Burroughs TC 500

OPERATION AND PROGRAMING MANUAL

Printed in U. S. America February, 1969 For 1034006

PREFACE

This manual describes the equipment features, operating characteristics, and programing of the Series TC 500 Terminal Computers. It includes the operation and programing of the TC 500 in both an on-line data communication network, and in an off-line mode independent of a data communication network.

This manual is also suitable for operating and programing the Series L 2000 which includes all of the off-line capabilities of the TC 500. However, since the L 2000 has no data communication capability, those features and programing instructions relating to data communications should be disregarded. Certain L 2000 styles include features which will subsequently permit converting the system to a terminal computer with data communication capability. At such time that the conversion is accomplished, these topics relating to data communication would then apply.

This manual is arranged in three parts. Part I describes the equipment features and peripheral devices. Part II defines the programing instructions and explains their usage. Part III defines the programing instructions in symbolic form for use with the assembler software.

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Burroughs TC 500

OPERATION AND PROGRAMING MANUAL

Part I

EQUIPMENT REFERENCE MANUAL

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PART I - TC 500 EQUIPMENT REFERENCE

1. INTRODUCTION

The Series TC 500 Terminal Computer is a desk type, operator controlled, electronic digital computer with integrated circuitry. It can function as an independent computer or as a remote terminal in a data communication network to a central computer data center. It contains two processors to provide independent data communication and main memory control.

A magnetic disk provides the memory for the system and serves both the data communication processor and the main memory processor. Programs are stored internally in main memory. The main memory processor permits a variable and flexible instruction list. The data communication processor implements a flexible communication control procedure and provides for message buffering.

The TC 500 includes keyboards for operator entry of numeric and alphabetic data, and a serial printer for output. These represent the basic means of input and output. Optional features include punched paper tape and edge-punched card input and output, or 80-column punched card input and output.

1.1 MODES OF OPERATION

The TC 500 can operate in any of the following modes, and is changed from one mode to another by the introduction of a different user program.

1.1.01 Local Control – Operator Attended

The TC 500 serves as an independent off-line computer performing a local job by operating on a user program in main memory. Input can be through the keyboard and/or with an automatic input device. The data is acted on in accordance with the problem solving procedure implemented by the user's program. Output can be through the console serial printer and/or with a punching output device.

1.1.02 Remote Terminal - Operator Attended

The TC 500 serves as a remote terminal in a data communication network, receiving data from and transmitting data to a central computer. A user program in main memory accepts data input through the keyboard and/or from an automatic input device; acts on the data performing any necessary editing, calculation, accumulation, and formatting to prepare a message in the proper sequence; and causes the data (message) to be transmitted. The same user program acts on messages received to provide desired printed and/or punched output, with the ability to format and otherwise rearrange the message data into any sequence desired prior to output.

1.1.03 Remote Terminal – Unattended

The TC 500 serves as an unattended remote terminal responding to signals from the central computer for the receipt or transmission of data. A user program in main memory acts on data received to provide desired printed and/or punched output. It also transmits data that has been pre-loaded in an input device. After input and prior to transmission, the data may be acted on to accomplish necessary editing, calculation, accumulation, and formatting, etc.

1.1.04 Local and Terminal Control Overlapped

The TC 500 may operate in a mode combining local and terminal control, alternating between the two, provided that the program requirements of each can be contained in main memory concurrently, and that there is no conflicting need for input or output.

2. MEMORY

The memory of the TC 500 consists of a magnetic disk of ceramic composition, which revolves at a speed of 6,000 RPM, or 10ms per revolution. The disk contains 1,280 words of 64 bits each, and is organized into 5 blocks of 8 tracks each, or a total of 40 tracks. Each track contains 32 words, and has its own read-write head. Only one side of the disk is utilized.

Each word in memory may be utilized in any of the following formats: It may consist of 15 digits plus sign; it may contain 8 alphanumeric characters; or it may contain four instructions of 4 digits each (in machine language coding). This flexibility permits memory to be used to store program instructions, numeric factors and constants, alpha characters and messages, printing formats to control printing and punching, and other information for control of the system such as flags and registers for indexing and forms control.

2.1 ALLOCATION OF MEMORY

Memory may be considered in two major divisions; one part is reserved exclusively for the Data Communication Processor. The other part is referred to as Main Memory and is accessed by the Main Memory Processor in fulfilling the TC 500's local computing capability.

The data communication processor uses 8 tracks (or 256 words) of memory to implement the control procedures for the transmission and receipt of messages. These control procedures are implemented by a stored program (micro program). Two of the eight tracks provide a 256-character transmit buffer and a 256-character receive buffer.

The Main Memory Processor uses the remaining 32 tracks (or 1,024 words) of memory and operates independently of the Data Communication Processor, except that it has the ability to transfer message data to and from the Data Communication Processor. This allows simultaneous processing in the Main Memory and Data Communication Processors. Main Memory is subdivided into the CONTROL area and the NORMAL area.

The CONTROL area of Main Memory contains Microprograms which determine the system control functions and which implement the instruction list. This area is not available to the programmer. Each instruction available for the use of the programmer, referred to as a Macro Instruction, is actually implemented by a Microprogram in the Control area; the Microprogram consists of a precise sequence of Micro Instructions. A Micro Instruction is executed by "hard" electronic circuitry and usually performs only one of many small steps necessary for the total function specified by a Macro Instruction; thus a series of Micro Instructions are required to fulfill the Macro Instruction function. Hence, a Microprogram. The composite of all the Microprograms in the Control area constitutes what is referred to as "System Firmware" or just "Firmware". The System Firmware is supplied with the TC 500 by Burroughs. Refer to Part II for the Programing Language and Firmware sets.

The NORMAL area of memory is used to store the user's programs (Macro Programs) which are written with the Macro Instructions provided by the Firmware. Macro Instructions are used to exercise all of the capabilities of the TC 500 such as arithmetic, logical comparisions, printing, input/output (paper tape or cards), and data transmission. The NORMAL area is also used for storing constant data, messages, and for accumulating totals.

The amount of Main Memory available in the NORMAL area varies depending on the memory options of a given style and the particular set of Firmware.

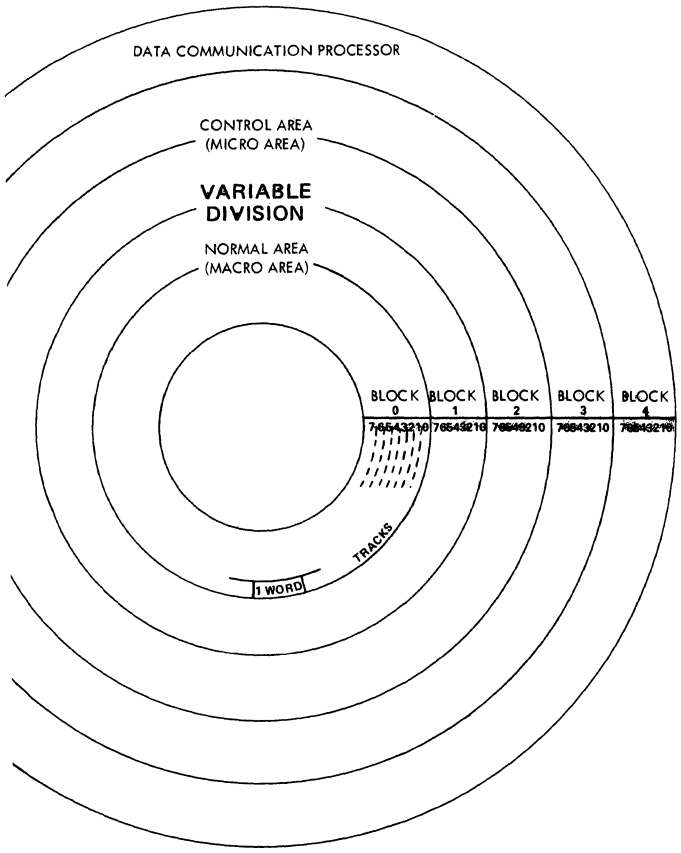


Figure 2 - 1 Example of Magnetic Disk Memory Organization

2.2 ACCUMULATOR

The computer contains one Accumulator which is used when data is entered in a numeric mode. Data can then be moved to any desired location (word) in the NORMAL area of memory. Any subsequent entering of data in the numeric mode destroys the contents of the Accumulator and replaces it by the newly entered data. The Accumulator is also used to print numeric data, as all numeric data to be printed must pass through the Accumulator.

The Accumulator serves as a working memory location for moving data from one word of memory to another.

The Accumulator is separate from the NORMAL area of memory and has a capacity of 15 digits plus a 16th position for flags (-, C,M, Special flag).

