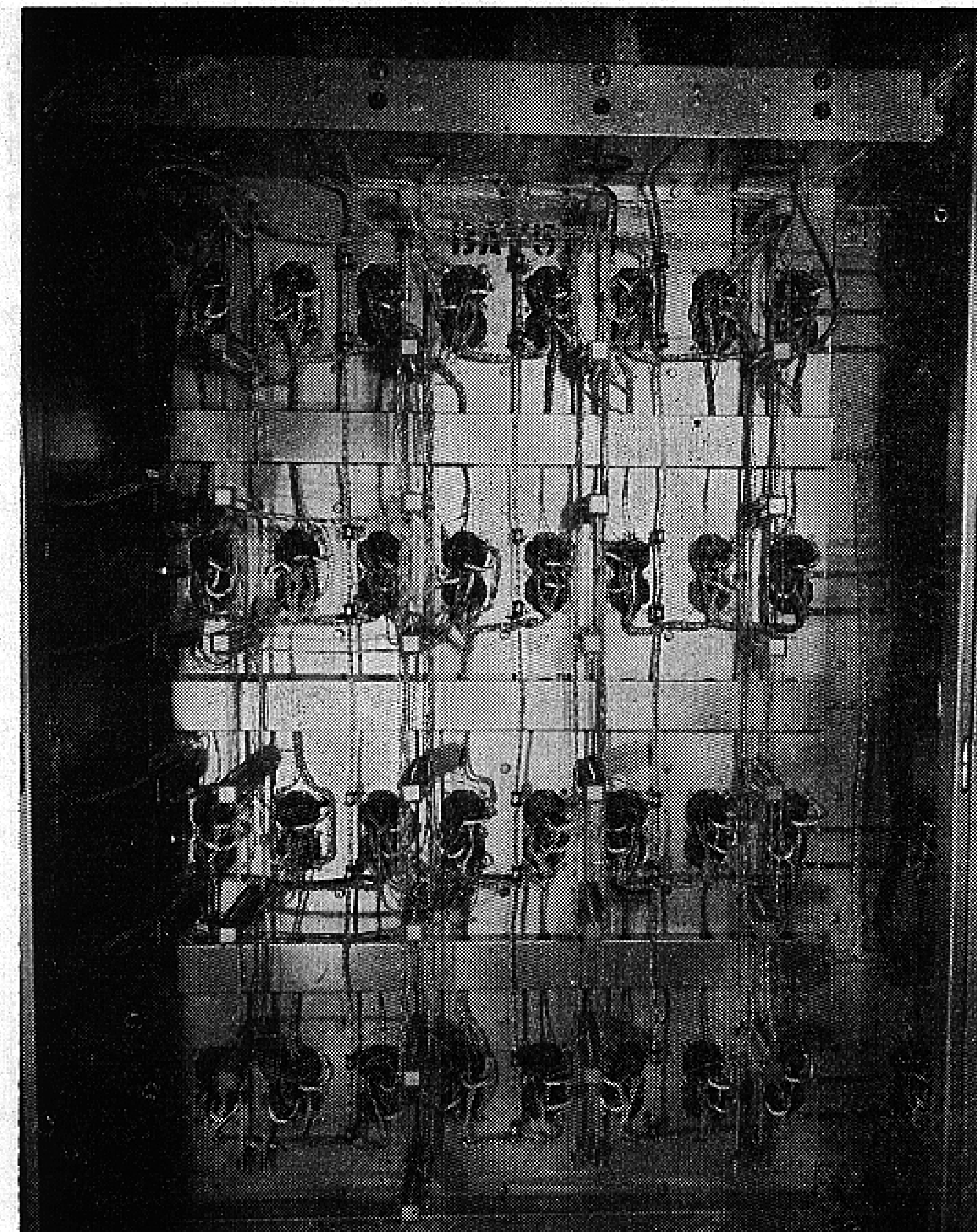

Fig. 9—Typical cabinet wiring.

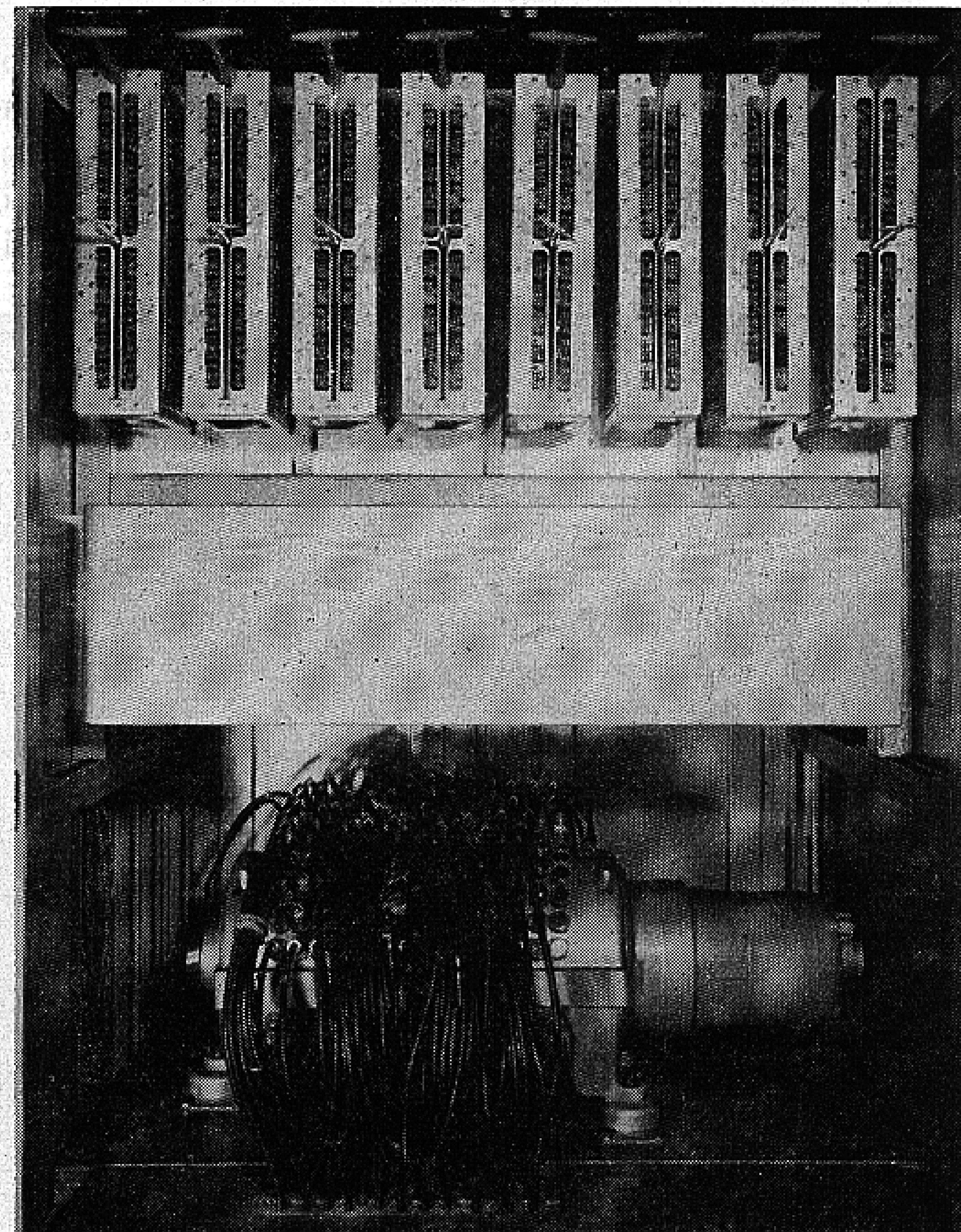

Fig. 10—This view shows how the magnetic storage drum is mounted in the storage cabinet.

ACKNOWLEDGMENT

During the design and development of this computer close liaison was maintained with the personnel of the ONR-sponsored Logistics Research Project at George Washington University, Washington, D. C. Many valuable contributions to the logical design of the computer were made by this group.

The Remington Rand Type 409-2 Electronic Computer*

LORING P. CROSMAN†, ASSOCIATE, IRE

Summary—The Remington Rand Electronic Computer, Type 409-2, does computations by arithmetic steps in sequence with a unique self-proving feature. Parallel inputs to ten vacuum-tube decades are added or directly subtracted into a 22-column Accumulator. The Accumulator is connected in a ring so that a number or pair of numbers can be shifted to any position. Decimal positions are automatically handled by a Decimal Computer. Signs are handled algebraically. The total electron tube complement includes 1476 vacuum tubes and 1128 cold-cathode gas diodes. Most of these are designed and manufactured especially for computer use.

Inputs are brought to the Accumulator, using a Call Line for each complete number, from three types of storage:

1. Variables from a tabulating card reading block of Sensing Switches; 2. Constants from manually settable Constant Switches; and 3. Intermediate results from Storage Relays.

