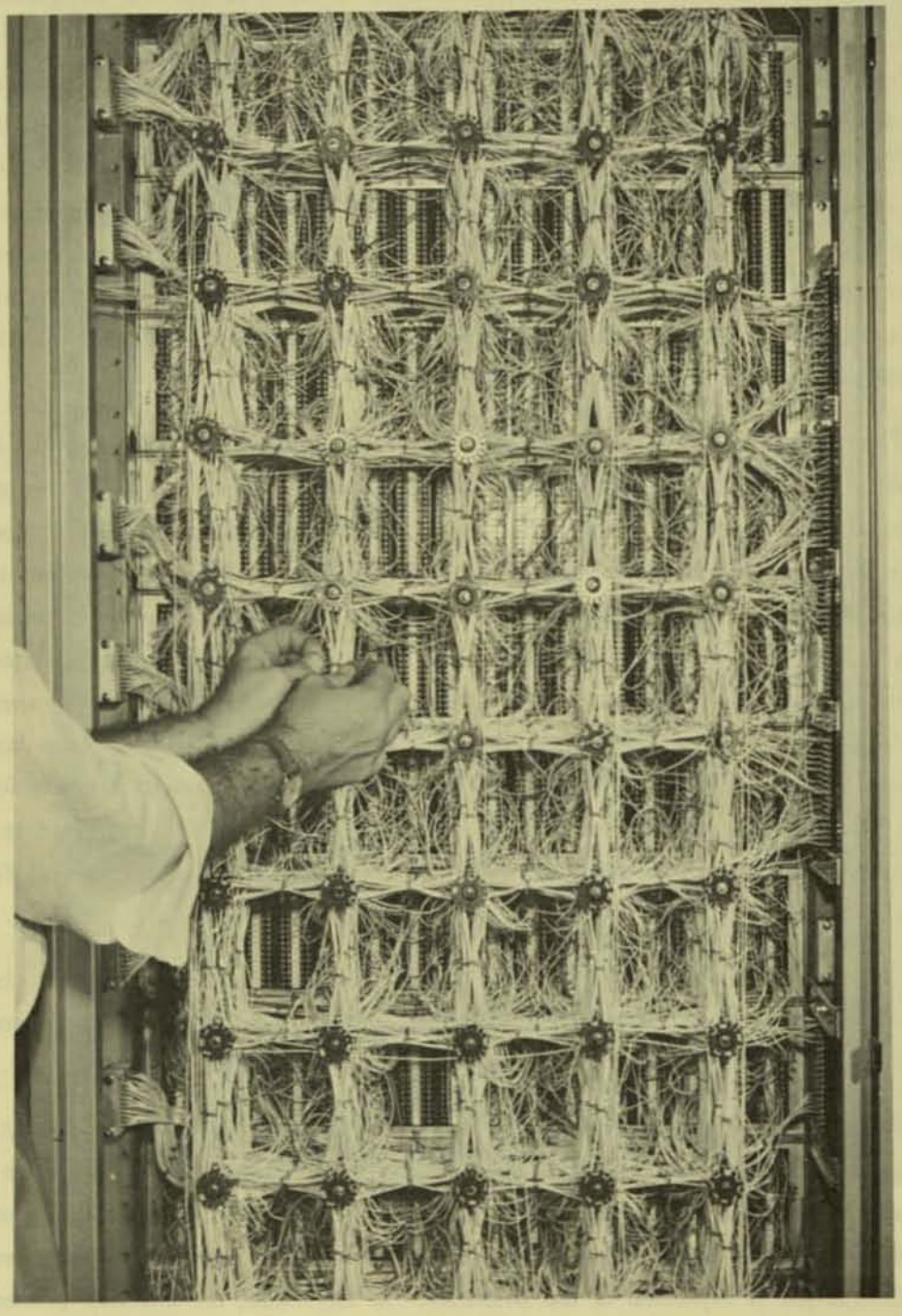
Hundreds of relay units are combined in the construction of ERMA. The units are all of the "plug-in" type and can be replaced with a minimum of difficulty and lost time.

The operator, we'll now assume, picks up from the pile Mr. Brown's check for $19.00. She depresses the keys 19.00 in the amount side and places the check in a slot of the check reader in front of her. The reader then scans the check and reads the account number. It instantly pulls down the keys on the account portion for 15711756. In fact, this is accomplished far faster than the operator can enter the check amount. The operator, if need be, can see the account number the machine has read, although ordinarily there is no reason for her doing so. Or, she can enter the account number by hand if need be. The operator next presses an entry bar at the side of the keyboard. This signals the machine to take over the bookkeeping functions, whereupon it initiates a long but lightning-fast chain of events.

The machine calls for Mr. Brown's current balance from its storage of such information. The machine simultaneously searches for two other pieces of information. Is there a "stop payment" against this check? And, are there any "holds" against funds in Mr. Brown's account? Stop-payment and hold data are stored on the machine's magnetic drum, as are account numbers and current balances, but on a separate section reserved only for that purpose. The machine, in effect, scans the storage drum for a stop-payment signal on a $19.00 check in account 15711756. If such is found, a light flashes before the operator and the machine refuses to take further action on this check. Meanwhile it goes on to the next input position ready for it. If any holds against this account are found, their amounts are transferred to the arithmetic unit and subtracted from the current balance so that the actual funds available are known.

The machine, we'll assume, finds no stop payment on this particular check. It has delivered into the arithmetic unit the amount of this debit and the amount in Mr. Brown's account available for withdrawals, i.e., current balance minus holds.

Next the arithmetic unit makes the subtraction of $19.00 from that amount. If the result of this subtraction is a negative quantity, it indicates that Mr. Brown has overdrawn his account. This unhappy fact is flashed, by signal light, to the operator who refers the matter to the supervisor. The supervisor sends the item to the branch for authorization or rejection of the overdraft. In any case, the machine processes this item no further until directed. It moves on to the next item at the next ready input position.



Many hundreds of thousands of connections and a million feet of wiring are needed to make ERMA function.

Ordinarily the check passes these examinations. The subtraction is completed in the arithmetic unit to establish a new current balance. After the machine checks its arithmetic in several ways, the old current balance for account 15711756 is replaced on the drum by a new one less the $19.00.

Meanwhile the account number and the $19.00 debit item are "written down" in another section of the drum reserved for the temporary storage of this information. It is held there for an appreciable period of time – minutes perhaps, or an hour or so – until convenient for the machine to transfer the information to its detail, account activity file, i.e., magnetic tape. Thereupon, – which is but a small fraction of a second since the start of the operation – the account number and the amount of the item are printed on paper tape in view of the operator.

Checks and deposit slips for different branches and different accounts come to the machine in completely random fashion. The information obviously must finally be stored in an orderly manner. The drum processes the information in whatever sequence it arrives. The drum then holds that processed information (in temporary storage) until it is transferred to the magnetic tape where the details of the transactions to all accounts are held in sequence and in complete detail. Meanwhile, the five operators at the input keyboards continue to feed new check or deposit information into the drum.

Transfer of information about Mr. Brown's withdrawal of $19.00 from the input keyboard to the temporary storage section of the drum is done in a semi-ordered fashion. On the drum are many circular tracks of information. At any one time a track or a group of tracks is assigned to a particular block of account numbers that correspond to those on one of ten magnetic storage tapes. Within that set of tracks the information is stored in random (incoming) order. When information about Mr. Brown's check is sent to temporary storage it is placed on the next empty space on the particular group of tracks assigned to the tape assigned to 15711756.