3. KEYBOARD OPERATIONS

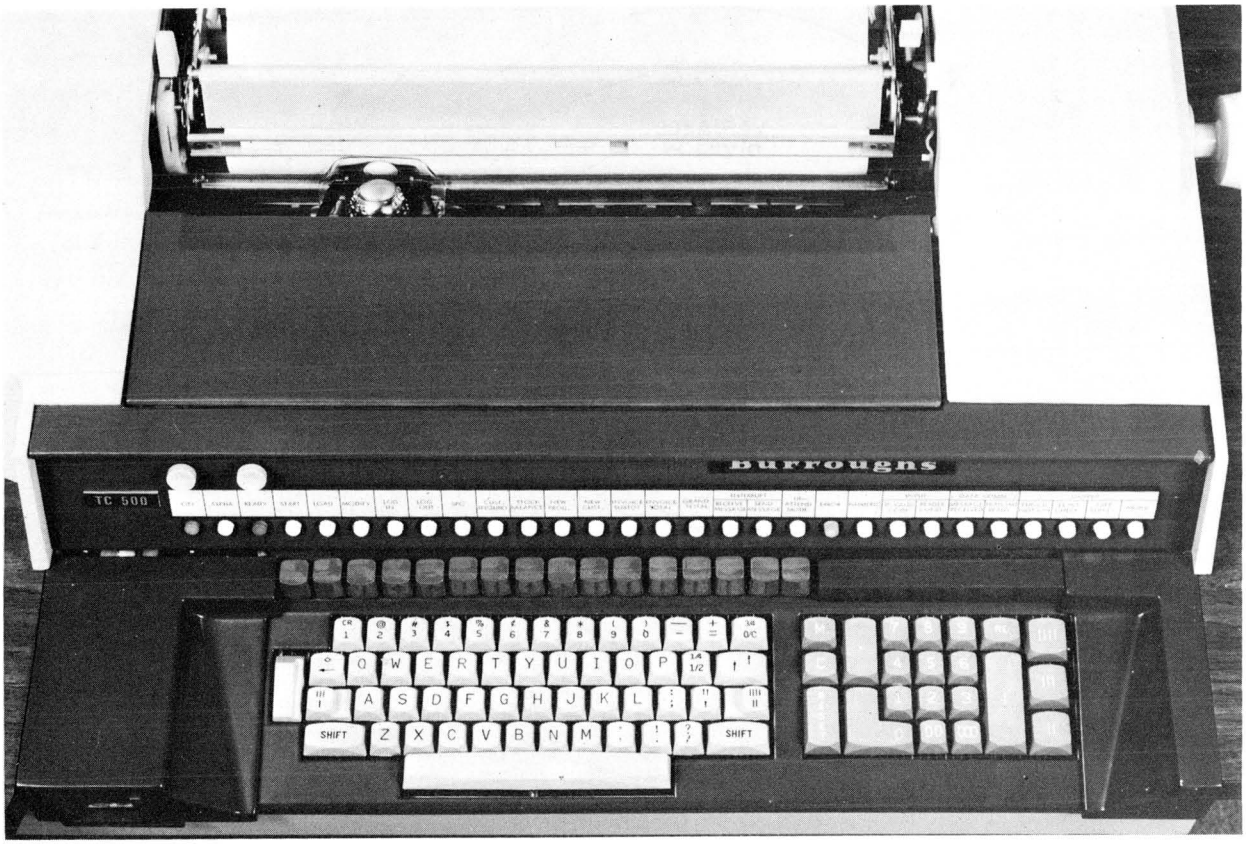


Figure 3 - 1 TC 500 Keyboard, Printer Carrier and Forms Transport

3.

For the purpose of explaining key functions and keyboard instructions, the console is considered as having three separate keyboards: Typewriter, Numeric, and Program Selectors. From a design standpoint however, it has but one keyboard since there is no mechanical linkage between it and other sections of the computer. Key depressions activate magnetic core transducers, located apart from the keyboard assembly, which supply electrical signals to the computer. All keys on the keyboard have but one function and that is to transmit its own unique code to the computer's main memory processor. The use of that code is determined by the interpretation given to it by the system firmware, which may treat it as an alpha character, a numeric digit, or as a functional code such as to terminate an instruction, vertical space, or set a flag. Most firmware sets interpret the codes in accordance with the key markings.

Use of the keyboard does not provide any direct result, other than to enter codes into a keyboard buffer. A program instruction is required to accept the data from the buffer into the system for processing and/or printing.

All keys – Typing, Numeric, and Program Select Keys – are interlocked to prevent simultaneous depression.

When power is off to the machine, keys are not locked against depression. However, if the keys are depressed, no action will result from the depressed key or control when the power is turned on.

3.0.01 Indicator Lamps and Error Indication

Lamps are provided to communicate various operating conditions to the operator. These indicate which keyboard and/or program keys have been enabled, whether an operator error has occurred, and the status of input/output adjuncts (See Fig. 3 - 1). Each lamp is discussed with its associated key or function in following sections.

Failure of an indicator lamp will not prevent the function associated with the lamp.

3.1 NUMERIC KEYBOARD

The Numeric Keyboard consists of 12 Numeral Indexing Keys, a Decimal-Fraction Key, three Accumulator Flag Keys (commonly used as Reverse Entry Key, Per Hundred Key and Per Thousand Key), Reset Key and Four Operation Control Keys (OCK's).

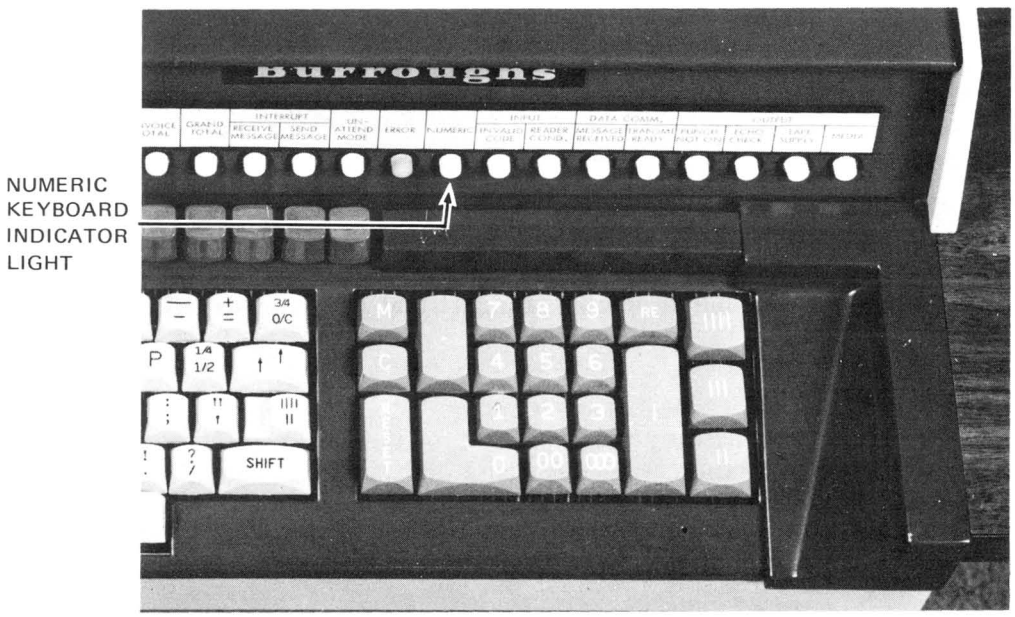


Figure 3 - 2 Numeric Keyboard

Each of the above keys delivers its own unique code to the keyboard buffer. If a Numeric Keyboard instruction is in the process of being executed, these codes are accepted from the buffer to perform a function as dictated by the System Firmware. If a Typewriter Keyboard instruction is being executed, the numeric keyboard codes (except OCK's) are rejected, the Keyboard Error Light is turned "on", and the alarm sounds once (see Fig. 3 - 3).

The numeric keyboard may be programed for operator entry of a maximum of 15 digits, most significant digit first. Indexing capacity is a function of the Numeric Keyboard Instruction. If the programed capacity is exceeded, the Error light is illuminated and sounds the alarm.

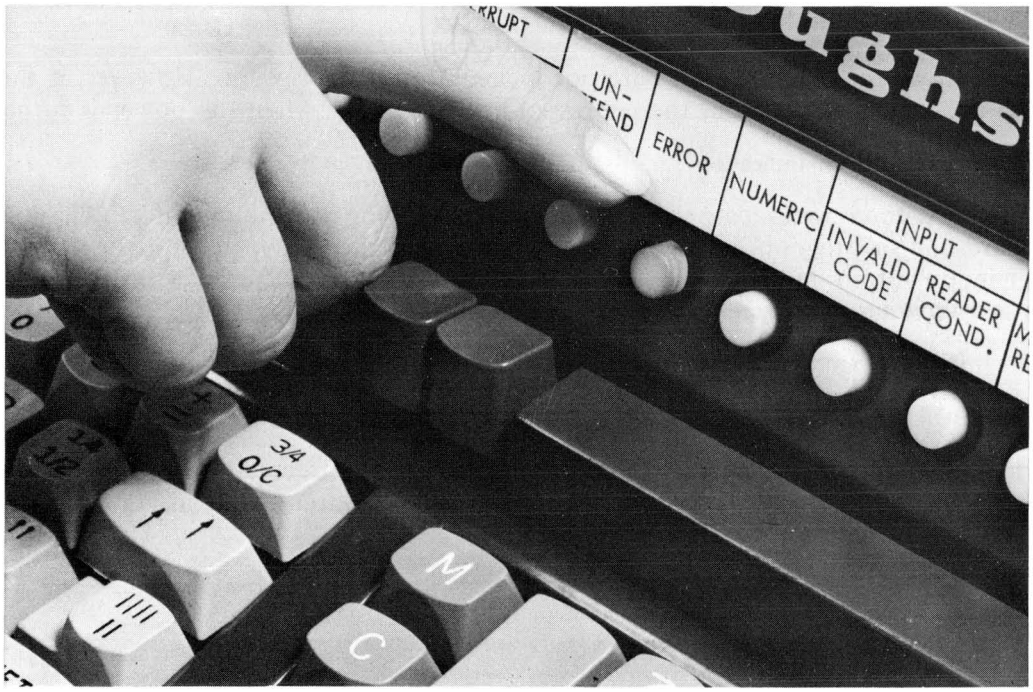


Figure 3 - 3 Error Indicator Light

3.1.01 Numeral Indexing Keys

The Numeral Keys consist of keys for "0 through 9", a Two-Cipher key and a Three-Cipher key. Keys indexed cause digits to be stored in the buffer. Digits are then stored and aligned in the Accumulator as dictated by the programed Numeric Keyboard Instruction, modified by usage of the Decimal-Fraction Key. The maximum number of digits that may be indexed is specified in the instruction.