Outputs are delivered to Punching Storage from Intermediate Storage, in one or two blocks. Results are punched into the same tabulating card or following cards, as may be desired. Programming is directed by interchangeable Plug Boards. There are 40 Calculating Steps and 6 special steps: Clear, Set I, Set II, Sort I, Sort II and Trip.

Each Calculating Step has 5 addresses and a process designation: 1st Operand; Process (+, −, ×, ÷); 2nd Operand; Result; Next Step if Result is "plus"; and next step if Result is "minus." Each step is automatically proved by a reverse process and repeated if the stored result is wrong so that progress to the next step is impossible until the preceding step has checked itself correct.

A Reproduce feature provides for storing alphabetical or numerical information for punching into following cards, or transferring to other Fields of the same card.

INTRODUCTION

THE REMINGTON RAND Electronic Computer, Type 409-2, reads information from punched cards, performs one or more sequences of arithmetic steps, and punches results into the same card from which the information was read, or into following cards.

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† Remington Rand Inc., Laboratory of Advanced Research, South Norwalk, Conn.

For example: $[(A \times B)/(C+D)]-E=P$ is done in a sequence of four arithmetic steps. 1, Multiply: $A \times B$; 2, Add: $C+D$; 3, Divide: $(A \times B) \div (C+D)$; and 4, Subtract: $[(A \times B)/(C+D)]-E$. Each step is proved automatically, by reverse process, without programming, before the following step is initiated. This will be explained later. The complete computer as shown in Fig. 1 consists of two units, the Card Sensing-Punching Unit and the Electronic Computing Unit. These units are interconnected by multiconductor cables. The general organization is indicated by the diagram of Fig. 2.

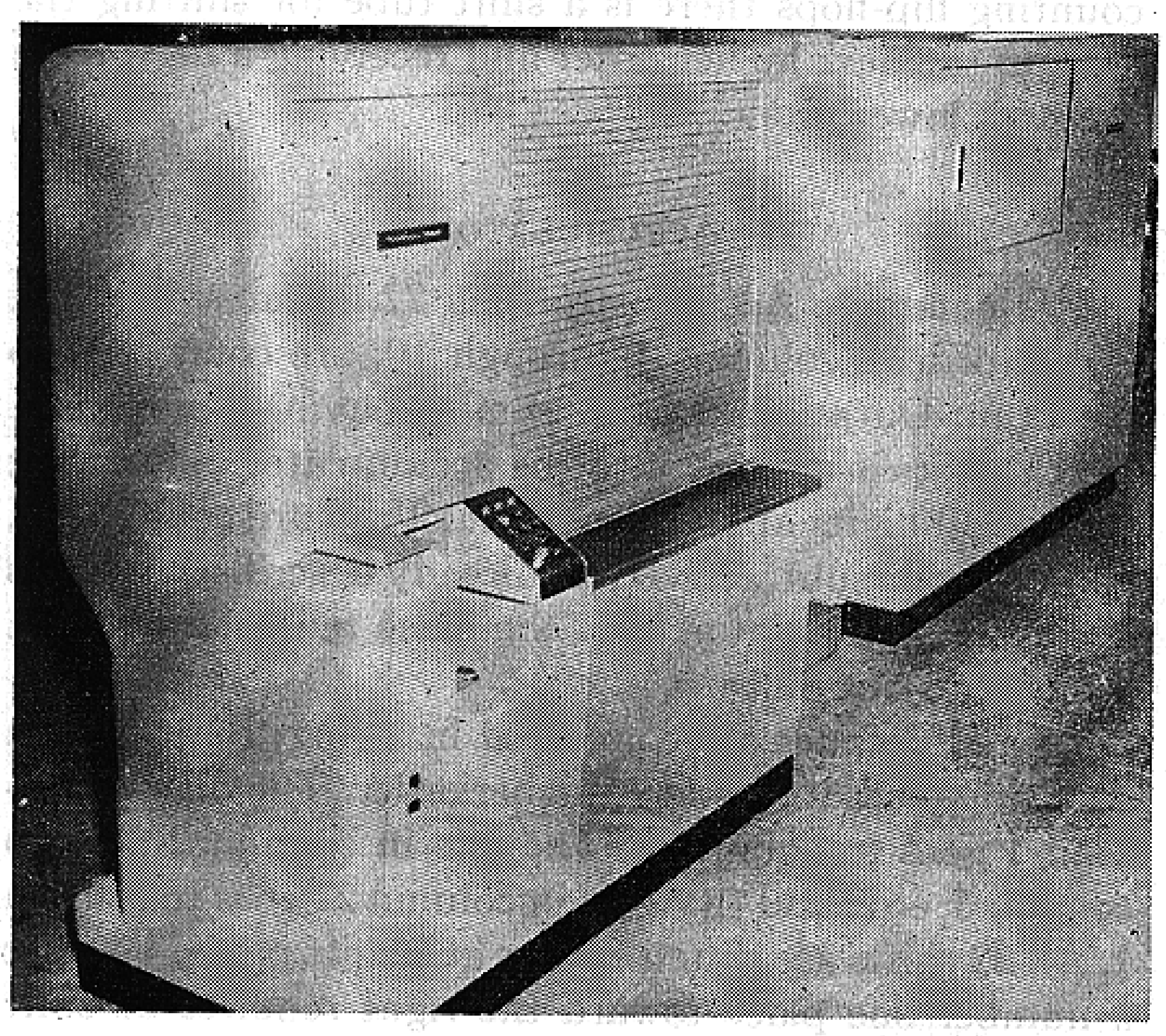

Fig. 1—The complete Electronic Computer assembled for operation, Sensing-Punching Unit at left, Electronic Computing Unit at right. The two units are interconnected by multi-conductor cables. Routine operating controls and indicators are on the sloping panel in foreground.

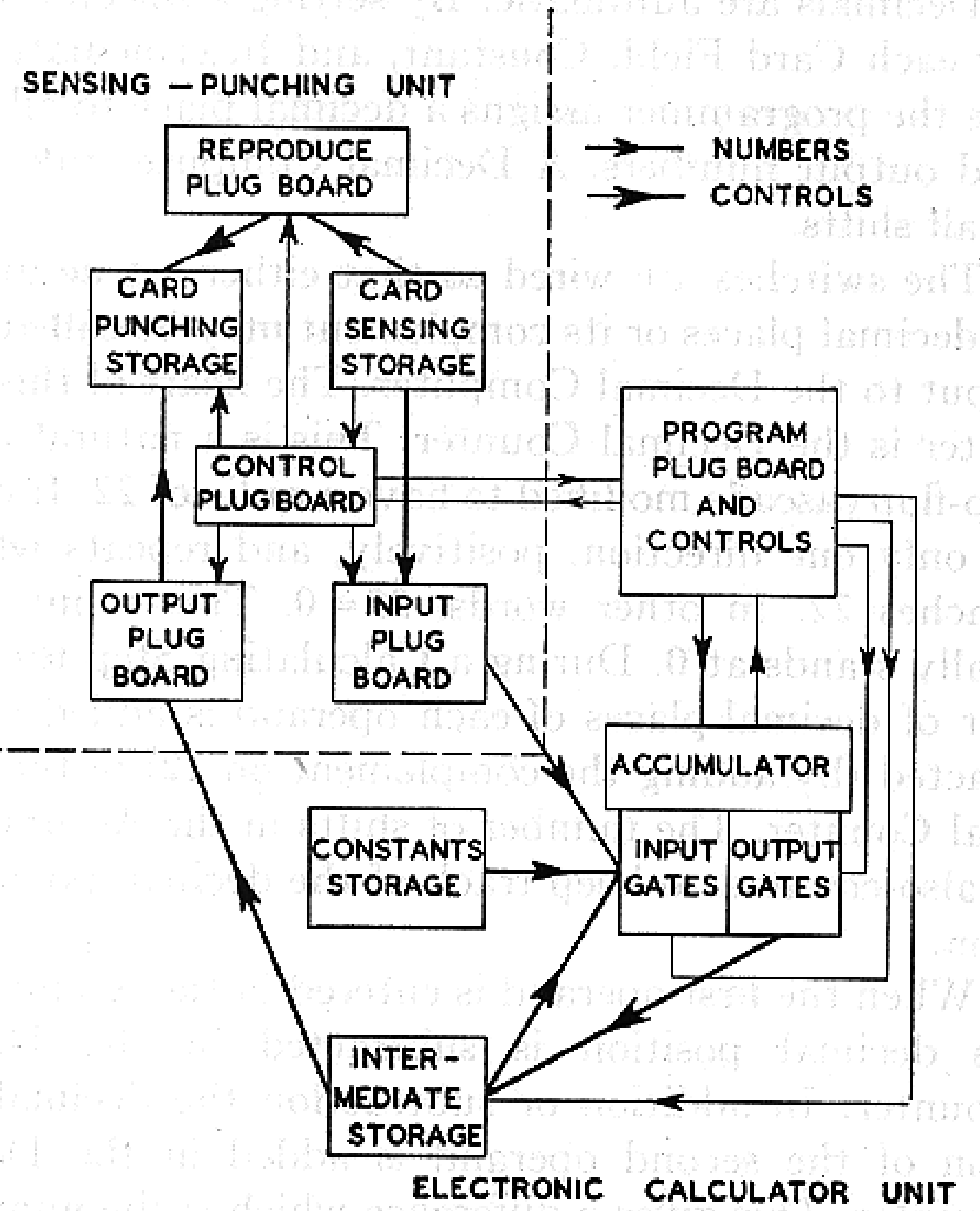

Fig. 2—Logical organization of the 409-2 Electronic Computer with routing of numbers indicated by heavy lines and control functions by light lines.

