ENGINEERING DEPARTMENT

IBM - FRANCE

WWAM LOGIC

by

M. PAPO

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ABSTRACT : This paper is a brief résumé of the logic which is used in the World Wide Accounting Machine.

This logic, intended for an expandable machine with wired programming, has appeared to be most successful in the input and output controls.

W W A M LOGIC

All the W W A M Logic has been constructed around the main idea of building an expandable machine which would start as low as possible in the 407 area with a single feed unit, little computing possibilities and one printer output, a summary punch, no buffer arrangement, no overlapping between computation, reading, printing or summary punching. This machine, which has to compete with the Bull Gamma, can be expanded up to the 750 area with two readers and a reader punch input printer and summary punch output, full input and output buffering and simultaneous read, compute, print, punch and summary punch.

A simple study shows that a stored program is not compatible from the view point of cost with a machine in the area of the 407. This means that we have to use for the W W A M Logic a control panel type of addressing. But a basic requirement of the expandability is to have the same type of wiring when the same operation is to be performed in the basic machine or in the maximum machine as well as in any intermediate of the W W A M range. This obvious statement has been the leading idea for the entire W W A M Logic. Whenever a new device was to be incorporated, its application in the different machines has been studied. Many possibilities for a non buffered machine, for instance, have not been included just because it was impossible to provide the same advantage when the machine is expanded. The current laws on the maximum weight to be lifted by an operator limit the size of the control panel to the

407 type. This means that the controls of the basic machine as well as the three feed machine have to be concentrated on a single control panel if we want to avoid the almost possible interconnections between 2 or 3 control panels.

The only way to concentrate all the controls on a single 407 control panel is to eliminate input and output wiring position per position. In the W W A M the quantities read from the cards are entered as they are in 80 position storages; numeric data as well as alphabetic or special characters are translated in the 1 2 4 8 A B code. The output information is prepared entirely in storage in exactly the same form as it has to be printed or punched including commas, special characters, blanks, etc. Since the input information (card) as well as the output information (punched card or printed form) are of variable length by nature, the general logic of the W W A M has to be of variable length and the information flow of a serial by digit type. The expandable storage of the W W A M is then constituted by "blocks" of 80 characters. This storage is composed of magnetic core matrices. Within each block the fields can be of any desired length. For 120 or 160 print positions two blocks can be coupled together.

It is to be noted that, though the W W A M logic has not been built around any specific components, transistor circuits are especially suitable due to the low impedance associated with low amplitude signals, which they present for control panel drive.

INPUT LOGIC

Since the storage arrangement in the W W A M is serial by digit, parallel by bit, a transformation parallel to serial has to be performed to enter the 80 brushes of the card reader to the input storage. This transformation is done at the same time as the code translation from Hollerith to 1 2 4 8 A B C by the following mechanism :

Every card reader has two read stations, i.e., two sets of 80 brushes. Each set of 80 brushes is wired in parallel to a plane of 80 magnetic cores. Reading the information from the card is then a very fast operation : it takes only the time of switching these cores. (see figure I).

These two planes of 80 cores are part of the special input storage block. This means that they are scanned by the same drivers as the input storage block. After every cycle point of the card reader, a scanning of this input storage is started. Every position of the storage as well as of the read plane buffer is read out. Their information is compared (for 0 or special code) and their combination is entered back into storage.

One main advantage of the wired programming is the ability to use relay selectors which give through co-selectors as many transfer points as can be required. This possibility exists in the W W A M input logic through the use of assignment hubs. Every relay selector has an electronic pick-up through a coincidence unit. As seen before, during the scanning of the input storage, after each cycle point, all the holes of the card appear in a sequential fashion at the output of the first or second row sense amplifier. If we bring on the control panel the outputs of the scanning ring we can select a given column of the card by making a coincidence between the moment when this column is scanned and the presence or the absence of an impulse at the sense amplifier. This coincidence picks up the pilot selectors.

A main feature of this device is that when an extra reader is added, the same scanning ring being used, it is only necessary to add the few assignment hubs on the control panel to differentiate the inputs as far as pilot selectors are concerned.

Another advantage of this method is to have sequentially on a single wire all the holes of one card under the first and the second read stations. It is then easy to provide a very good check of the reading by merely counting the number of holes under the first and the second read stations. The information being checked at the read station is entered properly in storage through the encoder by the use of a redundancy C bit checking.

A single exclusive OR comparator between the outputs of the two rows sense amplifiers gives a simple means of performing group control on any number of columns.

X pick-up or digit selectors are very easily provided on the control panel through assignment hubs.

ARITHMETIC OPERATION

W W A M arithmetic is serial per digit, parallel per bit. There is no accumulator, program steps are of the two address type. All W W A M logic is algebraic : Sign is carried over the units position. The basic operation is : A + B = B'. B' is stored in the positions previously occupied by B. Field A is called RO field and is always regenerated at the end of the arithmetic operation. Field B or B' is called RI field and this is where the result of the operation is found. Accumulation which is the basic function of an accounting machine is then performed in a single program step whereas the 604 for instance would take three program steps.

STORAGE SPLITTING AND STORAGE ADDRESSING

Any field of storage can be used as RO or RI field. The only difference comes during the actual program step by the scanning means.

The scanning of the storage is performed independently by two rings, one associated with the RO field, one associated with the RI field. These two rings are positioned through the control panel at the beginning of every program step to start scanning the proper RI and RO field. Scanning takes place from low order to high-order digit. The end of the fields and of the program step is also obtained through the control panel. Since RI and RO fields are interchangeable in storage, there is only one set of sense amplifiers and only one character can be processed at the same time, i.e., one digit of the RO field is read first, then the digit of RI field is read out added to the digit of the RO field and the result regenerated in storage. The program steps function in the same fashion : during the first part of each program step, the RO ring and then the RI ring are set to the first position of the RO and the RI fields which are to be processed. Then the actual operation occurs during which a test is made at every digit to detect the end of the R O or the RI field. The end of that variable length program step allows a test time for branching the program from the result of the arithmetic operation (zero test, balance test, etc.).

Actual addressing of the RO and RI fields is made through storage splits. (see figure II)

Each storage split appears on the control panel through three hubs : pick up, group and units.

The pick up hub is impulsed from the RO or RI hub of the program step exits whenever the corresponding field is to be processed. The units hub is wired to a storage location hub (1 to 80) and indicates the position of the less significant digit of the field. The high order of the field is not wired. Since the most common case is to have adjacent fields, the high order of a field for the machine is the position next to the units defined by the next storage split.

The storage location hubs indicate only the units position within a given block; the block instruction is then wired from the group hub to the group entry.

The difference between this type of storage splitting and that of the 702 is that several different splitting arrangements can exist simultanously through the use of several storage splits. Furthermore, these arrangements can be easily selected from card to card through relay selector points.