Essentially instantaneous emptying of the temporary-storage section of the magnetic drum is not necessary. Information is transferred from temporary storage to only one tape at a time.

In a short while it becomes time for the tape containing Mr. Brown's account to be brought up to date by receiving information for its accounts held for it in drum temporary storage. The machine makes the decision when that time arrives. It continually surveys its temporary storage sections, and when one nears filling, it automatically plans for connection to the associated tape at an early opportunity.

The drum rotates 30 times per second (and hence scans all the information held in any particular group of tracks 30 times per second). The tape moves slowly—relatively—at 75 inches per second. Hence some speed-matching device between them is necessary to effect the transfer of information from drum to tape. This device, called the shift register, is an array of electronic tubes that can receive information from the drum at a rapid rate but delivers it slowly to the tape.

After information for one account is transferred from drum temporary storage to the tape via the register, the temporary storage-drum reading head searches the tracks for the next higher account for which it has an item. (Because the drum scans itself 30 times per second this search is accomplished in practically no time at all.)

Assume the next account for which temporary storage has information is that of Mr. Brown. His account number and the $19.00 debit item are transferred to the register and held there while the tape unwinds through the intervening accounts for which no items are available. When the tape reaches account 15711756, that fact is signalled to the register, which readies itself to transfer the item information to the next available empty space on the tape. Physically this is immediately after the most recent entry to Mr. Brown's account. This may have been earlier in the day or on a previous day.

When the item has been entered in the proper place on the tape several cross-checks for accuracy occur. When the machine satisfies itself that it has made no mistake, the transfer-to-tape action proceeds to the next higher account number for which it holds entries. The process continues until the tape reaches its end, at which point the temporary-storage tracks have been wiped clean. The tape automatically rewinds itself to await its next turn for a new round of information.

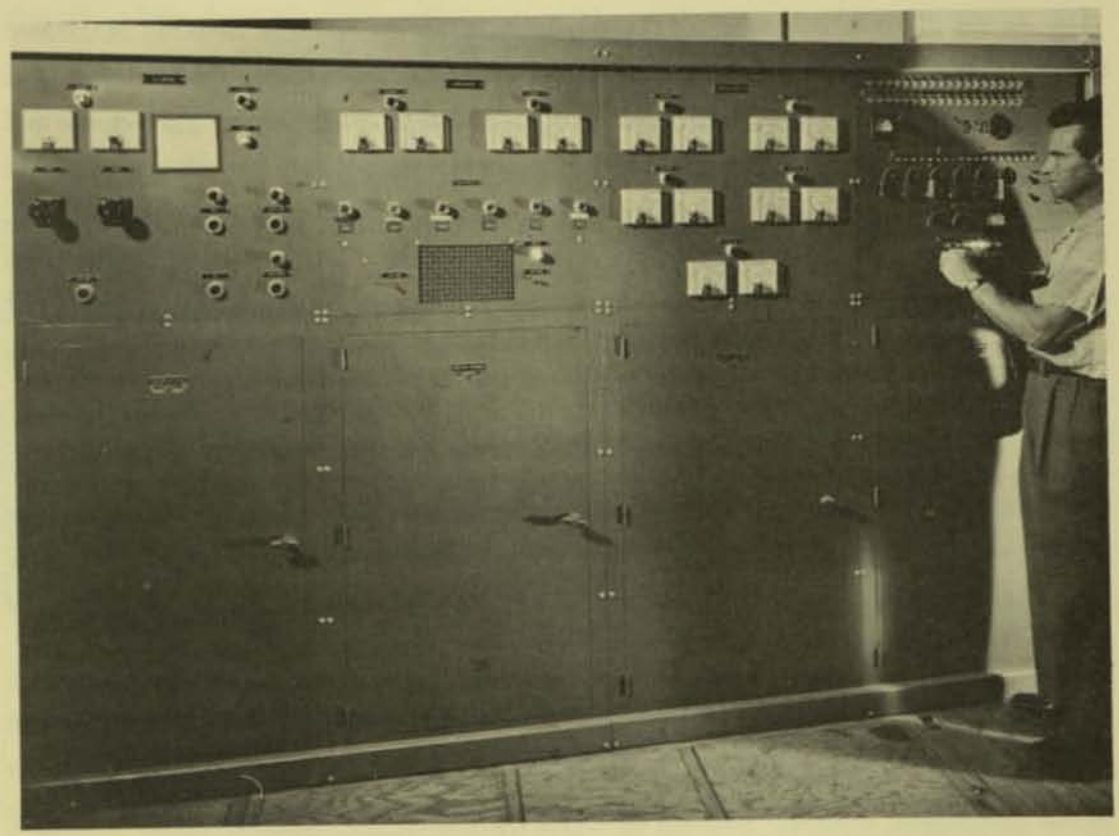
The bookkeeping for Mr. Brown's $19.00 check has now been accomplished. In like manner other withdrawals and deposits are entered throughout the remaining days

of the month. At the end of each day the machine automatically calculates from magnetic tape information Mr. Brown's new current balance. It is checked against that recorded on the magnetic drum and is recorded on the magnetic tape.

At the close of business for the month each tape is removed from the electronic bookkeeper and connected to a high-speed printer. Meanwhile, the machine has calculated the service charge automatically, prints that charge on the statement, and alters its own records on the drum and tape accordingly. The machine figures this charge automatically, applying a formula that includes account activity, balance, and type of account, which the machine ascertains from a code within the account number. Sinultaneously a written record of account activity is printed on paper for the bank's permanent record. When ready to print, the information held for each account in code on the tapes is converted into words and numbers, which it prints on the conventional-appearing monthly statement.

The machine-printed statement is combined with Mr. Brown's checks for the month, which have been sorted by machine and stored in the same order they were processed by the bookkeeping machine. The statement and his checks are delivered to Mr. Brown in the usual way.