DECADE

Since every digital computation is basically a series of counting operations, let us first consider the Decade Unit. Like most of the electronic circuitry of the machine, this is housed in a box-like pluggable chassis structure (Fig. 3). The tubes are mounted in the back of the chassis. These are mostly Type 5964, designed particularly for computer operation. The circuit components are mounted in "cages" (Fig. 4) which are plugged into the front side. Each cage is directly opposite the tube with which it is related. Projecting on both sides of the chassis are silver plated, beryllium copper contacts which make all electrical connections with the fixed frame wiring. All of the tube sockets, cage sockets and contacts are interconnected by wiring within the chassis. Coarse-thread jack screws fastening into frame members, one at each end, facilitate quick change of chassis.

This construction puts the tubes on the inside of the machine where there is a ventilating air stream. The cages may be removed without disturbing the chassis and almost every junction in the circuits may be probed at the outer ends of the cage wires, even while the machine is running.

The Decade Chassis has 21 double triode tubes. Six of these are in Eccles-Jordan flip-flop circuits, each having two stable states. They are arranged in a biquinary fashion, and can count either forward or backward.

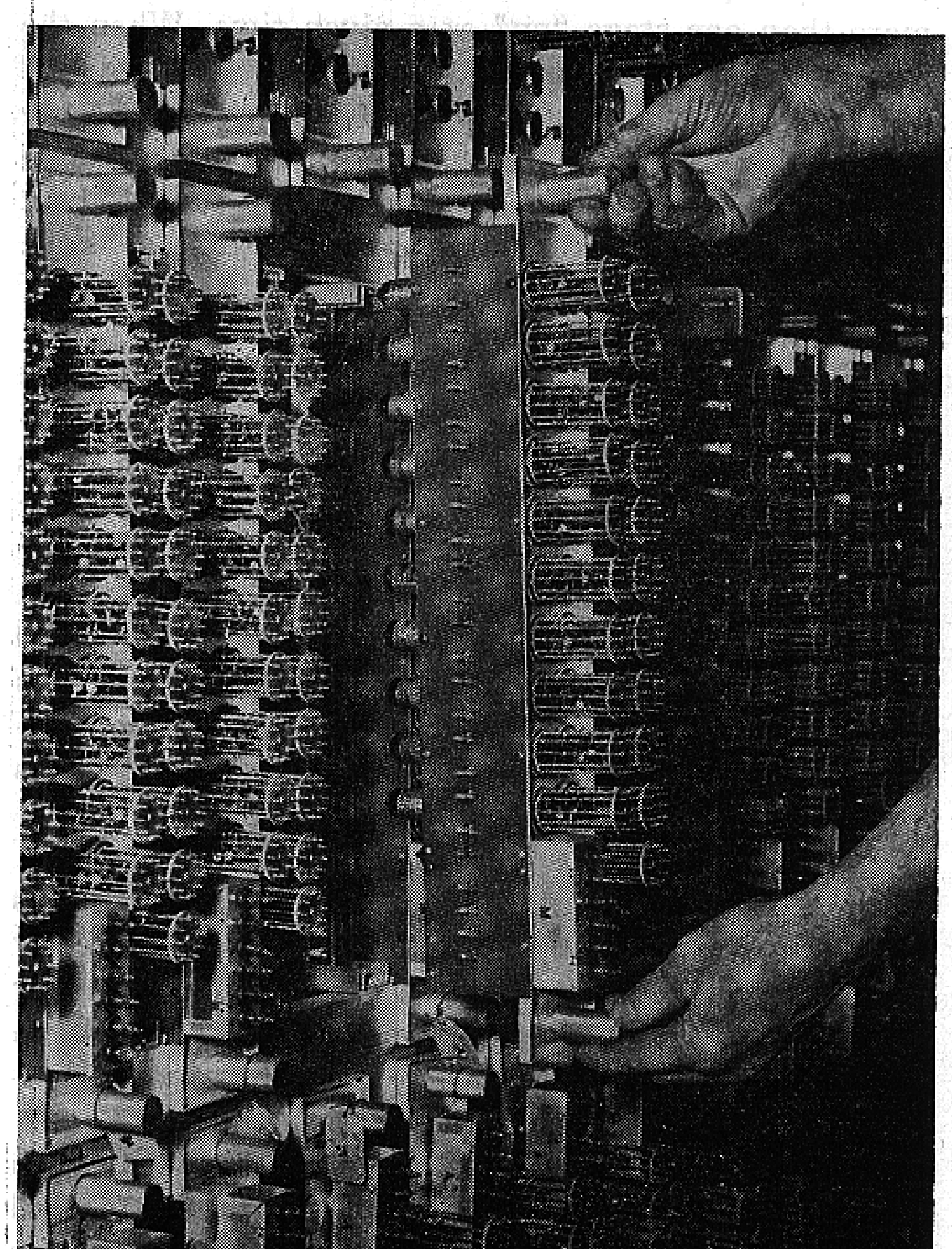

Fig. 3—Typical 24 Tube Chassis, tubes toward inside of machine, pluggable cage opposite each tube for components in its circuits. Each chassis has contacts for all electrical connections on either side and coarse-threaded screw at each end for quick change.

One flip-flop, which is the "bi" of the biquinary counter, determines whether the digit is odd or even. One state of this flip-flop, which we shall call the "off" condition, has no numerical significance. The other state, which we shall call the "on" condition, has a value of 1.

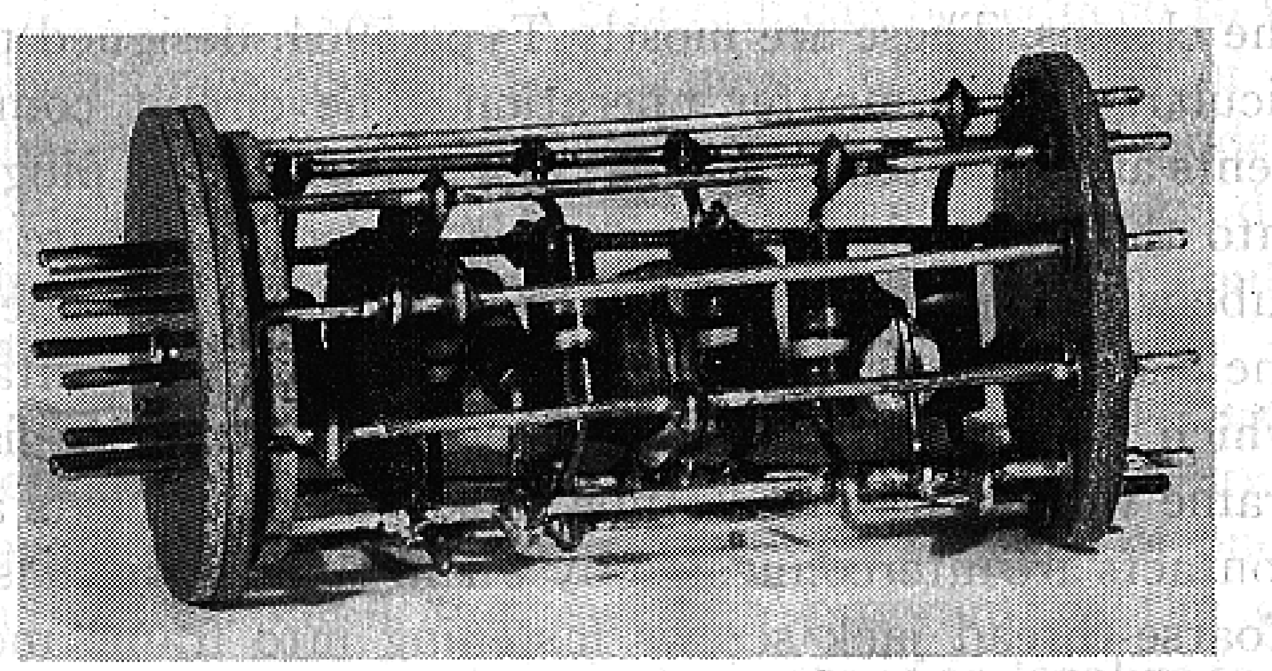

Fig. 4—A Typical "Cage." Each resistor and capacitor is soldered between two of the ten wires, all but one of these wires projecting through the base to fit a miniature 9-pin socket. The wires radiate heat and serve as probe points.

