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# "Mail Separator" Control Computer Preliminary Logical Design

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A computer design is presented for a "Mail Separator" type machine whose purpose is the synthesizing of an automatic continuous flow process from a post office's letter sorting operations.

This computer accepts letters' category and machine storage location information as aperiodically generated at twenty operator stations. Using the storage locations, the computer places the category information in a memory section whose arrangement is analogous to the letters' physical storage component. A running inventory with respect to 200 categories is kept for the contents stored in the machine's 2,400 individual letter slots (locations). Periodically, the computer makes a determination, premised on optimum inventory reduction, of the next category to be unloaded from machine storage. This category is shifted to the section which analogously retains the 10 to 30 categories of the stacks forming on the machine's output conveyor. The computer continuously makes identity comparisons between the categories of the stacks forming and the letters stored. The slot location coincident with an identity is then converted to a slot gate opening signal. After testing the letter category of each slot location in the machine, the stack category with its synchronism is transmitted for the purpose of controlling the subsequent process operations.

## Introduction

The object of this computer is to provide the control of a machine which enables the synthesizing of an automatic continuous flow process from a post office's letter sorting operations.

The "Mail Separator" sorting machine, in providing time-discrete outputs at a single location, introduces the capability of automatic processing for succeeding operations. Each output is a stack of letters for a particular destination, and the flow diagram, figure I, illustrates the system integration of the subsequent operations of supplying a label, tying the stack into a bundle and conveying the bundle to the proper transit pouch.

Conventional sorting machines work on the pigeonhole method which is typical of the manual process. This method, in a postal operation, requires a substantial amount of labor to service the multitudinous output points.

As an example, a post office might require 10 conventional letter sorting machines each with 300 output bins. Each machine's bins, while being supplied by a crew of 12 synchronized operators, are serviced by 6 to 8 more operators who in turn are randomly paced by the filling of those bins. Also, the reorganization of the post office's 3,000 bin outputs into a smaller number of dispatch pouches is a considerable task in itself. In addition, between bins and pouches, the letter stacks must be tied into bundles in order to maintain facing, and routing labels must be included with some bundles. Such a process is obviously not fully automatic besides being poorly adaptable to becoming so.

Figure II shows the conventional sorting machine principle as well as that of the "Mail Separator." The latter's principle of operation may be stated as follows:

> Physically similar articles are deposited randomly into *individual* storage containers emplaced in a rack. Each article's category information along with its storage location is filed in the machine's memory. In order to sort, the memory is searched periodically for articles of *like category*, so that these then may be unloaded to a common output conveyor belt. This single belt is used for different categories during successive periods. Emptied containers are immediately available for reuse by new articles of any category.

The internal system operation of the "Mail Separator" is shown in figure 1.

This sorting machine's physical handling component consists of twenty input operator stations and a common output conveyor belt. Each operator station contains an alpha-numeric keyboard, a keyboard-controlled letter feed, a rack of individual letter storage slots of 120 nominal locations, and a shuttle for transferring letters from the feed to the slots. The racks of slots are placed in stationary end-to-end alinement several inches above the output belt.

The striking of a code for the letter's address causes the feed's indexing and transfer of the letter to one of the two compartments of the double-ended shuttle. This compartment, carried by the shuttle during a traverse of half the station's rack, then deposits the letter into the first empty slot. For each succeeding letter, the shuttle traverse alternates between rack halves. The input capability for each station is specified at 120 letters per minute.

As a section of the output belt progresses under the machine's array of slots, letters of a particular address category are released synchronously to form an orderly stack. Different stack categories form on succeeding sections of the belt. The stack spacing (pitch) is adjustable to enable the concurrent formation of 10 to 30 stacks, while the output rate is adjustable between 24 to 40 stacks per minute.

The control means described here depends upon a one-to-one relationship between the stack category unload signal progress rate in slots and the revolutions of the information storage drum, so the speed of this drum and, likewise the output belt, is set for a desired specific combination of the aforementioned variable parameters.