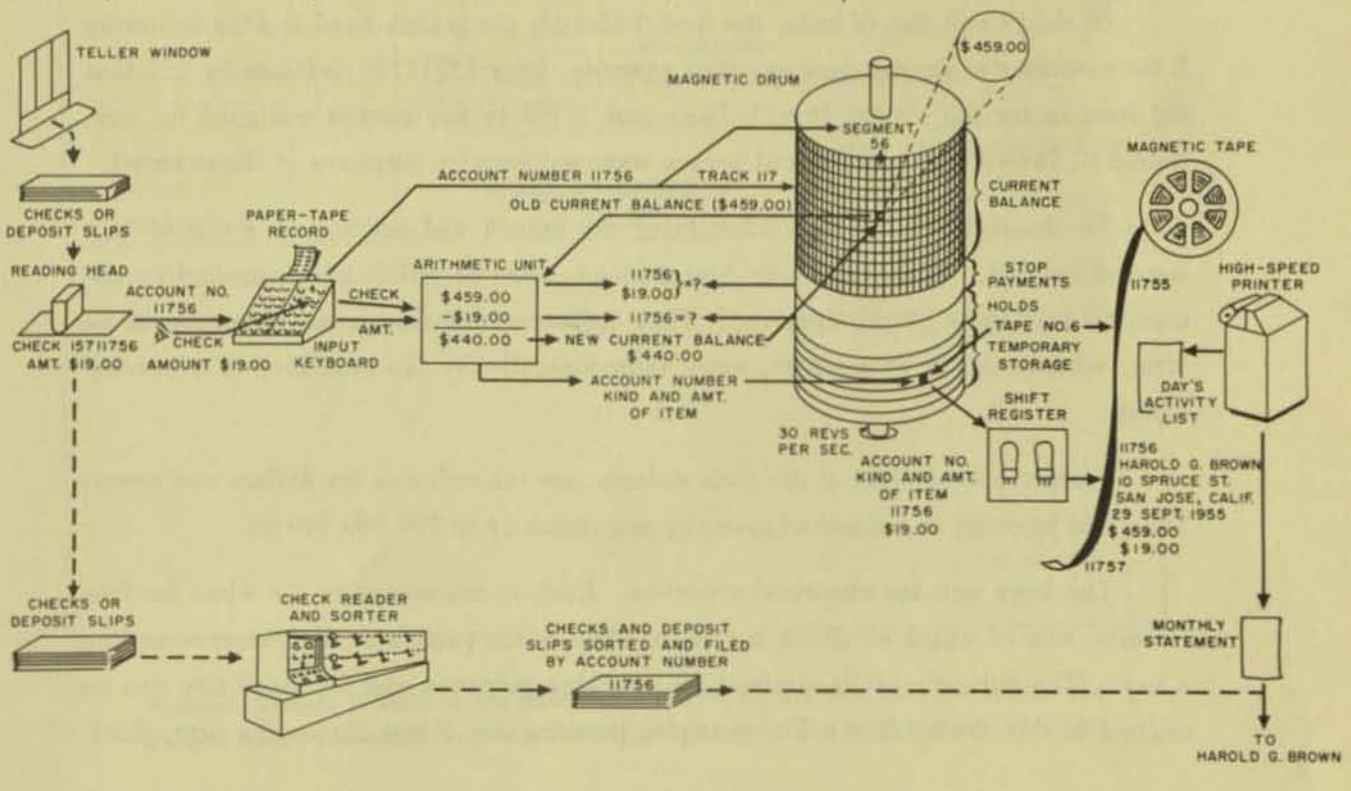
When the machine has printed the monthly statement for Mr. Brown it retains (1) on the drum only his account number and current balance and (2) on the tape his account number, name, address, and the current balance. The machine is now ready for next month's activity to Mr. Brown's account, and all others for which it is charged.



Power at seven different voltages is required to keep ERMA in operation. This panel controls the units required to convert 80 kilowatts of alternating current to direct current and to assure freedom from voltage variations.

ERMA. . . . *Electronic Recording Machine, Accounting*

This chart shows the path of a check or deposit through the electronic bookkeeper. The physical check or deposit slip takes the path of the dotted line; the information from it follows the solid lines. Checks or deposit slips in bundles come, in the usual way, to the operators of ERMA. Assume, as a typical case, a check for $19.00 by a Mr. Brown. The number 157 11756 has been assigned to him, the first three numbers (157) identifying the branch bank with which Mr. Brown does business. To perform the bookkeeping for this check, the machine requires three pieces of information. The amount of the check and the fact that it is a check not a deposit is supplied by the operator who presses the proper keys at her keyboard. The account number is read by the machine from the check. Having this information, the machine looks up the old current balance for this account, and delivers that sum to the arithmetic unit. It also determines if there is a stop-payment against this check or any holds against funds in this account. If none, the subtraction of the amount of the check is made from the old current balance by the arithmetic unit. If the remainder is plus (a minus sum indicates an overdraft), the new current balance is written on the magnetic drum and the item details are stored in the temporary storage section of the drum. Later these details are transferred, via the shift register, to the magnetic tape where all information for this account for the current month is held in sequence in space assigned at the beginning of the period to Mr. Brown. At the end of the month the account details for the period are read from the tape by a high-speed printer which writes them onto the statement. This is combined with the checks, which have been automatically sorted and filed, and delivered to Mr. Brown in the usual way.



THE MAIN ELEMENTS OF THE ELECTRONIC BOOKKEEPING MACHINE

INFORMATION INPUT

The input keyboards are the eyes and ears of the electronic bookkeeper (ERMA for electronic recording machine accounting). It is the means by which the machine receives information. In external appearance it is the keyboard of a large adding machine. Its principal array of keys are arranged in 19 columns of nine keys, one for each digit. In addition, there are keys that inform the machine whether the entry to an account is a check or a deposit. An entry bar at the side enables the operator to signal the machine when she is ready for it to process the item.

Of the 19 columns of keys, the first 3 identify the branch bank and the following 5 the customer's account number. For example, keys 15711756 indicate by 157 that the item is for the Hester Branch Bank and 11756 is the number assigned to, say, Harold G. Brown (the hypothetical person assumed here for purposes of illustration).

To the right of the keys identifying the branch and account is a row of red, lettered buttons. These are code designations, some of which are controlled by the machine and some by the operator. They indicate such things as correction of an error, adjustment to an account, entry (automatically by the machine) of a service charge.

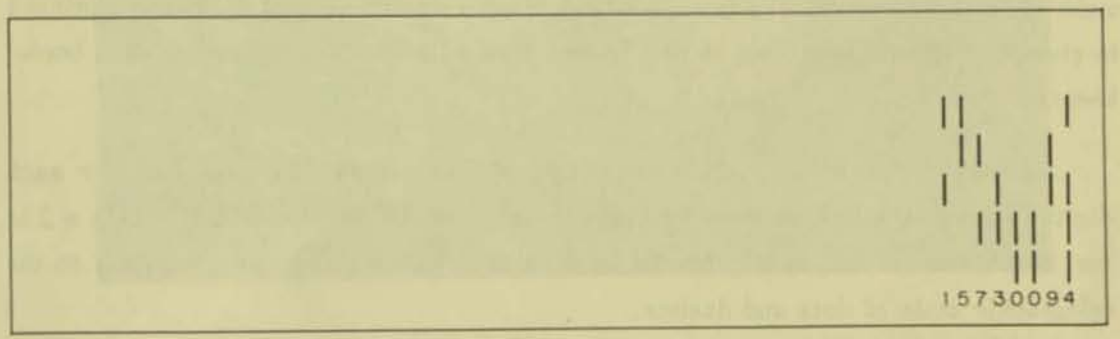
Finally, at the right of the code column, are ten columns for dollars and cents. Thus, the machine is not embarrassed by any check up to $99,999,999.99.

The keys actuate electrical switches. Each is connected to the wires for five circuits, four of which establish a code to identify the particular digit represented by a key. (The fifth circuit is retained for checking purposes and for simplicity can be omitted in this discussion.) For example, pressing any 8 key closes the first, third,

and fourth code circuits connected to it; the second circuit remains open. Thus, the machine recognizes an 8 by circuits 1, 3, and 4 being closed but 2 open. This can be represented by 1011. Likewise the number 7 is coded as 1010, and so on. The four circuits provide enough on-off combinations to identify all ten digits plus several symbols.

The electronic bookkeeper has five input keyboard positions (four operators and a supervisor). Because the machine handles the average item in half a second, it can switch itself without apparent delay among all operators as they signal to it. Even if all four operators happen to press their entry bars at once, one of them might have to pause about a second if she were entering items as fast as possible before the keyboard would respond to her next entry.

