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Implementation of a Microprocessor Based Accounting System for Agricultural Uses

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IMPLEMENTATION OF A MICROPROCESSOR BASED
ACCOUNTING SYSTEM FOR AGRICULTURAL USES

BY

HERBERT R. ALLEN, DUANE SANDER AND
JAMES BEALS

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TABLE OF CONTENTS

	<u>PAGE</u>
SUMMARY AND CONCLUSIONS	1
SITUATION AND OBJECTIVES	2
METHOD AND PROCEDURE	2
MICROCOMPUTER DESIGN	3
The Microcomputer	3
External Devices	7
Programming	8
CASH FLOW ACCOUNTING PROGRAM	9
Program Commands	10
List Options	12
Entering Data	13
Data Retrieval	15
RESEARCH RESULTS	17
Hardware	17
Software	17
CONCLUSIONS AND RECOMMENDATIONS	18
BIBLIOGRAPHY	20
APPENDIX	21

LIST OF TABLES

<u>TABLE NO.</u>		<u>PAGE</u>
1	CODING GUIDE	11
2	FORMAT FOR INCOME AND EXPENSE ENTRIES .	14

SUMMARY AND CONCLUSIONS

This study has demonstrated the feasibility of using microcomputers on the farm or in the home to solve problems involving manipulation of large quantities of data or detailed mathematical procedures. A microcomputer with at least 32,000 words of memory and magnetic disk storage is recommended for efficient data processing. This capacity is required for programs of the type presented in this publication. A printer with at least an 80 character line is an essential feature. It is frequently necessary to have hard copy printouts of financial statements or cash flows in order to document the farm financial position. Programs may be prepared to serve this purpose if a printer is available. Without the printer, it is necessary to prepare documents from data viewed on a video screen. Other important features to consider in a microcomputer system include the capability for expansion and hardware compatibility with larger computer systems.

Additional work is needed to develop software that is necessary in order to make the microcomputer a useful tool. Some farmers are beginning to purchase microcomputers being produced commercially. As these farmers grow in numbers, there will be an increasing demand for programs to meet their needs.

IMPLEMENTATION OF A MICROCOMPUTER BASED ACCOUNTING SYSTEM FOR AGRICULTURAL USES

by

Herbert R. Allen, Duane E. Sander and James Beals*

Situation and Objectives

Microcomputers are fast becoming an important tool in many areas of business. Technological developments have made the capabilities of a large computer available in small compact units adaptable to the home and the farm. Such units are now available with a wide range of capabilities.

The Electrical Engineering Department and the Economics Department at South Dakota State University conducted a cooperative research project for the purpose of designing and studying the requirements for a microcomputer based system that would be functional and economical as a farm or ranch business management tool. The development of software for the microcomputer, which would be useful in farm financial management, was also an important objective.

Method and Procedure

A prototype system comprised of a Southwest Technical Products Company microcomputer (SWTP6800 series) was built as a kit. The unit was initially set up with 16,000 bytes of memory, a 40 column printer, a TV terminal and a cassette recorder. The TV terminal was used to control and program the microcomputer, view data, and present input data to the computer. The printer was used to print data or results on paper. The cassette recorder was used to store programs and data before the system is turned off.

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Cash flow accounting was determined to be an area of need most appropriate to the capabilities of a microcomputer. A cash flow accounting system was developed as a program for testing the functional requirements of a microcomputer system.

Microcomputer Design

In order to understand the computer and what it does, it is important to know some of the terminology and general makeup of a microcomputer system. A schematic diagram of such a system is presented in Figure 1.

The Microcomputer

The microcomputer is a portion of the total system. It is made up of devices referred to as the microprocessor, memory, timing circuits and interface circuits as shown in Figure 2. The microprocessor is where all the "action" takes place. It receives data, performs mathematical operations and routes the data to memory or to external devices such as terminals, printers or disks.

A very important part of the microcomputer is the memory. This is used to store data and programs. The memories are also divided into Read Only Memories (ROM) and Random Access Memories (RAM). The ROM can only be read from and its contents cannot be altered. Data is permanently "burned" into the ROM and does not disappear when power is turned off. The RAM can be read from or data can be written into it. Programs being written and subject to change may be put in RAM. The RAM differs from ROM in that if power is turned off, it loses all of its data. Programs that are used many times or have to operate after a power failure are put in ROM. RAM is used as a "scratch pad" for calculations.

The size or capability of a computer to manipulate and store data is frequently associated with the amount of storage space in the memory of the

