Tallying, the recording of the number of occurrences of specific events, although basically a simple repetitive act, has somehow failed to become mechanized in the general trend toward relieving humans of the drudgery of paper work. A tremendous amount of event counting is still recorded in the tally records of modern business establishments in the symbols of the ancients, the four strokes and slash. This system is used especially when the number of different events being tallied is large. It is true that the ticket taker has his thumb-operated counter and the baseball umpire his finger-operated wheels for balls and strikes, but as the number of events grows, the mechanism fails to keep pace. The Electronic Statistical machine has 62 counters and another company makes an analysis machine equipped with 80, but for the problems at hand in the field of merchandising, neither of these is at all adequate. Tens of thousands of counters are required if record of the movement of merchandise bought and sold by even a small mail-order house is to be maintained.

As a means of mechanizing the tallying operations of the John Plain & Company merchandising activity, the Remington Rand Speed Tally has been developed. This machine maintains 39,000 tally totals in an "up-to-the-second" condition while simultaneously receiving 9,000 entries per hour which affect many or all of the totals thus held. Before describing this machine in detail, first let me relate the story of how the development came about.

Early in 1951, Mr. Harold Lachman and Mr. Walter Richter, both of the John Plain Company, became convinced that some electronic methods were ready for introduction into their mail-order business. After a rather comprehensive search of the field, they contracted with Engineering Research Associates, Inc. to design and construct an equipment that eventually became the Speed Tally. Their stated requirements were to provide a mechanism which would permit them to count (or tally) the number of orders they received each day for each of approximately 8,000 catalog items, and to make the result of the counting available at the end of the day. The method they were then using required about 20 tally clerks and required another one or two days for the cross-footing of the 20 sets of 8,000 subtotals thus acquired. Since the activity ran to 75,000 item orders per day, the conventional mechanized approaches appeared to be impractical.

The existence of a rather well developed magnetic drum storage mechanism and its reliable performance in several computing systems immediately dictated its use for the recording of this large number of tally totals. The reasonably short access time of an adequately large drum as well as its non-volatile and selectively alterable characteristics made it appear to be an almost ideal storage device for this purpose. After a considerable amount of compromise, attempting to balance all factors, a capacity of 39,000 three-decimal-digit tally totals was selected. These were subdivided into 13,000 sets of three totals, each set to be specified by a five decimal digit item or
catalog number. A ternary\(^1\) digit identifying each of the three tally totals for each item was provided to permit tallying orders, sales and cancellations. Each total was allocated recording space on the drum for three decimal digits which permits the accumulation of tallies up to 999. The location of the total on the drum surface is identified by the five-decimal-digit catalog number plus the ternary or category digit.

To permit the processing of as many as 75,000 tally entries per day, the Speed-Tally was designed to perform its internal operation in the minimum possible time, one and a fraction drum revolutions, since the new total is always restored to the same location from which the old one was obtained. With the addition of the time necessary for a series of cascaded relay operations, the complete operation time becomes just under 400 milliseconds, thus permitting 150 tallies per minute. To match this action time to average human operators, ten keyboard units are provided; however, with skilled operators, six appears to be an adequate number. An allotting mechanism, not unlike automatic telephone exchange practice, seeks each keyboard as the operator completes the tally entry. Approximately 400 milliseconds later the operation is repeated for another keyboard. At this rate, the required 75,000 tallies per day are accomplished.

So long as the 39,000 totals remain only as invisible magnetic marks on the surface of the magnetic drum, they are unusable. To make them available to the users of the Speed-Tally, an output system consisting of an adding machine type printer and a perforated tape reader are provided. During an output sequence, perforated control tapes pass through the tape reader controlling the printing of selected item totals from the magnetic drum. This operation proceeds at a rate of 75 totals per minute, and the record on the magnetic drum may optionally be destroyed or retained. It is, therefore, possible to extract an hourly record of the activity of a few hundred items by only a few minutes interruption of the tallying. A complete record of all 13,000 totals in one category can be printed in less than three hours.

Figure 1 shows a simplified block diagram of the Speed Tally System. In the process of following a single operational cycle, let us presume that the Input Register is already holding the information normally received from one of the keyboards. This consists of a five-digit catalog number, a "one-of-three" designation of the category, and a two-digit quantity. The first two are translated to provide a track selection or magnetic head selection and a specification of the angular position at which the desired existing total is available. As soon as the translation is completed, and at the next drum position which satisfies the angular position criterion, the old total is read out through one of the two reading amplifiers to the Quantity Register. As soon as this occurs, the addition (or subtraction) process begins creating the new total. This operation is exactly analogous to the reading operation just described. The quantity digits are used to make a time selection from a recorded counting pattern on the drum and to pass an appropriate number of pulses into the Quantity Register. The consequence of this action is to form the new total and retain it in the Quantity Register. The new total is completely formed in the two-fifths drum revolution immediately following the acquisition of the old total.