Each of the five input stations required to keep ERMA busy also have means for printing on paper tape a record of each item entered into the machine, i.e. account



Account numbers printed on the customer's check, on the back in code and on the front in arabic numbers, are printed in magnetic ink for use by the check scanner.

number, amount of item, and whether it is a debit or credit. This same print-out device gives a written answer to any question asked of ERMA, such as, "What is the current balance in Harold Brown's account?" Because the print-out mechanism is operated by depressed keys, each key has a solenoid to pull it down in response to the machine's answers to queries. In other words the keys can be depressed by the fingers of the operator or by solenoids responsive to electronic circuits.

Incorporated into each input station is the account-number reader.

MACHINE READING OF NUMBERS

One of the major technical accomplishments embodied in the electronic banking machine is the ability given it to read numbers automatically from the paper. This development not only plays a large part in the success of the machine but also has enormous implication for other data-handling machines.

This scheme differs from most previous attempts to "train" machines to "read." It does not rely on optical methods such as photocells that distinguish between light and dark or that utilize phosphorescent inks. This machine reads numbers by a magnetic process at the rate of 1000 characters per second. The numbers are printed on the paper in magnetic ink – ink containing particles of iron oxides, about 40 millionths of an inch in size. After the ink has dried, the particles can be aligned like tiny magnets by exposure to a strong magnetic field.

The technique of machine reading of information printed in magnetic ink was undertaken in two steps. The first was to develop a method of reading numbers printed in code in magnetic ink. This is the system used with the prototype electronic bookkeeping machine.

These codes consist of combinations of five narrow black-ink bars for each digit. Thus a 1 is represented by blank, blank, bar, blank, bar (00101) while a 2 is bar, blank, bar, blank, blank (10100), and so on. These codes are analogous to the telegraphic code of dots and dashes.

When a check, with its magnetic-ink coded number on the back, is placed in the check reader to be read it first passes under a magnetizing element. This causes the

tiny iron-oxide particles to line up in a prescribed direction. Immediately thereafter the check passes under a reading unit containing five magnetic reading heads side by side. Because the positions of magnet-ink bars differ, the pattern of voltages at the five reading heads differ for each digit. The machine's electronic circuits are designed to distinguish between these unique wave patterns.

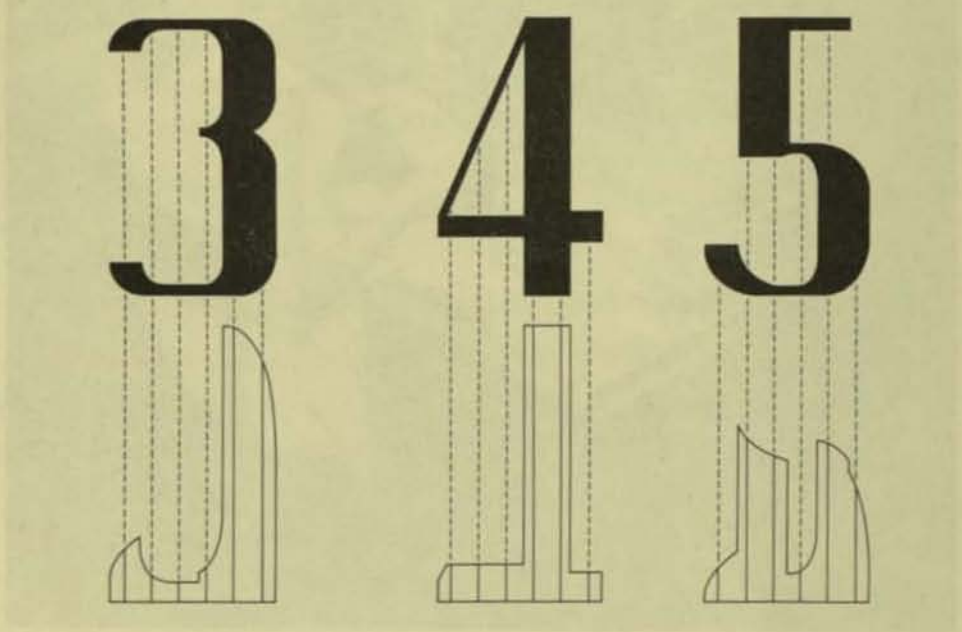
Operator using the Travelers Check number-scanning machine. This machine "reads" arabic numbers on Travelers Checks and punches IBM cards for use in Bank of America accounting systems.

Obviously it would be tremendously advantageous for the machine to read not codes but conventional arabic numerals. Arabic numbers are easier to print, and occupy less space on the check.

The second phase of the development program – direct reading of numerals – has proceeded in parallel and beyond with the code reading. A technique for direct number reading has been developed and successfully tested. It will be incorporated in future electronic bookkeeping machines.

The particular phase of the banking function chosen for the development of machine reading of conventional appearing numerals was the serial number on Travelers Checks. This was done for reason of simplicity. The traveler's check problem could be isolated from other phases of banking, yet it provided all the elements required for the development of direct number reading by machine.

The numbers as printed on the front of Travelers Checks (and eventually as the branch-bank and account number on depositors' checks) are recognizable to the human



Arabic numerals and the wave forms produced by the Travelers Check scanner. As the numbers printed on the Travelers Check pass horizontally beneath the read-head, the head sums up the total magnetic ink covered in a given time interval and produces a proportional electric signal.

eye as ordinary printed numbers. However, the numbers have been designed so that the machine can recognize them with a high degree of accuracy.

The Travelers Check reader has been tested with over 300,000 checks. On many of these the serial number has been purposely disfigured by rubber stamps, ink, dirt, fingermarks, tears, scotch tape, or crumpling, that make optical machine reading impossible. Because this machine responds only to magnetic ink it is not confused by such obliterations. The printing tolerance is large. Numbers can be printed as much as one-half inch above or below their normal position without influencing reading accuracy.

Also, before each check is read it passes through a set of pressure rollers to take out wrinkles. Checks that have been folded or crumpled and crudely smoothed out are readily handled by the machine.

The machine also verifies its own reading accuracy. Each Travelers Check is printed with a nine-digit serial number and a tenth number that indicates check denomination. In addition, an eleventh number is provided. This number, in every case, is chosen such that the sum of all eleven digits is divisible by nine. The check reader makes this summation after each reading. If the sum is not divisible by nine the machine "knows" that it has not read the number correctly, for some reason, such as faulty printing. The check is diverted into a separate compartment for attention by a human operator, or re-run through the machine. These are called rejected checks.