When the counter stands at zero this odd-even flip-flop is "off." A single pulse to this stage turns it "on," counting 1. A second pulse switches it "off" and an output from the "off" side goes through a gate to the "quinary" part of the counter. This part has five flip-flops each with its "off" or "on" condition. The "on" states of these flip-flops have values of 0, 2, 4, 6 and 8, with never more than one stage "on" at a given time. When the counter stands at zero, the 0 flip-flop is "on." Input pulses to this quinary ring go to all five stages and serve to turn "off" whichever one is "on." The stage which goes "off" gives an output pulse to the next stage to turn it "on." In the process of addition this next stage is the one of higher value and in subtraction it is the next of lower value.

Thus, in the above example when the second pulse turns the 1 stage "off" its output goes through an addition gate to the ring of five, turns off the 0, which turns "on" the 2 stage. A third pulse to the 1 stage turns it "on" again and we have a count of $2+1=3$. When we come to the tenth pulse it turns "off" the 1 stage, which turns "off" the 8 stage and the latter turns on the 0 stage, and also a carry storage flip-flop. The carry takes place after the addition of a digit when the output resulting from turning "off" the carry storage stage goes to the 1 stage of the next higher order decade.

Input pulses to the Decade do not all go to the 1 stage. In fact, it never gets more than one or two pulses in adding or subtracting a digit. Other pulses go directly to the ring of five. For instance, to add 9 there are four pulses to the ring of five and one to the 1 stage. Each pulse to the ring counts a value of 2, thus nearly doubling in effective value the 40-KC pulse rate.

There are two switching gates at the output of each stage of the biquinary counter, six addition gates and six subtraction gates. Normally all of these gates are closed, which condition facilitates the shifting of numbers in the accumulator to be described later. When addition is called for by the program all six of the addition gates are opened so as to advance the counter 0, 1, 2, 3, 4, etc., while in subtraction it goes the other way, 0, 9, 8, 7, etc.

Counting in either direction may be unique in electronic computers. At least it is unusual. Most machines add a complement in order to subtract. While this decade uses more tubes than the minimum requirements, it lends itself to simpler circuits elsewhere and uses a different set of gates in the proof. For each of the 6 counting flip-flops there is a shift tube for shifting the digit to the next higher order and receiving a digit from the next lower order.

Accumulator

The complete Accumulator has 22 decades. The ten lowest orders, columns 1 through 10, are connected to ten Input-Output chassis. A number having a maximum of ten digits is entered into the accumulator in parallel; that is, all digits at the same time. They are counted in, additively or subtractively as already described. Results leave the accumulator from the same ten columns on a single read-out pulse.

The 22 decades are connected in a ring; that is, each digit advances to the next higher order. The digit in column 1 goes to column 2. The one in column 2 goes to column 3, etc., and the digit in column 22 goes to column 1. All 22 shifts are simultaneous at a shift pulse. To shift a number one place toward the right requires 21 shift pulses. These pulses come from a multi-vibrator Shift Impulse Generator at the rate of 20 KC per second.

Decimal Computer

Decimals are automatic. By setting a selector switch for each Card Field, Constant, and Intermediate Storage the programmer assigns a decimal place to all input and output numbers. A Decimal Computer takes care of all shifts.

The switches are wired so that either a true number of decimal places or its complement may be called as an input to the Decimal Computer. The heart of this computer is the Decimal Counter. This is a natural binary flip-flop cascade modified to have a radix of 22. It counts in only one direction, positively, and repeats when it reaches 22. In other words, $22=0$. This counter normally stands at 0. During a Calculating Step the number of decimal places of each operand is added or subtracted (by adding the complement on 22) in the Decimal Counter. The number of shifts in the Accumulator is also counted to keep track of the decimal point location.

When the first operand is entered in the Accumulator its decimal position is subtracted in the Decimal Counter. In addition or subtraction the decimal position of the second operand is added in the Decimal Counter. This gives a difference which is the number of column shifts required to align the decimal points. The first operand which is now in the Accumulator is shifted while counting until the Decimal Counter reaches 22, i.e. 0. After adding or subtracting the sum stands in the Accumulator with the same number of decimal places as the second operand. Before storing, the above procedure is repeated, subtracting the decimal position of the second operand, or sum, from that of the storage and shifting the sum to decimal alignment.

Decimal positions in multiplication and division are handled in a similar manner.

Inputs and Outputs

As shown in Figs. 5 and 6, ten Input-Output chassis are located directly across from the first ten columns of the Accumulator on the other side of the Electronic Computer Unit frame.

Except in the Accumulator, which uses the biquinary code described above, all numbers are represented in the Remington Rand "90-column" Code that is used in the punched cards. Each column has six hole positions. The values of these positions, from top to bottom, with a single hole punched in the column are: 0, 1, 3, 5, 7, 9. When the 9 position is punched and another hole is punched in the 1, 3, 5 or 7 position the values are 2, 4, 6 or 8 respectively. This code is readily translated into and out of the Accumulator code by vacuum-tube circuits.

All ten digits of an input number are translated simultaneously at a rise in voltage of a call line related to the storage location of the number. This is accomplished by means of specially designed sub-miniature gas diodes whose characteristics are given in Table I, page 1336.

There are six gates in each chassis for passing count-

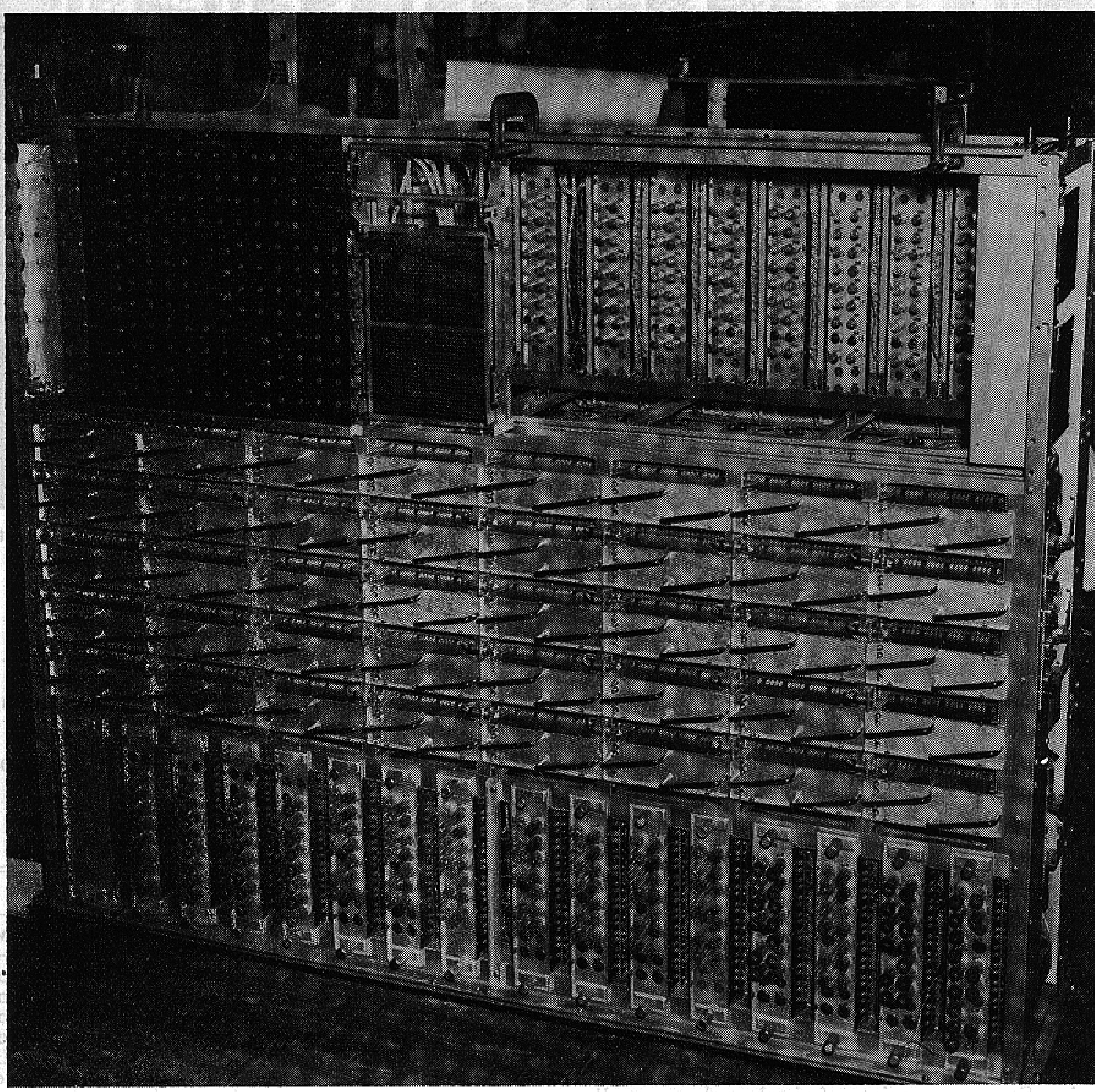

Fig. 5—Front side of Electronic Computer Unit with covers removed. Constants and Program Plug Board at upper left, tube side of Step Sequence Chassis at upper right. Intermediate Storage relay chassis (with diagonal handles) occupy full length in center. The Call Line Bias Chassis is the first at lower left and Input-Output Chassis are at lower right and center. Clamps at top are used only in final assembly and test.