PROGRAMMING

In the W W A M , the program steps are non sequential, i.e., every program step has "in" and "out" hubs which define the sequence of their operation and make the branching easier. A program start hub is wired to the "in" of the first program step while the out hub of the last program step is wired to a program end.

PRINT EDIT

Before being printed out or punched the information standing in storage has to be edited, i.e., it has to be arranged in the proper sequence, all the punctuation, the special characters and even the blanks between quantities, have to be inserted. This operation required by the absence of output wiring is done in the W W A M during one program step calling for the operation print edit.

During that program step, the information is transferred from card storage and working storage into the print storage at the same time it is rearranged and edited. When the printed line has 120 or 160 characters, two groups of storage are coupled together and are considered by the machine as a single group. Actual editing is done serially as the rest of the logic of the machine (see figure III.)

On the control panel 160 hubs represent each one position of printed information. Each one of these hubs can be considered as the operation hub of a subroutine constituted by 160 program steps which are originated by the print edit instruction.

These print edit hubs can be wired :

1) - To a character insert hub. These hubs include not only the 48 alphabetic, numeric and special characters but also instructions like blank start, blank stop etc. When an impulse reaches one of these hubs it causes the transfer operation to stop by stopping the RO ring while the RI ring is still advancing. The proper characters are then inserted instead of the normal transfer which is delayed.

2) - To a sign detect hub. When this hub is impulsed (at the units position of a field) it means that the field to be transferred is purely numeric. In order to be transferred as such, the X information (sign) over the units position is eliminated and also the presence or the absence of that X is kept in storage for further use (credit symbol or minus insertion).

3) - To the storage location hubs and/or the group location. This information is interpreted by the machine as a skip of the RO field to pick up a new quantity which is not adjacent to the last one previously transferred.

No matter where the information stands in read or working storage and how many special characters and punctuation have to be inserted, it is then possible to edit in storage the line exactly as it will be printed out.

Zero suppression is automatically performed in every field, unless otherwise specified by a non zero suppress instruction. This zero suppression occurs just before printing through a reverse scanning. During the same scanning the floating $ and the ★ protection are also inserted. The instruction for the floating $ or the ★ protection is given through the normal print edit scan by a single wire.

In figure 3 for instance, the print edit operation is started by transferring position 67 of a given block (storage split RO) into position 76 (storage split RI) of the print storage. At this position 76 a sign detection instruction is given. The minus sign is suppressed over digit 3 and kept in storage. Position 74 is a decimal point insertion. Position 70 is a comma. Position 68 is a single blank insertion. Position 67 is the insertion of a credit symbol. This insertion is under the control of the sign detection performed in position 76 ; since the corresponding sign was minus an R and a C will be printed in position 67 and 66. Position 65 is a blank start up to position 63 which is a blank stop. Position 62 of print edit is a skip to pick-up in the same RO group the position 62. In this case, we have assumed an arithmetic field which is always positive. This is why no sign detection is wired from position 62. Position 60 is again a blank start and so on.

When printed out, the information stays unchanged except for the automatic zero and comma suppression which has taken place.

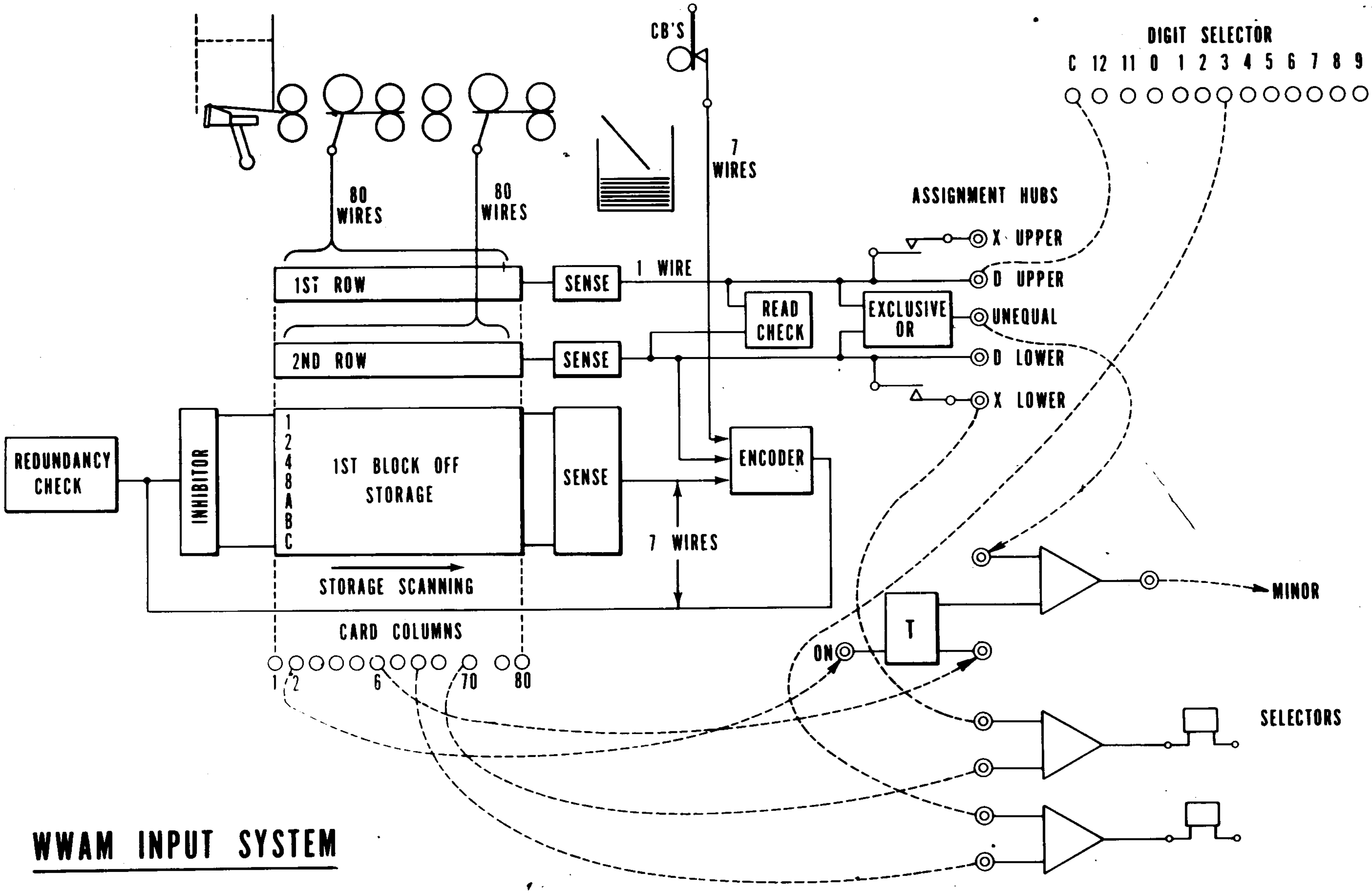
SELECTOR OPERATION

As mentioned before, the availability to select the plugging through pilot selector relay point is a very important advantage of the wired programming. But in the conventional wired program logic, different types of selectors would have to be used for each input, for computing and for printing out the information, because of the different timings required especially in the buffered machine. It is a unique feature of the W W A M logic to allow the use of a single type pilot selector for any selection in the machine.