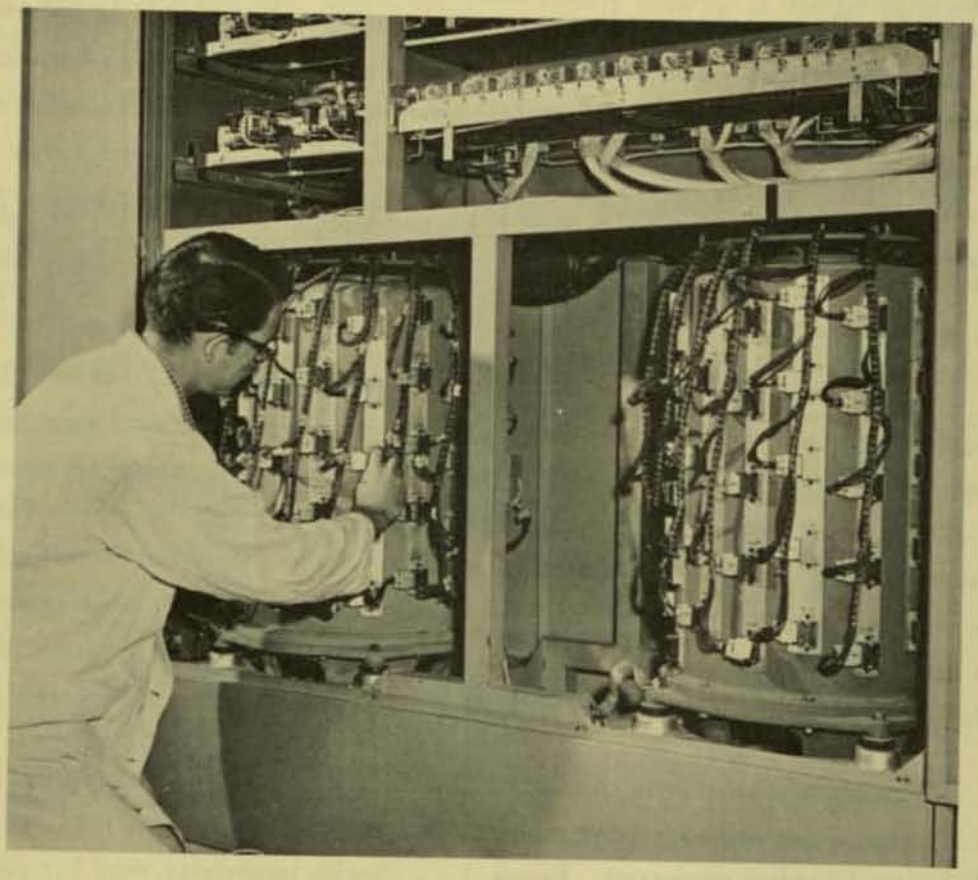
The prototype reader is currently reading (and verifying) the eleven-digit numbers at 100 checks per minute. Rejected checks normally amount to less than one percent of the total number processed. Errors, i.e., checks incorrectly read but passed as correct by the machine are less than one in one hundred thousand, as determined by laboratory tests using machine error-detection techniques. It is expected that even this outstanding performance, which is perhaps 50 times better than human accuracy, will be improved.

THE MAGNETIC DRUM

The magnetic drum is one of the information "files" in the electronic bookkeeping machine. Physically, it is a smooth vertical cylinder of non-magnetic metal 16 inches

in diameter and 20 inches high contained in a dust-proof housing. An electric motor drives it at a constant speed of 1800 rpm.

The drum surface is coated with a resin containing millions of tiny particles of iron oxide. Under the influence of fields from electromagnets mounted close to the drum surface, groups of these can be made to act like small permanent magnets of



ERMA's magnetic drums are contained within these vertical cylinders. The drums store current balance, stop-payment and hold information for future use.

controlled polarity. A surge of electric current through the electromagnet in one direction causes the microscopic iron-oxide particles in the tiny area under the electromagnet to align themselves so that their north poles lie in one direction and south poles in the opposite direction. If the current, i.e. field, is impressed in the opposite direction the poles are reversed.

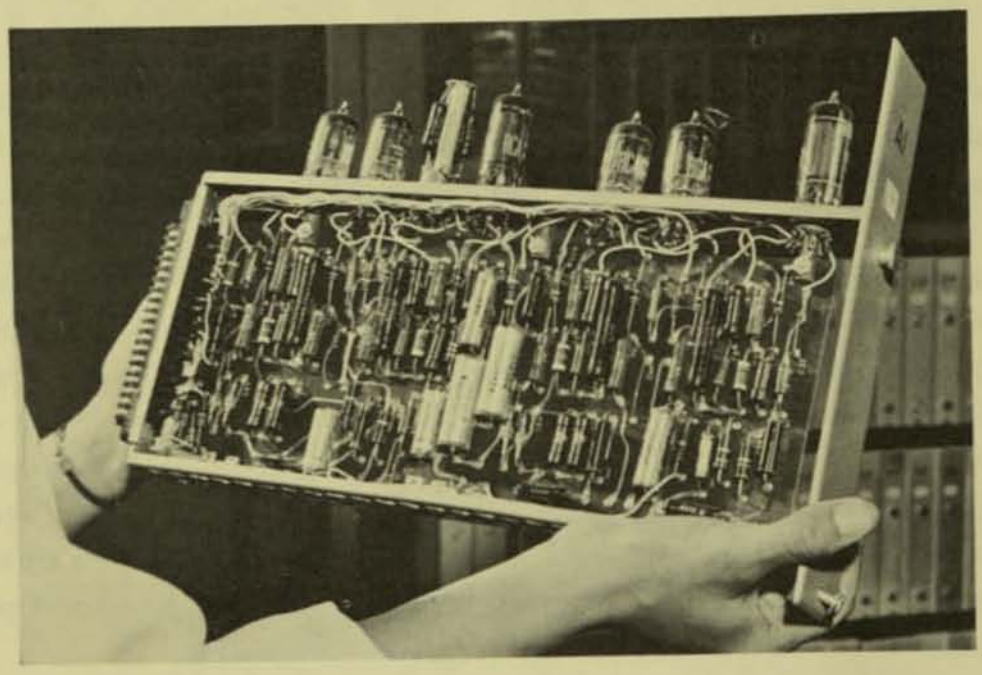
The drum surface with its iron-oxide particles is invisibly divided into 300 parallel, circular tracks, each about 0.040 inch wide. In a lengthwise direction each track is divided – again invisibly – into sections 0.010 inch long. Each little magnetic cell stores what is called a single binary digit or bit of information. Thus the drum surface can be thought of as made up of 1,500,000 separate, but invisible, magnetizable areas. Each of these can be magnetized at will in one direction or the other. The drum thus provides, on the binary system, 1,500,000 information elements.

Four bits are required to store a single digit (a fifth is also reserved for each digit but it serves for checking purposes and can be neglected in understanding the basic principles of the machine). Thus to store an account number such as 11756 the first two sets of four bits on a track are magnetized N-S, S-N, N-S, N-S, (0100), which in machine language means 1. The third set, for the numeral 7 (1010) would be magnetized S-N, N-S, S-N, N-S. Actually, to save bits, which cost money, the information is stored in a way that does not require writing the full account number for each account. The drum is divided in a sort of pigeon-hole or post-office box system in which there are 100 "boxes" in each vertical column (corresponding to 100 spaces around one track) and 300 columns (i.e. drum tracks). Thus, Mr. Brown's account number is filed in the 56th box of the 117th track, without the necessity of having to write on the drum the account number with the current balance. Following the account number on the track the current balance is stored, using the same language of properly polarized four-element magnetic cells.

A set of about 300 elements, one per track, are held close to the rotating drum and spaced evenly around its surface. Each element is used for both reading and writing. These enable the machine to add information into this file, to read its contents, or to empty it when necessary.

Each magnetic head element consists of a coil through which current can be passed. It is wound around a piece of magnetic material containing an air gap spaced a few thousandths of an inch from the rotating tracks. To write a number onto the drum, bursts of current, electronically timed, are passed through the coil. These bursts, by their direction, magnetize the sets of four bits in accordance with the code for the number to be written. The number thus written down remains until it is necessary to change or erase it. Should electric power be turned off no information is lost.