3.1.02 Decimal-Fraction Key -- (.)

Numeric Keyboard entry is modified by the depression of the Decimal-Fraction Key. Keys indexed prior to depression of the Decimal-Fraction Key cause digits contained in the Accumulator to shift one place to the left. Depression of the Decimal-Fraction Key terminates left shifting in the Accumulator. Keys indexed following depression of the Decimal-Fraction Key cause digits to be aligned in positions of the Accumulator reserved for decimals by the Numeric Keyboard instruction.

Alignment of digits during keyboard entry is controlled by the stored program.

Example: A program permits entry of three whole number digits and two decimal number digits. Operator enters 456¼ decimally.

Sequence of Key Depressions	Alignment of Digits in Accumulator Locations 4 3 2 1 0	
4	4	
5	4 5	
6	4 5 6	
Decimal/Fraction Key	4 5 6	Note: The Decimal point is not stored.
2	4 5 6 2	
5	4 5 6 2 5	

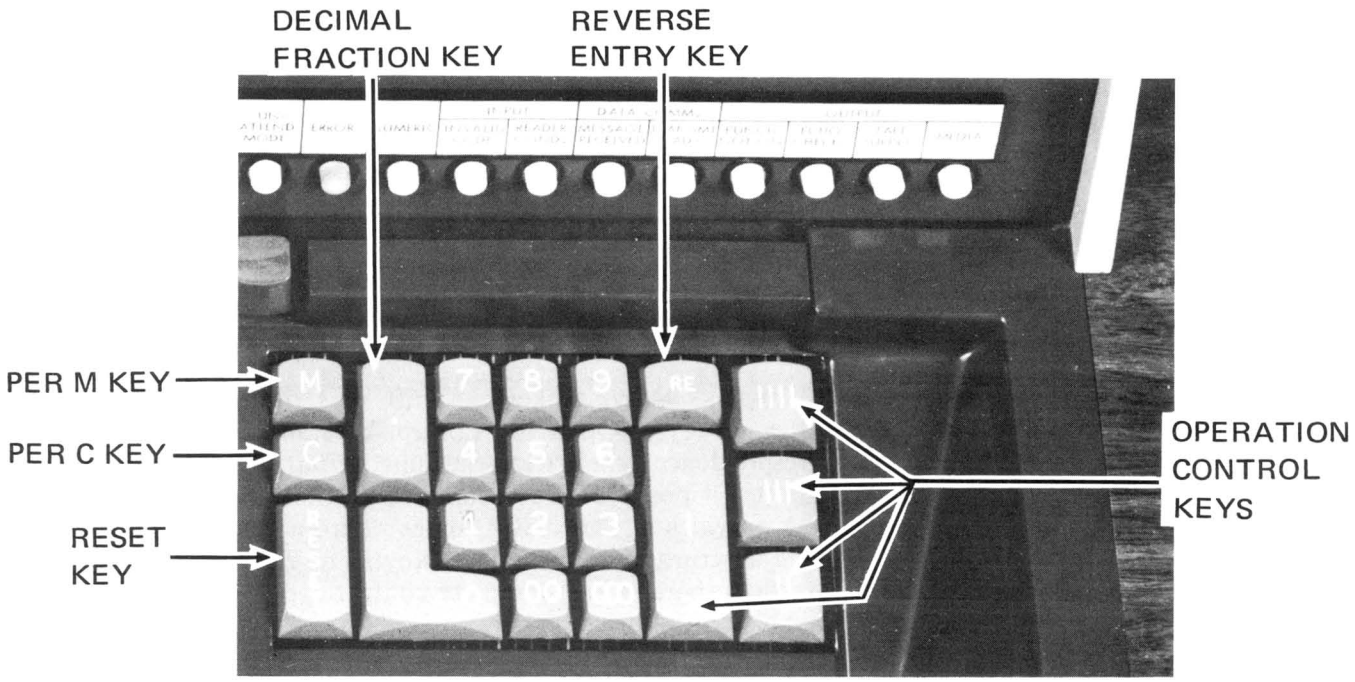


Figure 3 - 4 Numeric Keyboard

3.1.03 Reverse Entry Key -- (RE)

Depression of this key changes the sign of the Accumulator to minus. The use of this key causes the "Minus" Flag in the flag position to be set. This is used to enable proper arithmetic and provide printing of special symbols. It also can be used for selecting alternate program routines (branching). The key may be used only when programed. Use of the key without programing will cause the error light to illuminate and sounds the alarm.

3.1.04 Per Hundred Key -- (C) or %

Depression of this key causes the "C" Flag in the flag position of the Accumulator to be set. This flag can be used to provide special symbol printing, and is usually used to modify a Shift Instruction to effect decimal point-off (scaling) after a calculation. The key may be used only when programed. Use of the key without programing will cause the error light to illuminate and sounds the alarm.

3.1.05 Per Thousand Key -- (M) or ‰

The depression of this key causes the "M" Flag in the flag position of the Accumulator to be set. This flag can be used to provide special symbol printing, and is usually used to modify a shift instruction to effect decimal point-off. The key may be used only when programed. Use of the key without programing will cause the error light to illuminate and sounds the alarm.

3.1.06 Reset Key

This key can be used with either the Typewriter or Numeric keyboards. When used with the Numeric Keyboard after a keyboard error alert, or prior to use of an OCK, it performs the following functions:

1. Clears the Accumulator, including the flag position.
2. Turns "off" the Keyboard Error Light, if light is "on".
3. Re-initiates the active "Numeric Keyboard" instruction.

3.1.07 Operation Control Keys (I), (II), (III), (IIII), (OCK's)

The four Operation Control Keys located on the Numeric keyboard are all used to terminate keyboard entry, thus allowing the program to continue to the next instruction in sequence.

Depression of an OCK sets a corresponding OCK flag in the control section of the computer. This flag can be used by the program to select alternate routines or functions.

3.2 TYPEWRITER KEYBOARD

The Typewriter Keyboard consists of 53 keys: – 44 typing keys, 2 Shift keys, a Space Bar, a Backspace key, an Open/Close key, a Line Advance key, 2 Operation Control keys and a memory load switch. Touch is that of an electric correspondence typewriter. Sustained input of 15.5 digits or characters per second (186 words per minute) is possible. To accommodate the varying speed of manually indexed data, a keyboard buffer provides intermediate storage of from 7 to 35 characters. Refer to Part II, Section 2.1 for a detailed description of buffering. Keyboard entry of either numeric or alphanumeric data can be enforced by the program, and complete control over the "size" (number of characters) of the data entered is available to the programmer.

Figure 3 - 5 Typewriter Keyboard

When depressed, each of the above keys delivers its own unique code to the keyboard buffer. If a "Type" or "Type into Memory" instruction is being executed, these codes are accepted from the buffer and perform their assigned function. If a Numeric Keyboard instruction is being executed, the codes are rejected and the Keyboard Error Light is turned "on", except when the numeral keys 0 - 9 on this keyboard are used, thus permitting entry of numeric data on this keyboard. The Reset Key, on the Numeric Keyboard, is available for use during a Typewriter Keyboard instruction. (Refer to 3.2.09.)