One selector picked up during a card cycle is transferred just before compute time and stays transferred up to the end of the next read cycle (see figure IV). Since all the arrangement for printing out or punching out is done during programming, the same selector points can be used to select computation, printing, punching, summary punching and even if required the reading pulses of the next card as far as picking up other selectors.

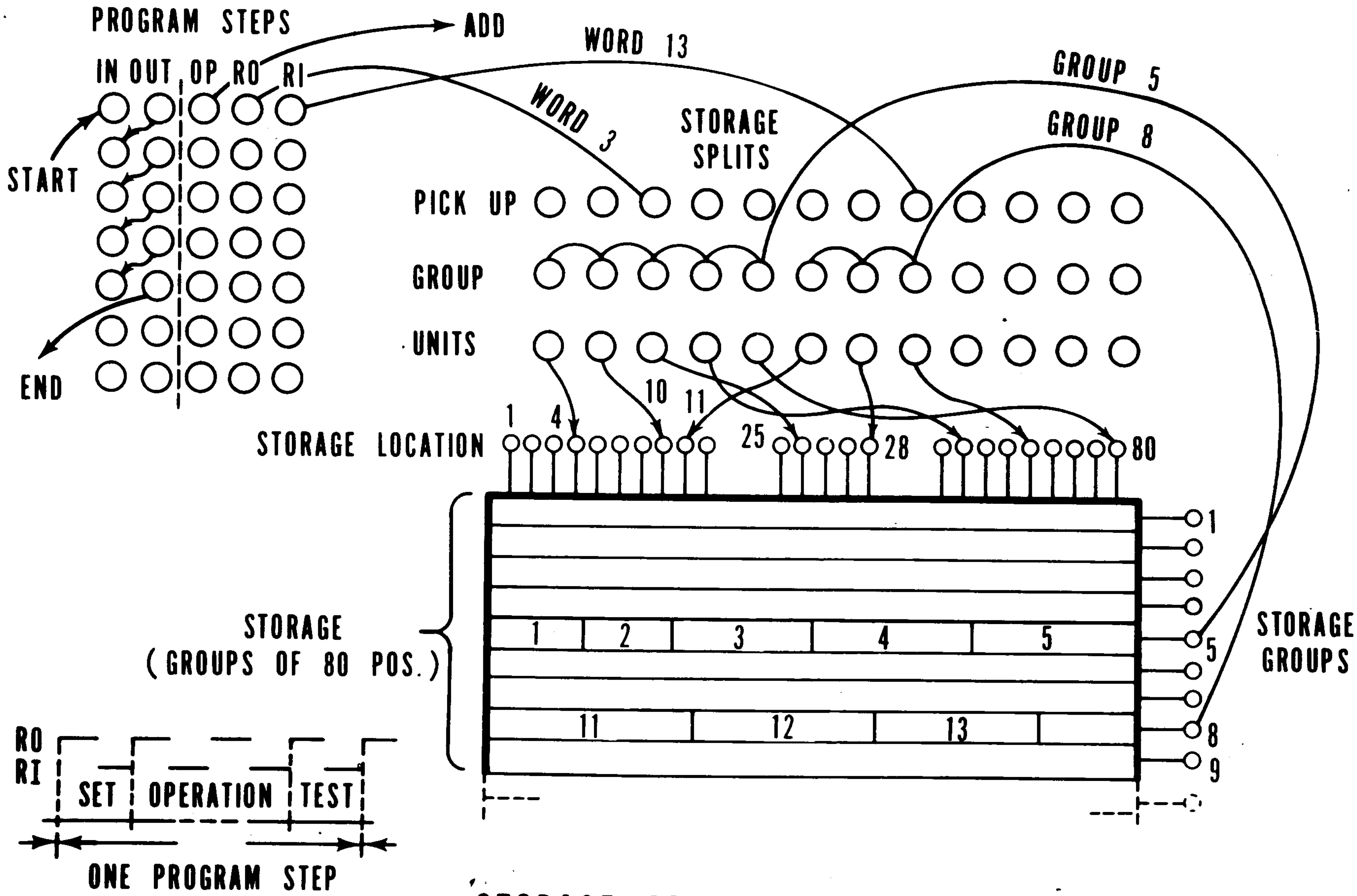
CONCLUSION

The W W A M logic has solved the problem of getting all the controls of a big system including two card readers, one reader punch, one computer, one printer and one summary punch in one 407 control panel. But this logic has been too successful to be restricted only to the W W A M, its application is now studied for a print edit control unit which would be a tape to print or a buffer to print processing machine for E D P M equipment.