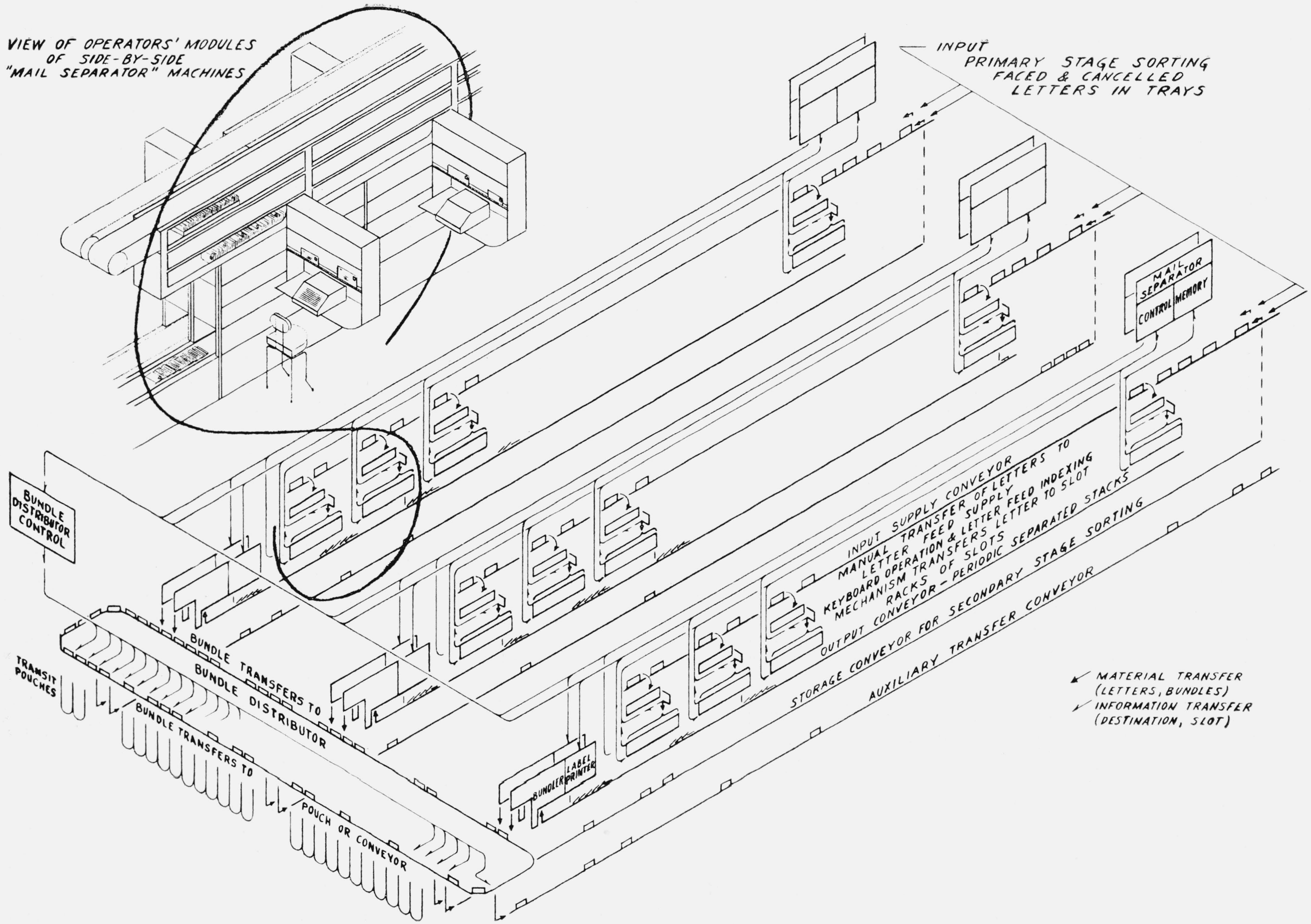


Figure I. *Flow diagram (three dimensional) of proposed mechanized letter-sorting system using semi-automatic "Mail Separator" machines and automatic label printing, stack bundling, and bundle distribution.*

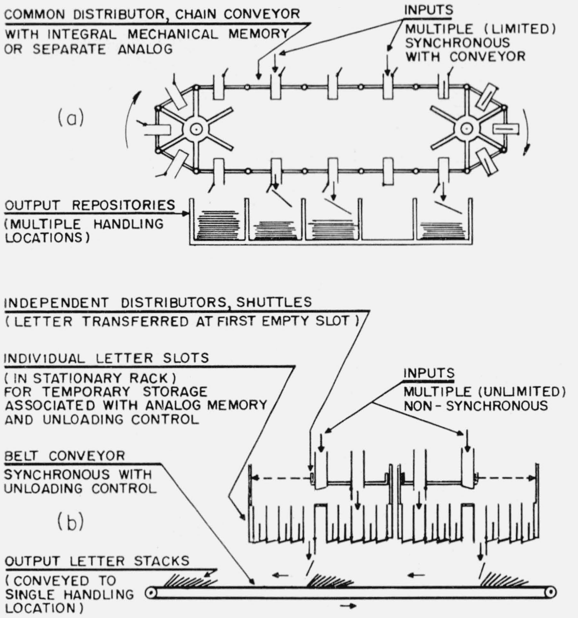


FIGURE II. *Illustration of machine sorting principles.*

(a) Conventional sorting machine.
(b) "Mail Separator" sorting machine.

Both the drum and the output belt are driven by synchronous motors whose speeds are controlled by a common adjustable frequency power source. The belt drive transmission incorporates a lag which governs the spread of the letters of the stack, and an allowable belt speed tolerance is reflected harmlessly in the length of the completed stack.

Figure 2 shows the means of generating time gates for sectors, words, characters and characters' digits as well as their associated clock pulses. This diagram also shows revolution accounting for timing the functions which pertain to the starting of new stacks.

## Input to Loading Buffers (fig. 3)

At each station, an operator strikes a one, two, or three character code for each letter's address category. Each character is keyboard-converted into a six-line binary output which persists for 0.025 sec. During this time, the magnetic drum makes at least one revolution. With the aid of a 40 unit ring counter, all keyboard outputs are sampled during each drum revolution. The six-bit parallel output is serialized in the process of transfer to its reserved position in the drum's first loading buffer track. The completion of a category code initiates its transfer to the second loading buffer track where the category waits for the letter's slot location. A six-bit parallel output is automatically generated when a letter enters a slot. This digital slot number is guided by the ring counter output to a sector of the second buffer. Each loading buffer is divided into 40 sectors which are analogous to the 40 rack-halves of the sorting machine. The rack-half to receive the letter is mechanically sensed when the feed first presents this letter to the operator.

The information concerning each letter is completed as a 24-bit word serially written in a sector of the second loading buffer. Now, in order to obtain adequately fast access for our stack forming method, the letter category is transferred to a storage block one bit long and 18 tracks wide alongside its slot number. The 2,400 prewritten slot numbers correspond analogously to the slots' physical locations. Figure 8 shows how this information is arranged on the drum.

## Transfer to Information Analog (fig. 4)

In order to write the letter category in its storage block, the entire word is intermediately transferred to registers. An indication that these are clear enables the search and serial transfer of a slot number from a sector of the second loading buffer. The presence of information in the slot number register enables the serial transfer of the remainder of the word to the letter category register.

The sector's traverse during this serial transfer requires that the corresponding sector of the information analog be retarded, so that its slot numbers may be searched earlier than the next revolution. So this search starts at the beginning of the following "40" sector, and the indication of a match between a reading from the slot number analog and the slot number register enables the parallel insertion of the category code into the letter category analog. At the same indication, a "1"-bit is written alongside the category in a separate count bit track. This count bit signifies that the newly added letter requires a tally recount.

## Tally Accounting (fig. 5)

When a letter address code is added to the information analog, its category is entirely reinventoried. This function is performed in three stages each of which requires a revolution of the drum, but the stages operate concurrently for different successive categories.