Figure 1. MICROCOMPUTER SYSTEM

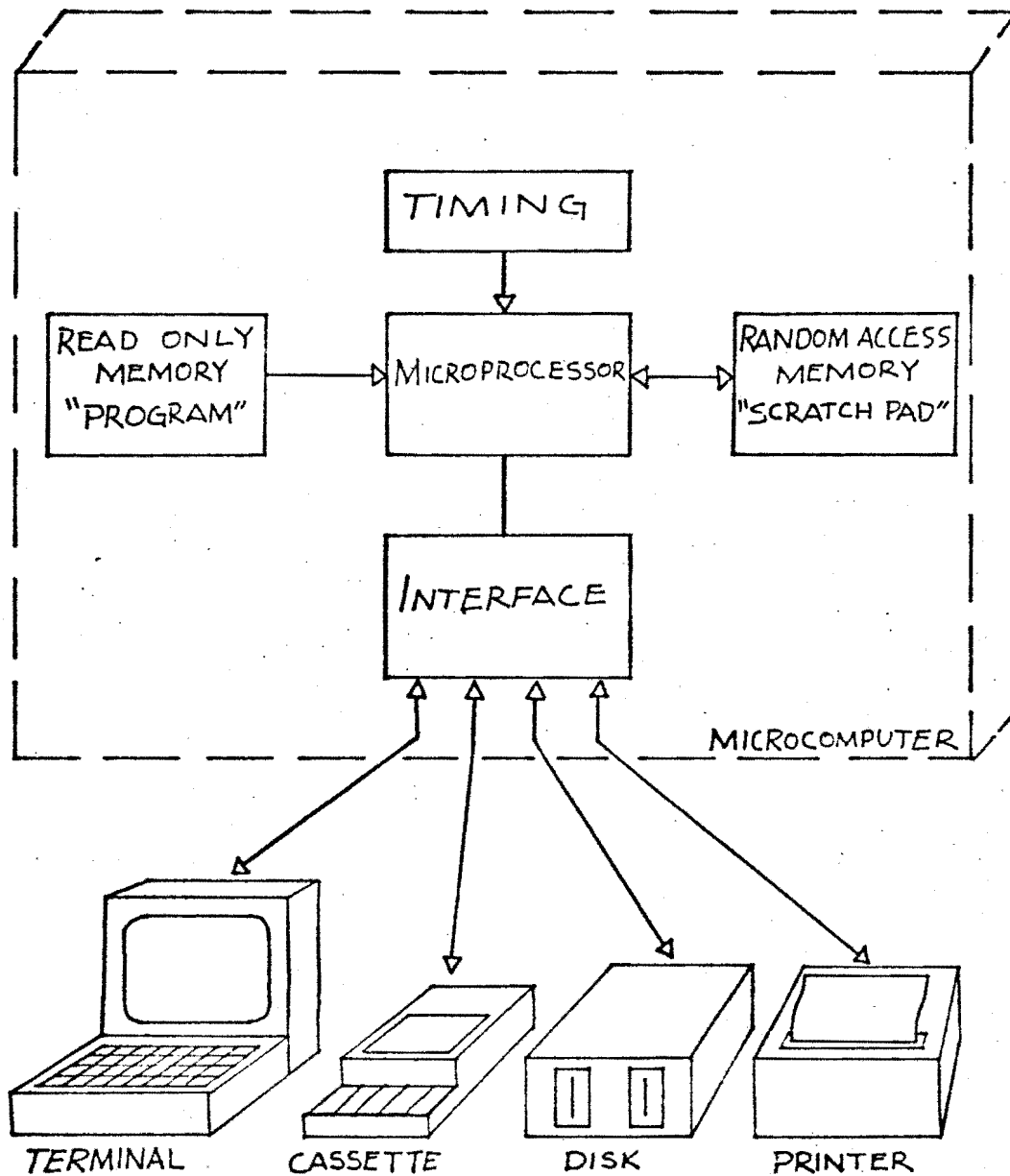
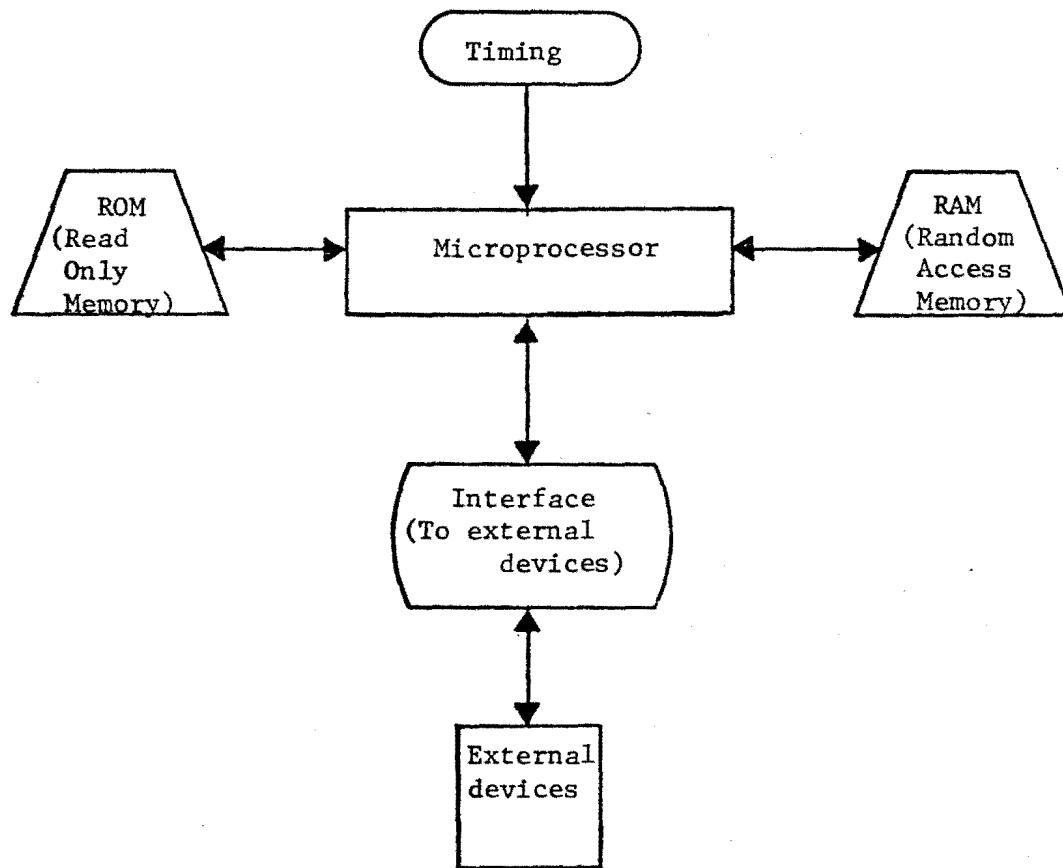


Figure 2. Microcomputer



computer. This storage space is often specified or measured by the number of "bytes" it contains. The terms "byte" and "word" are often used interchangeably and should be defined carefully.

First, it is important to understand how a memory works. Some memories work on a magnetic principle. A small doughnut shaped magnetic "core" is used to store a "true" or "false" or a corresponding "1" or "0" in each core of the memory. A single core, or binary unit, is called a bit. These cores have the property of remaining magnetized in one direction or the other after all power has been removed. A core magnetized in one direction may represent a "1". If it is magnetized in the opposite direction it may represent "0". A core can be "read" by sensing the direction of the magnetization. These "bits" can be organized into associated strings to represent numbers, or letters of the alphabet. For instance, the letter A might be represented by a string of 8 bits such as 11000001. A string of 8 bits is usually referred to as a "byte". If all of the different combinations of 8 "1's" and "0's" were tabulated, there would be 256 (2^8) different codes available to represent numbers, letters, etc.

The above discussion was centered around a magnetic memory. However, most microprocessor memories are not magnetic, but use an electronic circuit to replace the magnetic core. By measuring a voltage on this circuit, a "1" or a "0" may be read as +5 volts or 0 volts respectively.

A "word" in memory refers to the data stored at each memory location. Most microprocessor systems either store 8 bits or 16 bits at each memory location. Since 8 bits, or one "byte" is the most common memory location size at this time it is common practice to use the terms "byte" and "word" interchangeably. Thus, a 16,000 "word" memory can be made up of 16,000, 8-bit "words" or 16,000 "bytes". A computer with 16,000 bytes of storage space

would be able to store 16,000 characters of data. The letter K is used to represent the Roman numeral for 1,000 and hence this is commonly referred to as 16K bytes or words of storage capacity.

The size of a word also varies by type of computer. Suppose a computer word will hold 4 characters. This requires 4 bytes or 32 bits. The IBM 360/370 uses a 32-bit word while the IBM 1130 uses a 16-bit word. The prototype microcomputer built for use in this research study uses an 8-bit word; therefore, in this case, a word equals a byte and 32K bytes of storage capacity is equivalent to 32K words of capacity. However, if a 16-bit word could be stored in each location of memory, a storage capacity of 16K words would be equivalent to 32K bytes of storage space. Currently, most microcomputers use a word size which is equivalent to one byte. However, many manufacturers are either producing or considering the production of 16-bit microcomputer systems.

The timing circuits coordinate various parts of the system so that data and command signals are transferred from one device to another in an orderly and understandable way.

Interface circuits provide the linkage between external devices and the various parts of the microcomputer block. These circuits monitor the external devices and coordinate data transfer to or from the device. For instance, the computer is much faster than a printer and therefore must wait between each character until the printer is ready before it sends more data to it.

External Devices

The most common external devices consist of a terminal, cassette recorder, disk memory and printer. These devices must be compatible with the microcomputer and must be purchased with the correct scheme for interconnection to the microcomputer being employed.

Terminals, can be either a cathode ray tube (CRT) with a typewriter keyboard, a teletype unit, or a simple typewriter. The CRT unit is popular, since it is fast, errors are easily corrected before sending messages to the microcomputer and no paper is used. Many situations may not need documentation, such as initial programming, where errors are made and erased often.

When documentation is necessary, a printer can be attached. This can be used to print programs, financial statements, letters, bills, checks, receipts, orders, inventory lists, etc. Some considerations regarding printers include sprocket paper feeds to prevent paper slippage when printing on forms, thermal paper or regular paper requirements, size of forms to be printed, type of characters available, etc.