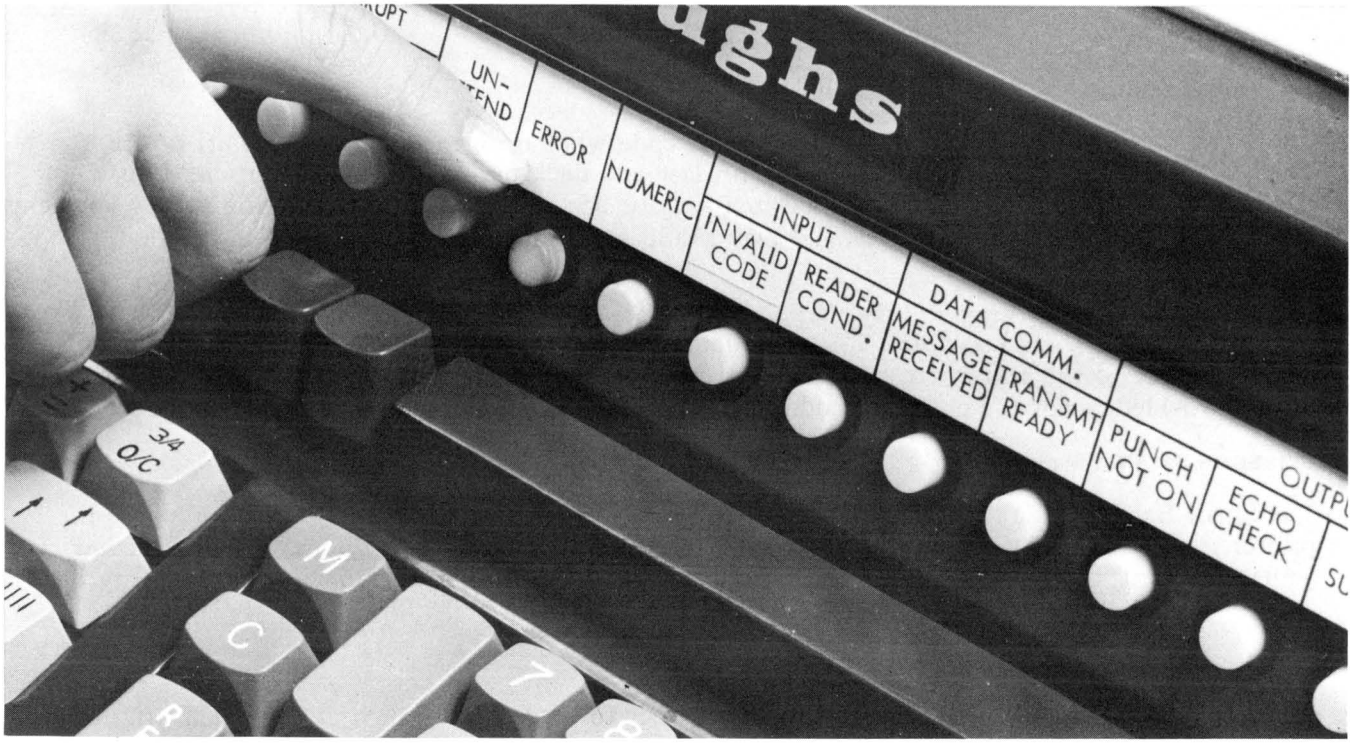


Figure 3 - 6 Error Indicator

A Type instruction provides for typing a maximum field of 150 characters. If the programed capacity is exceeded, the Error light is illuminated and the alarm sounds.

The typewriter keyboard is enabled only when any typewriter instruction is programed. The typewriter indicator lamp (ALPHA) is illuminated.

Figure 3 - 7 Typewriter Keys

3.2.01 Typing Keys

There are 26 alpha keys which transmit the same code whether in the shift or non-shift position. There are 20 typing keys (including the Open/Close and Backspace keys) which transmit a different code depending on whether they are used in a shift or non-shift position. Depression of any key sends its corresponding code to the buffer, and may result in printing, depending on the instruction.

3.2.02 Shift Keys (2) "SHIFT"

The two shift keys, marked "SHIFT", when depressed with any shift character key, sends the shift character code to the buffer. A shift key used with any non-shift character key, where only single. case is provided, sends the character code to the buffer as if the shift key had not been used.

3.2.03 Space Bar (Not Marked)

The Space Bar (not marked) when depressed will send the space code to the buffer, and cause the printer carrier to space 1/10 inch to the right if printing is enabled. When depressed to a second actuation point, it will send spacing codes until released or until the programed typing capacity is exceeded.

3.2.04 Backspace Key " ◊ "

When depressed, this key will cause the printer carrier to space 1/10th inch to the left if printing is enabled. If the typing instruction is entering the data into memory, the Backspace key decrements memory one character position for each 1/10 inch backspace. When depressed and held to a second actuation point, the printer carrier will continue to space to the left until the carrier reaches the location at which it began the Type instruction or until the key is released, whichever is first.

The shift position provides for a printed character (◊). When depressed, it will cause the printer carrier to advance 1/10th inch and print. When held to a second actuation point, the printer carrier will continue to advance and print until released, or until the programed typing capacity is exceeded.

3.2.05 Line Advance Key " ↑ "

This key, marked as shown, when depressed will cause the forms in the forms transport to be vertically spaced 1/6th of an inch. On systems equipped with a split platen, with the shift key depressed while depressing the Line Advance key, the right side of the platen will space; without the shift key, the left side of the platen will space.

If the Line Advance key is depressed to the second actuation point, it will cause the forms to space continually until released. Upon release of the key, the platen will continue to space up until the buffer is unloaded (usually 2 or 3 lines). This also applies to systems equipped with a split platen.

3.2.06 Open/Close Key "3/4" O/C

The Open/Close key, marked as shown, when depressed will cause the lower pressure rolls to open if closed, or to close if open. In addition, this key will open the Form Guide Bail from a closed position. When the Form Guide Bail is in an open position, depression of the Open/Close key will not close the bail immediately, but will cause it to close after the next 10 line advances have occurred.

The O/C key is operative in the Ready Mode and during any keyboard instruction, both alpha and numeric. If the O/C key is depressed during an operation, the O/C code is stored in the buffer until the operation is completed, then the transport will open.

The shift position provides the code for printing the fraction "¾" as a single character.

3.2.07 Hyphen/Underline Key " - "

The Hyphen/Underscore key marked as shown, sends a code for the appropriate symbol and has a second actuation point which causes the underline or hyphen to send codes continuously until the key is released or until the programed typing capacity is exceeded. The Underscore code results when the key is used with the shift key. The Hyphen code is the lower case code.

3.2.08 Numeral Keys - Variously Marked

The numeral keys "0" through "9" have a dual function. When used under an alpha instruction, these keys send codes for typing; when used under a numeric instruction, they may be used in place of the numerals on the numeric keyboard. When the shift key is used, each key sends a special character code to the buffer, acceptable only to an alpha instruction.

3.2.09 Reset Key "Reset"

The depression of the Reset key will re-initiate a Typewriter keyboard instruction and position the print head to the start position, if the system is not in an error condition. If the system is in an error condition, depression of the Reset key will remove the error condition, and extinguish the error indicator (Fig. 3 - 6). The print head will not move. If the system is in an error condition, and it is desired to re-initiate the typewriter keyboard instruction, a second depression of the Reset key is required.

On the Typewriter Keyboard to Memory and Enter Alpha into Memory instructions, the Reset key will remove an error condition (if present) without moving the print head or erasing any part of the entry into memory. If the Reset key is depressed when no error is present, or as a second depression following an error condition, the instruction is re-initiated; subsequent entry of data destroys and replaces the previously entered data.

3.2.10 Operation Control Keys (OCK's) "III" "IIII" I II

The OCK's located on the Typewriter Keyboard are used to terminate keyboard entry, thus allowing the program to continue to the next instruction in sequence. OCK 1 with the shift key depressed becomes OCK 3. OCK 2 with the shift key depressed becomes OCK 4. These OCK values and functions are the same as the Numeric Keyboard OCK's.

Depression of an OCK sets a corresponding OCK flag in the Control area of the computer. This flag can be used in the program to select alternate routines or functions.

3.3 PROGRAM SELECT KEYBOARD

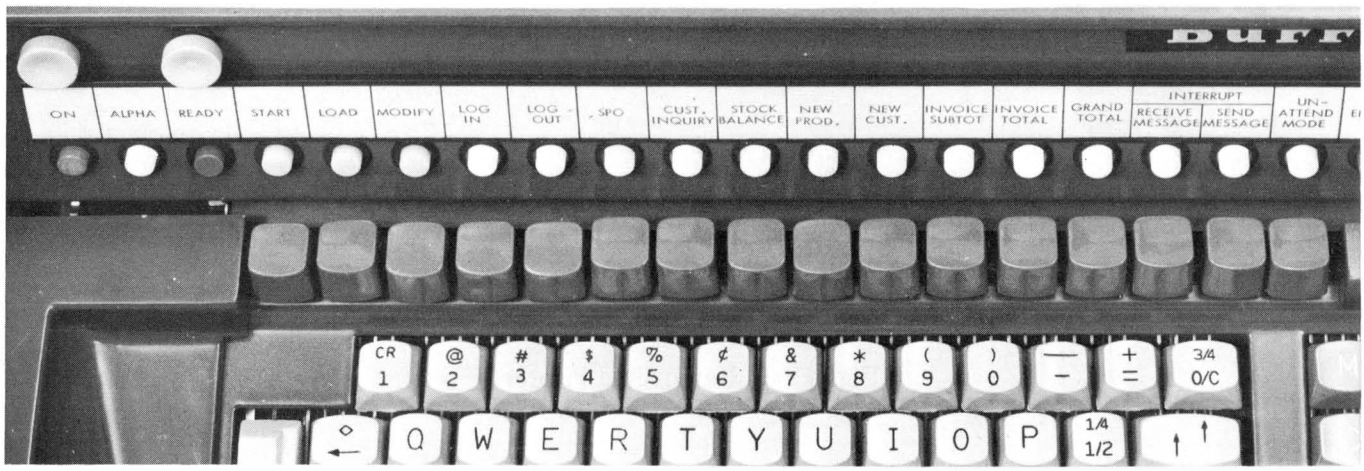


Figure 3 - 8 Program Select Keyboard

Program Keys, (PK's) located immediately above the typewriter and numeric keyboards, permit operator selection of alternate routines and functions. The TC 500 is equipped with up to 16 PK's.

PK's are usable only when the computer is performing typewriter or numeric keyboard instructions (these "halt" the program allowing the operator to select a PK). However, the individual PK or PK's that are available at a keyboard instruction are determined in advance by programing an "Enable PK" instruction. The "Enable PK" instruction provides control over the use of these keys. (See Part II, Section 2.5.02.)

For the purpose of setting up a key pattern, PK's are divided into two groups of eight keys each. Keys are numbered "1" to "8" from left to right within each group, A and B.

An indicator light associated with each PK informs the operator which key(s) have been enabled. An identification strip is used to describe the individual lights and PK functions. Since PK functions can be changed from one application to another, the identification strip is designed to be easily changed by the operator. PK functions can be reassigned within the same program.

An interlock is provided to prevent simultaneous depression of PK's. The entire keyboard will remain interlocked until the PK is released. Depression of an inactive PK will cause an error condition, sounding the alarm.