In the first stage, a count bit indication enables parallel duplication of its category in a register if the latter is clear. At the start of a new revolution, this category is transferred in parallel to a second register and the first stage process is repeated. However, if the next category found compares identically with the one in the second register, the first register is cleared, and the first stage operation continues until a different category is found.

In the second stage, the category in the second register is compared with the entire letter category analog, and each indication of an identity jogs a counter besides erasing the count bit if present. On occasion, this category being counted will be found to match a category being unloaded (which information is supplied from the Stack Forming Synchronizer). At the point such a match is found, the count is inhibited, because all pertinent letters in advance of a stack forming will be unloaded to that

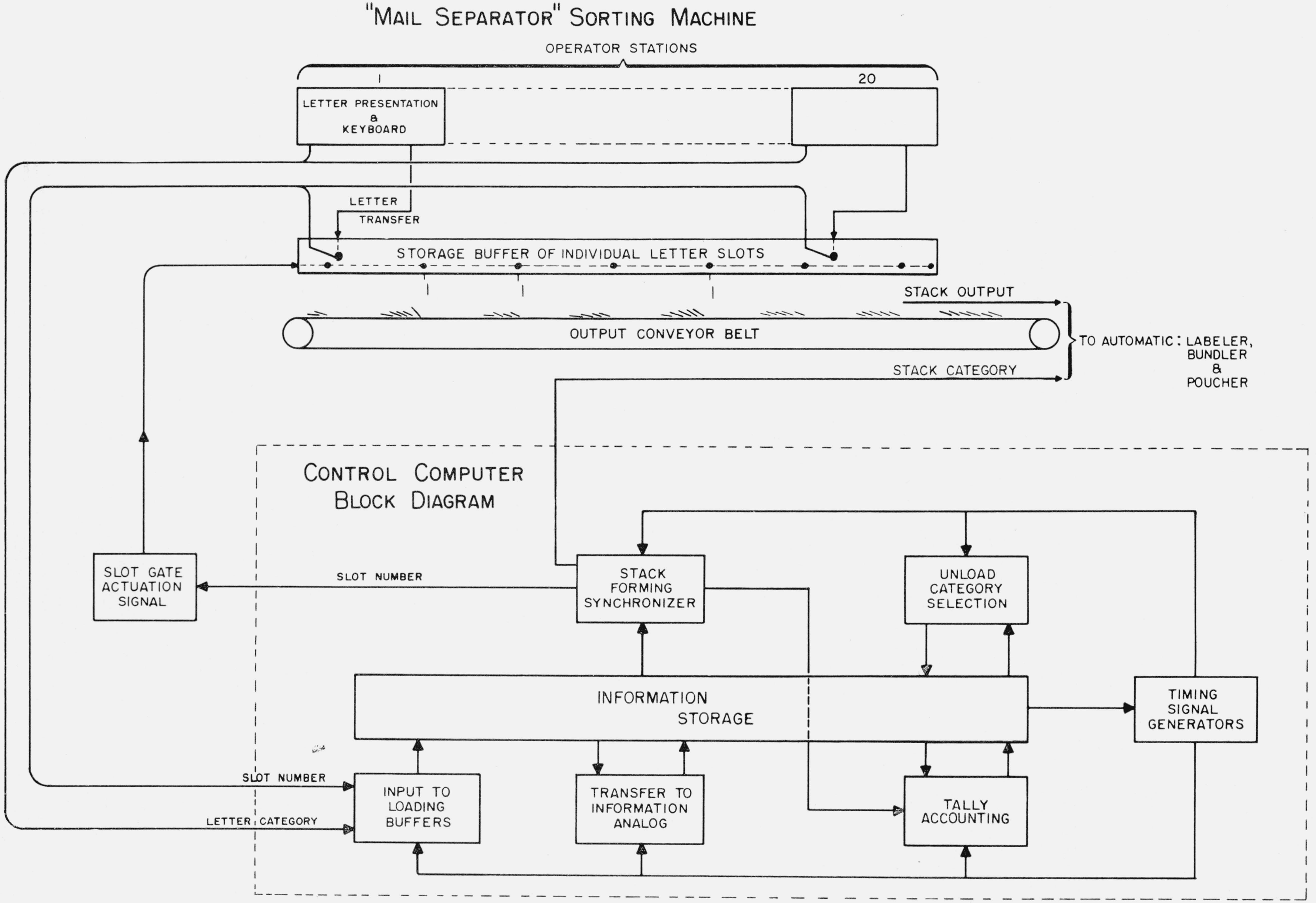


FIGURE 1. *"Mail Separator" control system.*

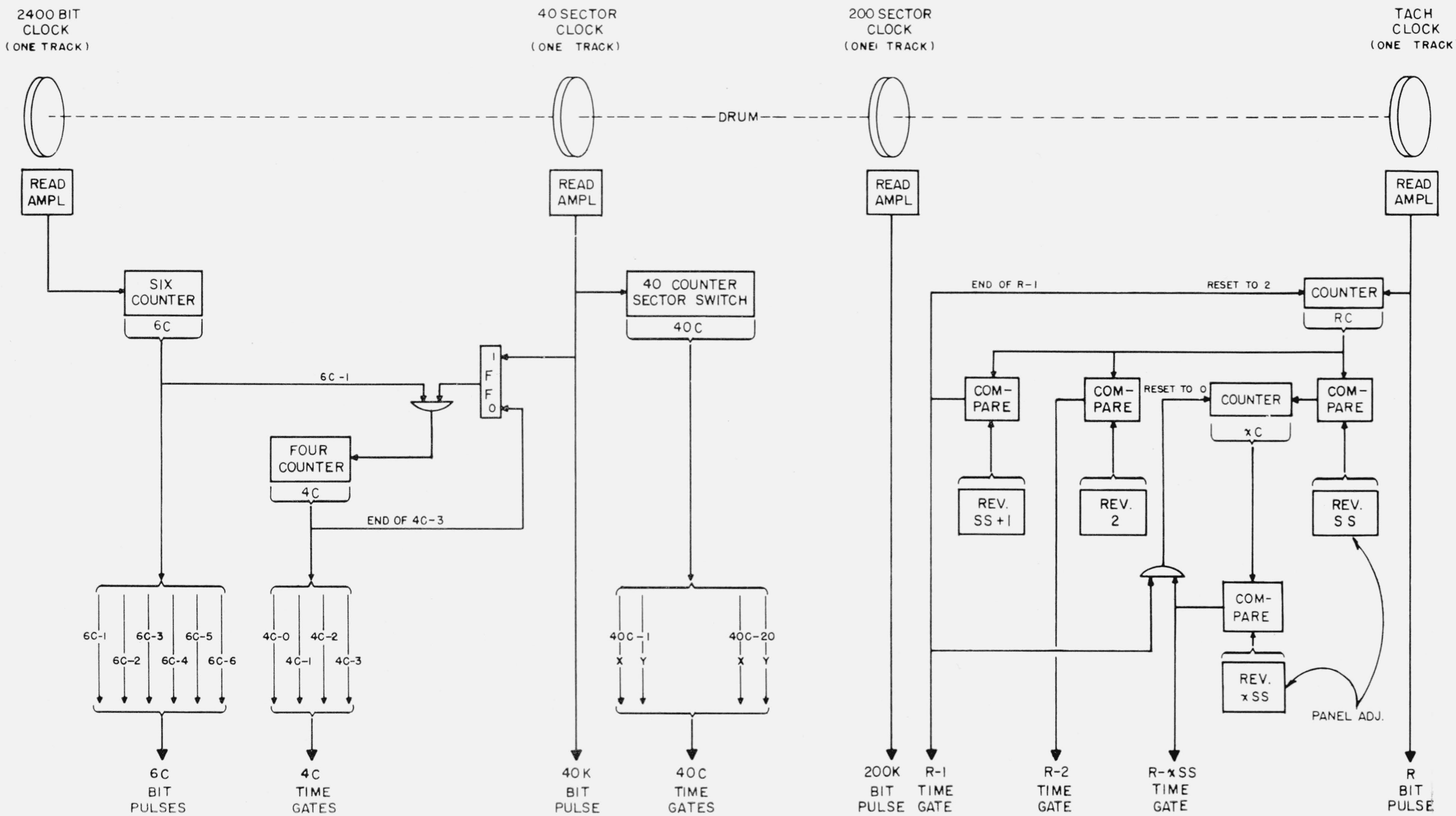


FIGURE 2. *Timing signal generators.*

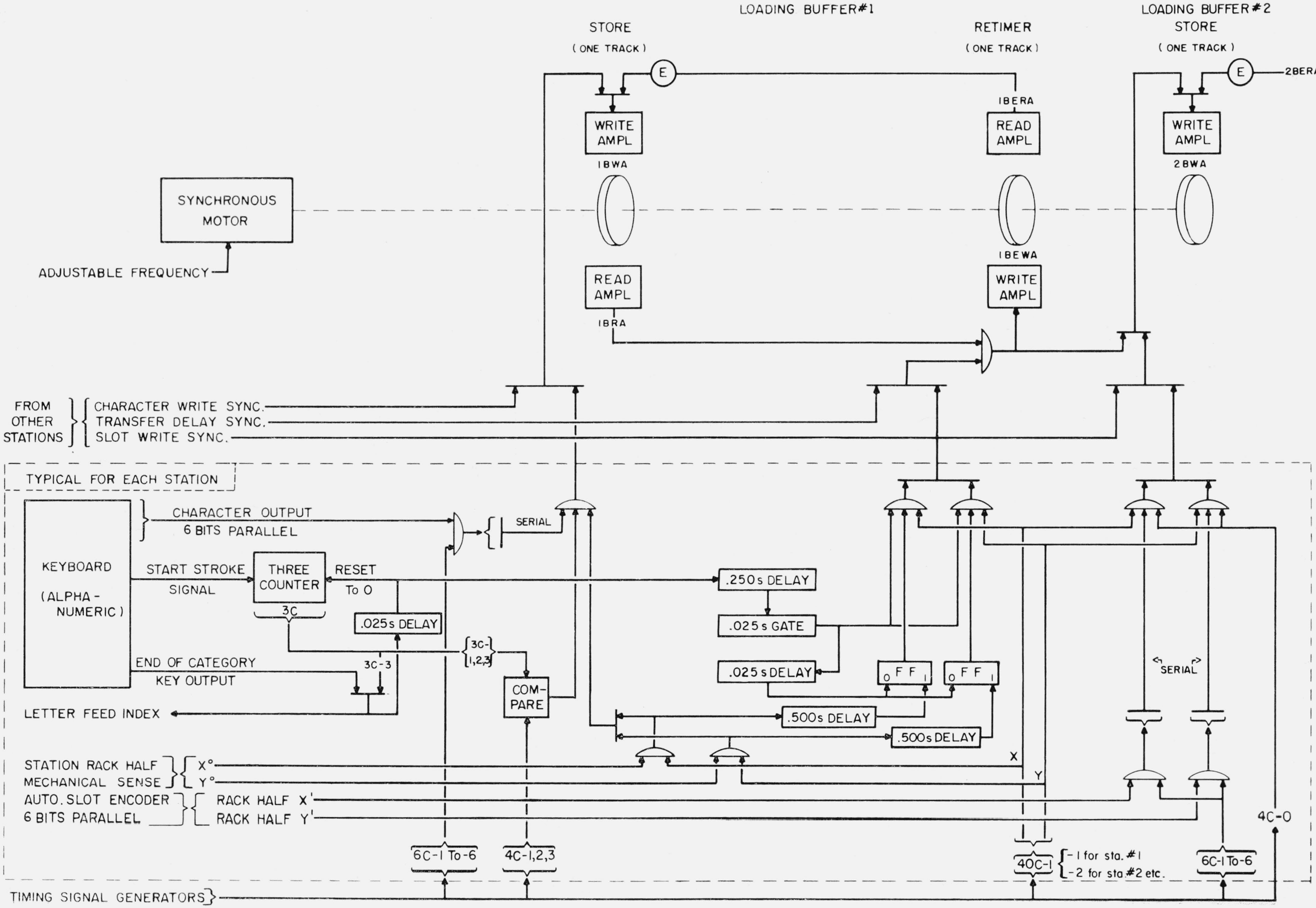


FIGURE 3. *Input to loading buffers.*

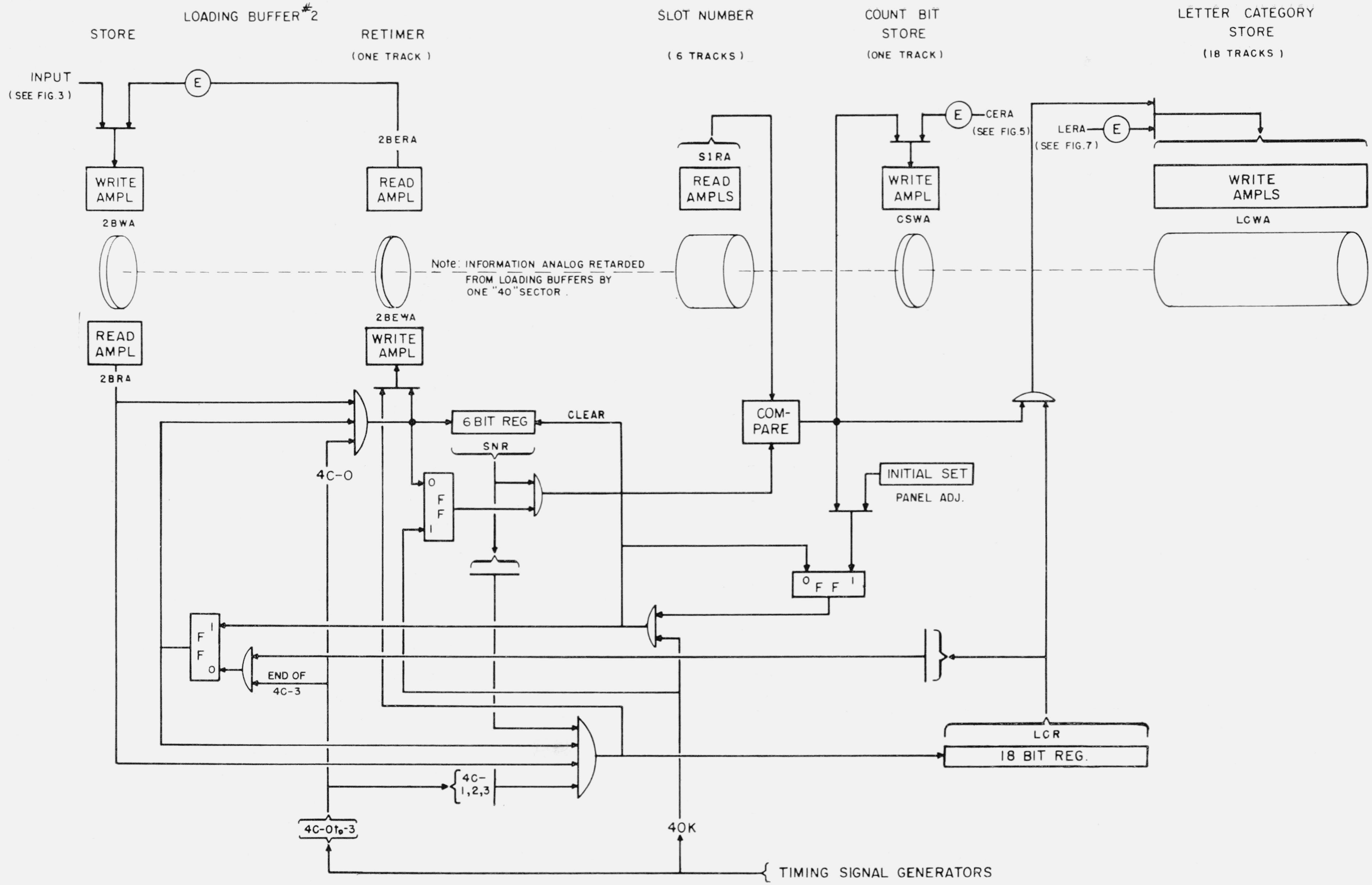


FIGURE 4. *Transfer to information analog.*

