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Technical Report No. 6

A TRIADIC DECIMAL DIGIT PRINTER - READER UNIT

PRELIMINARY DESIGN CONSIDERATIONS

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This is one of a series of papers describing the progress of a program in Informatic Data Research at the University of Wyoming. The purpose of this program is to investigate and to develop means of utilizing new types of data processing and informatic data portrayals in order to obtain more rapid means of automatic recording and reading while retaining manually recognizable characteristics, and to yield recordings of large amounts of numerical data which have superior "quick look" or qualitative interpretation characteristics.

The work described in this report has been accomplished largely under the sponsorship of the National Aeronautics and Space Administration, Grant No. NsG 658. A companion report, "An Initial Use Test of Triadic Decimal Digits" by Richard J. Jiacoletti and Donald L. Veal describes these newly conceived "TRIADIC" decimal digits and presents an initial use-test of them for portraying orbital position data.

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PRELIMINARY DESIGN CONSIDERATIONS

BRIEF

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PRELIMINARY DESIGN CONSIDERATIONS

1. Introduction

Until recently, the manner in which a numeral was written was specifically related to the ease with which a man could read or, especially write that numeral. At present, virtually all numerical operations can be performed entirely automatically and, until the end result is obtained, man need not observe or monitor the operation. Therefore, it would seem feasible that a new form of numerals might be developed which would provide for improved automatic read-write capabilities for automatic data processing, and in addition would retain easily recognizable characteristics for manual reading.

As a part of the Informatic Data Research program presently in progress at the University of Wyoming, work has been done toward developing a new "TRIADIC" form of decimal digits.[1] As opposed to the method proposed and accepted by the American Bankers Association,[2] no attempt is made to retain the classical shape of such numerals. The system utilized by the A.B.A. forces the retention of classical numeral shape at the expense of equipments for reading these numerals automatically. This extravagance can probably be justified since the general public is being directly dealt with in the banking business. However, if the equipment, and consequently the monies involved can be minimized in technical data processing operations, the proposed system should have considerable merit even though it involves the use of a now unfamiliar form of numerals.

Consequently no attempt has been made to "make a TRIADIC three look like a three" or "make a TRIADIC nine look like a nine." Rather, the forms of the TRIADIC numerals have been chosen so that they are readily formed and read with automatic equipment while still possessing readability to a person familiar with them.

Specifically, the TRIADIC DECIMAL DIGITS illustrated in Figure 1 have been selected as fulfilling the requirements of automatic read-write capabilities along with manual reading characteristics. Although these digits appear very strange at first glance, an individual with a minor amount of experience can readily recognize the Triadic equivalent of the classic Arabic digit.

The characteristics of the Triadic digits, any combination of which can be employed to read and write these digits, either automatically or manually, are as follows:

<u>For Recording</u>.

1. If n is an even number, the top of the digit is single width. If n is an odd number, the top of the digit is double width.
2. If $n < 5$, the bottom of the digit is single width. If $n \geq 5$, the bottom of the digit is double width.
3. If $n < 5$, there are n <u>changes</u> in width of the digit, or there are n <u>internal</u> steps on the left side of the digit. If $n \geq 5$, there are n-5 <u>changes</u> in width of the digit, or there are n-5 <u>internal</u> steps on the left side of the digit.
4. The Triadic digit can be considered as being made up of two traces with the right hand trace being on for five steps and the left trace being turned on and off for a period of five steps. If $n < 5$, then in 5-n steps, starting at the bottom of the digit, the left trace begins to alternate on-off-on-off etc. If $n \geq 5$, then in 10-n steps, starting at the bottom of the digit, the left trace begins to alternate on-off, etc.

<u>For Reading</u>.

1. If $n < 5$, n is equal to the total number of width changes (including the changes from and to zero width) minus two, or n is equal to the number of <u>internal</u> changes in width of the character being read.