Long term data storage or memory is usually in the form of an audio cassette or a magnetic disk. The common cassette is the least expensive, however, it is very slow in terms of data transfer time. If a person is using programs generated by someone else, this is a good method of data and program storage. However, it may take 5 - 10 minutes to load a program from tape, or store data on tape. If it is necessary to do this very often in a work session, it becomes tedious and frustrating. The magnetic disk reduces this problem with fast data transfer, however, cost is a factor. Disk units may cost from \$1,000.00 to \$2,500.00, whereas a cassette unit may cost from \$50 to \$500. Disks are usually used where large programs and large amounts of data are frequently transferred back and forth. This occurs when the user works with useful accounting, inventory, cost analysis, and payroll programs or when the user is programming.

Programming

In order to make the computer useful to a person it must first be

programmed to do a desired task.

The program is usually a step by step set of detailed instructions telling the computer what to do with data it has been given. The computer may be programmed to read a line of type which specifies quantity, item description, cost, etc., and manipulate the data so as to establish a set of accounts.

This programming may be done by someone else, who sells programs, or may be done by the computer owner. It usually requires considerable time and effort to develop a worthwhile program. The time required to develop a program can range from hours to months. Therefore, many computer companies provide programs which do specific tasks. Some examples are, accounting, inventory, etc. These programs must be purchased and may or may not conform to the methods of accounting, inventory, etc. that is desired. Some programs can be modified to accommodate different business situations, but others may not be easily modified. Modifications usually require some advanced programming knowledge and do take considerable time to complete.

Cash Flow Accounting Program

Introduction

This program has been written in a communicative format and enables the user to make entries by responding to computer commands. Each expense entry is coded with a number to identify the type of expense plus an enterprise number to identify the enterprise to which this expense item should be charged. Each cash income item is also coded with an income code number and an enterprise code number. Code numbers for this purpose are given in Table 1.

When the program has been entered into computer memory, the computer responds with the "READY" and "#" sign. The operator types "RUN" and presses

the carriage return. The computer will respond by asking the operator if he wishes to see a list of commands. The operator responds by typing YES or NO.

Program Commands

Commands are entered as requested by the computer. Four commands employed in this program are LIST, ENTER, BALANCE and DONE.

The LIST command instructs the computer to output a list of all the entries currently on file in the computer. This command is used when we wish to check our recent entries for accuracy or when we wish to retrieve information from the file. There are a number of options as to the kind of listing that may be requested.

Table 1. CODING GUIDE

<u>CASH EXPENSES</u>	<u>CASH INCOME</u>	<u>ENTERPRISES</u>
2010 Labor hired	1010 Eggs sold	0 Undistributed
<u>Crop Costs</u>	1020 Dairy products sold	100 <u>Grain Crops (dryland)</u>
2021 Seeds & plants	<u>Raised Livestock Sold</u>	101 Corn
2022 Crop insurance	1030 Breeding stock	102 Oats
2023 Irrigation water	1035 Market livestock	103 Spring Wheat
2024 Fertilizer	1154 Livestock being depreciated	104 Winter Wheat
2025 Weed spray		105 Grain Sorghum
2026 Pesticides	<u>Purchased Livestock Sold</u>	106 Feed Barley
2030 Gas, fuel & oil	1040 Breeding stock	107 Malting Barley
2040 Machine work hired	1045 Market livestock	108 Flax
2050 Machine repairs	1154 Livestock being depreciated	109 Soybeans
2060 Freight & trucking	1049 Wool sold	110 Sunflowers
2070 Auto expense	1050 Crops sold	111 Winter Rye
2080 Telephone & electricity	1060 Honey, syrup & sugar	150 <u>Irrigated Grain Crops</u>
2090 Farm supplies	1070 Other produce sold	151 Corn
2100 Livestock expenses	1080 Machine work for others	152 Oats
2110 Other farm expenses	1090 Breeding fees collected	153 Spring Wheat
2120 Building repairs	1100 Wood & lumber sold	154 Winter Wheat
2130 Insurance premiums	1110 Other forest products	155 Grain Sorghum
<u>Taxes</u>	1120 Dividends and refunds	156 Feed Barley
2141 Land taxes	1130 Government payments	157 Malting Barley
2142 Farm property taxes	1140 Other farm income	158 Flax
2143 Sales taxes	<u>Capital Items Sold</u>	159 Soybeans
2150 Interest paid	1151 Machinery sold	160 Sunflowers
2160 Rent	1152 Auto sold (farm share)	161 Winter Rye
2170 Feed purchased	1153 Building & improvements	200 <u>Forage Crops (dryland)</u>
2180 Livestock & poultry purchased	1154 Livestock being depreciated	201 Hay Crops
<u>Capital Items Purchased</u>	1155 Land sold	216 Pasture Crops
2191 Machinery	Insurance on casualty losses	231 Silage Crops
2192 Auto (farm share)	entered as a sale under the	241 Seed Crops
2193 Building & improvements	appropriate item sold	250 <u>Irrigated Forage Crops</u>
2194 Livestock to be depreciated	1160 Loans received	251 Hay Crops
2195 Land purchased	1170 Contributions	266 Pasture Crops
2200 Loan principle payments	1180 Non-farm income	281 Silage Crops
		291 Seed Crops
		300 Poultry
		400 Dairy
		500 Hogs
		600 Beef Cows
		700 Cattle Feeding
		800 Sheep
		900 Horses
		950 Other

List Options

The "list" options are employed by entering the option name when requested by the computer. The request will appear as "OPTION?" and the operator response will be to type one of the following option names.

<u>Option Name</u>	<u>Description</u>
TODAY	This will provide a list of all the current entries into the computer. This option is usually employed when checking the entries for error in data entry.
NAME	All entries with the same description will be listed.
CODE	All entries with the same expense or income code number will be listed. We may identify the code number desired.
DATE	This will list all entries on a specified date.
ENTERPRISE	All entries with the same enterprise code may be listed.
BALANCE	This option will list the cash flow for all entries on file. It will output the total credits and total debits by date, code, enterprise or for all entries in total. When the BALANCE option is selected the computer will respond by asking for DESCRIPTION? The operator must then identify the type of cash flow desired. This is done by typing DATE, CODE, ENTERPRISE or TOTAL.
PRINTER	List output on the printer.
TV	List output on the TV screen.

<u>Option Name</u>	<u>Description</u>
CHANGE	This permits the operator to select an entry for the purpose of making a change.
RETURN	This returns the operator to the COMMAND mode and the operator may proceed by entering one of the commands.

Entering Data

The "enter" command is employed when entering data. The format for income and expense data is given in Table 2 for an example set of data. The following is an example procedure for entering the transaction for cows sold. After each entry has been made into the computer it must be followed by a carriage return. A question mark following a computer response indicates that the operator is being asked to make an input.

<u>Operator Entry</u>	<u>Computer Response</u>	<u>Comment</u>
ENTER	THE DATA WILL NOW BE ENTERED WITH THE FOLLOWING FORMAT DESCRIPTION DATE AMOUNT ENTERPRISE "#?"	The "#?" is a page prompt, the computer is waiting for a carriage return.
Press Carriage Return	ENTER TODAYS DATE (MM/DD/YY)?	Enter month, day and year separated by /
2/28/80	DESCRIPTION?	The description may be a maximum of 16 characters long, including spaces.
COWS SOLD	DATE?	Enter month and day of transaction
06/04	AMOUNT?	
835.41	CODE?	
1030	ENTERPRISE?	
600	DESCRIPTION?	