WWAM INPUT SYSTEM

Figure 1



STORAGE ADDRESSING

Figure 2

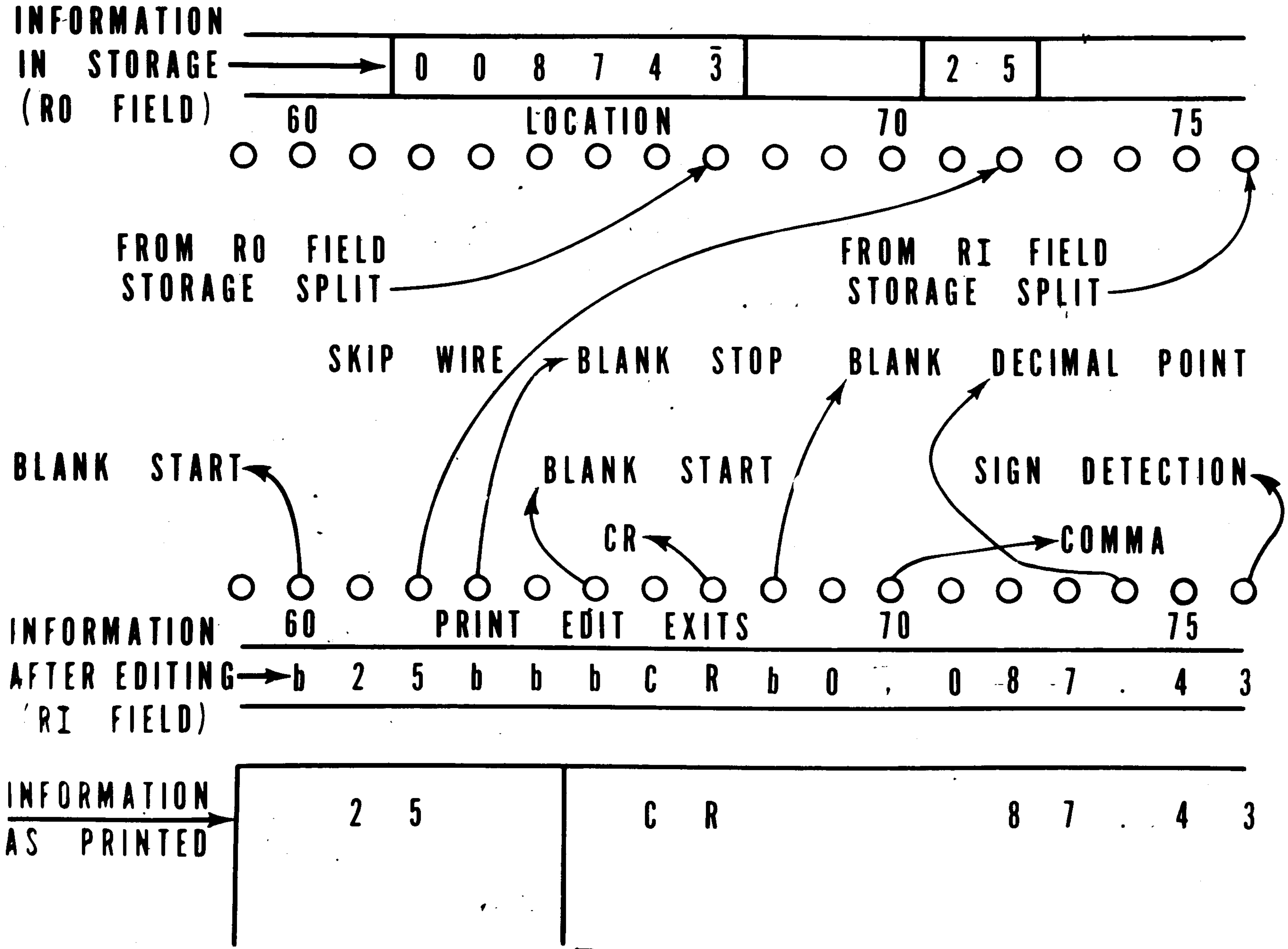
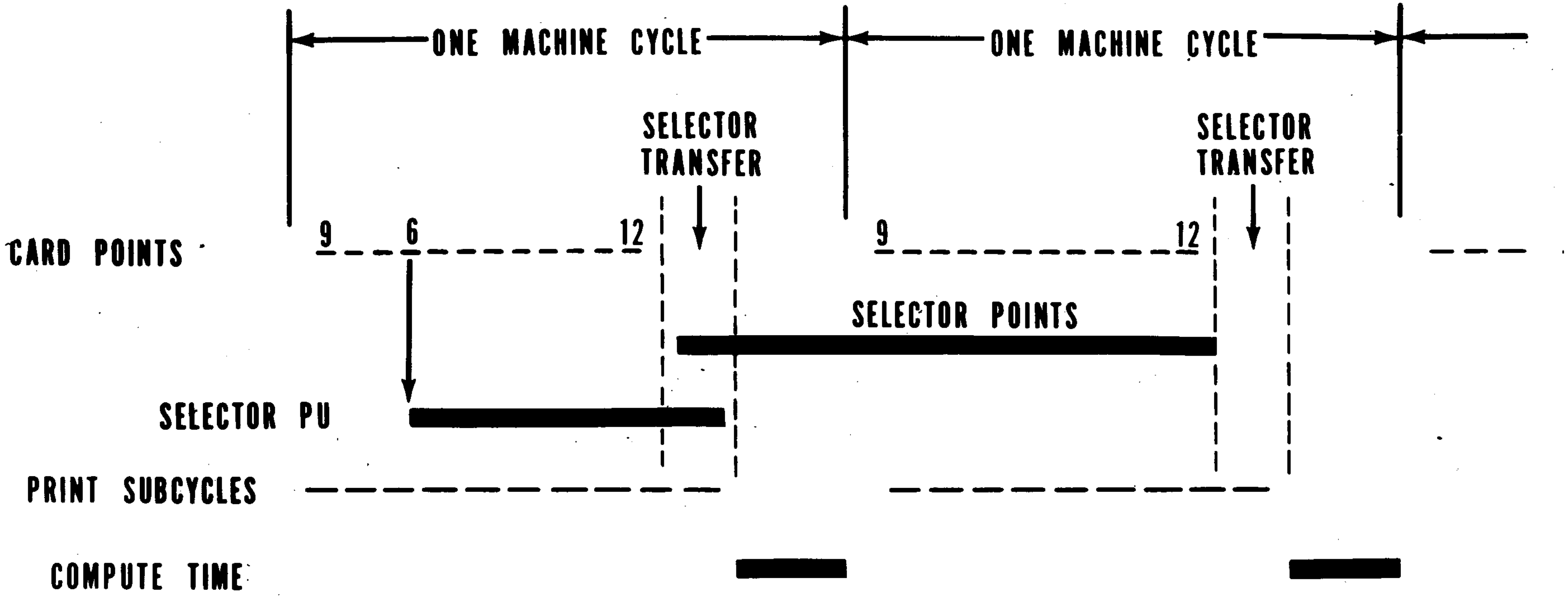

INFORMATION IN STORAGE (RO FIELD)
0 0 8 7 4 3̄
2 5
60
LOCATION
70
75
FROM RO FIELD STORAGE SPLIT
FROM RI FIELD STORAGE SPLIT
SKIP WIRE
BLANK STOP
BLANK DECIMAL POINT
BLANK START
BLANK START
CR
SIGN DETECTION
COMMA
60
PRINT EDIT EXITS
70
75
INFORMATION AFTER EDITING (RI FIELD)
b 2 5 b b b C R b 0 , 0 8 7 . 4 3
INFORMATION AS PRINTED
2 5
C R
8 7 . 4 3