TRIADIC DECIMAL DIGITS

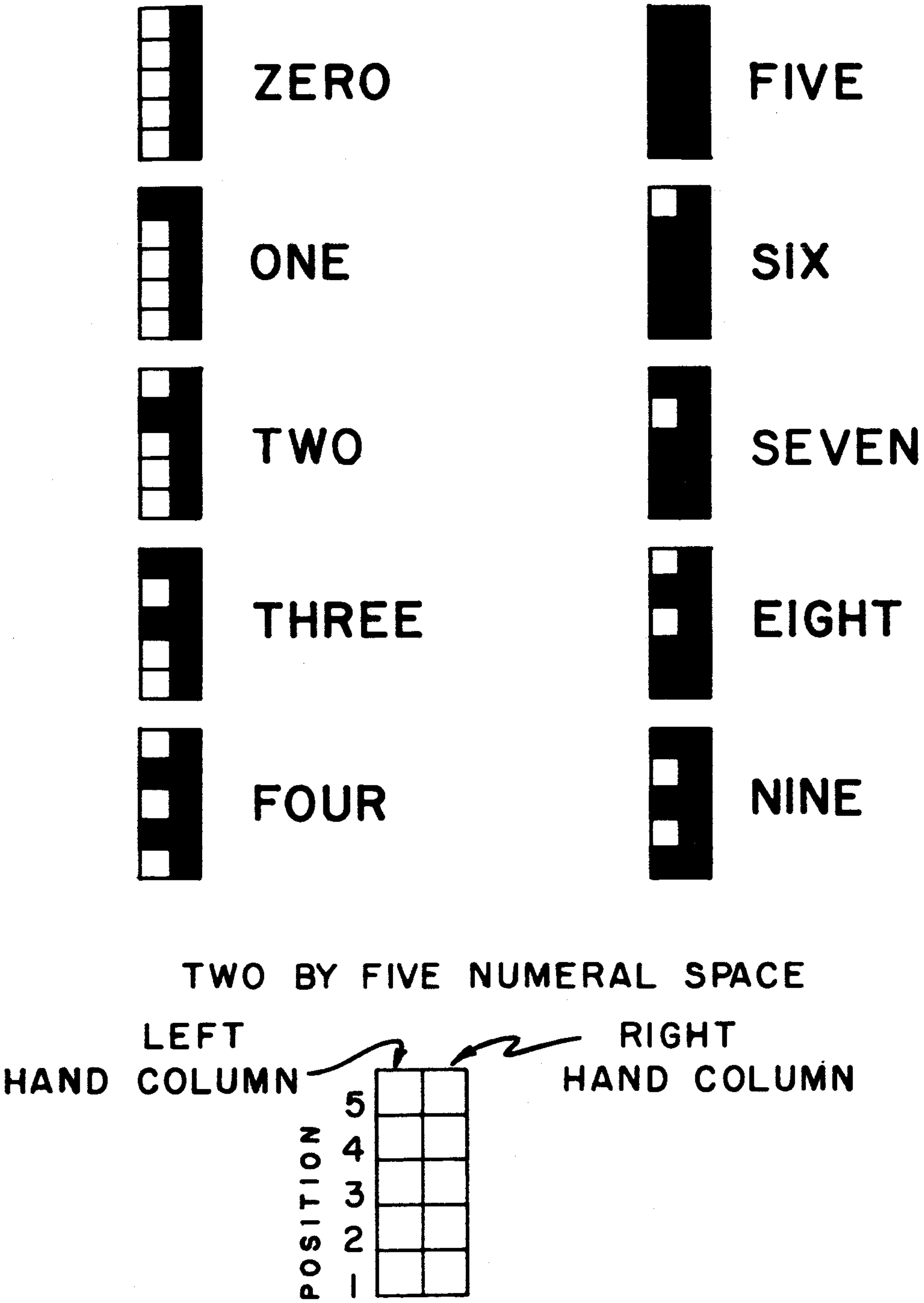

FIGURE 1

2. If $n \geq 5$, n is equal to the total number of width changes minus two plus five, or n is equal to the number of <u>internal</u> width changes plus five.

3. $n < 5$ if two or less of the five steps are of double width and $n \geq 5$ if more than two of the five steps are of double width.

4. $n < 5$ if the bottom step is of single width and $n \geq 5$ if the bottom step is of double width.