The numbers are read by the same magnetic head elements that write them. Thus each magnetized bit on the drum as it sweeps by the element induces a voltage in the coil. The direction of this voltage is determined by whether the little magnet on the drum is N-S or S-N. Thus the heads can look for a given desired number by searching for the proper combination of bits on the drum. Information, such as current balance, can be read in similar fashion.



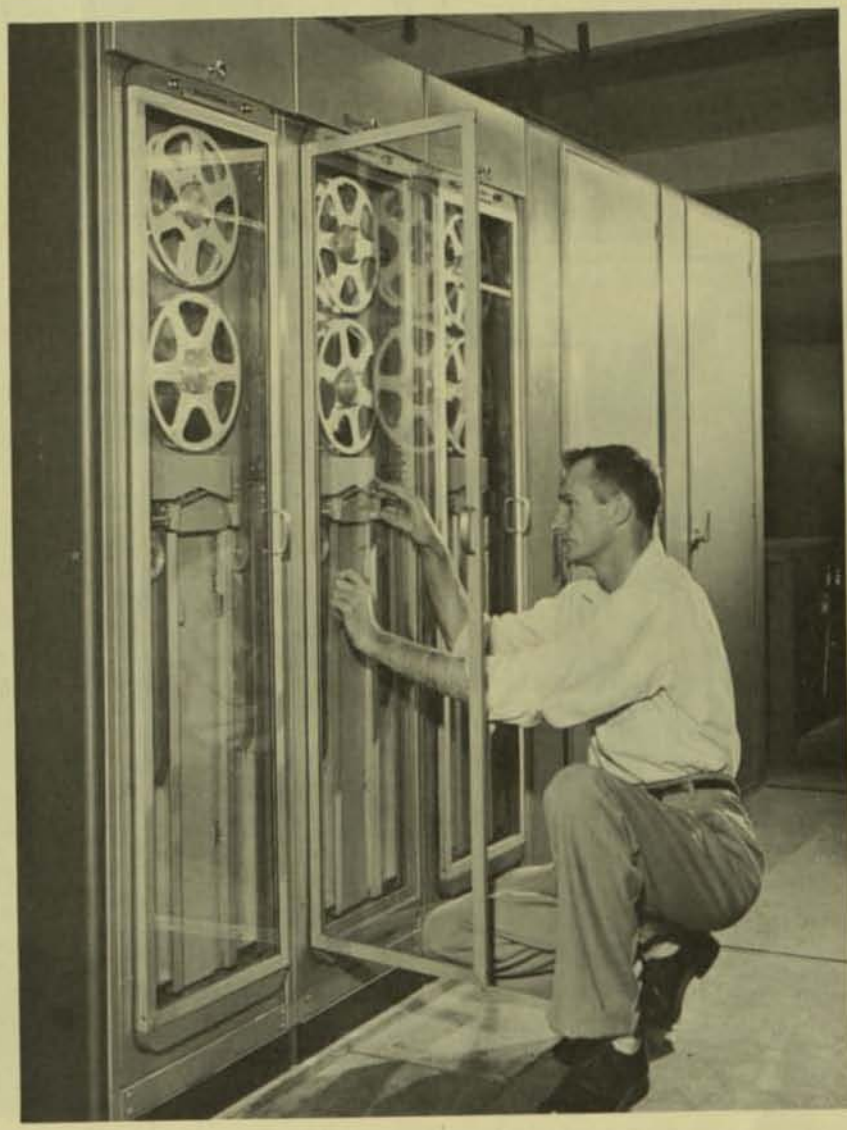
One of the "building blocks" used in the arithmetic unit, capable of performing additions and subtractions on sums as large as $99,999,999.99.

When it is desired to change a number, for example to write a new current balance, it is necessary only to "write over" the old number. The magnetizing forces, applied in the proper coded sequence, are strong enough to overpower the magnetism of any bits that previously were oppositely polarized. Or, a section can be completely "erased" by simply magnetizing all the bits in one section with a common polarity.

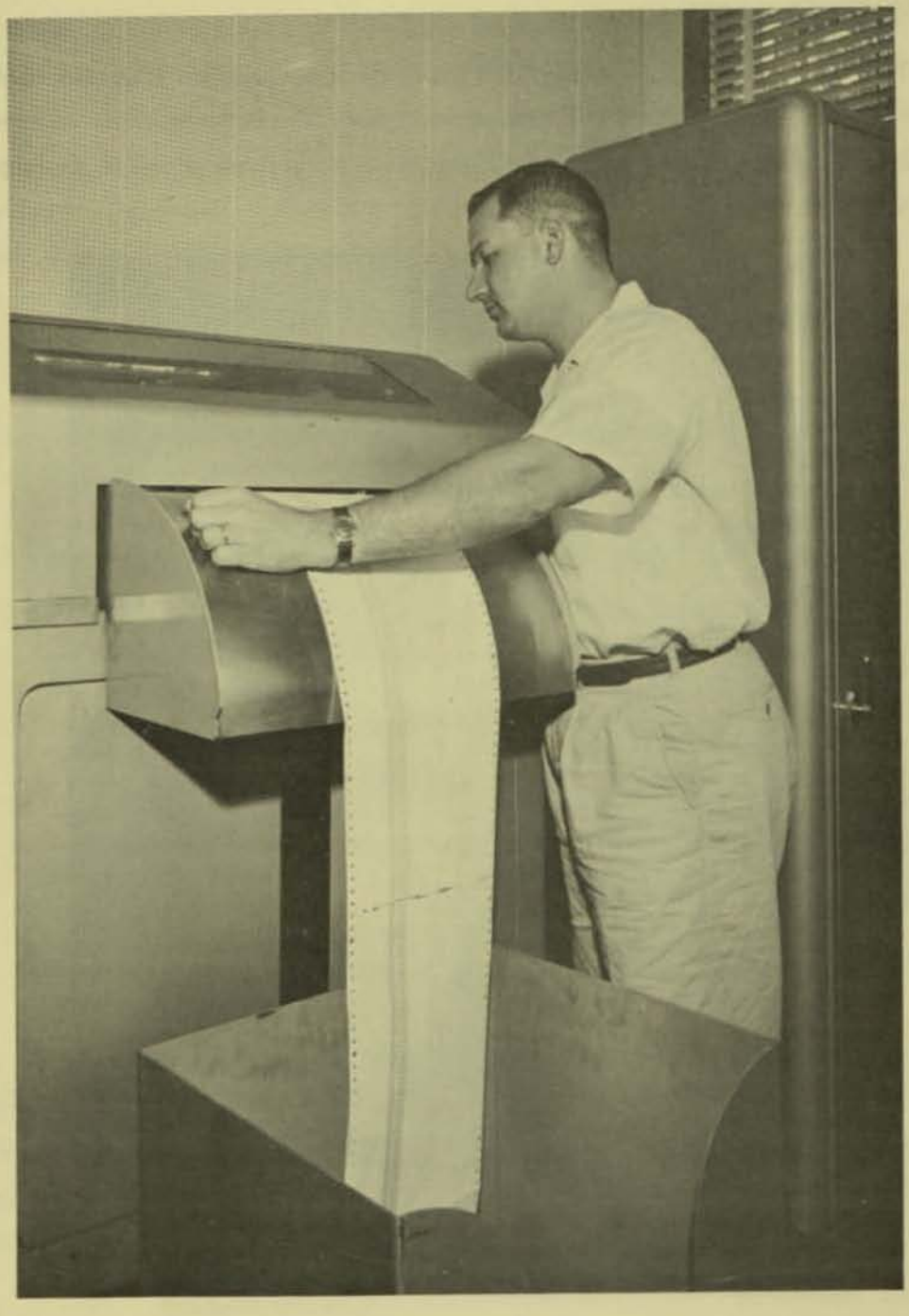
A drum has space for about 300,000 decimal digits. Actually two drums are used, for reasons of practical physical size. This gives a total of approximately 600,000 digits of information. This is adequate for servicing the accounts under ERMA's jurisdiction.