Table 2. FORMAT FOR INCOME AND EXPENSE ENTRIES

Description	Date Yr.Mo.Day	Amount	Income or Expense Code No.	Enter- prise Code No.
1-17	18-23	24-33	34-37	38-40
Cows sold	79 06 04	835.41	1030	600
Hogs sold	79 05 03	61.80	1030	500
Corn sold	79 09 07	3549.15	1050	100
Oats sold	79 07 06	162.24	1050	100
Wheat sold	79 10 08	10896.41	1050	100
Cattle supplement	79 08 03	2095.00	2170	600
Protein blocks	79 07 03	32.08	2170	700
Water tank purchased	79 01 10	300.00	2193	700
Fence posts	79 01 10	186.00	2193	700
Truck repair	79 09 07	223.98	2050	0

Operator Entry

Computer Response

Comment

DONE

THE ENTRIES FOR 2/28/80
ARE; 1 COWS SOLD
06/04 835.41 1030 600
CHANGE?

When entries are completed, the operator tells the computer that he is done. The computer will output the data just entered.

1

DESCRIPTION?
DATE?
AMOUNT?
CODE?
ENTERPRISE?
CHANGE?

The computer asks if the operator wishes to change an entry. The change is made by typing in the entry number at the left of the entry.
An entry may be changed or a new entry added in the same manner as previous entries.

0

ENTER COMMAND?

A zero means no more changes. The computer is now in the command mode and operator may continue with any of the commands.

Data Retrieval

Cash flow data may be retrieved from the file with the use of the BALANCE command. This command will list the cash flow by date, code number, enterprise or total cash flow for all entries. The following procedure illustrates the input-output operations to be followed.

Operator Entry

Computer Response

Comment

LIST

LIST OF OPTIONS?

NO

OPTION?

DATE
9/07

?
1. CORN SOLD
9/07 3549.15
THIS IS ALL, A TOTAL
OF 1 ENTRIES

Input the month and day separated by /
All entries made on this date will be listed

\$?

Press Carriage
Return

OPTION?

BALANCE

DESCRIPTION?

The computer is asking for type of cash flow wanted. Enter DATE, CODE, ENTERPRISE OR TOTAL.

Operator Entry

Computer Response

Comments

DATE
9/01
9/30

PERIOD FROM?
TO?
FOR THE PERIOD
9/01 to 9/30
THE CASH FLOW IS:
CREDITS \$15,505.01
DEBITS \$ 300.00
BALANCE \$15,205.01

OPTION?

The cash flow balance is printed and the computer returns to the LIST mode and asks which option is wanted. The BALANCE option may be entered again and a listing obtained for a different date or by code, enterprise or total.

RETURN

ENTER COMMAND?

This option returns the operator to the COMMAND program.

DONE

READY

At this point the program checks to see that all data is stored and returns the program to the BASIC interpreter. RUN may be typed in with a carriage return to rerun the program.

Research Results

Hardware

In our research it was found that a microprocessor system required at least 32,000 bytes* of memory in order to run programs that were useful. It was also determined that data and program storage on a cassette was not satisfactory. This was emphasized by the time required to read large programs or large amounts of data off the cassette into the computer. These times could run up to 5 or 10 minutes. This discourages the use of main programs or different data sources. The solution to this problem was a magnetic disk data storage unit. This unit reduces the data transfer times to seconds.

An adequate system should consist of a CRT terminal with keyboard, a microcomputer with at least 32,000 words of memory, a disc memory, provision for a cassette tape memory, and a page printer. As more requirements are generated, this basic system could be expanded. Expansions might be extra memory, CRT terminals, printers or other devices to be controlled or monitored by the computer.

Software

Previous work in farm management resulted in the development of a computerized farm accounting program for use on the IBM/370 computer. This program was written in Fortran and exceeded the capacity and capabilities of the small microcomputer. However, the design of the accounting system, including sort routines, coding, etc. served as a model for a cash flow accounting system adapted to the microcomputer. The program, written in BASIC, is stored on a floppy disc and entered in the computer memory. It is important to recognize, however, that while the language in BASIC is the same for all computers, there may be variations in special commands for loading programs, prompt signals, etc., that are peculiar to the microcomputer system

being used. The procedures in this publication are those employed with the prototype system developed by researchers in electrical engineering.

Conclusions and Recommendations

The work completed to date includes fabrication of the computer system, and programming the Cash Flow farm accounting program. The system is functional at this time and should be field tested at an actual farm site.

Problems that were observed in the development of the computer system included ease of data entry, operator convenience, reliability, and finally, the usefulness of the computed results. It is anticipated that hardware reliability may be a problem and should be improved if additional system work is done.

As the present microcomputer system was designed, fabricated and programmed, a number of observations were made. These observations relate to system components which should be considered in the purchase of a system and future research which would be beneficial to the agricultural community.

The need for direction and assistance in purchase as well as program acquisition has become more evident as requests for information come in. It seems prudent to begin an effort of studying available hardware and software and compiling data for comparison and information purposes. For example, hardware data should answer questions on compatibility of a micro system with a large network such as AGNET (could the system be used as an AGNET terminal when large analysis programs are needed?) Other tasks the system may be called on to do, such as monitoring or environmental control, must also be considered.

It is evident that many people are buying systems which may be satisfactory for a small variety of tasks and do not have the capability of

expansion. The essential components of a computer system are: 1) the computer, and 2) the CRT or TV terminal. However, programming, storage and sharing of programs are all very difficult with just a computer and terminal. The next improvement would be a cassette tape deck for the storage of programs and data. In order to have useful documentation or the facility for form preparation, a good printer is essential. Finally, in order to reduce data storage and retrieval times, a disk system should be purchased. Also, hardware reliability must be considered, because, small circuit errors may occur due to loose connectors, poor circuit board designs, or electrically noisy environments. These errors may confuse a program and require reloading and restarting a program. This can be frustrating if a serious task is being done.

Software programs need to be written and data collected on appropriate software products which presently exist. It is important to know if the programs can be run on different computers. Or, if they cannot be run on a particular unit, what is involved in modifying the programs so that they will run. A clearing house and programming group may be the solution for generating or providing program information so that unnecessary duplication is reduced and needed software can be transferred quickly.

Another aspect of computer usage on the farm is oriented toward monitoring and control functions which can be done together with the accounting functions. Again, the system must be analyzed to assess the difficulty and expense involved in adopting a system to perform these tasks. This area has not been fully explored and input from Agricultural Engineering, Ag Faculty and farmers may be a first step in assessing the many opportunities which exist.