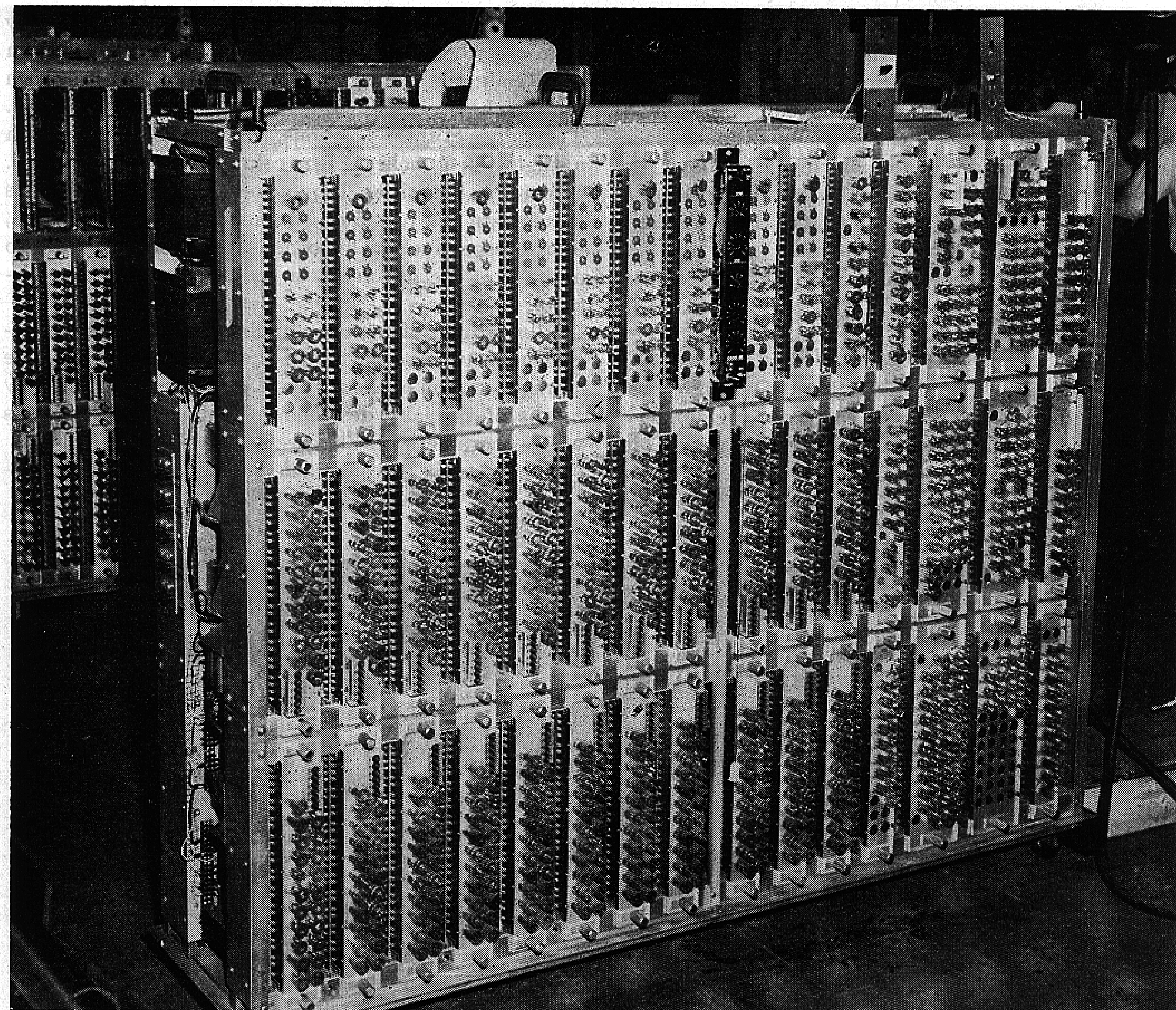

Fig. 6—Rear of Electronic Computer Unit with covers removed. There are ten Step-Sequence chasses (top row left) and twenty-two Accumulator chassis, first 11 columns (lower left) and columns 12 to 22 (middle left). Controls and Routines chassis are at right, top to bottom, including Decimal Computer and Service Switches.

ing pulses to the corresponding Decade of the Accumulator. The translator circuits open appropriate gates so that pulses from the Registration Impulse Generator (RIG) will be counted. Two gates control pulses to the odd flip-flop, or 1 stage. The third controls a single pulse to the ring of five to count a value of 2. The fourth passes 2 pulses for a count of 4. The fifth passes 3 pulses for a count of 6, and the sixth passes 4 pulses for a count of 8. For each add or substract registration, the RIG makes one cycle, producing timed pulses over six lines.

The Input Gates read numbers from three kinds of storage; namely, punched card Sensing Storage, Constant Storage and Intermediate Storage. The Output Gates deliver numbers only to Intermediate Storage.

The Sensing Storage consists of single-pole normally-open switches. There are 90 columns in the card with six hole positions in each column, making a total of 540 hole positions. There are 540 Sensing Switches, each occupying an area of $\frac{1}{4}'' \times \frac{5}{32}''$ which is the spacing of the hole positions. The 540 pins press lightly, but positively

TABLE I

Type 6332 Gas Diode Characteristics

	Min.	Ave.	Max.
Anode Supply Voltage,* DC	100	—	— Volts
Breakdown Voltage, DC	—	80	— Volts
Voltage Drop, DC	50	55	60 Volts
Regulation, DC (.2 to 1.5 ma.)	3	—	5 Volts
Current, DC	0.2	0.6	1.0 Milliamperes
Breakdown Time†			50μ seconds

* Tube should never pass current with reversed polarity.
† With 100 volts DC applied.

against the card being sensed and those which find holes in the card close the related switches. The switches latch closed and constitute storage for all information in the card, while the pins retract and the card is fed to the adjacent punching station.

The card columns are grouped in Fields. For example, a very simple invoicing problem would have a Field for Quantity, another for Unit Price, perhaps a one-column Field for the size of the unit (each, doz., gross, hundred, etc.) and maybe a Field for discounts which apply. The card is designed with enough columns in each Field to handle the largest number ever encountered in the work.

A plug-board on the Sensing-Punching Unit (Fig. 7) groups the connections for each Field, indicates the decimal location and, if required, makes connections to read one or a combination of holes which show whether the number is positive or negative. Each Field is connected to a Call Line so that the Program can call for whichever Field it needs and register the number in the Accumulator. There are 9 call lines for a maximum of 9 Fields.

The so-called Block Sensing described above is fast, requiring only about 20 milliseconds to change from one card reading to the next.

Constant Storage consists of manually settable decade switches (Fig. 8). Twenty constants, varying in capacity from 4 to 10 digits, may be stored for use by the program. Each has a settable decimal position switch, a plus or minus sign switch, and a Call Line for signals from the Program.

Intermediate Storage (Fig. 5) has a capacity of 8 ten-digit numbers.

These numbers are stored in relays, five for each digit and one sign relay for each number (Fig. 9). A pair of holding contacts on each relay retains the information. A second pair communicates with the Input Gates to the Accumulator and a third pair handles the output to Punching Storage.

As just described, the card reading or Sensing Storage, the Constant Storage, and the Intermediate Storage furnish the inputs to the Accumulator. The Intermediate Storage also communicates its stored results to Punching Storage (Fig. 10) via a panel of the Sensing-Punching Unit Plug Board (Fig. 7). This panel groups the Field columns of the card for punching results and also assigns the decimal position of each Field.