Figure 3

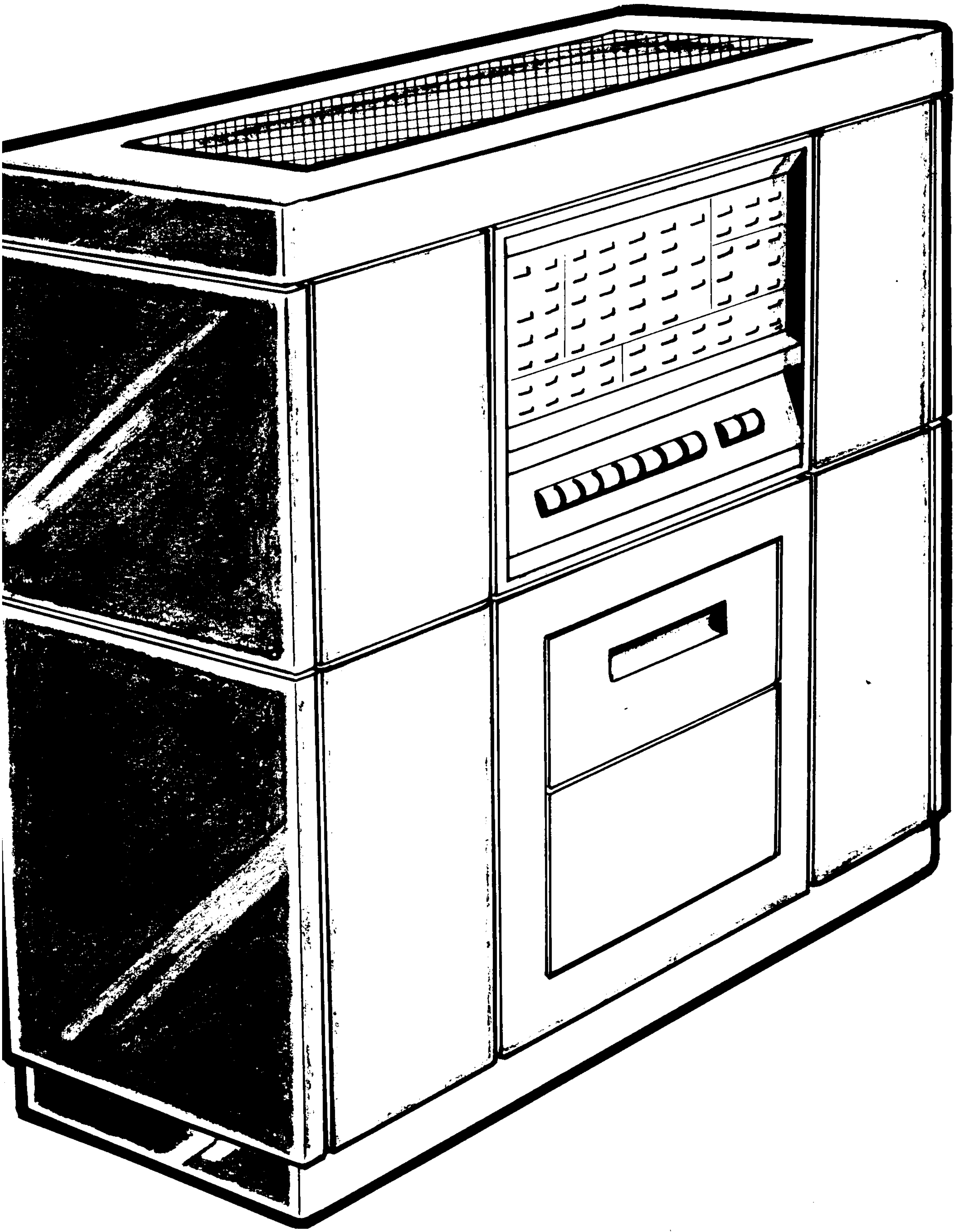


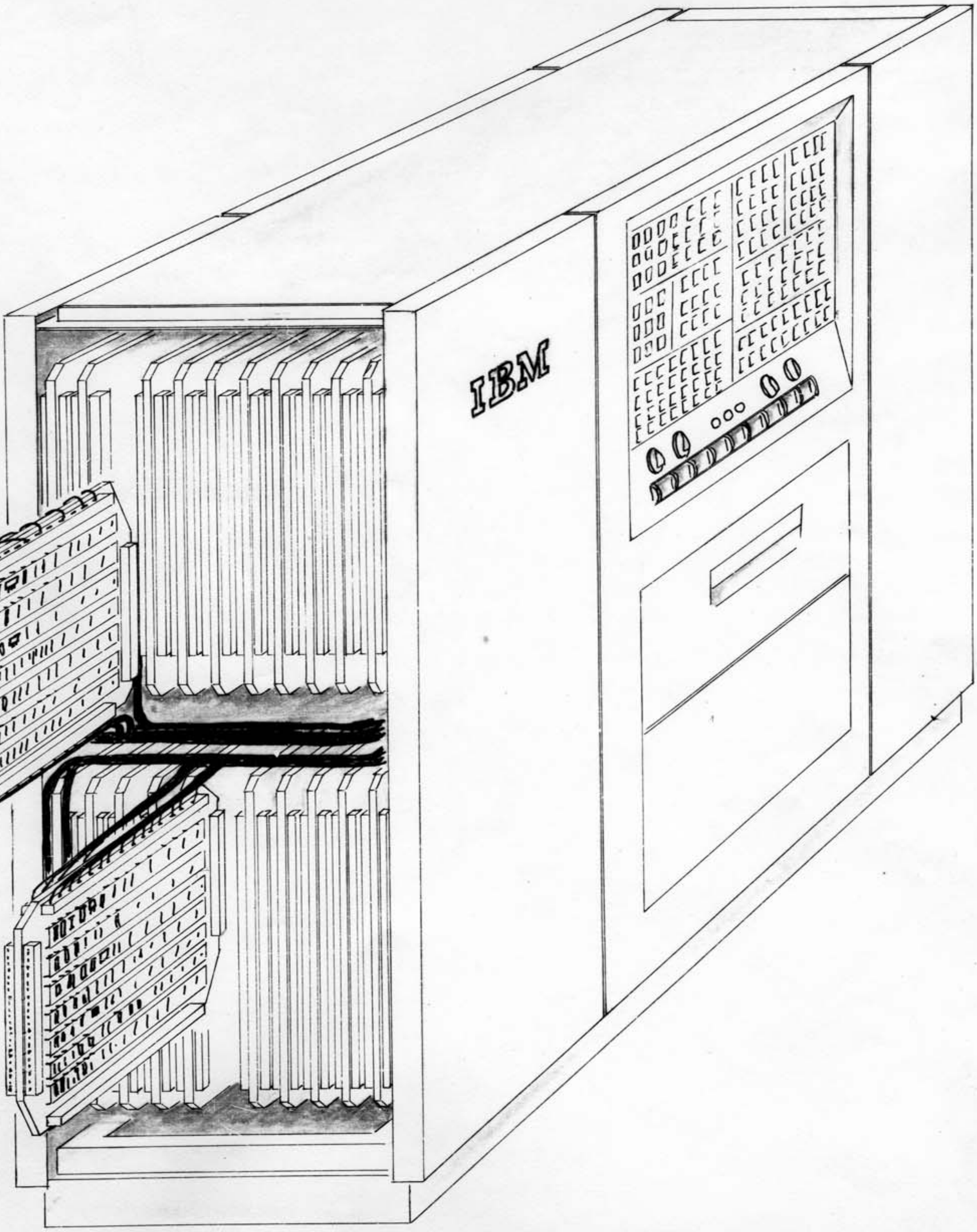
POINTS OF THE SAME SELECTOR CAN BE USED FOR