4. PRINTER

The Printer is a 64-character removable ball, which prints serially 10 characters per inch at a rate of 20 characters a second. It is mounted on a carrier mechanism called a servo device. Printer positioning and printing are controlled by the program. The print line is 150 character positions. The print cycle executes an escape before it prints.

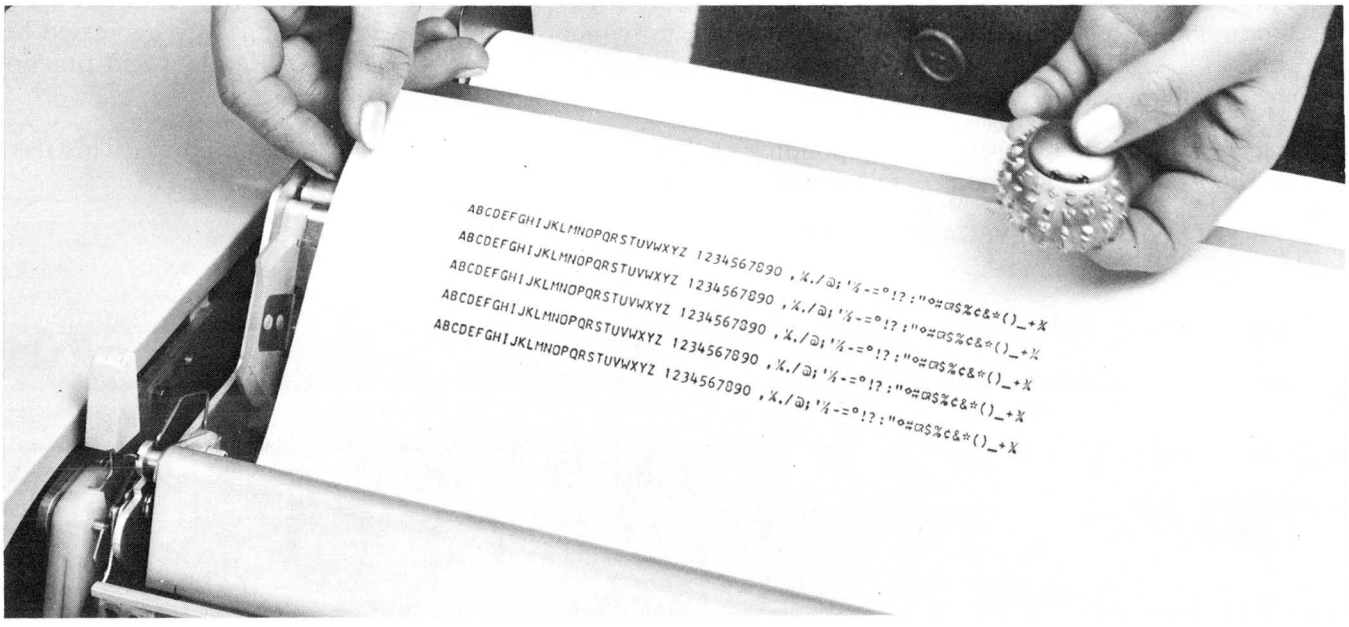


Fig. 4 - 1 Removable Printer

POSITION	7	6	5	4	3	2	1	0	15	14	13	12	11	10	9	8
ROW 0	=	'	1/2	/	3	2	1	0	C	B	A	◇	S	R	Q	P
1	-	;	•	,	7	6	5	4	G	F	E	D	W	V	U	T
2	+	"	1/4	?	%	$	9	8	K	J	I	H	¢	Z	Y	X
3	—	:	!	°	CR	)	#	@	O	N	M	L	3/4	(	*	&

Fig. 4 - 2 Character Position Chart
(U.S. Standard Character Set)

The standard 64-character set includes the 26 letters, A through Z, numerals 0 through 9, fractions ¼, ½, and ¾, and 25 symbols. The overall height and width varies with the individual character. The nominal size of a printed character is .110" high X .082" wide.

The Printer is positioned entirely by programed instruction to any 1/10" position from 0 to 150, eliminating the need for mechanical "tabs" or "stops". Escapement to the right or backspace to the left is in 1/10th inch increments. Printer escapement may be from a "space code" in any print instruction or from the Typewriter Space Bar. Backspace may be from the Backspace key only. The printer is positioned in either direction at a nominal speed of 20 inches per second.

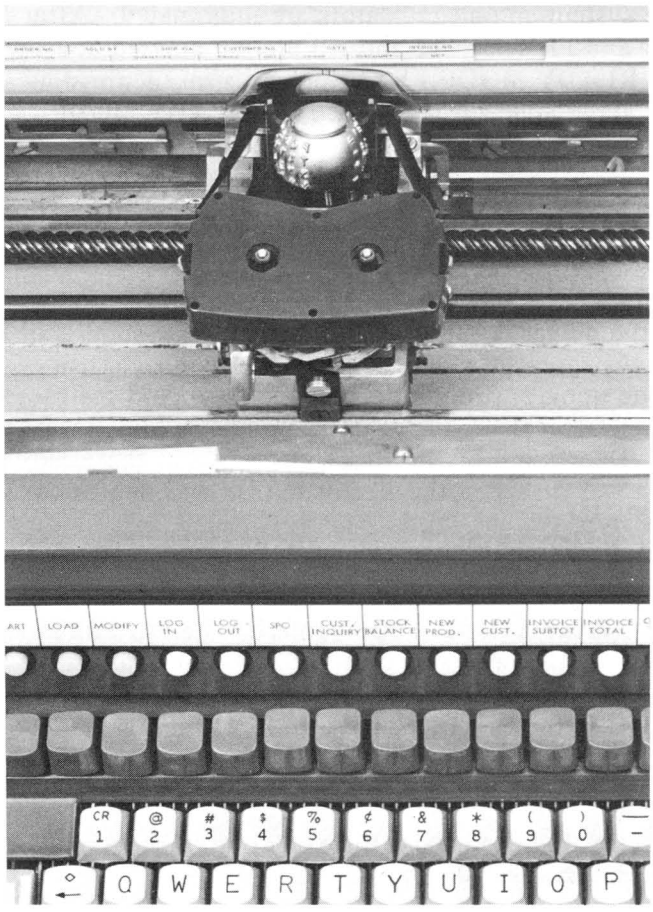


Fig. 4 - 3. Ribbon Cartridge and Printer

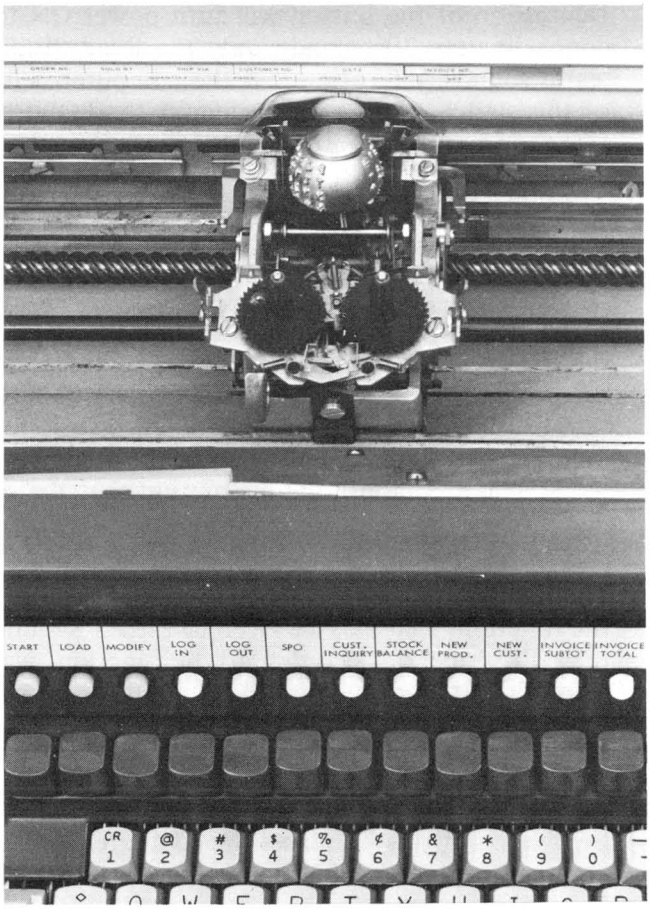


Fig. 4 - 4. Printer with Ribbon Cartridge Removed.

The Printer Ribbon with two-color control (black and red) is contained in a removable cartridge which is attached to the printer carrier. An automatic reversing mechanism is provided to reverse the direction of ribbon travel.

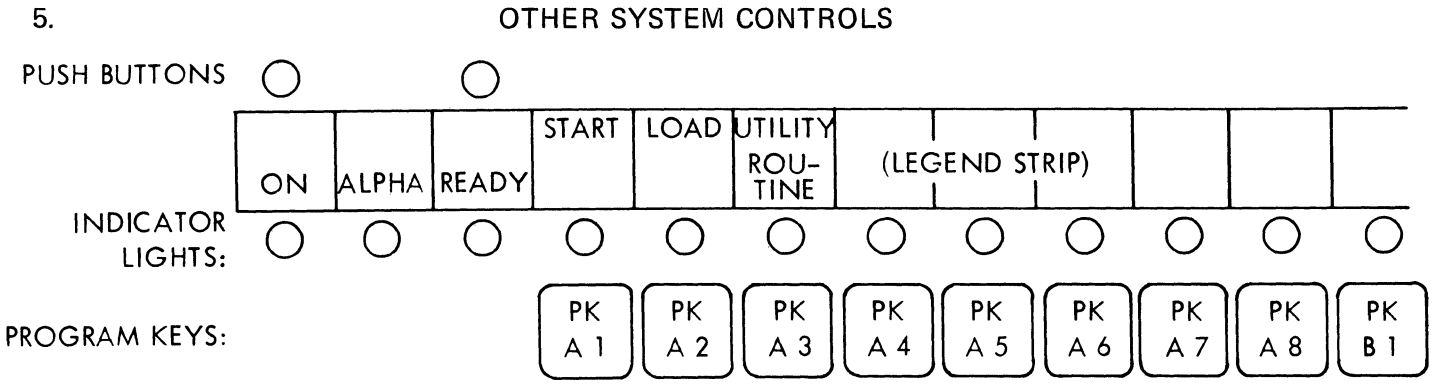


Fig. 5 - 1 Program Keys and Indicator Lights

5.1 POWER "ON" PUSH BUTTON

The Power ON push button switch and associated indicator (green) are located at the upper left end of the PK's. The legend strip insert is marked ON.