Punching Storage consists of 540 small magnets, one for each possible hole position in the card. These magnets trip interposers which block pins in the Punch Setting mechanism. All of the magnets related to the result numbers may be actuated by a single signal from the Electronic Computing Unit to a thyratron powered

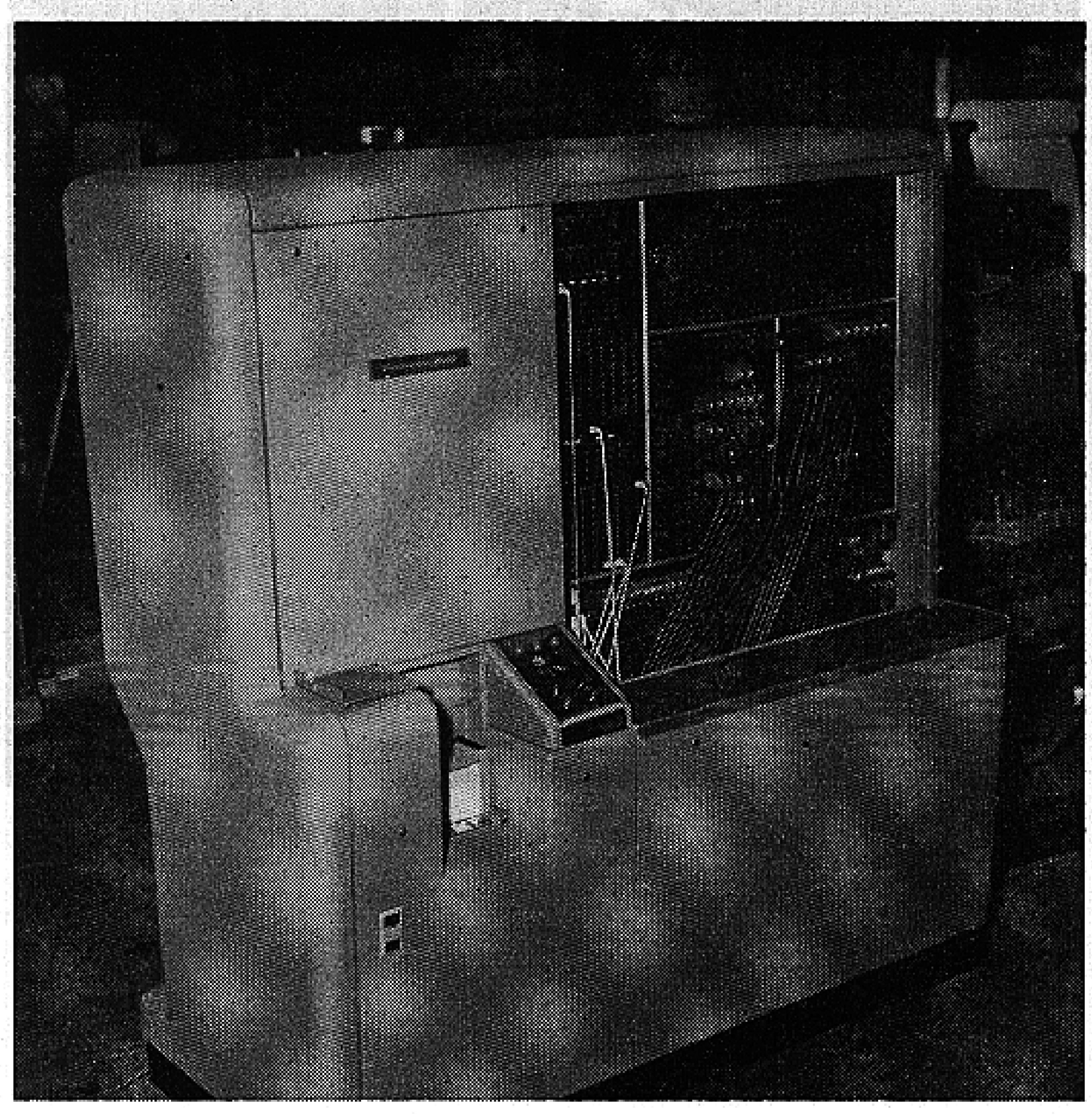

Fig. 7—The Sensing-Punching Unit with panel board uncovered. The card feeding magazine is in pocket at left, operator controls and indicators at right of magazine. The four plug-board panels are: (1) Calculator Input (lower center) with Decimal Setting Switch at left of each row; (2) Control Panel (vertical at left) which is plugged for controls and minus signs, Input in upper part and Output in lower part; (3) Calculator Output Panel (lower right) with Decimal Switches for setting decimal location of each row or field at the right; (4) Reproduce Panel (top right) containing 90 sockets for grouping of fields for alpha-numeric reproduction.

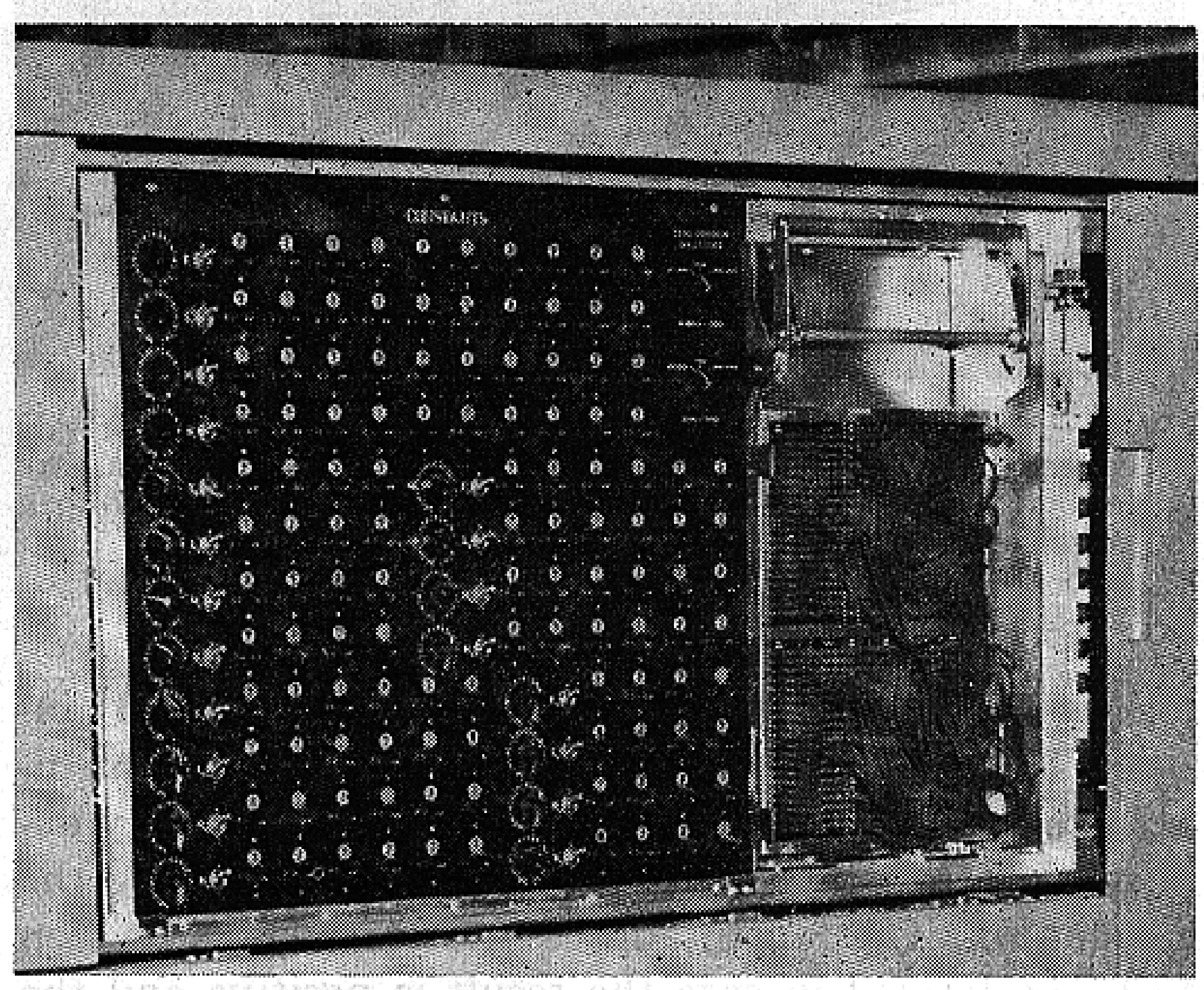

Fig. 8—The Constants Panel at upper left of Electronic Computer Unit has 20 rows of decade switches, plus or minus toggleswitch and a Decimal Setting switch at left end of each row. Program Plug Board, at right of Constants, has interchangeable panels with patch cords.

from the AC supply line. Thus the actual punching of the card does not take time out from the calculation. If the calculation is not finished before the Sensing-Punching machine cycle reaches normal, the clutch fails to trip for continuous operation and the machine stops till the signal comes. Thus no program can be too long for the machine cycle. On some programs most of the cards feed at the continuous rate of 150 cards per minute while an occasional card may take longer.