CARD FORMAT SELECTION
PROGRAM SELECTION
PRINT EDIT SELECTION
PUNCH EDIT SELECTION
AND SELECTION OF NEXT CARD CONTROLS

SELECTOR TIMING

Figure 4

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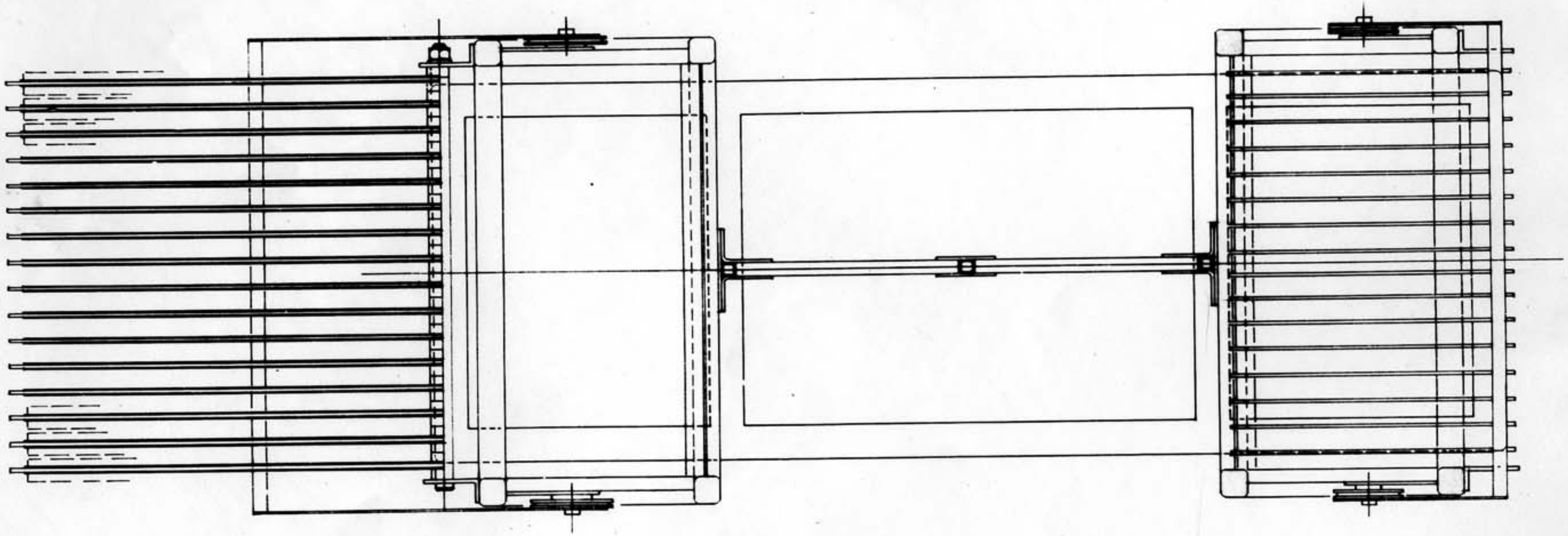
WWAM FRAME

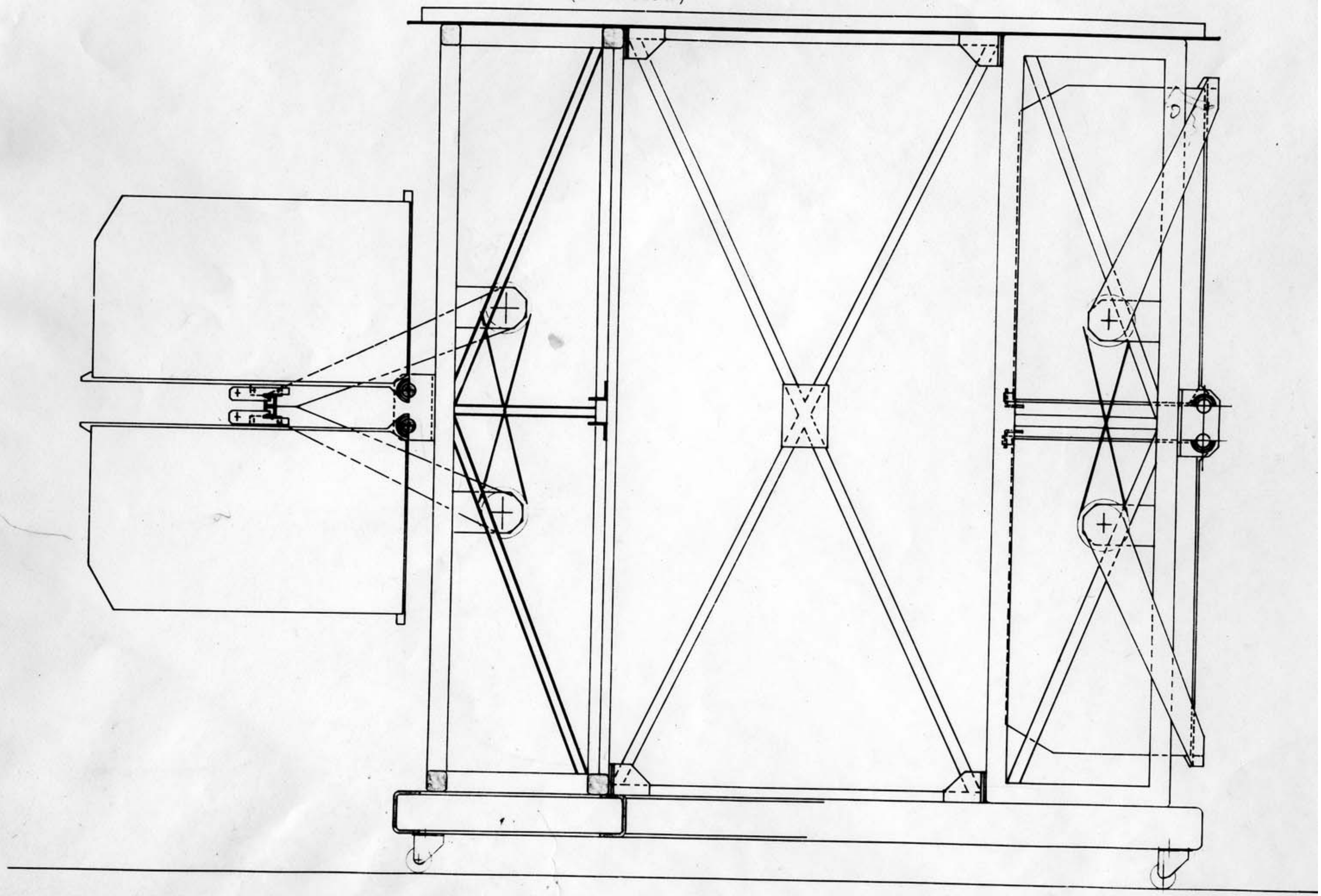
(top view)