Depression of the button will turn power ON to the system and all indicators are illuminated. After approximately 30 seconds, only the Ready Indicator and PK's A1, A2 and A3 are illuminated and the alarm sounds, indicating that the computer is in the READY MODE. When power is on, depression of this switch returns the system to the POWER ON state, and will then go to the READY MODE after approximately 30 seconds.

5.2 READY PUSH BUTTON

The Ready Push Button switch and associated indicator (green) are located at the upper left end of the PK's. The legend strip insert is marked READY.

If the Ready button is depressed immediately after the power is turned ON or when the system is in the Ready Mode, it turns power off to the system. If depressed when the system is under control of the program, it returns the system to the Ready Mode upon encountering the next keyboard instruction or immediately if on a keyboard instruction when depressed. PK's A1, A2, and A3, and Ready indicators are illuminated when in the Ready Mode. Depression of the Reset key when in the Ready Mode will re-establish the instruction that the system was on when the Ready button was depressed.

5.3 KEYS WITH SPECIAL FUNCTIONS ONLY WHEN IN THE READY MODE

The Ready Mode assigns special functions to PK's A1, A2, and A3 which are completely independent of the functions that may be given to these PK's under the Program Mode. Upon entering the Program Mode, these PK's operate according to the function given them by the program currently in the Normal area of memory; but any time that the computer enters the Ready Mode, these PK's operate as special Control Keys whose functions are provided by the Firmware. Also, the Reset Key has a special function while the computer is in the Ready Mode.

5.3.01 PK A1 - Start

Depression of this PK places the computer in the Program Mode and starts the execution of the user program, beginning with the instruction located in word 0 syllable 0.

5.3.02 PK A2 - Load

Depression of this PK places the computer in the Program Load Mode, thus enabling an operator to load a program into the Normal area of memory. The program tape is placed in the Memory Loader device (see 5.6) and depression of the Memory Load Switch (after depression of PK A2) causes the tape to be read at a speed of 15.5 characters per second. The computer is now in Load Mode. It stays in Load Mode, even after the tape has been read in completely and the Memory Load Switch is turned off, until the operator touches the Reset key to return the computer to the Ready Mode.

5.3.03 PK A3 - Utility Routine

Depression of this PK starts the execution of a special utility routine residing in a reserved portion of control memory (such as the Memory Modify or Memory Punch routine). The resulting operation depends upon which of these utility routines has been loaded into memory (5.3.02) as they all occupy the same storage area in memory. After completion of the utility routine, the Ready button will return the computer to the Ready Mode.

5.3.04 Reset Key

Depression of the Reset key re-establishes the last keyboard instruction; that is, the keyboard instruction that was in the process of being executed when the Ready push button was depressed placing the computer in the Ready Mode. The keyboard instruction may have been in the user program or in one of the utility routines.

5.4 EMERGENCY LINE SWITCH

The Line switch is an ON-OFF toggle type switch and is located on the left inside panel under the keyboard (above the Halt button). In the OFF position, power is off to the system. In the ON position, power is on and permits the system to be turned ON by the Power On button. This switch normally remains ON, untouched by the operator. When the system is operating, it should be used only in emergencies to turn off power, and then only while holding the Program Halt button depressed. Otherwise, use of the Line switch alone may cause a parity error in the stored program and/or microprogram. Holding the Program Halt button depressed when turning the Line switch to OFF prevents the parity error possibility. A power failure or unplugging the line cord during system operation could also endanger the programs. If the program does not operate properly after such emergency action, the Macroprogram should be reloaded.

5.5 PROGRAM HALT BUTTON

The Program Halt button is a push button type switch located on the left inside panel just below the line switch. Depression of the button will cause the computer to restore to the Ready Mode.

The Program Halt button may be used when a program is in progress. When depressed, it will permit the completion of the instruction being executed, and then restore to the Ready Mode. This differs from the Ready Button, which can only be used when the program has halted for a keyboard entry.

5.6 MEMORY LOADER

The Memory Loader is a special purpose paper tape reading device which automatically loads programs into memory. The Memory Loader is located at the lower left-hand corner of the keyboard. It contains a self-threading paper tape cartridge (removable), a feeding device, and a tape reader to read program tape into memory. This device is under control of the Memory Load Switch (enabled by PK 2 - (LOAD) - in the Ready Mode).

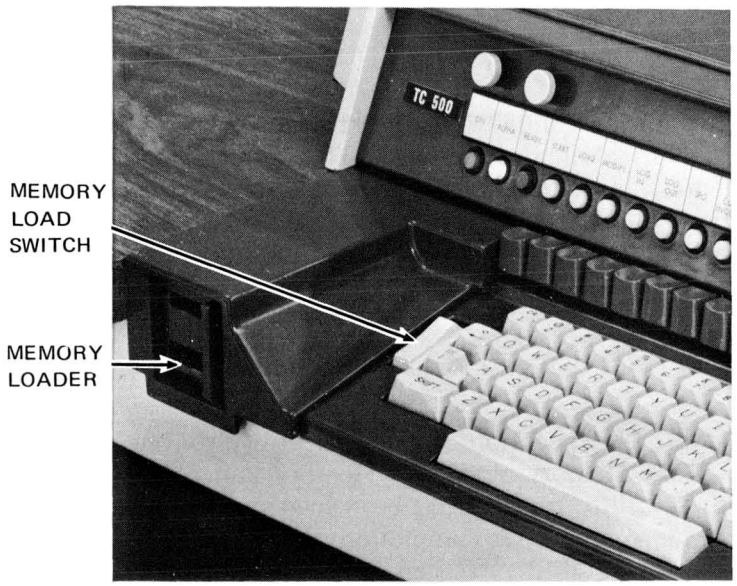


Fig. 5-2 Memory Loader and Memory Load Switch

The Memory Loader is capable of reading program tape at the rate of 15.5 codes per second. Program tape (8 channel) is inserted into the lower slot of the self-threading tape cartridge with the reference edge (three punched holes below the feed holes) of the tape to the right. The tape is ejected through the upper slot.

This device is to be used only for initial loading of memory or changing of programs. It is not for use for input of transaction data during program operation. A punched-paper tape reader is available for the reading of data during program operation.

5.7 PROGRAM TAPE CARTRIDGE, STYLE PC 1

The Style PC 1 Program Tape Cartridge is an optional device that will accommodate an endless loop program tape. This device is used when changing from one application or program to another. The basic self-threading tape cartridge is removed and the Program Tape Cartridge is inserted in the same location.

5.7.01 Program Tape Specifications

The type of tape that must be used within the cartridge is one or 2 ply mylar tape, one inch in width. (Refer to Subject 12.2.) The cartridge can accommodate a minimum of 10 feet of tape and up to a maximum of 40 feet, including leader and trailer tape.

Certain requirements must be met in the preparation of program tape for the PC 1 cartridge:

1) There must be a minimum of 20 inches with only sprocket feed holes before the start of program codes in the tape.
2) 1½ inches of sprocket feed holes only are to be cut out of the tape between the ending sprocket feed holes and the beginning sprocket feed holes of the punched program. This is to prevent continuous feeding of the tape. When the tape feed sprocket is in the cut out area of the tape, it requires moving the tape manually by moving the feed drum until the sprocket feed holes in the tape engage the feed sprocket.
3) There must be a minimum of 10 inches with only sprocket feed holes following the end of the punched program tape.

The tape can only be advanced counterclockwise from the drive end. An interlock prevents turning the paper tape feed wheel clockwise.

5.8 MEMORY LOAD SWITCH

The two-position rocker type Memory Load Switch (not marked) is located on the left side of the typewriter keyboard, and is adjacent to the back space key and OCK 1. The switch is used to turn power "on" and "off" to the Memory Loader.

P K A2 (LOAD) must be depressed prior to turning the Memory Load switch ON; otherwise the tape would feed without loading memory.

6. FORMS TRANSPORT

The Forms Transport is designed to permit rear feeding of individual cut forms or continuous forms of various lengths and widths, and provides programmatic alignment to the first printing line with either type of form. It includes a stationary 15.5 inch platen. The length of the print line is 150 characters, at 10 characters per inch.