5. n is even if the top step is of single width and n is odd if the top step is of double width.

2. <u>Reader</u>

The proposed reader configuration is shown in Figure 2. A photo-transistor or photo-diode is used as the photo-reader, P.R. in Figure 3, and scans the line being read. The photo-reader will see either an all black area, a half black-half white area, or an all white area, as illustrated in Figure 3. Hence, the output of the photo-reader will have three distinct levels, corresponding to the absence or presence of a numeral under the photo-reader as well as the difference between a single width numeral (right side only) and a double width numeral. Two Schmitt trigger circuits, ST-1 and ST-2 in Figure 2, are set to trigger at levels corresponding to the two possible outputs from the photo-reader when scanning a numeral. ST-1 is set to trigger when the reader sees a single width numeral and ST-2 is set to trigger on a double width numeral. The inverting amplifier raises the output of the photo-reader to drive the Schmitt trigger circuits as well as to invert the signal so that the output for a double width is larger than the output for a single width.

By reading the numerals in the direction indicated in Figure 3, a decision as to the magnitude of the number with respect to five may easily be made, i.e. $n < 5$ or $n \geq 5$. If the photo-reader sees a single width first, $n < 5$ and if the photo-reader sees a double width first, $n \geq 5$. The two term "and" gates, G_1 and G_2, are qualified by $1\cdot\bar{2}$ and $1\cdot 2$ respectively, where 1 and 2 correspond to the outputs of ST-1 and ST-2. Therefore an output from G_1 corresponds to the situation where $n < 5$ and an output from G_2