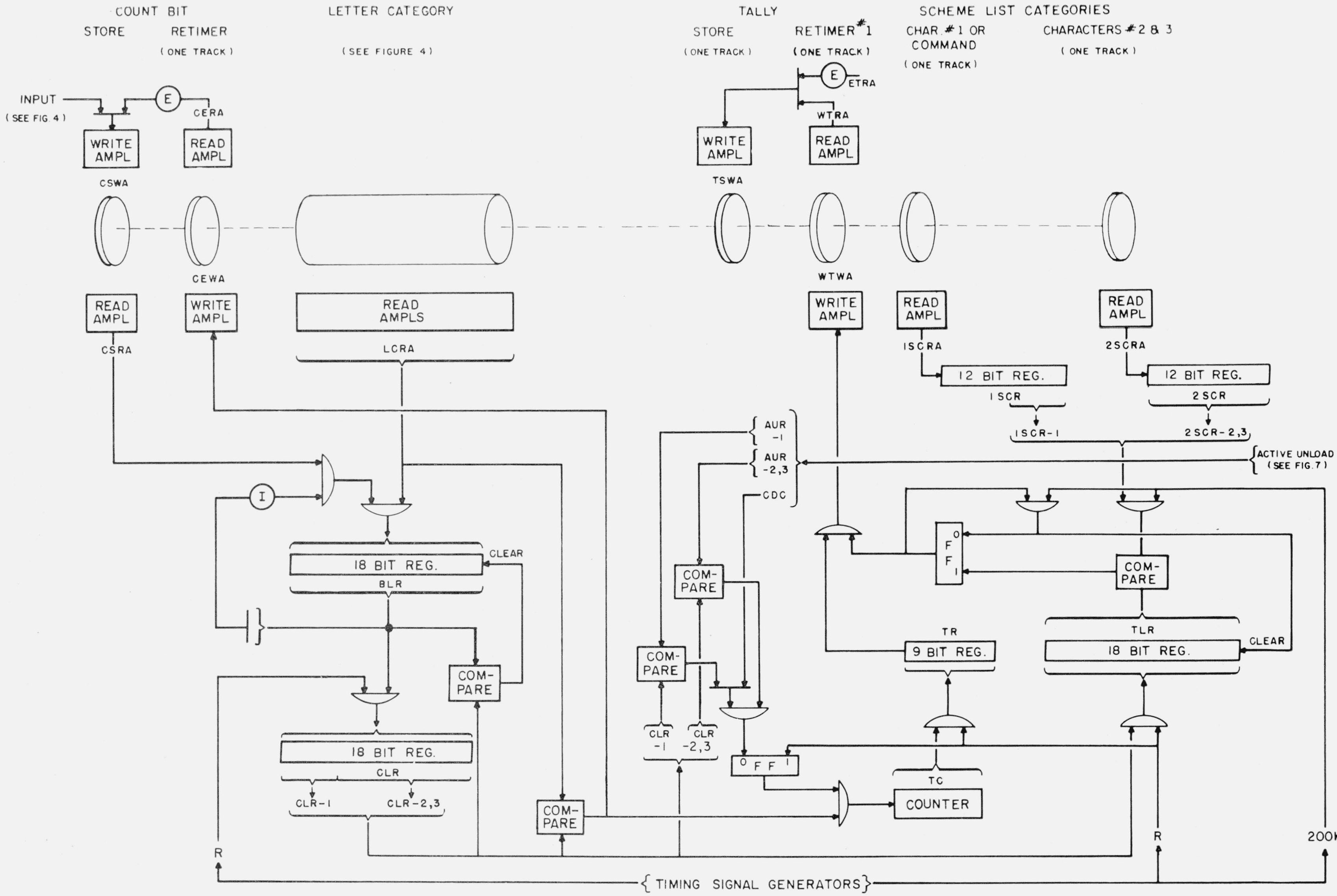


FIGURE 5. *Tally accounting.*

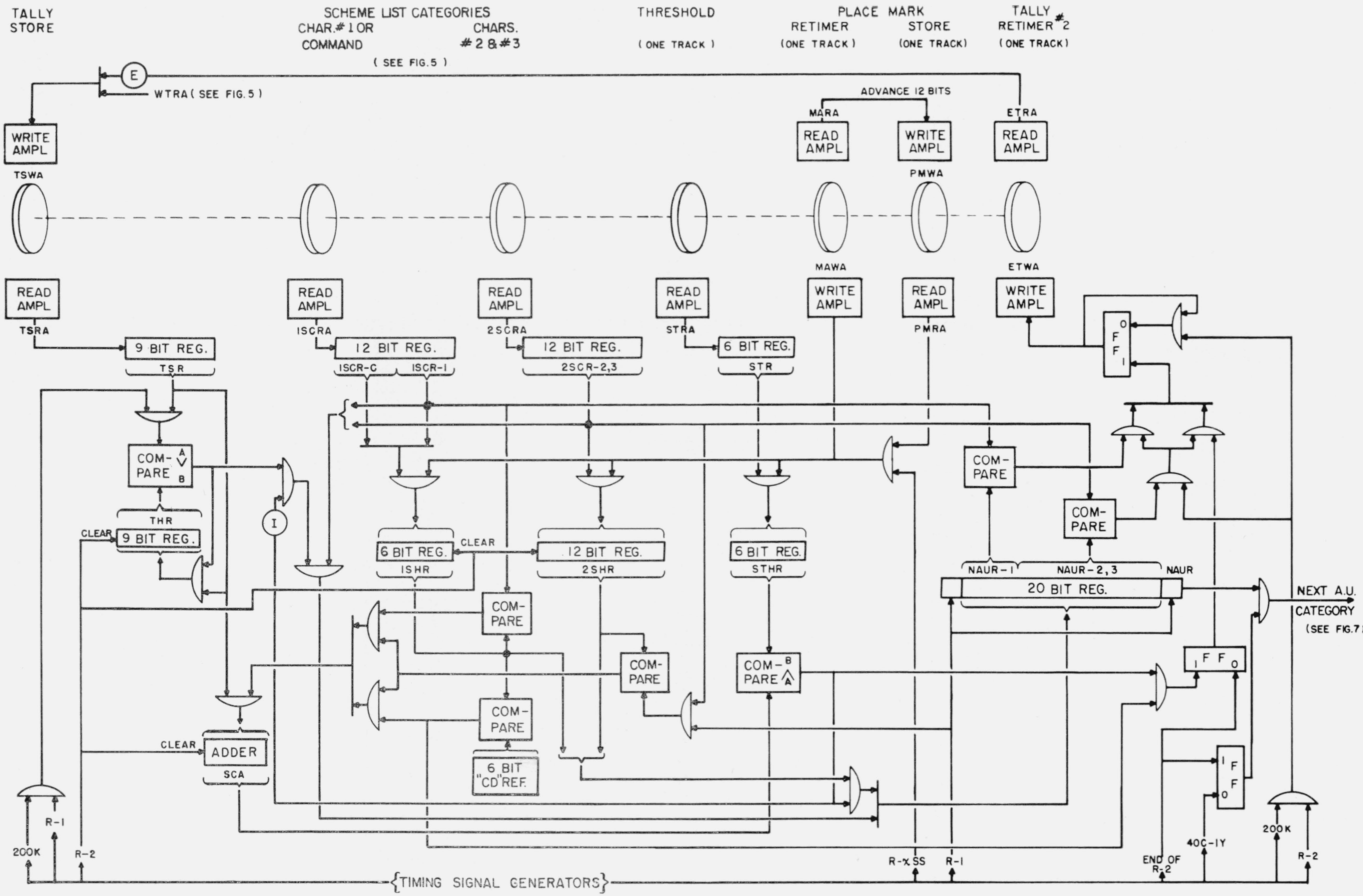


FIGURE 6. *Unload category selection.*

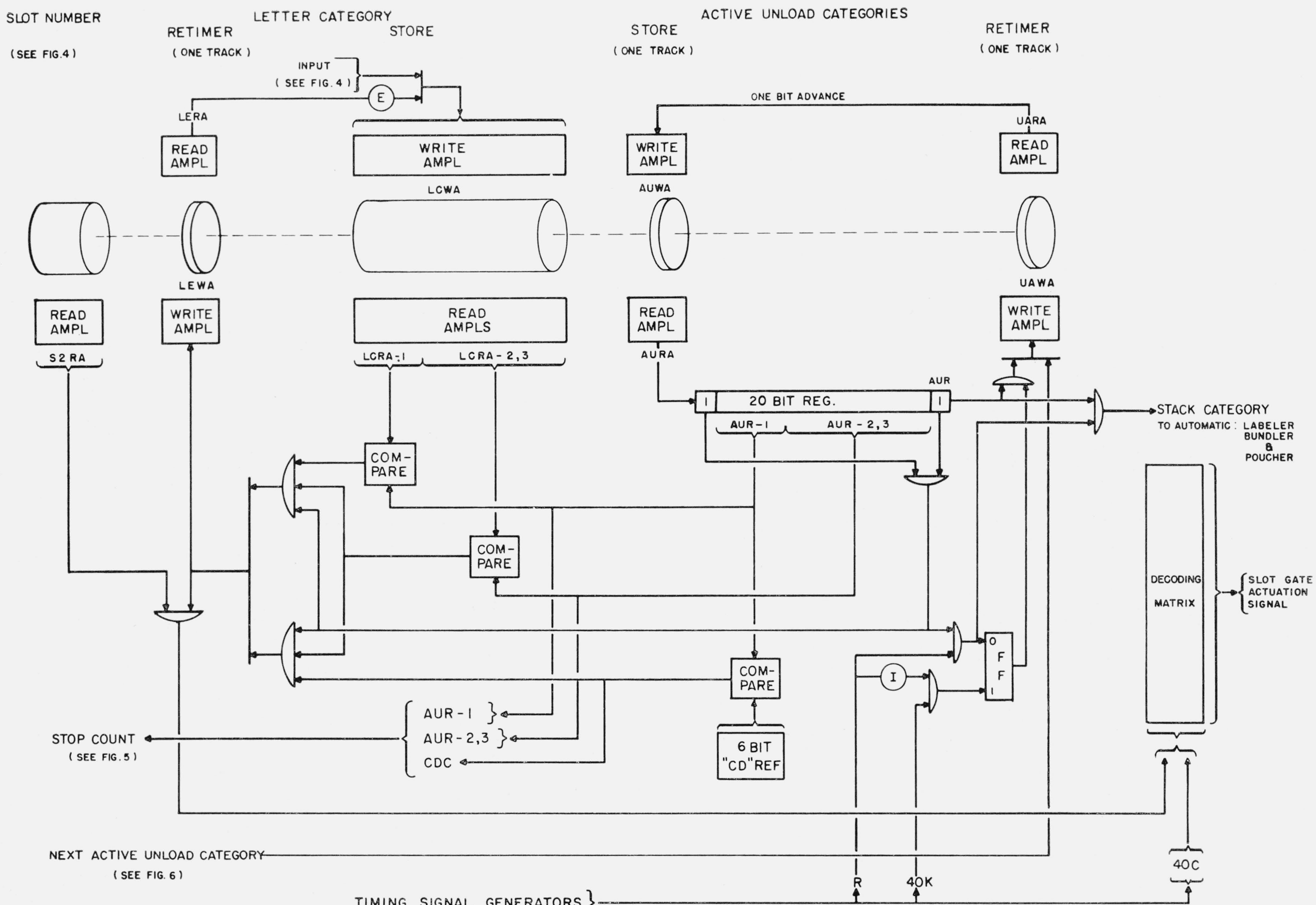


FIGURE 7. *Stack forming synchronizer.*

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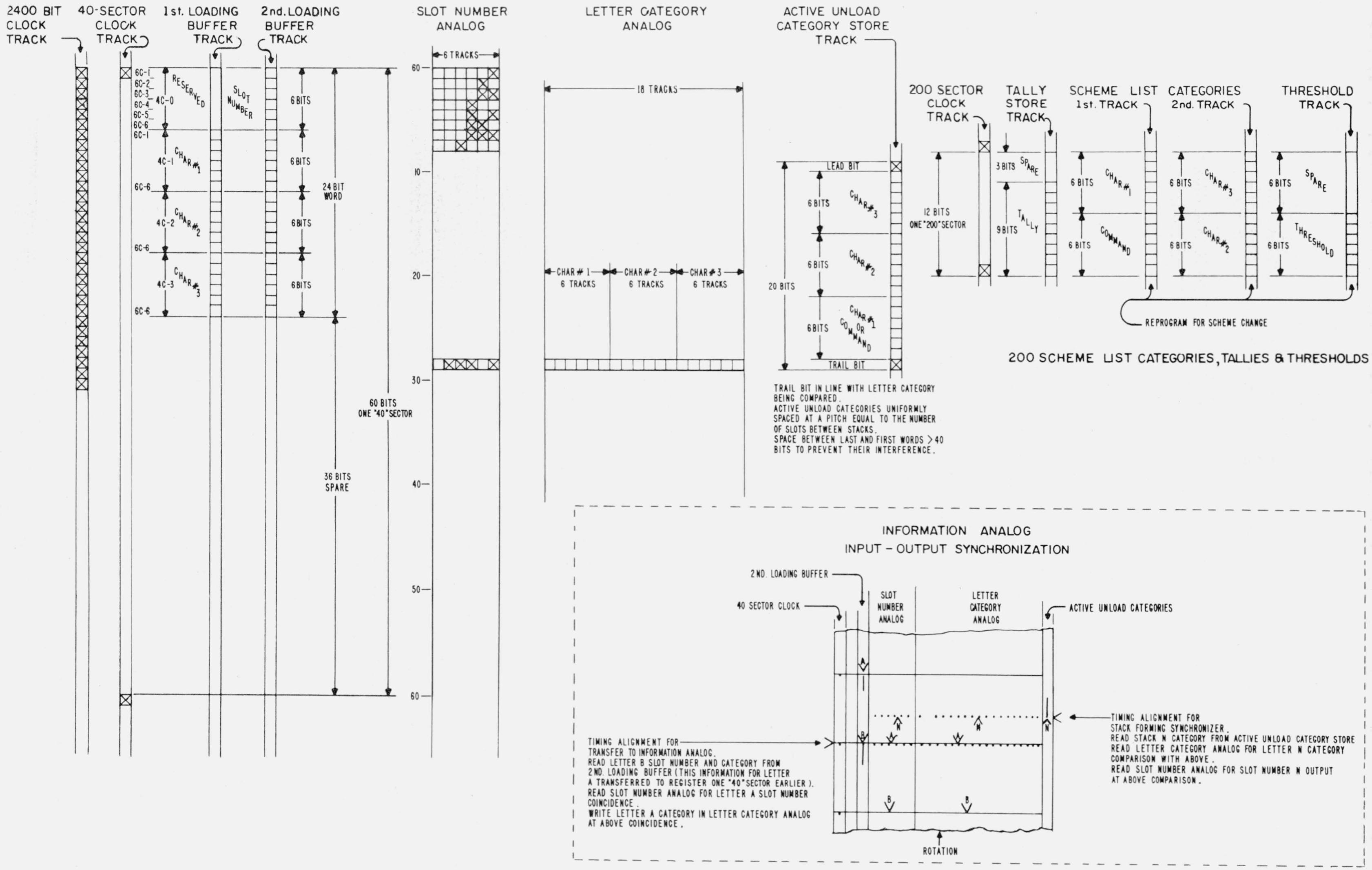