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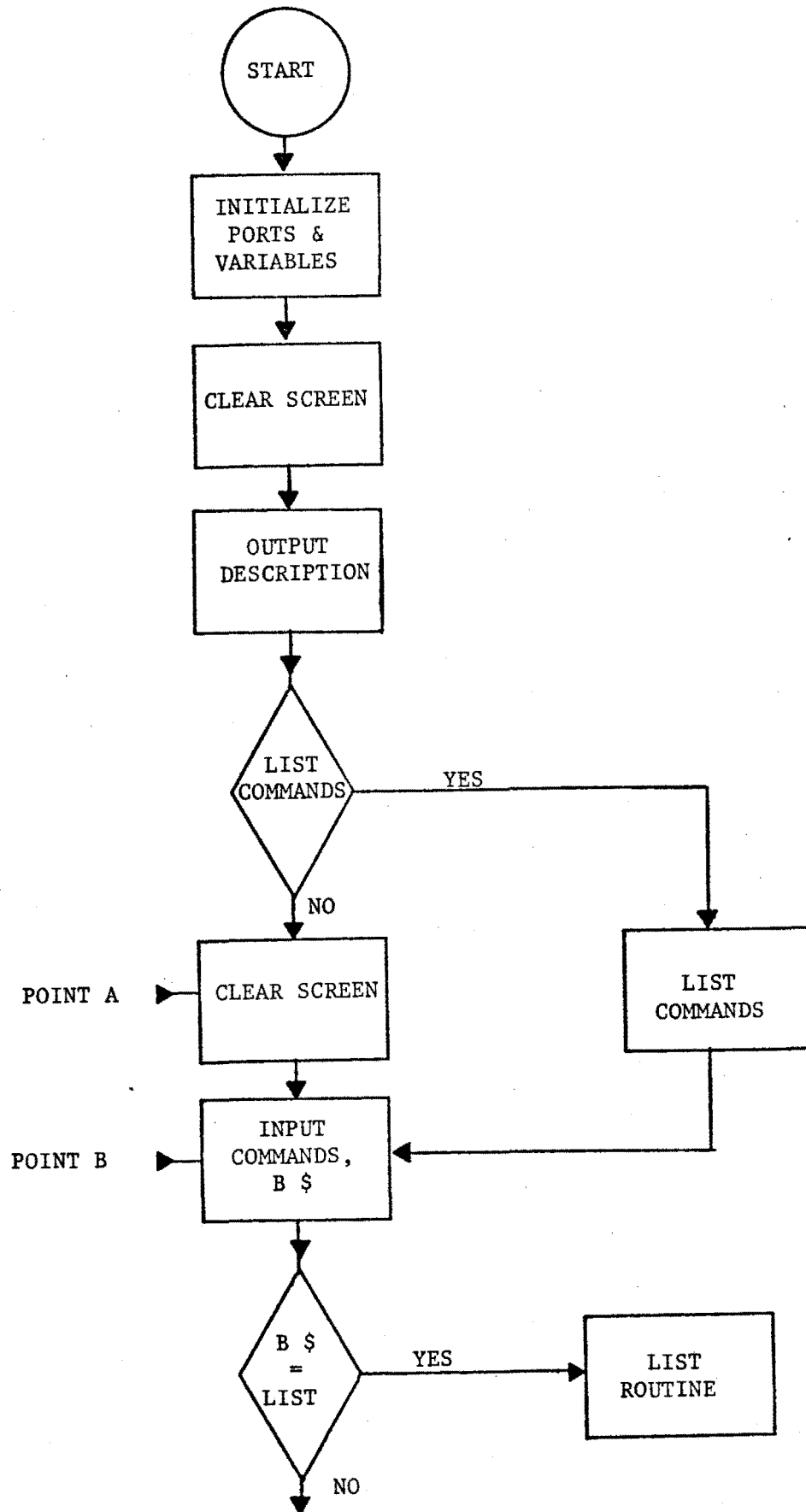
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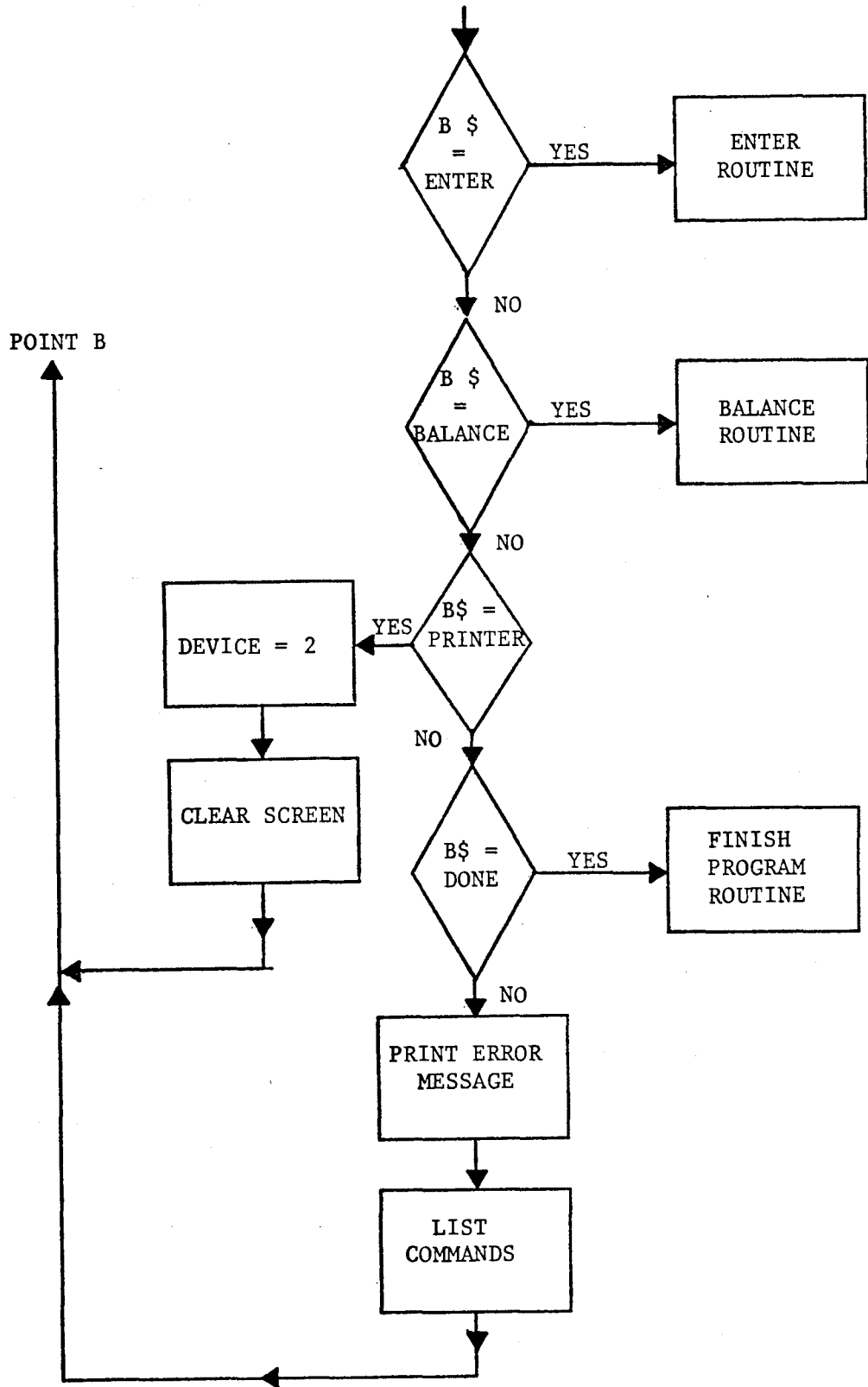
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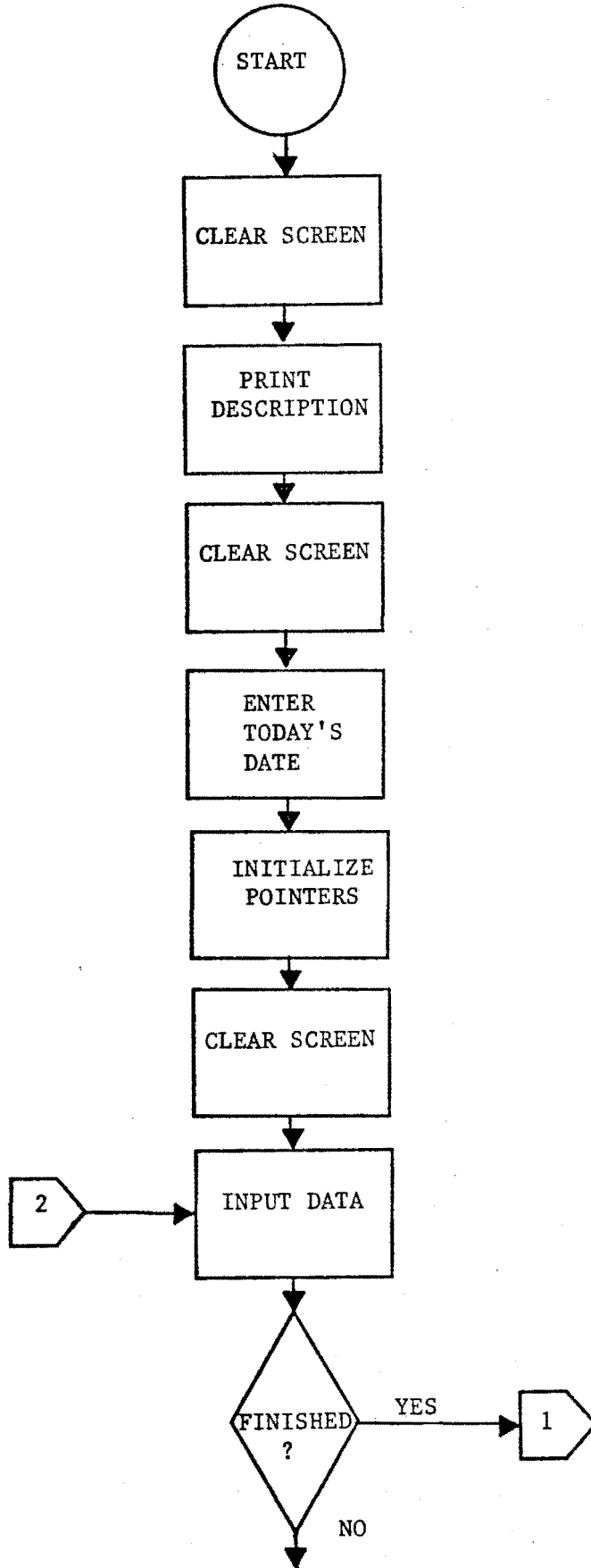
APPENDIX