READER
BLOCK DIAGRAM

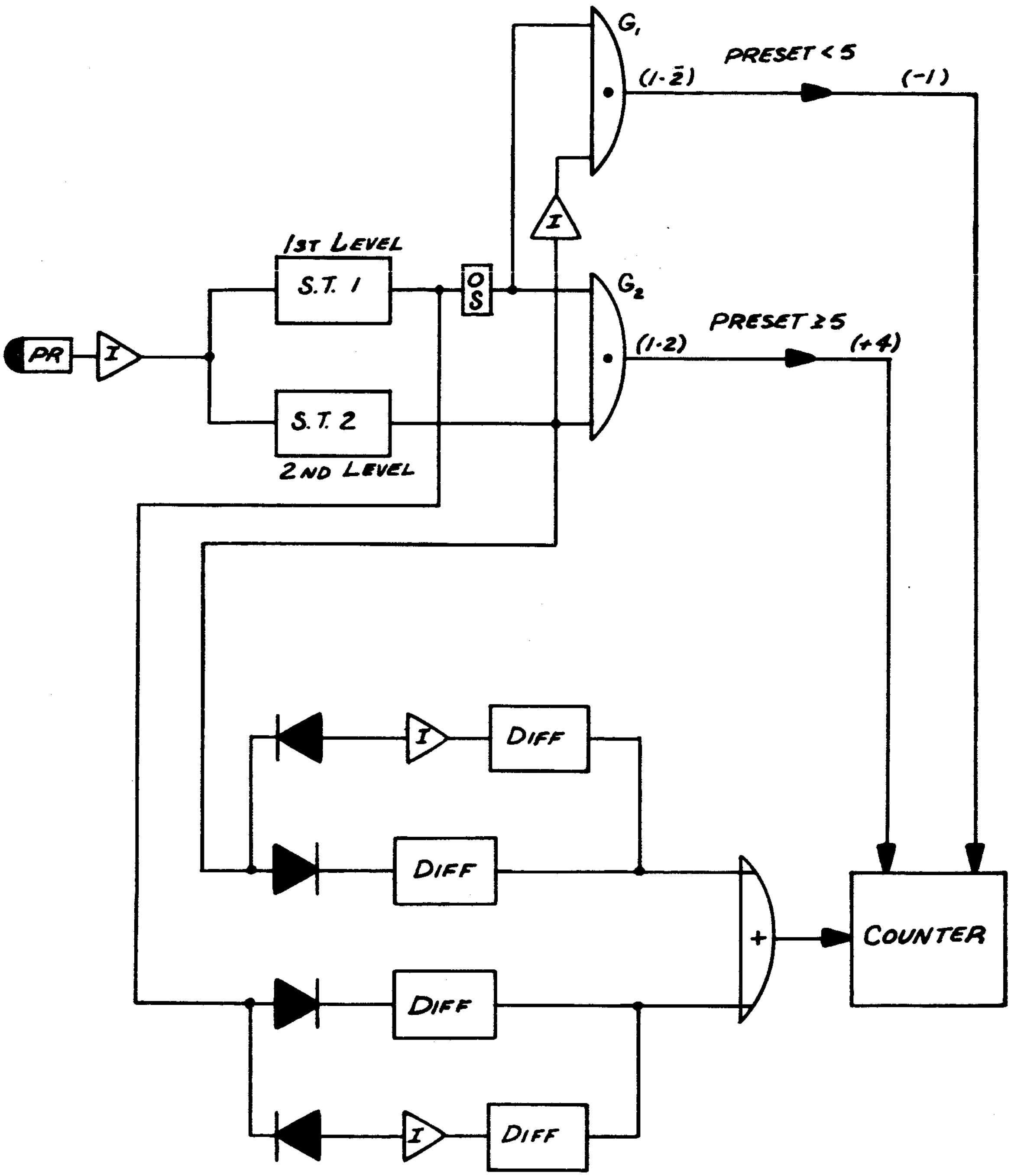

FIGURE 2

METHOD OF READING A TRIADIC RECORDING

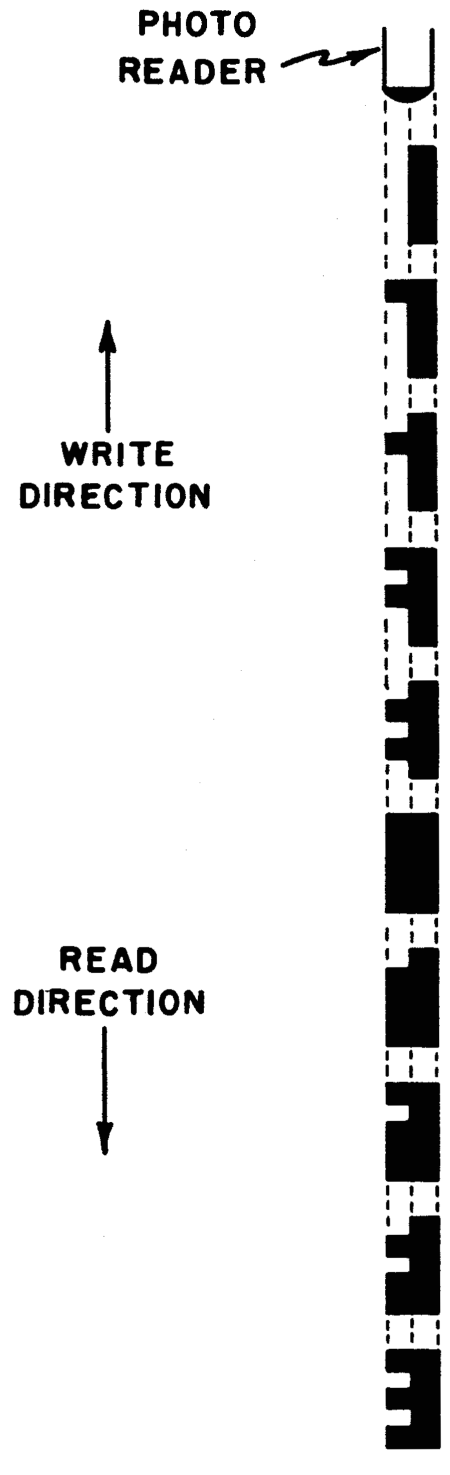

FIGURE 3

corresponds to the situation where $n \geq 5$. The outputs from G_1 and G_2 may then be used to preset the counter for the $n < 5$ and $n \geq 5$ conditions.