THE ARITHMETIC UNIT

The arithmetic unit is one of the many devices built up from the standard electronic "building blocks." It comprises a battery of electronic tubes and related components capable of performing additions and subtractions on sums as large as $99,999,999.99.



Detailed account activity information is "filed" by ERMA on 10 reels of magnetic tape, each almost half a mile in length. Accounts are kept in numerical order on the tapes which provide storage space for a month's activity.



The high speed printer, used in statement preparation, prints 15 lines per second. The printer can prepare all the statements for ten branch banks in about five working days.

Since the basic building blocks can count only up to two (i.e., they recognize only numbers 0 and 1) the decimal numbers are handled in a coded form such that each decimal number is represented by a unique pattern of binary numbers.

The tubes are arranged in pairs, known as flip-flops, so that when a potential is applied to a pair, one tube becomes conducting, the other non-conducting. The next application of potential causes the conducting tube to become non-conducting, and vice versa. Thus the device has the essential features of a device to store one bit of information, just as each cell on the drum served this function.

THE MAGNETIC TAPE

The second and more detailed information file is kept on magnetic tapes, of which ten are used for storage and two serve auxiliary functions. The entire month's activity for each account is kept together in its incoming sequence, each account being in numerical order, just as in a standard manual file.

The tape itself is the same as conventionally used with data-processing machines. It is a tape 2400 feet long contained on a reel, which provides space for the detail information for several thousand accounts. The tape can be unwound past a set of magnetic heads, similar to those used on the drum, that either write new information on the tape or read information from it as needed. The tape stores information on the same binary basis—bits that are magnetized either N-S or S-N—as on the drum. The tape consists of a plastic backing coated with a film containing iron-oxide particles. The tape of standard size gives room in one row across the tape for seven information bits. Because the tape must store words, i.e. letters, as well as numbers seven bits are required to identify all letters and numerals. The bits in one row across the tape are used for a single letter or numeral. In this way, however, information as to account number, name and address, and account activity for a month can be maintained in about nine inches of tape for an average individual checking account. Space on the tape is allocated at the beginning of every month. The amount of that space in each case is determined by previous experience with that account.

The manner of writing information, reading information, or erasure is essentially as described for the magnetic drum.

HIGH-SPEED PRINTER

Under present banking procedures the entries to monthly account statements are posted daily by hand. This is essential because the volume of work makes doing it all at one time a physical impossibility if it were done manually.

With machine accounting daily posting to the customer's statement sheet is unnecessary. Each statement is printed all at one time on a selected day each month. To make this system possible, however, requires a means of printing information of statement sheets at extremely high speed.

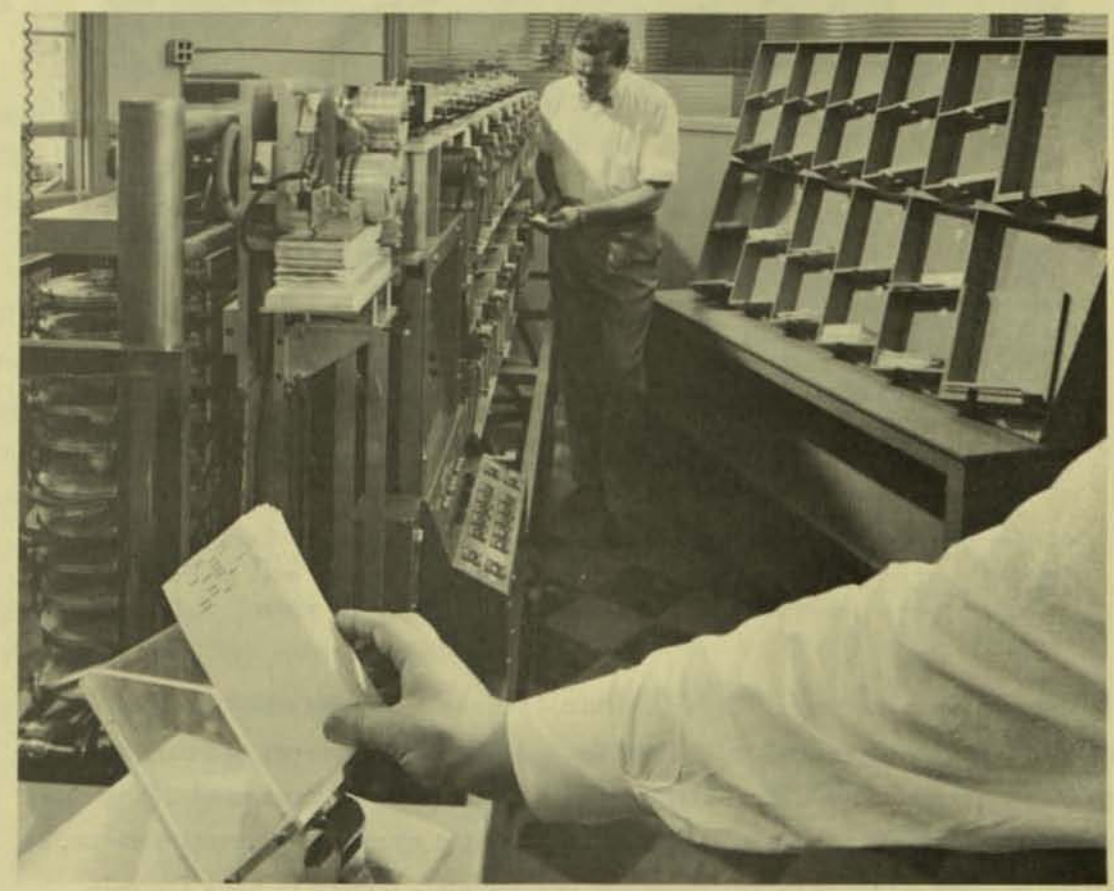
Consider the enormity of the job of statement preparation. For 50,000 accounts and with an average of, say, 25 lines to be printed on each statement (name, address, daily activity, daily balances, service charge, final balance, etc.) that amounts to 1,250,000 lines to be printed.

When the development of the electronic accounting machine was begun the highest speed printer available could manage three lines per second. That seems fast. However, to print 1,250,000 lines at 3 per second – and counting no lost time between statements – would require 120 hours of uninterrupted operation, or five 24-hour days.