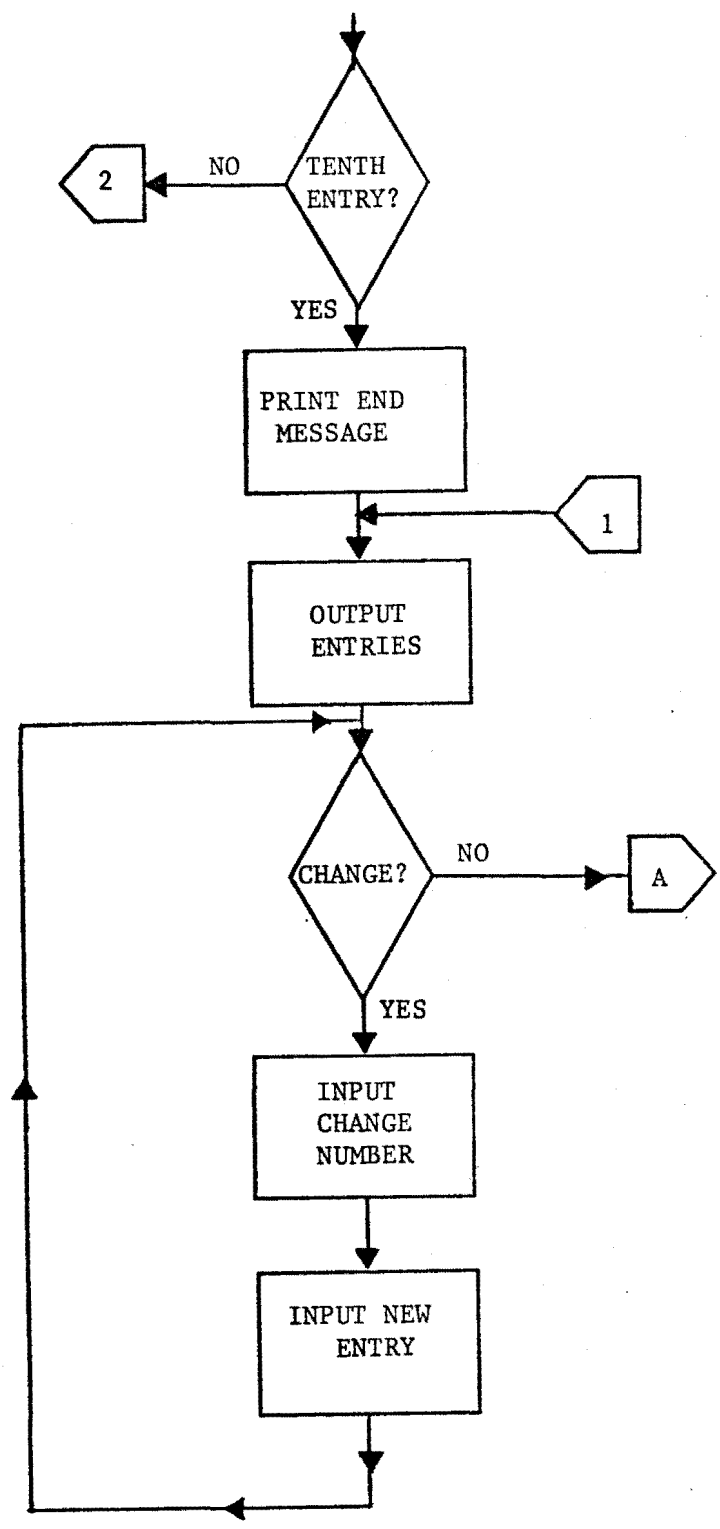
MAIN PROGRAM



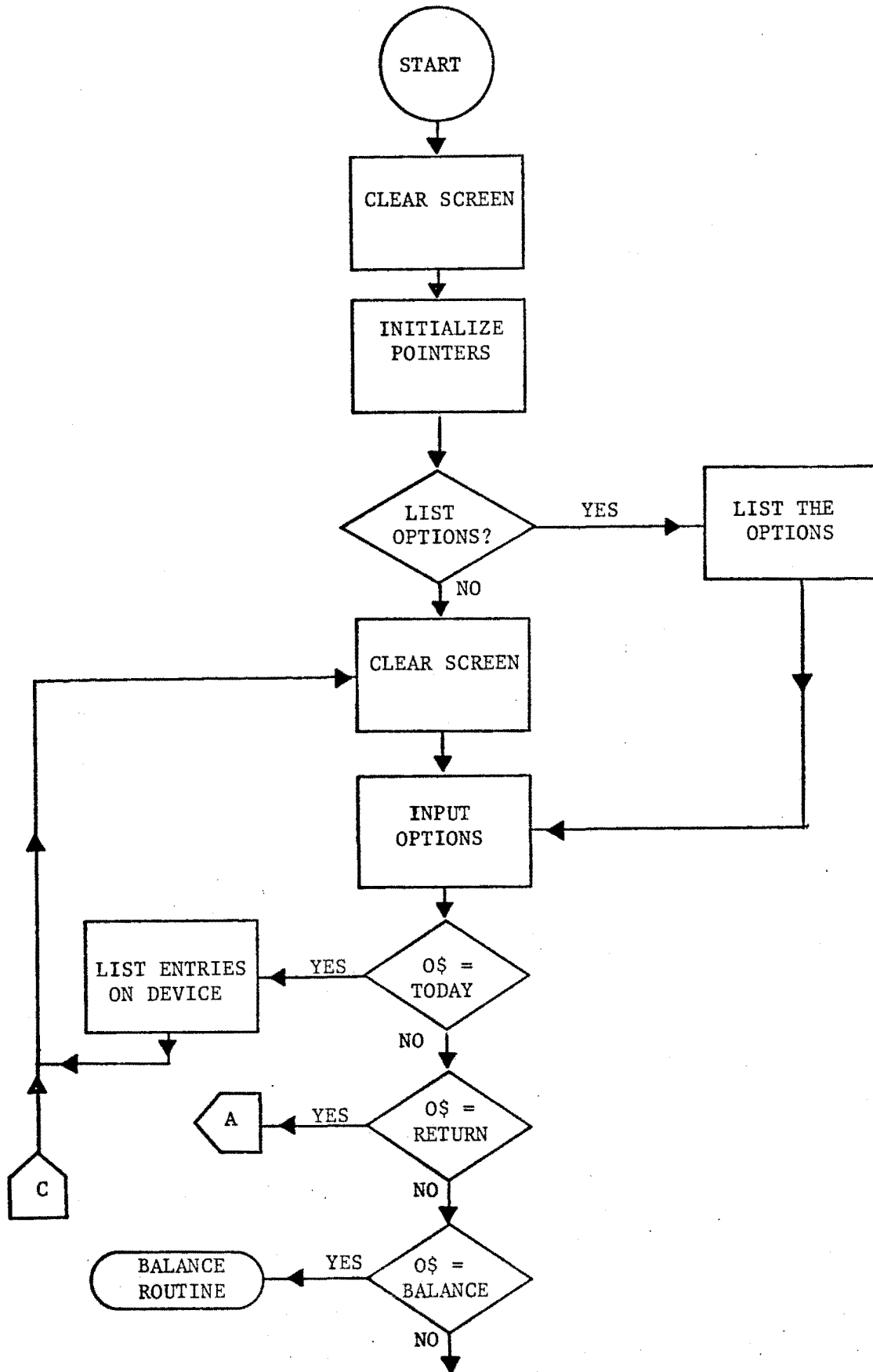