\(^1\) A ternary digit may have three values, (a decimal digit has ten values).
The actual selection of this old total from among the three hundred present on the selected track is the function of the Address Timing Selector. This same device also directs the assembly of the individual digits of the old total in the Quantity Register. Exactly one drum revolution later, it directs the issuance of the new total from the output terminal of the Quantity Register and its simultaneous recording on the drum in the location of the old total. This operation forever obliterates the record of the old total.

Not shown in this diagram is a control function whereby the originating keyboard directs the arithmetic operation, causing the two-digit quantity either to be added to or subtracted from the old total.

Now let us look at some of the hardware by which the operations are accomplished. Figure 2 shows the completed equipment in service. I believe you will agree that this is one of the most attractive pictures of a computing system you have ever seen! The next picture, Figure 3, shows a close-up of one of the keyboard units. As you can see, it is built around the small keyboard and case of a hand adding machine, with the rear console appended to hold some of the added electrical equipment. The operator's controls consist merely of the ten-key numeral selectors, an add-subtract key and a mechanical clearing key projecting out of the case in the front, and a category switch which is normally fixed. The three vertical apertures are used for a neon lamp display of the new total after each operation, and the two lamps above these are used to display various alarm conditions when an abnormal condition exists.

This keyboard configuration eliminates every possible nonessential and concentrates on the speed of operation. As each numeral key is depressed during the registering of an entry, it is stored in a mechanical memory device, also common to the progenitor adding machine. When the last digit of the entry is registered, a signal is given to the central equipment which stimulates a seeking switch (the allotter) to connect this keyboard to the input register. In approximately 140 milliseconds, the input register is in possession of the entire quantity of information registered in the keyboard, and the internal cycle of operation previously described begins. At the conclusion of the recording of the new total, a reset signal is issued, the input registers are cleared, and the allotter sets out in search of the next keyboard. The mechanical and electrical restoration operations continue under local control in the keyboard unit for another 200 milliseconds.

This resetting of the keyboard has been given an auxiliary operation to perform which is both interesting and of great utility. Besides restoring all of the mechanical memory elements to their original state, the reset operation enters a quantity of one in anticipation of the next operation. This was so designed because almost 90% of the orders being tallied by the John Plain Company call for a quantity of one. Should this anticipatory operation be an incorrect one, the operator merely flicks the clear lever with her thumb and proceeds to make a proper entry of the desired quantity. Should her next operation be the tallying of a quantity of one, she merely enters the five digit catalog number, the machine having spared her the necessity of entering any quantity information.
When an output is desired from the machine, the equipment shown in Figure 4 is put into use which disables operation of any input keyboard for the duration of the output operation. The equipment shown consists of an adding machine type line printer on the left and a tape reader and perforator unit on the right. The operation in process, as this picture was taken, is the preparation of a perforated tape to be used to control a subsequent output operation. By manipulating a keyboard having a pattern identical to that used for input, the operator perforates a sequence of item numbers into the tape in any arbitrary arrangement. In a typical installation, many tapes, each listing a relatively small but related group of items, are prepared and held in a library. Any one or several of these control tapes may be run through the tape reader to produce printed output of the type shown in Figure 5.

This is a sample of both the control tape and the output printing. Binary coded decimal digits in the control tape are read in groups of five by the action of the fifth level control hole causing the printer to print an output tape as shown. The five left-hand digits identify the stock number and the three right-hand digits the quantity recorded in the magnetic drum. As you will note, the stock numbers can be listed in any arbitrary sequence to produce output information exactly fitting the needs of a particular buyer or other administrative official.

The complete tallying process is performed by the central equipment shown in Figure 6. Fifteen pluggable electronic chassis in the upper right portion of the equipment constitute the entire tube complement except for the D.C. power regulators which are shown in the lower left. Immediately below the electronic section are 130 relays used for magnetic drum head selection. The relays shown in the upper left portion of the equipment comprise the input register and the output control group. The twin cabinets housing the central equipment are each 36" wide by 30" deep and 78" high and enclose the entire equipment with the exception of the input and output devices. Approximately three kilowatts of power is consumed from the a-c mains.