June 7, 1957

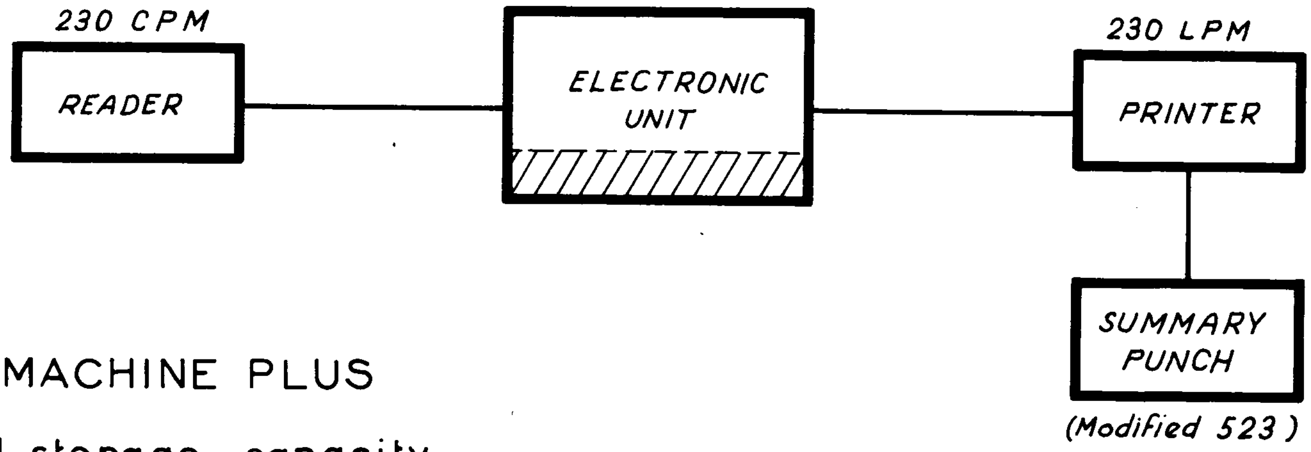
WWAM FRAME

(side view)



June 7, 1957

W. W. A.M. Model

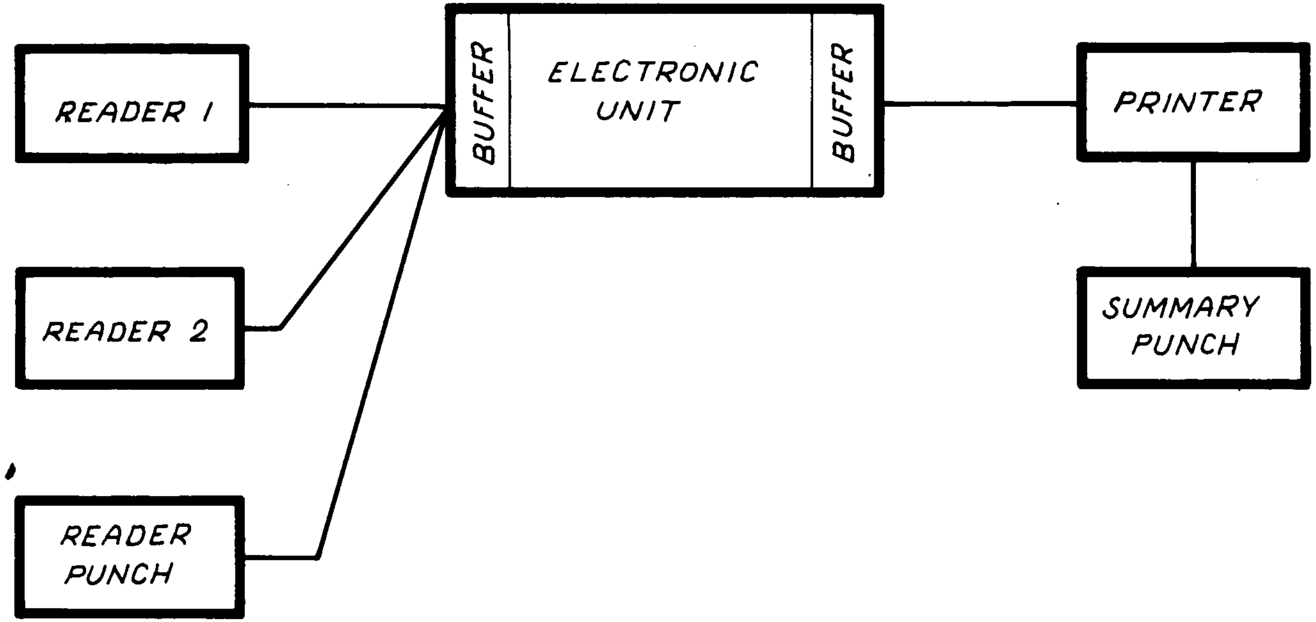


BASIC MACHINE PLUS

- Full storage capacity
- All program steps
- All storage splits
- All branch units
- All selectors
- Multiplication - division
- Shift - 1/2 adjust
- Overlapped summary punch