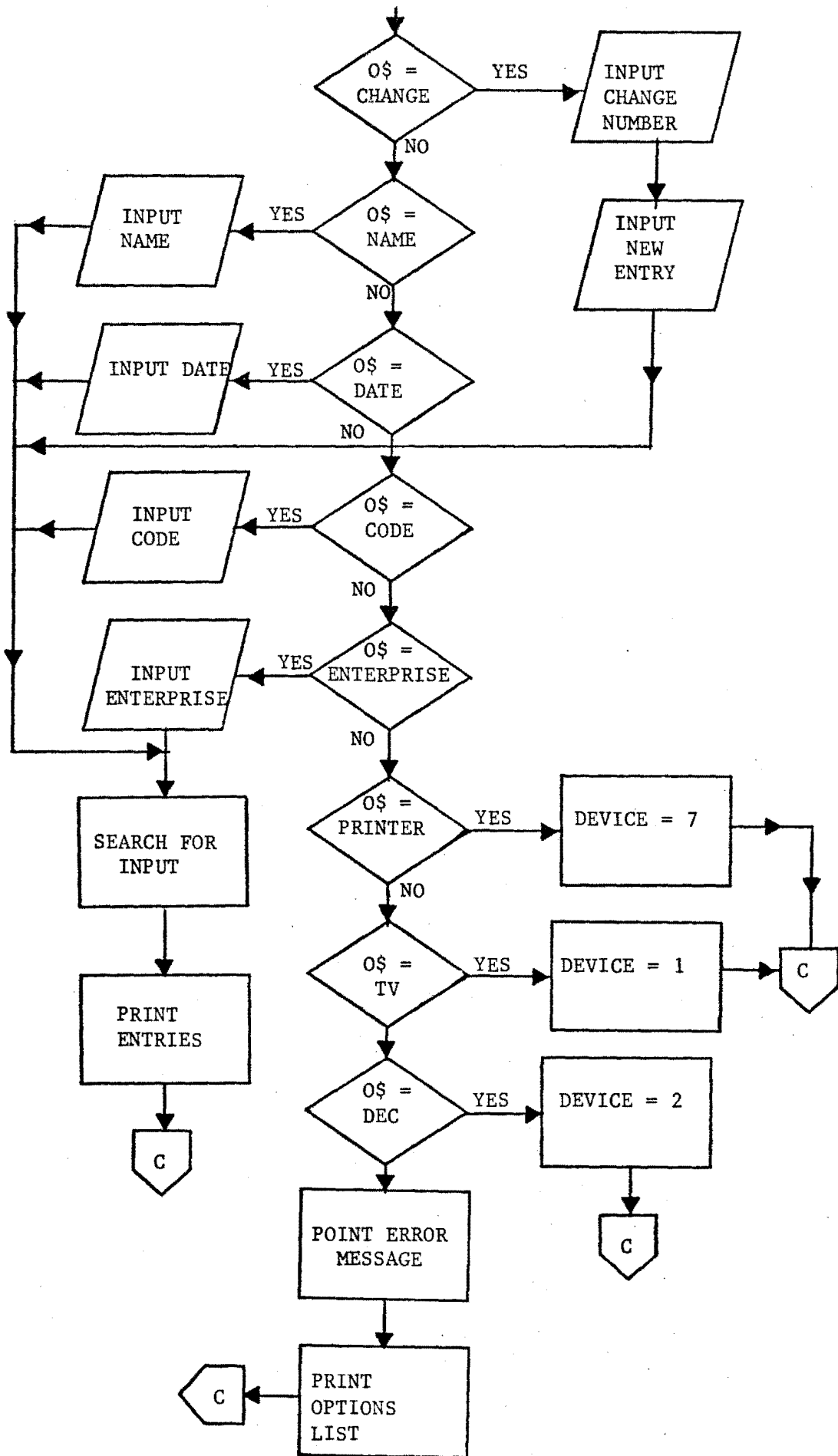
ENTER ROUTINE



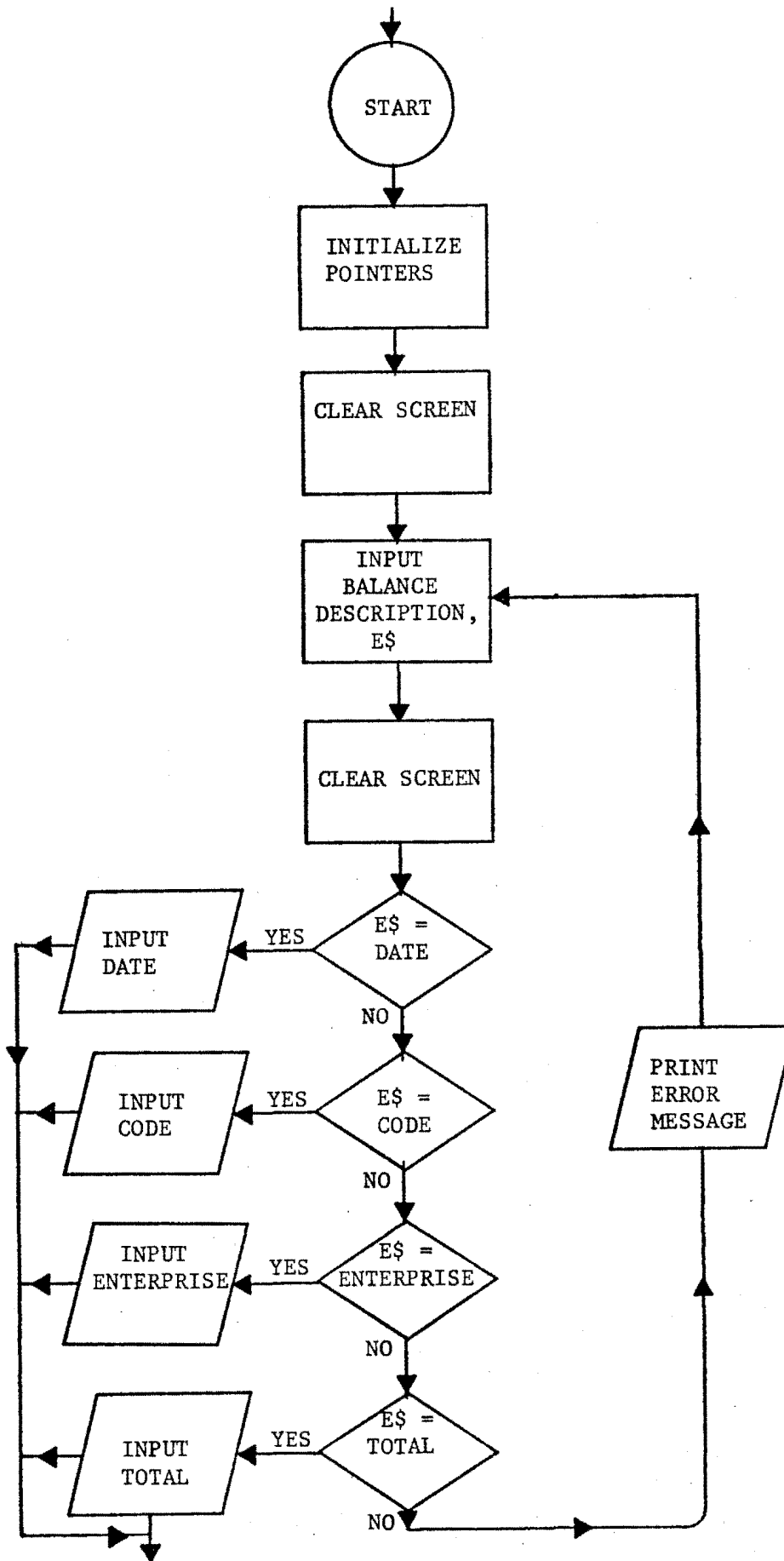