Figure 7 is a rear view of the same equipment and shows the magnetic drum, a 17" diameter cylinder having a 10" axial dimension. It is continuously driven at 1750 rpm by a 1/3 horsepower induction motor. At the upper right in this view is shown the address translator which consists of two 10 x 10 crossbar switches and a bank of 1300 miniature selenium rectifiers. Not all of the latter are in fact necessary, but their presence eliminates all concern about sneak circuits. Directly below the translator are two power supplies and below them and not visible is a motor generator. These three power sources provide all d-c for the vacuum tube circuits.

The translator, consisting of the two crossbars and ten other relays, performs a very significant service in this equipment, since it permits the 13,000 item spaces in the magnetic drum to be located by arbitrary combinations of five decimal digits. The only compromise from complete random distribution of these numbers is the requirement that not more than 1300 permutations of the four highest order digits be used. In most stock numbering systems this is almost as acceptable as complete randomness and it significantly reduces the dimensions of the translator. Another way of stating the stock number distribution is that recording space is provided for 1300 item number decades - the decade signifying ten item numbers in which the lowest order digit ranges from zero to nine for a given set of high order digits. The coil circuits of the crossbar switches and the other ten relays constitute the input register for three of the five item number digits and twenty more relays provide the input register function for the other two.
The operation performed by the Speed-Tally equipment which appears to intrigue most technical observers is the location and selection of one specific tally record from the 39,000 present on the drum surface. Figure 8 illustrates the principles employed in performing this locating operation. In the center of the figure in boldface you will note a sample catalog number and category, \textit{AI064X}. The category, "A" in this case, merely identifies which of three tally totals of the set associated with this item number is to be located. This information comes from the input keyboard or the control-tape reader as one of three electrical signals. The remaining five digits, \textit{1064X}, describe a particular item number from among the 13,000. The "X" is merely used to signify one of the values, zero through nine. The higher order three digits, 106, perform two operations. First, they select one of the 130 magnetic heads and thereby reduce the 39,000 candidates to 300 (100 sets of 3). The remaining two digits, \textit{4X} in this case, specify a particular set from these 100, however, with the random number system employed, there may be several totals among this 100 which are specified by the same ten's-digit value of four. Therefore, the track selecting digits, 106, also modify the value of the ten's digit to one which avoids having duplicate values in any one track. This is the principal action of the translator referred to in the previous figure.

Since the timing track contains 3600 discrete bit positions, the consecutive action of the category and item number digits reduced these by 1/3, 1/10, 1/2, and 1/5 leaving only twelve bit locations eligible for controlling the output of the reading amplifier into the quantity register. The timing pulse count-down which achieves this selection is performed by four counters, and their relationship is arranged to space each of the twelve bits by an interval of sixty bit positions and to concentrate them in one-fifth of the drum periphery. Our convention is to arbitrarily label the sector containing the desired item space "Sector 1" and the subsequently arriving sectors 2, 3, 4, and 5. This convention does more than merely aid in locating a particular item record, since the programming of the several actions performed during each operational sequence is done by the consecutive existence of the numbered sectors. In this way, by the time Sector 1 returns to the magnetic head on the following drum revolution, the new total is available and is written in place of the old.

Having shown you the machinery of the Speed Tally, I shall conclude with a word or two about applications of machines of this kind. The Speed Tally has been applied to that region of the unit control problem referred to yesterday by Mr. Shaffer, that of recording for analysis, the unfilled demand, here it has been able to provide information for use by the merchandise buyers quickly enough for them to take some action. It should be evident that this kind of machine is not limited to this work; but is capable of handling many associated portions of the unit control problem. It is my belief that it will only be a short while until its use in a variety of commercial applications will give rise to new concepts of utilization; and, of importance to equipment designers, new concepts of design for an even wider range of applications. I believe we are witnessing the office machine counterpart of the introduction of the internal combustion engine into our lives, and just what and how much change it will bring is as yet unmeasurable.

Our first Speed-Tally machine, and the only one in existence, has now given us six months of experience centered on the Christmas rush business of the John Plain Company. It has provided our industry with another illustration of the potential of electronics in business. To the user, this illustration has been very dramatic and understandable. It has further dispelled any feeling that these computing devices were only for the commercial giants. To the designers and machine builders it is revealing a much clearer picture of commercial requirements which has already resulted in machines of the Speed-Tally type better matched to the unit control problem.
Figure 1. Simplified Block Diagram of the Remington Rand Speed Tally System

Fig. 2. General view of the Remington Rand Speed Tally System

Fig. 3. Keyboard unit

Fig. 4. Output printer and control tape unit
Fig. 5. Sample control and output tapes

Fig. 6. Front view of Speed Tally Central Equipment

Fig. 7. Rear view of Speed Tally Central Equipment
Figure 8. Principles of Speed Tally Locating System