The preset counter conditions depend entirely on the means employed to determine the actual number being read. That is, if the first change in width to be seen (actually the occurrence of the number being read) is to be used to make the $n < 5$ or $n \geq 5$ decision and to preset the counter, the number is then equal to the succeeding number of changes in width minus one. Therefore, if the BCD counter is preset to -1 (actually 15) for $n < 5$, and preset to 4 for $n \geq 5$, the minus one operation is automatically accomplished. If all changes in width, occurring after the initial appearance of the number, are then fed into the counter, the counter will contain the actual numerical value of the Triadic numeral at the end of each reading operation. The diodes, inverters and differentiators shown in Figure 2 are used to steer the appropriate polarity pulses into a two term "or" gate, G_3, with the output of G_3 used as the input to the counter. The one-shot multivibrator, indicated as OS in Figure 2, is used to insure that the preset signal will last longer and hence predominate over the first input to the counter. This first input, occurring with the appearance of the numeral under the photo-reader, would most likely be counted if the preset signal were not lengthened in order to make it the dominant signal.

3. Printer

The proposed printer configuration is shown in Figure 4. Clock pulses are indicated as being generated by TACOS, the Tabular Converter System,[3] because of proposed usage in conjunction with that system. Clock pulses could also be generated and supplied from any other source.

It is assumed that the data to be printed out in Triadic digits is available as BCD data which is loaded in parallel into the counter in Figure 4. The first decision to be made is to determine if the number is greater than or less than five. If $n \geq 5$ at least one of the inputs to G_3, a three term "or" gate, will be qualified, thereby setting the false side of the flip-flop, $\bar{Q}$, high. If $n < 5$ there is no output from G_3, thereby leaving the flip-flop in its true or reset state with Q high.