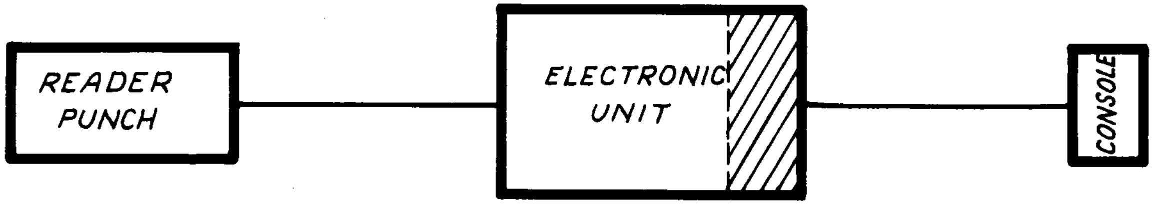
M.P. /m.m.s.
11-13-56

W.W.A.M. Full Machine



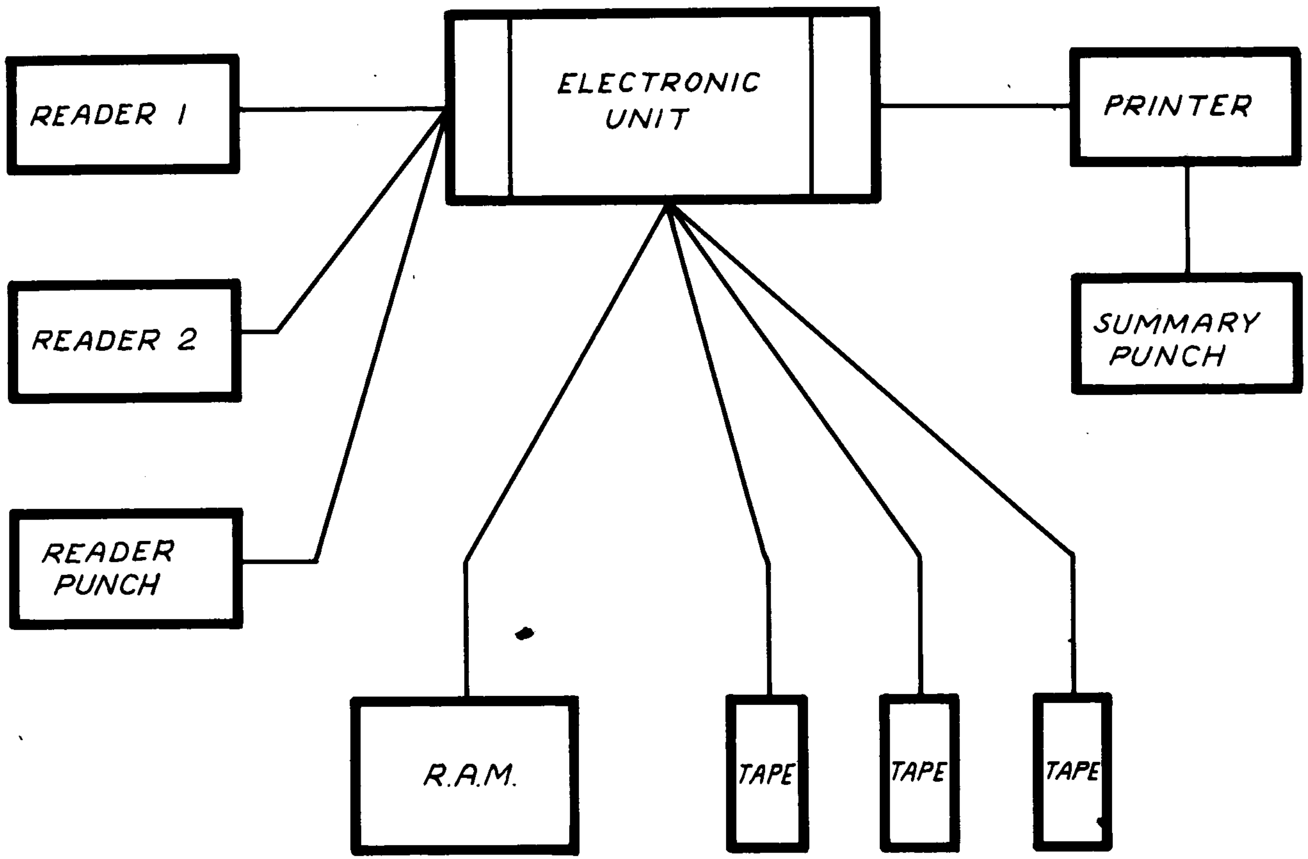
M.P. /m.m.s.
11-13-56

W.W.A.M. Calculator



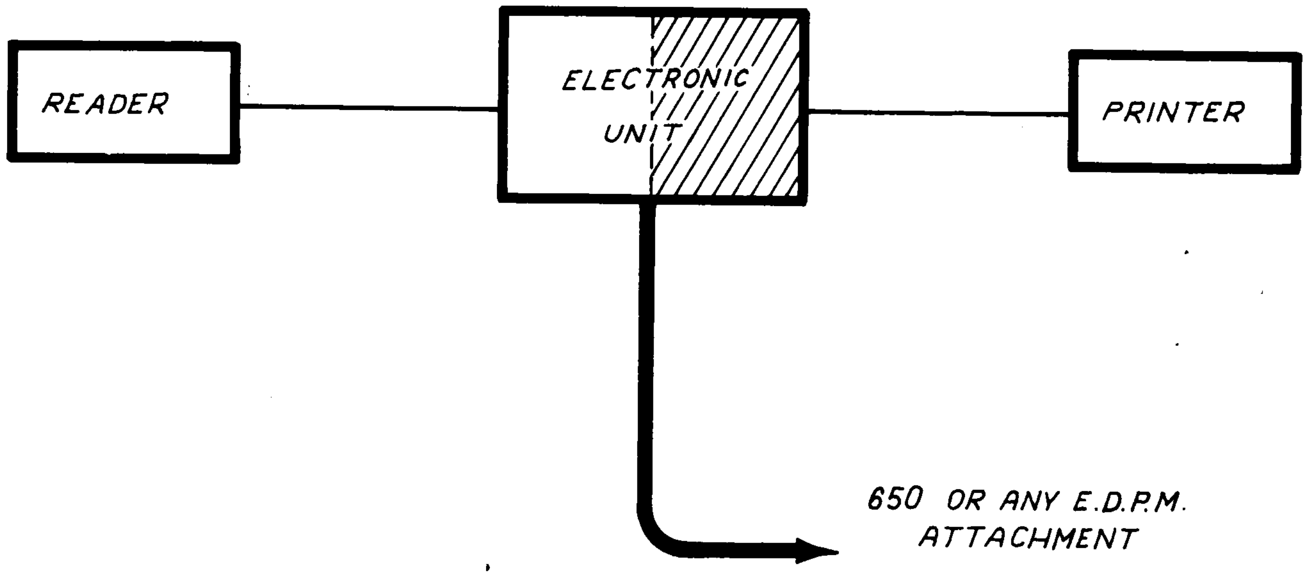
M.P./m.m.s.
11-13-56

W. W. A. M. Extended Version



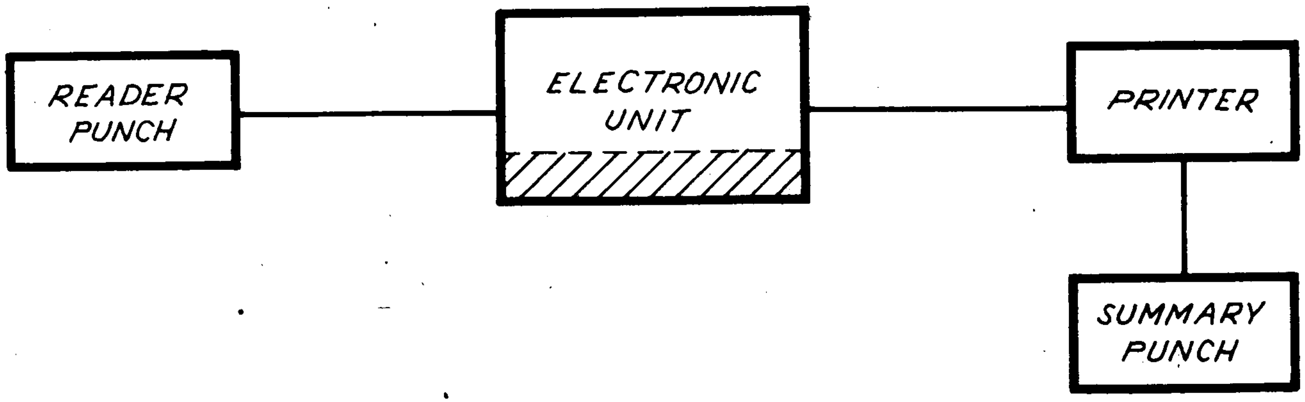
M.P. /m.m.s.
11-13-56

W. W. A. M. Input Output to E. D. P. M.



M.P./m.m.s.
11-13-56

W. W. A. M. Reader Punch



M.P./m.m.s.
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