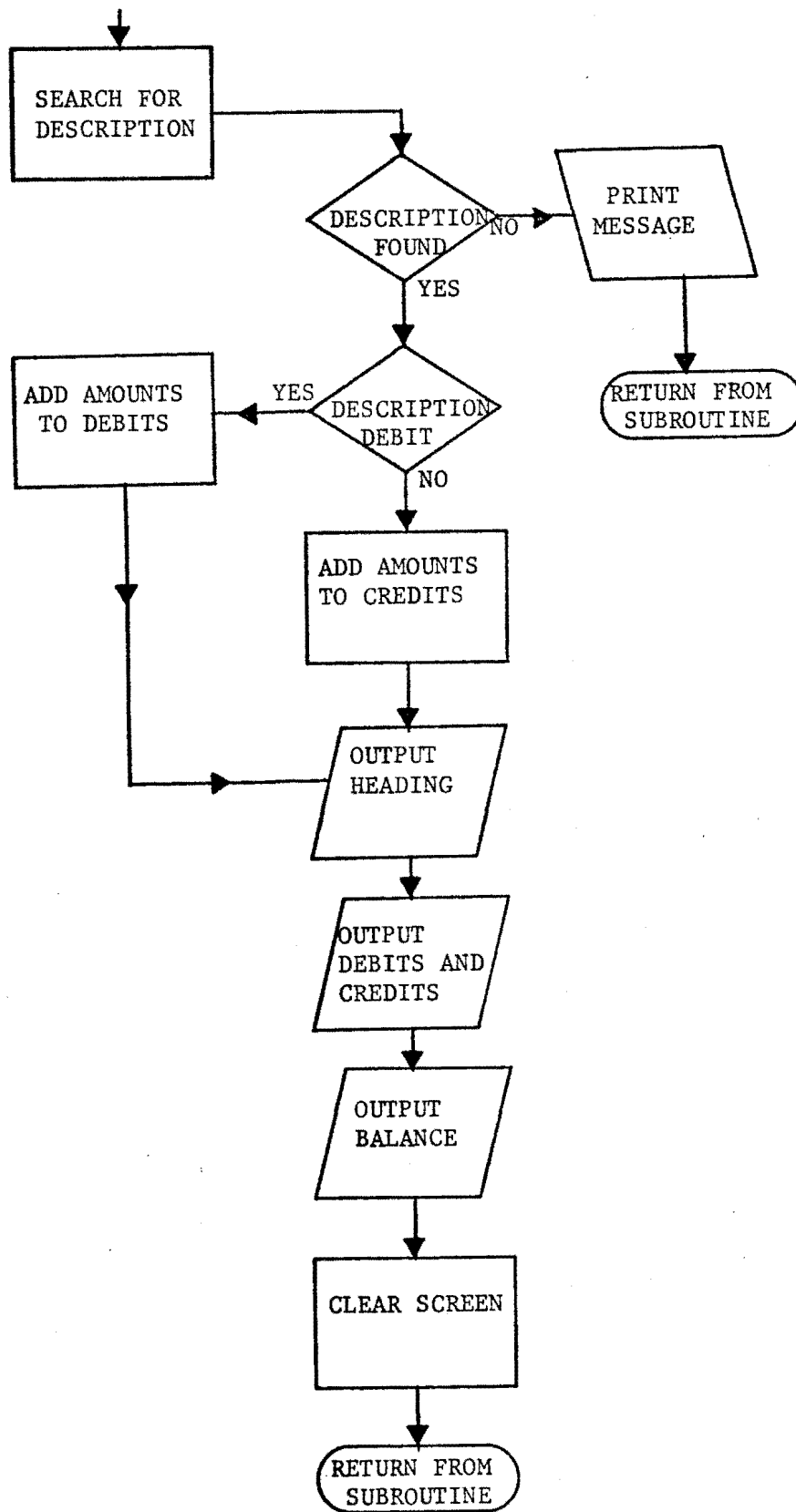
LIST ROUTINE





BALANCE ROUTINE





FINISH ROUTINE