PRINTER
BLOCK DIAGRAM

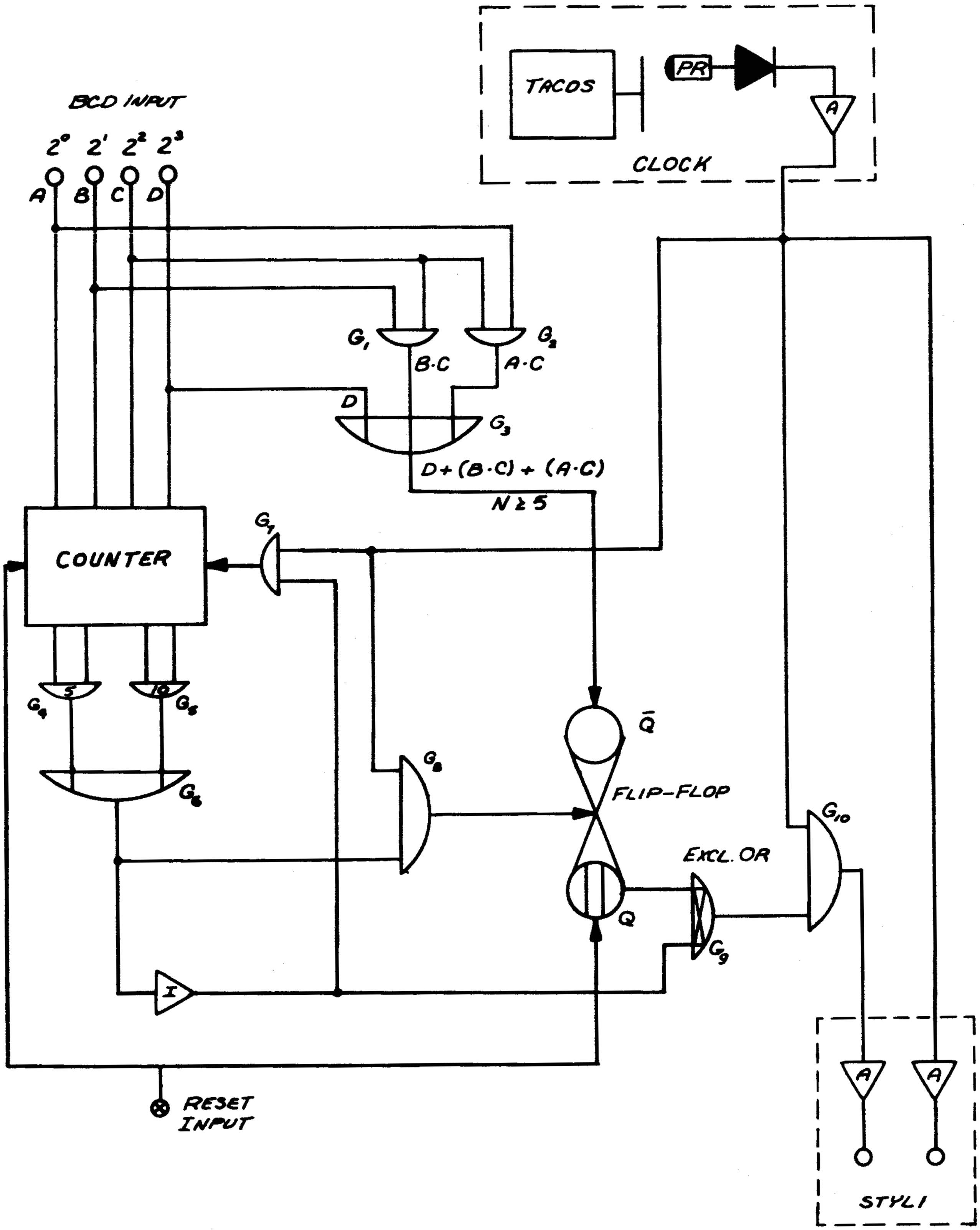

FIGURE 4

Immediately after a number is loaded into the counter, a two input "and" gate, G_7, is periodically qualified by the inverted output of G_6 and the clock signal. Thus, the counter counts up in correspondence with the incoming clock signal. If the input number were less than five, the counter counts up until it reaches five, at which time gate G_4 is qualified, and the output of G_6 goes high, thereby disqualifying G_7. If the input number were equal to or greater than five, the counter counts to ten, at which time gate G_5 is qualified thereby disqualifying G_7. Thus, when the counter reaches either five or ten, input to the counter is stopped. Also at this time, gate G_8 is periodically qualified by the output of G_6 and the clock signal, thereby causing the flip-flop to change state in accordance with the clock signal. Since the inverted output of G_6 is low at this time, anytime the Q side of the flip-flop is high, the exclusive "or" gate G_9 is qualified, thereby qualifying G_{10} in accordance with the clock signal. The output to the left stylus is thus alternately switched on-off-on etc. in accordance with the change of state of the flip-flop.

If the input number is less than five, the inverted output of G_6 as well as the Q side of the flip-flop are high during the counting procedure. The output of the exclusive "or" gate G_9 is thus low and the print out is of single width during the counting period. It then alternates between single width and double width after the counter reaches the five condition. If the input number is greater than five, the $\bar{Q}$ side of the flip-flop is high, thereby removing one input to G_9, qualifying G_{10}, and yielding a print out of double width which then alternates in width after the counter reaches the ten condition.

It is seen that the clock signal must be a train of five pulses, occurring repeatedly throughout the operation. After a five pulse sequence, a reset signal is applied to the Reset Input in Figure 4, resetting the counter to zero and setting the Q side of the flip-flop high. The printer is then ready to receive the next BCD input.

4. Conclusions

The printer-reader unit proposed in this report was designed to employ the simplest and most reliable characteristics of the newly proposed Triadic decimal digits. Although design has not yet been reduced to a working model, it is felt that it represents an economical and reliable means of reading and recording Triadic numerals and performing the accompanying Triadic to BCD and BCD to Triadic conversions.

REFERENCES

1. "An Initial Use-Test of Triadic Decimal Digits," Richard J. Jiacoletti and Donald L. Veal, Natural Resources Research Institute, University of Wyoming, Information Circular No. 30, December 1965, 13 pp.

2. "The Common Machine Language" Bank Management Committee, The American Bankers Association.

3. "1965 Status of TACOS, An Experimental Tabular Computing System," C. N. Rhodine, Natural Resources Research Institute, University of Wyoming, Information Circular No. 29, December 1965.