FIGURE 8. *Information storage layout.*

stack. In this way, the count which is attained represents only those letters applicable to the selection of new unload categories.

At the start of the next revolution, the count and its category are shifted in parallel to their respective third stage registers. Here an identity is sought between this registered category and one of the 200 scheme list categories. The items in this list are programed on the drum in word blocks two tracks wide and 12 bits long. These tracks are read continuously through separate serial input 12-bit registers. The comparison is checked in parallel, and the identity indication starts a 12-bit duration time gate for the serial transfer of the tally. The tally is moved from its register to a single track 12-bit long block beside its scheme list category.

In addition to the tally, two other store tracks hold information associated with the scheme list categories. One of the tracks contains, for each of these categories, a programed threshold which puts a lower limit on the number of letters for the stack. The other track contains only a single bit which serves as a place mark for the successive use of these categories. The scheme list information layout is shown in figure 8.

## Unload Category Selection (fig. 6)

In order to regulate the introduction of new stacks, a count is kept of the drum's revolutions. This count is compared with a panel-adjusted setting of the desired stack-spacing in slots. An indication of the desired count starts the Unload Category Selection procedure which consists of a single or two concurrent determinations. The predominant category is sought at each selection opportunity, but also, at alternate times (second, third, etc.), a programed category from the scheme list is given its chance. If the latter category exceeds its threshold, it bumps the predominant one. A following programed category will include those related categories which had not met their thresholds.

Along with the scheme list categories, their tallies and thresholds are read continuously through appropriate serial input registers. Each tally reading which is shown to exceed the number in a second register is immediately transferred in parallel to the latter. The same indication invokes the transfer of the associated category to a register provided to hold the selected next active unload category. Thus, after all the tallies are checked in the course of a revolution, the predominant category is left in the next active unload category register.

At the opportunity for a programed category, the previous revolution will have yielded an indication of the place mark which caused the parallel duplication of the flagged category and its threshold in hold registers. While the tallies are being searched for predominance, the programed category associated tally or related tallies are recorded cumulatively in an adder. If the number in this adder exceeds that of the held threshold, the indication causes the parallel transfer of the held category to the next active unload category register while inhibiting the source of predominant categories. It follows that, when a programed category opportunity is missed, a predominant category is on the spot to take its place.

The next active unload category register is of 20-bit capacity in order to provide positive lead and trail bits for the code's anticipated serial use. During the revolution prior to its transfer, this category is checked against the scheme list, so that pertinent tallies may be erased.

At the start of the revolution after tally erasure, the 20-bit code is moved serially into the active unload categories' retimer track of the Stack Forming Synchronizer.

Retimer tracks are used for erasing and writing delays which are desired to vary with the drum speed. One of these tracks is used also to advance the place mark by one word block each time the mark is used.

## Stack Forming Synchronizer (fig. 7)

The 10 to 30 active unload category codes are stored at equal spacing in a single track. Each trail bit is in timing alinement with an item to be checked in the information analog. After each check, the category is advanced one bit for the next revolution.

The categories in this store track are transferred in turn to a serial input 20-bit register. The concurrence of the trail and lead bits in the register's first and twentieth positions, respectively, indicates that the code is complete in the register. At this point, an indication of this code's identity with the alined letter category of the information analog causes the latter item to be erased and its slot number to enter a decoding matrix.

The parallel six-bit code from the slot number analog along with the activated output of the 40 counter are decoded to provide a gate opening signal for a particular slot in the machine's rack. Such slot gate actuation signals are the computer's primary output.

The active unload category code continues to shift through its register bit-by-bit for a serial output which is written on a retimer track. The code is then read out and rewritten on the store track with a one bit advance from its previous position. In this manner, an active unload category checks each of the 2,400 items of the information analog in as many revolutions.

At an indication that the last item is being checked, the active unload category register's output is switched from retimer track entry to the computer's secondary output. This stack category code is then used as an order to print a label, tie the label and stack into a bundle, and convey the bundle to its dispatch pouch.

The order's synchronism is maintained through the sorting machine's conjunctive automatic label printer and stack bundler. This synchronism is also maintained with the order's transfer to the automatic bundle distributor which serves a battery of sorting machines, as previously shown in figure I.

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