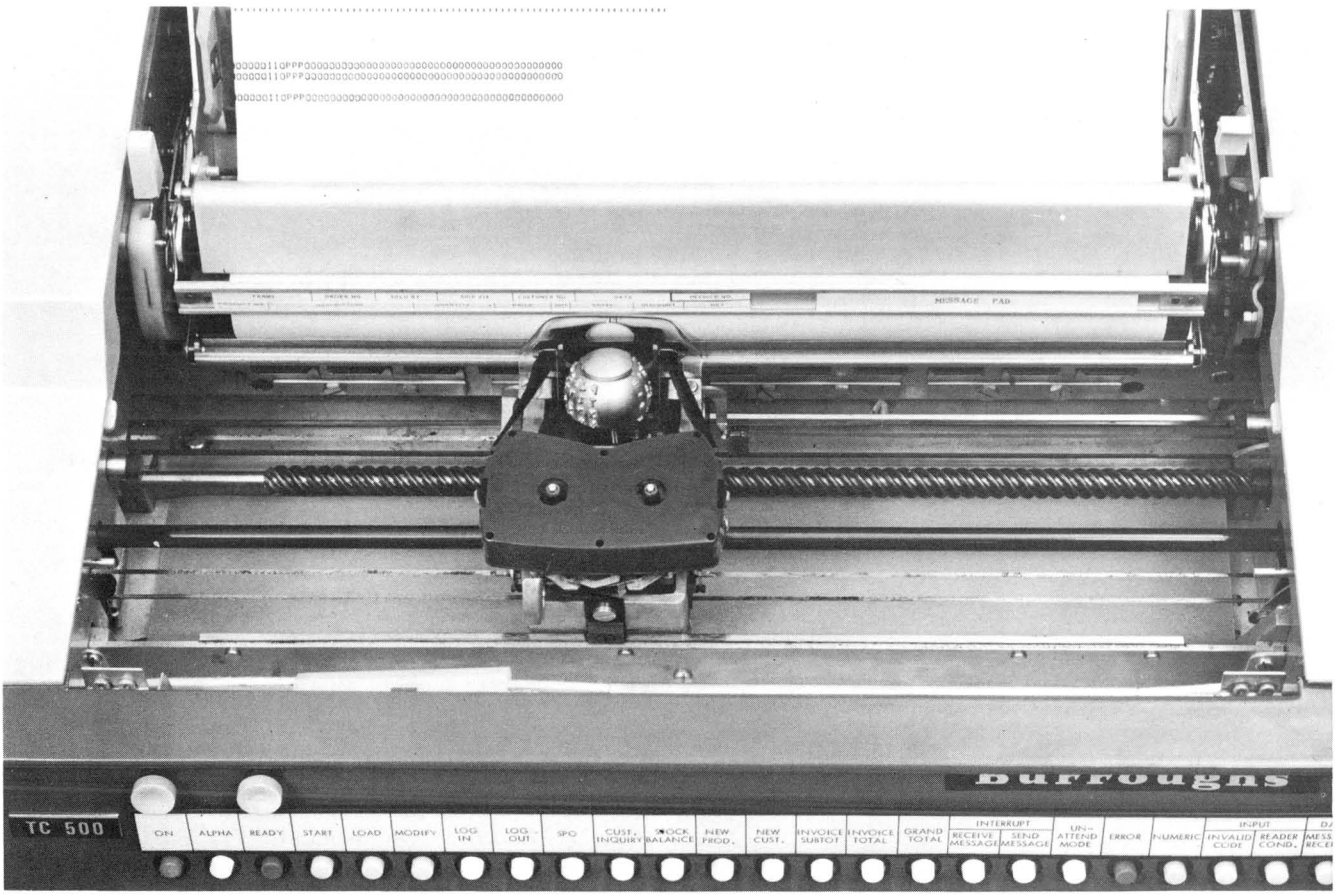


Fig. 6-1 Forms Transport

6.1 VERTICAL SPACING

Standard vertical spacing is in 1/6 inch increments. Vertical spacing may be automatic with a program instruction, or manual by using the platen twirlers, or Keyboard Line Advance key.

Any number of vertical spaces may be programed to occur at one time; or it may be programed to space to any given line on a form. A single space signal received from the computer advances the form one line (1/6") in a maximum of 80 milliseconds. For succeeding spacing, as in multiple spacing, each succeeding line advances in a maximum of 50 milliseconds or at 20 lines per second.

6.2 PLATEN TWIRLERS, RIGHT AND LEFT

The forms may be manually spaced in either direction 1/6 inch by turning the platen twirlers at either end. Fine adjustment of less than 1/6 inch spacing is provided by pressing the button on the end of the left platen twirler inward while turning.

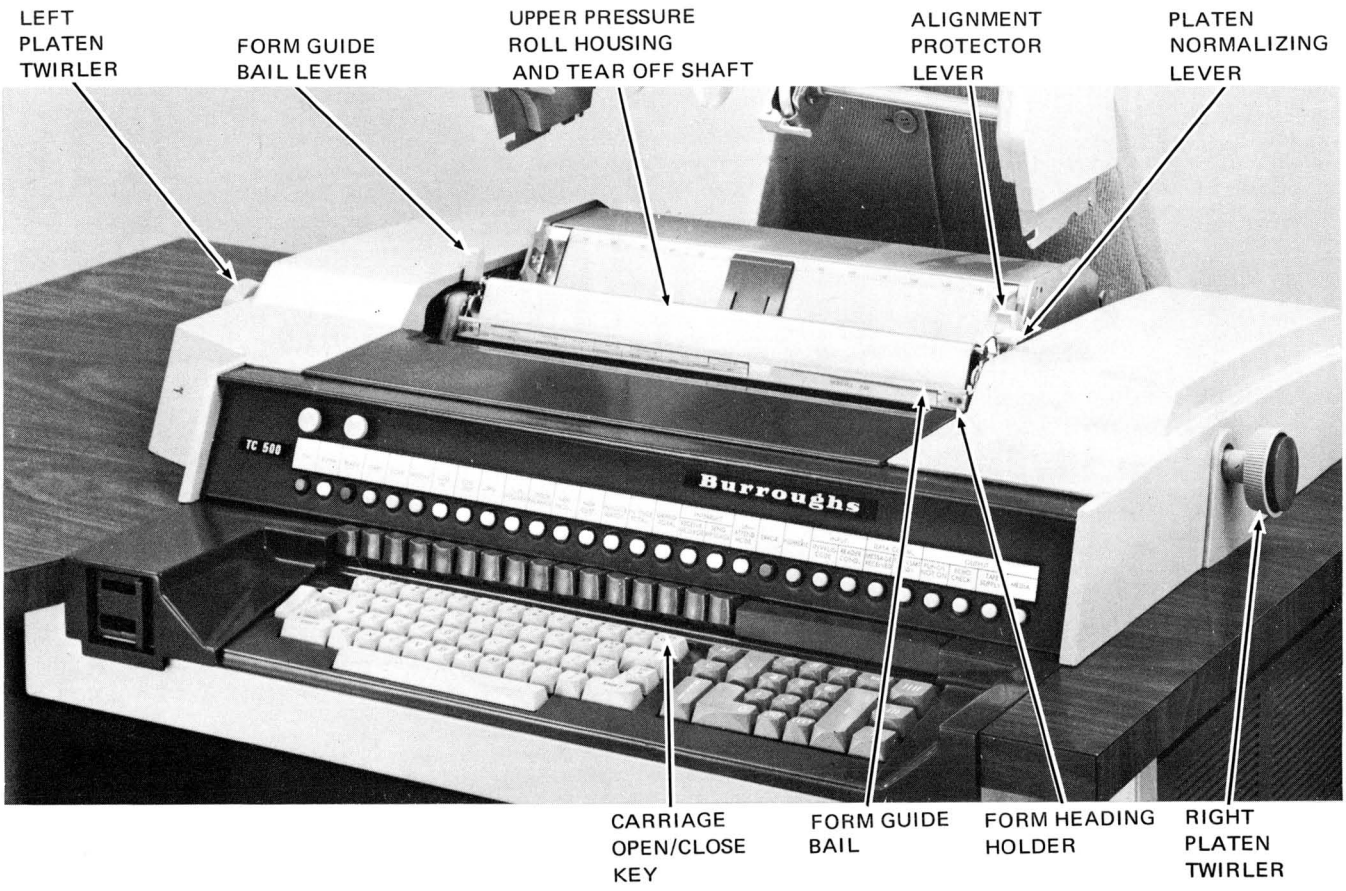


Fig. 6-2 Forms Transport Controls

There is an interlock active when the transport is closed that prevents back spacing the platen manually until 3 form spaces have occured. However, fine adjustment is not prevented.

6.3 PLATEN, SPLIT AND NORMAL

Split and Normal platens are provided to facilitate forms handling flexibility. The standard split location is 11.5" from the left end of the printing line, however, a number of split positions are available. The location of the split is in relation to the print position in that the split is located between print positions; therefore, printing can occur in print positions immediately to the left and immediately to the right of a split without impairment of any printed character.

6.4 PLATEN NORMALIZING LEVER

The Platen Normalizing lever is located on the right end of the transport. Depression of the lever and turning the right platen twirler clockwise (in the direction of paper advance) will couple the platen, and counterclockwise will uncouple the platen. (See fig. 6-2 above)

When the platen is uncoupled (split), both the right and left platen twirlers are variable. The right and left fine adjustment buttons are enabled. When the platen is normalized (coupled), the right fine adjustment button is disabled. The left fine adjustment button is used for adjusting the entire platen.

6.5 FORM LIMIT STOP

When a rear-fed unit document is inserted into the forms transport, the Form Limit Stop limits the document to a given position. From this position the form is spaced as programed to the first printing line. The minimum printing line is approximately 1 1/6 inches from the top of the rear-fed unit document. The last printing line is 7/8 inches from the bottom of the print to the bottom of the form. Alignment to the first printing line is usually accomplished programmatically.