Calculating Step

In the Program Plug Board there are forty Calculating Steps, each one just like all the others. Each step uses what might be called a five-address system. The first address locates the first operand, which may be any one of the 37 input numbers already enumerated; namely 9 Card Fields, 20 Constants, and 8 Intermediate Storages. One of four routines, add, subtract, multiply, or divide is designated in each step. The second address

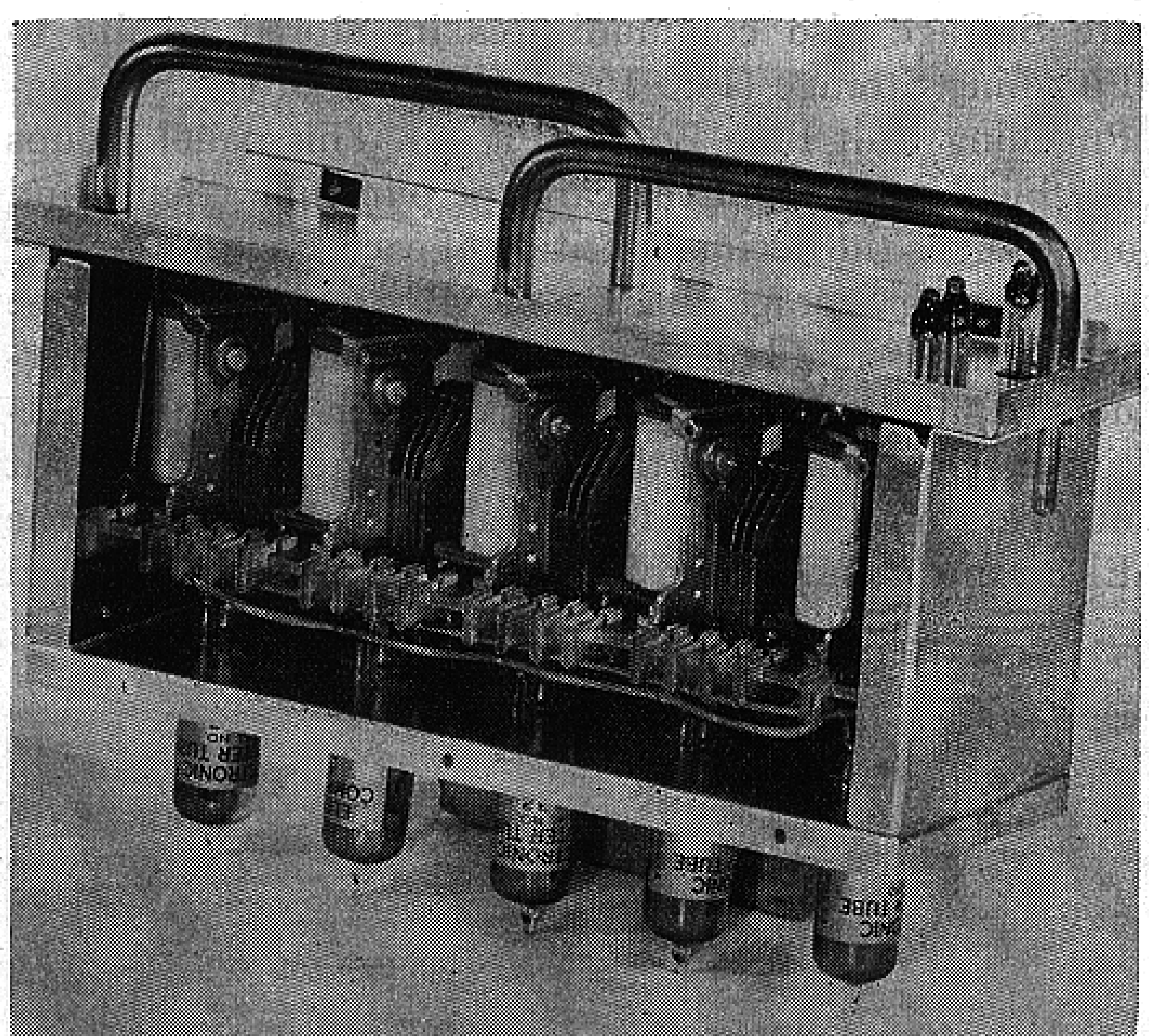

Fig. 9—An Intermediate Storage Relay chassis with phenolic side cover removed. Each side of a twin triode tube serves as a gate for one relay coil and each relay has 3 single-pole normally-open pairs of contacts.

locates the second operand, again any one of the 37 inputs. The third address chooses one of the 8 Intermediate Storages for the result. Any number previously deposited there will be cleared automatically during the calculation. The fourth address indicates the next step to be performed in case the result is positive and the fifth address indicates the next step if the result is negative.

Each of the 40 Calculating Steps calls for a subroutine which is common to all of these steps. First the Accumulator and the Intermediate Storage which is to receive the result are cleared to zero. Then a binary number locating the decimal position of the first operand is entered in the Decimal Computer, the sign is noted in the algebraic sign computer, and the first operand is registered (added) in the Accumulator.

The final signal from the above subroutine starts one of the four process routines, add, subtract, multiply, or divide.

The add and subtract routines enter the decimal position and sign of the second operand, shift the first operand to decimal alignment, call the second operand, add or subtract, enter the decimal position of the Intermediate Storage, shift the result to decimal alignment, add the number in storage which should be 0 and store the result including its sign. Before the result is stored, an overcarry may indicate a complementary number. A negative sign is temporarily stored in a flip-flop and the

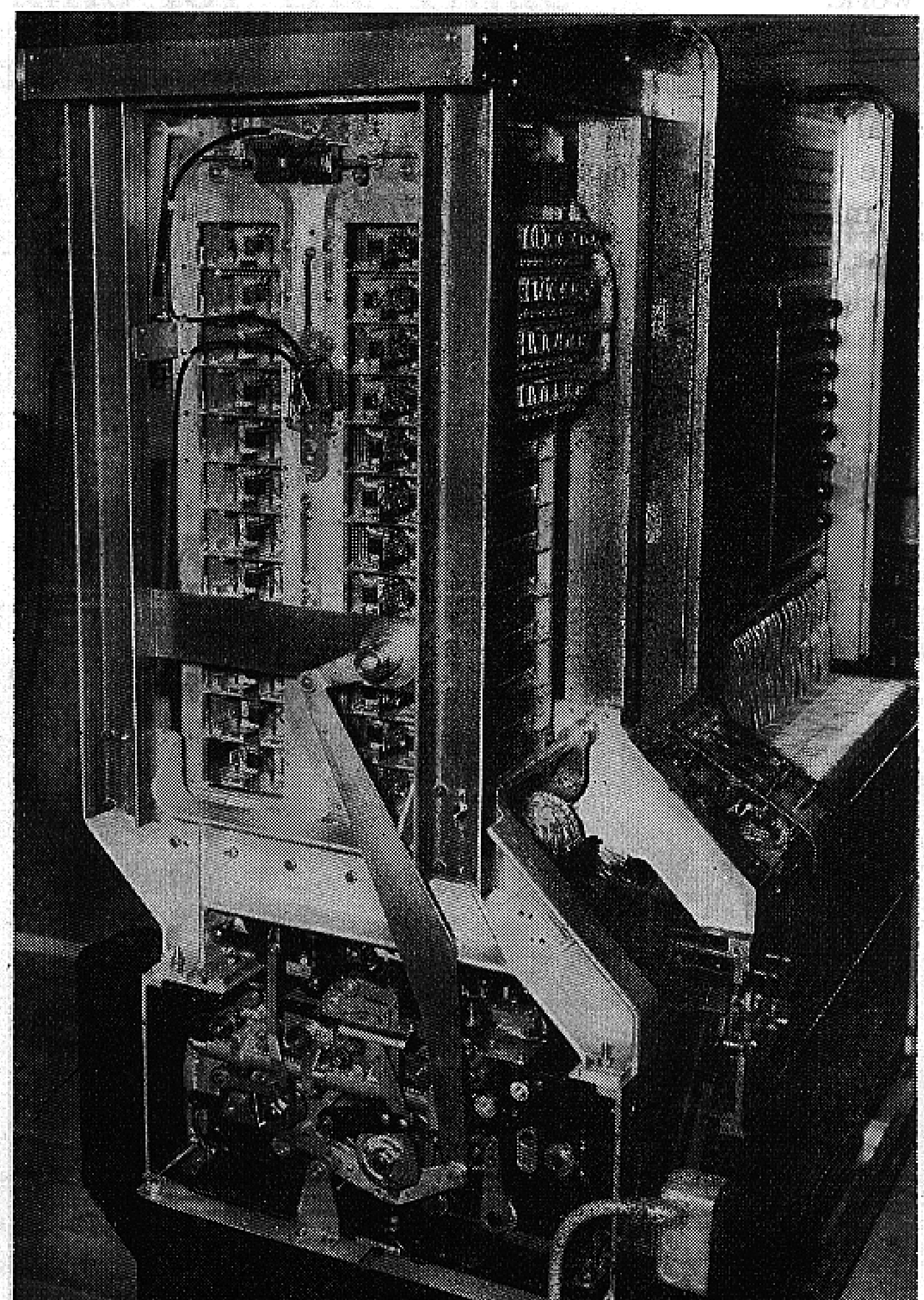

Fig. 10—The Sensing-Punching Unit with covers removed. Card feeding, sensing and punching mechanism is at lower center with Card Feeding Magazine and cables from Sensing Switches between sloping channels of frame at right front. Card Receiving Magazines are at bottom left and Punching Storage with shelves of Actuator Magnets at upper front.

step is repeated from the beginning with signs reversed. This insures a true number result with a negative sign which is then stored. The proof of the result will be explained later.