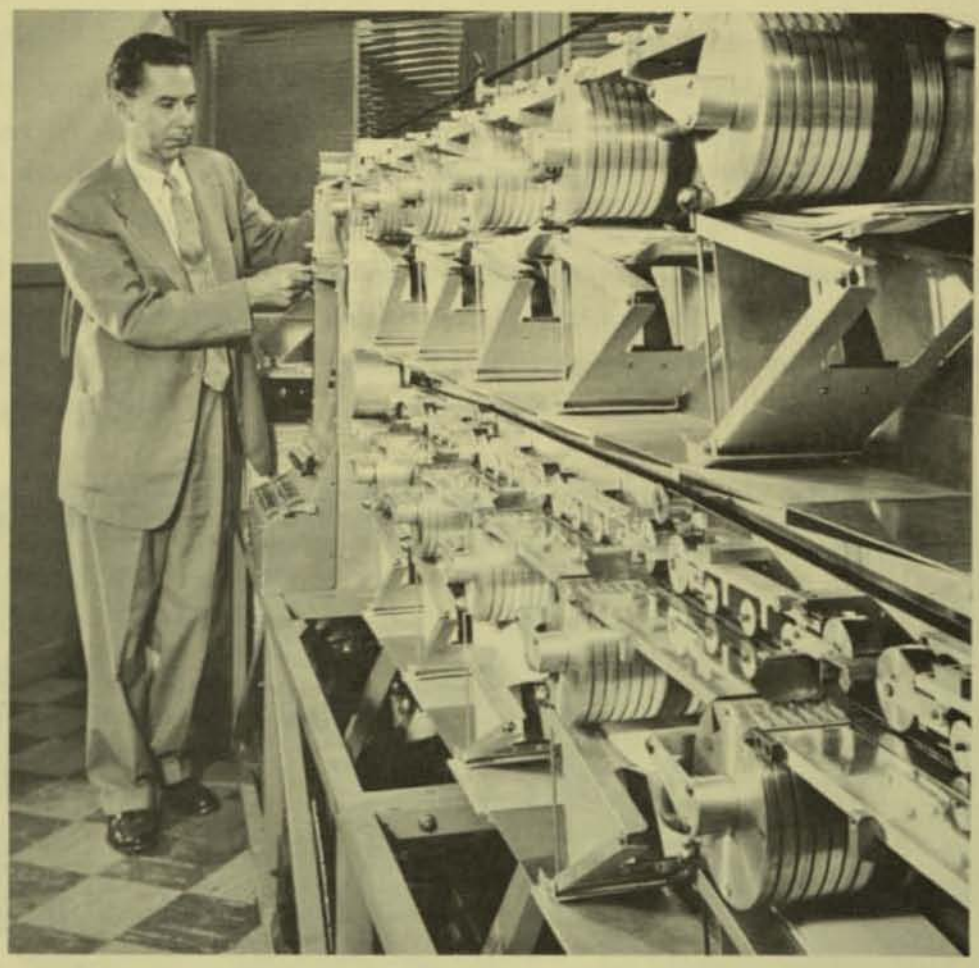
Subsequent developments have fortunately resulted in increasing the printer speed by more than three times – to 10 lines per second – and it is expected this will soon be increased to 15 lines per second. This enables the statement printing for all the accounts handled by the machine to be accomplished in about five normal working days. With the machine serving about 10 branch banks, the statements for all these branches can be turned out during a working week around the month end.

The actual printing element consists of a cylinder with rows of raised characters lengthwise across it. Each row is as wide as the line of printing on the statement. One row contains nothing but a succession of A's, the next, B's, and so on around the cylinder for the remainder of the alphabet, numerals, and other needed symbols. This cylinder rotates continuously at 1200 rpm, above a row of stationary striking hammers, one for each character in the row. Between the hammers and the cylinder is the statement blank and a carbon ribbon.

For printing statements the printer is connected to a magnetic tape where the account detail information is stored. Suppose the statement for the hypothetical Harold Brown is to be printed. As the reading heads at the tape reach the codes spelling out HAROLD BROWN, a blank statement at the printer is synchronized with it. When the line of A's on the cylinder are in a printing position, the coded signals from the tape cause the printing bar to strike the second A in the row of A's. One five hundredth of a second later the B line is in position and the B as the first letter in the surname is printed. There being no C's in the name no hammers strike the paper when the C row sweeps past. Next the D in the given name is printed, and so on.



The electronic check sorter separates the checks by account number and by bank branch so the checks may be returned to the customer with his monthly statement. Automatic sorting is made possible by a special magnetic ink code marking on the back of each check.



Another view of the check sorter which sorts by account number. Each bundle of checks must be passed through the machine five times (once for each digit). The checks travel at the rate of 150 inches per second through the sorter.

Thus in one complete revolution of the drum—one tenth of a second—the whole name is filled in. The paper then indexes to the next line for the street address, which is printed in like manner. Similarly, the remainder of the address, and the account information, including the machine-calculated service charge and current balance, is printed in. The average 25-line statement is completely printed in three seconds.

The monthly statement for Mr. Brown then is assembled with his checks in the order of their presentation which have been sorted by the check sorter and filed for the period. Mr. Brown therefore receives his monthly statement and checks in the

usual manner. Except that the statement carries the account number, nothing else distinguishes it to Mr. Brown from others he received before the advent of machine bookkeeping.

THE CHECK SORTER

After all the bookkeeping for a bundle of checks has been completed the checks must be sorted by account number and the checks filed in the same sequence as that in which they are held in the electronic bookkeeper. A machine has been developed to sort them mechanically.

The check sorter has the same ability to read account numbers printed in magnetic ink on the checks as has the input section of the electronic bookkeeping machine. The machine has 12 boxes or output compartments (0 through 9 plus two for rejected checks) into which it sorts the checks or deposit slips.

To sort checks, a bundle is first placed in the sorter. The top check is whisked off by a vacuum feeding device and guided to a scanning head that is manually set to read the first (units) digit of the account number. This information, i.e. whether the unit digit is a 0, 1, 2 or other number, is stored for a fraction of a second on a rotating mechanical memory device. Meanwhile, the check itself is being carried at the rate of 150 inches per second on a belt into the sorting section.

Mr. Brown's account number is 11756. Hence, when the sorter comes to that check, the value of the digit is read as 6 and remembered by the memory mechanism. When the check approaches the number 6 compartment, the memory device causes a gate to open, sidetracking the check into that compartment.

In this manner all checks are sorted according to the units digit. Then the checks from each of the ten compartments are manually collected and run through the machine again, this time sorting for the tens digit. On this next pass, Mr. Brown's check goes into the 5 compartment. By sorting each bundle five times (once for each digit) the checks are placed in sequence by account number—and the items for any one account are in the order of processing by the bookkeeping machine.

ERMA's "Service Station" used to insure the perfect operation of the many delicate circuits in the bookkeeping machine. This maintenance board facilitates the location of troubles within the machine.

ERMA. . . . *Electronic Recording Machine, Accounting*

The outstanding features of this device are not those of its basic principle of operation, which is relatively simple. The requirements of speed and accuracy are so high, however, as to generate engineering problems of a different order of magnitude. Account numbers are read and checks sorted at the rate of 10 per second. A stack of a thousand checks about 5 inches high "melts" down in the input container in about one and a half minutes. To obtain good accuracy at these speeds the paper is controlled pneumatically for both feeding and stacking, not by mechanical friction devices. The machine errors – checks sorted into wrong compartments – run less than 1 in 100,000. Rejects, or checks the machine cannot sort, are below one percent.

Machines are created by people. To conceive, develop, build and test a machine of the size and complexity of ERMA requires the services of many men and women with many skills.

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ERMA. . . . *Electronic Recording Machine, Accounting*

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