The multiply routine enters the decimal position and sign of the multiplicand, shifts the multiplier (1st operand) till its first significant digit stands in column No.

22, adds the multiplicand, subtracts 1 from column 22 as many times as necessary to reduce that column to 0, shifts both multiplier and partial product till the next digit not equal to 0 appears in column 22, etc., till 10 shifts have taken place. The whole product, having a maximum of 20 digits, shifts until its first significant figure is in column 22. Columns 1 to 11 are cleared and the first 11 digits of the product are retained. All shifts have been added in the Decimal Computer. The decimal position of the Intermediate Storage enters, the products shifts to decimal alignment and is stored. Since the maximum capacity of all storages is 10 digits, one or more of the less significant figures are dropped when storing. The number of digits retained depends upon the plugging of the Output Panel of the Plug Board (Fig. 7). If rounding is required, at least one extra digit is stored, then another Calculating Step adds 5 in the next lower order than the desired least significant figure and when storing in that step the extra digits are dropped. In the beginning of the multiply routine both factors are tested and if either or both are found to be 0, the remainder of the routine is jumped over leaving the storage at 0.

The divide routine enters the decimal position and sign of the divisor (2nd operand), shifts the dividend (1st operand) till its first significant digit stands in column 22, subtracts the divisor and adds 1 in column 12 as many times as necessary to produce an overcarry from column 11. Then the divisor is added and 1 subtracted in column 12 once. The partial quotient and remainder are shifted one column, and the above operation is repeated 10 times after the first successful subtraction giving an eleven digit quotient, and the remainder is cleared. The decimal position of the storage is entered, the quotient is shifted to decimal alignment and stored. In the beginning of the divide routine the two operands are tested for 0. If the dividend is 0 and the divisor is not 0 the rest of the routine is jumped over leaving the storage at 0. If the dividend is not 0 and the divisor is 0 the program may stop the machine and light an indicator N/0, or sort out the card and proceed to the next card, or treat the result as if it were 0. If the dividend is 0 and the divisor is also 0 the program may stop the machine and light an indicator 0/0, or sort, or call the result 0 as above. It is not necessary to make the same choice for 0/0 as for N/0.

Square root, trigonometric functions, logarithms, etc., are handled by an iteration in the program.

Proving

Every calculating step is proved by a reverse process. The programmer does nothing to accomplish this proof and has no control over it. In each step, after the result is stored, the routine calls for a proof routine which uses the add, subtract, multiply or divide routines in a different order. The result is read back into the Accumulator and operated upon by the two operands to produce a result which should be 0. These operations are as follows: Addition, $A+B=Y$; Proof: $Y-B-A=0$; subtraction, $A-B=Y$; Proof: $Y+B-A=0$; multiplication, $A\times B=Y$; Proof: $Y\div B-A=0$; division, $A\div B=Y$; Proof: $Y\times B-A=0$.

The result of the proving routine is tested for a value of 0 in the Accumulator. When it is not 0 it is usually because the less significant digits were dropped when storing, so a 1 is added in column 1 and the test repeated. If the proof result is still not 0 a signal is given to go back to the beginning of the step and try again. Or, if the programmer chooses, this signal may cause a new beginning of the whole program. The latter choice is not a good one if totals are being accumulated from card to card.

Thus the result of each calculating step, including the setting of storage, is proved before proceeding to the next step. Because of the self-checking feature, such things as intermittent grid-to-cathode shorts and marginal conditions definitely are prevented from causing arithmetical errors and may be allowed to exist until the trouble is frequent and thus easy to locate, or until an urgent job is finished.

Programming

Programming is done by wiring a plug board with "patch cords" or jumpers. The 40 calculating steps described above are arranged in 40 rows beginning with #1 at the top. There are six other steps which will be described presently.

At the beginning of a "run" of cards the first cycle of the Sensing-Punching Unit feeds a card into the Sensing Chamber where it stops while the machine continues into its second cycle. Early in this cycle the Sensing Switches are set and a Calculator Start signal is given to the Computer Unit via a patch cord in the Program Plug Board which chooses the first step to be performed. Usually this is calculating step #1 although it may be any other. The Calculator Start signal can be programmed to be contingent upon the presence or absence of a certain hole or combination of holes in the card so that some cards are passed through without calculating.

After the first step has been calculated and proved either the fourth or fifth address is called depending on the sign of the result. Both addresses may call the same step or different steps and if the result can have but one sign a single patch cord is sufficient. Often the choice of a next step is a logical consideration. For example, in a payroll there may be several methods of payment, piece work, day work, etc., each class requiring a different sequence. If it happens that some Field is used on one class of card and not on others, a step can subtract a constant of 1 from the least significant column. If any value is punched in that Field the result will be positive and call for proceeding to the appropriate sequence. If no value is found the result will be negative and can call for another step which may be another logical test. A coded Control Position in some column can be treated in a similar fashion. A Control Position which means "male" to the operator may mean "3" to the computer and be compared with one or two constants.

Each Intermediate Storage is usually used many times. In logical steps the numerical value of the result means nothing so the storage can be used again on the next step. Most results are not needed except as an input to a succeeding step and as soon as that step has been figured the storage is available for another number.

All Intermediate Storages retain their numbers until cleared. Clearing is done in several ways: A Clear and Start switch on the Computer Unit enables the operator to clear all storages at the beginning of a run or after an interruption. As already described each step clears its particular storage during the computation. Sometimes a Calculating Step, such as subtracting any constant from itself, is used for the sole purpose of clearing a certain storage. One of the six steps other than the Calculating Steps is a Clear Step. This step may be entered from any other step and may be plugged to call for any other step after clearing. The storage or storages cleared by this step depend on a double throw switch for each storage.

Any result which is required to be punched in the card must be transmitted to Punching-Storage before clearing. If the programmer finds that no more storages are available because of outputs already stored he may call for entering another special step called Set I. This step will deliver any selected group of results to Punching-Storage and then call for the next step of the programmer's choice. Thus the storages relieved by Set I can be used for further calculation.

Another special step, Set II, will then be called for at the completion of the calculation.

Two other special steps are Sort I and Sort II. These are usually used after a logical choice where it is decided to separate this card from the deck. Either step causes the card to be ejected into a second receiving magazine. The reason for two such steps is that the outgoing address is usually different.

The sixth and last special step is the Trip. This is the final step of every program which announces to the Sensing-Punching Unit that it should either continue to run, or start again if it has stopped to await the filling of Punching-Storage.

After the Trip signal all results in Intermediate Storage are still retained. Some of these results may be useful in calculating the next card. For example, one or more storages may be used to accumulate subtotals, totals, and grand totals. Again, groups of two or more cards may be used for a single problem.

Reproduce

When the job involves groups of cards there is usually a header card at the beginning of a new group and often a trailer card for receiving totals, etc.

In the Sensing-Punching Unit Plug Board there is a panel marked Reproduce (Fig. 7). This panel can be plugged to pick up either alphabetical or numerical information from a header card and hold it for punching into the same or different Fields of following cards. Information may be sensed or read from one or more Fields and punched into other Fields of the same card.

At the same time there may be a computation (of prices, for instance) in the header card, the results of which are applicable to each of the following cards. These results may be computed by a special sequence consisting of regular program steps, and held in Punching Storage for reproduction in following cards, or in Intermediate Storage if the information is needed as input constants.

A trailer card may have its own special sequence in the program for recording totals, clearing related storages, etc.

Service Features

The complete complement of 1476 vacuum tubes and some of the 1128 cold-cathode gas diodes are mounted in four sizes of chassis which contain from 18 to 48 tubes each (Fig. 3). There are 428 relays mounted in another style of chassis (Fig. 9). Circuits are arranged so that each chassis serves a function which is recognizable to the serviceman. All chasses are pluggable, for quick change, and every probe point is accessible after removing a panel of the cover case.

A serviceman's switch panel under the covers of the Computing Unit enables him to stop the program not only at any step, but at any point within a step. Indicator lights enable him to read the Accumulator at that point in the program.

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