6.6 TRANSPORT OPEN AND CLOSE

From a closed position, the Form Guide Bail and the lower pressure rolls open when either the O/C key is depressed (refer to 3.2.06) or when an Open Transport Instruction is executed. From an open position, the lower pressure rolls close when the O/C key is depressed, when printing occurs, or when a Close Transport Instruction is executed. The Form Guide Bail closes under the conditions described in paragraphs 6.7 and 3.2.06.

6.7 FORM GUIDE BAIL AND FORM HEADING HOLDER

The removable form heading holder contains a plastic insert and is capable of accommodating a paper insert 15/32 inches wide. When the transport opens, the bail will open. When the transport closes, the bail will close after 10 line advances or if the Form Guide Bail Lever is depressed. If the transport and the bail are closed, the bail can be manually pulled to the open position. Subsequent depression of the Form Guide Bail Lever will close the bail if the transport is still closed (lower pressure rolls are closed).

6.8 FORM GUIDE BAIL LEVER

The Form Guide Bail Lever is located on the left end of the platen. The lever pushed rearward causes the form guide bail to close if the form guide bail is open and the transport is closed. If the bail and transport are open, the depression of the O/C key followed by depression of the Form Guide Bail Lever will close the bail.

6.9 ALIGNMENT PROTECTOR LEVER

An Alignment Protector lever is located on the right end of the platen and is used for manually opening and closing the lower pressure rolls. The lever, in the forward position, opens the pressure rolls and holds them open during all operations. The lever, in the rearward position, permits the pressure rolls to close during operations that close the transport and permits the pressure rolls to open during operations that open the transport. The lever must be in the rearward position when a rear-fed unit document is used, and in the forward position if pin feed paper is used.

6.10 UPPER PRESSURE ROLL HOUSING AND TEAR-OFF SHAFT

This mechanism is located above the platen and is manually tilted rearward to permit insertion of roll or cut journals. Once the journal or roll is aligned around the platen properly, the mechanism is restored against the platen by pressing down on it.

When the journal roll is to be torn off, the tear off blade is used, as it is exposed at all times and runs the full length of the platen. The paper is pulled upward against the blade.

6.11 ADJUSTABLE FORM GUIDES, RIGHT AND LEFT

Form Guides, right and left, are provided to insure the square alignment of both single forms and roll journals. They are adjustable and are located on the rear form deflector panel.

6.12 REAR FORM DEFLECTOR PANEL

The Rear Form Deflector panel includes a graduated scale in increments of 1/10th inch from -5 to 155 with the inch graduations marked with numeral markings. The graduation 1 through 150 corresponds to the print positions of the computer.

6.13 ROLL PAPER HOLDER

A removable roll paper holder includes a shaft with right and left adjustable guides. The right and left guides includes a lever to lock the guide in the position it is placed. The guides can be positioned at the extreme right or left edge of the transport or at any point between these extremes. They are easy for the operator to adjust, reposition, or remove. More than one pair of guides may be used.

The roll paper holder can accommodate a roll of paper up to 3½ inches in diameter and from 2¼ inches to 15½ inches in width. The roll paper holder guides permit the inside edges of two adjacent rolls to be located within 5/8 inch of each other.

If roll or cut journal is utilized, it is not feasible to manually insert a rear-fed form in the area of the roll or cut journal. It is permissible to use a roll or cut journal adjacent to a rear feed form. Roll paper or cut journal are inserted from the rear of the transport under and around the platen and under the upper pressure roll. A Journal Roll Deflector prevents the journal (roll or uncut) from rewinding around the platen.

6.14 UNIT FORM DEFLECTOR

The unit form deflector is positioned by a lever located at the inner edge of the right end plate. The lever in the forward position will lower the unit form deflector. The lever should be in this position when stiff unit forms are used. The lever in the rearward poisiton will raise the unit form deflector. The lever should be in this position when flexible unit forms are used.

7. CONTINUOUS FORMS PIN FEED DEVICE

To facilitate handling of continuous forms, a Continuous Forms Pin Feed Device in three styles is available. The pin feed device can be easily removed or attached to the Forms Transport by the operator. It is important to note that when the device is used, it prevents manual insertion of rear fed unit forms.

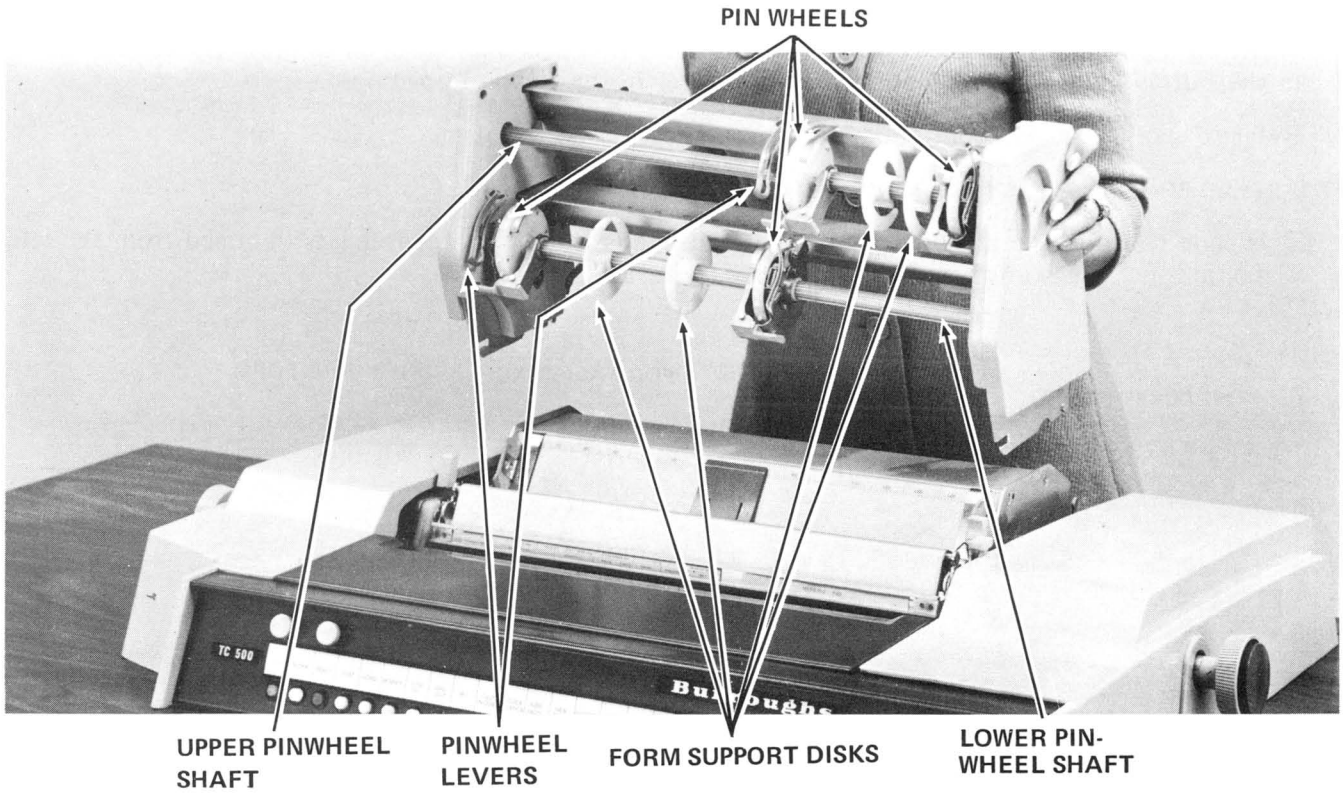


Fig. 7 - 1 Continuous Forms
Pin Feed Device (Dual)

The purpose of the Pin Feed Device is to allow programmatic control over the "slewing" of continuous forms. "Slewing" means to advance the forms several lines at a time automatically; e.g., the advancing of the forms from the last line printed on one form to the first printing line on the next form, or to a specific line on a form from any previous line.

Another very important purpose of the Device is to prevent the forms from "skewing". This is misalignment caused by one side of the form advancing ahead of the other, and results in printing at an angle. Without a positive means of control, forms advanced several lines at a time tend to skew, thus the advantage of using the Pin Feed device.

The Pin Feed Device contains 2 pin wheels upon which the forms are aligned; then a lever is locked down on the forms holding them in place. "Sprocket holes" in the margin of the forms ride over the pins. Thus, control over the spacing of the forms is enabled. The pin wheels are horizontally adjustable on the shaft which permits placement of the forms in any position in the transport. (See fig. 7-1.)

Two removable Form Support Disks are located between the pin wheels on the pin wheel shaft. These can be slid back and forth along the shaft to a position to provide the forms with rigidity and to assure proper advancing of the forms. (See fig. 7-1.)

A Form Aligning Table is located above the pin wheels and is graduated in 1/10 increments from a -4 to 154 with numeral markings at each inch position. The scale is used to locate the form in accordance with the print positions. (See Fig. 7-2.)

A removable Tear-Off Blade is provided as an optional feature.

The pin feed device may be used with a solid platen or with a split and normal platen, as desired.

When the Continuous pin feed forms device is used, it is necessary to open the lower pressure rolls in the Forms Transport (Alignment Protector lever in the forward position)

Refer to section 8.2 for continuous forms specifications.

7.1 STYLE PF 1, SINGLE, SYNCHRONOUS PIN FEED DEVICE

This style controls one marginally punched continuous form. Form spacing is obtained from the left platen advance mechanism and is synchronous with the platen.

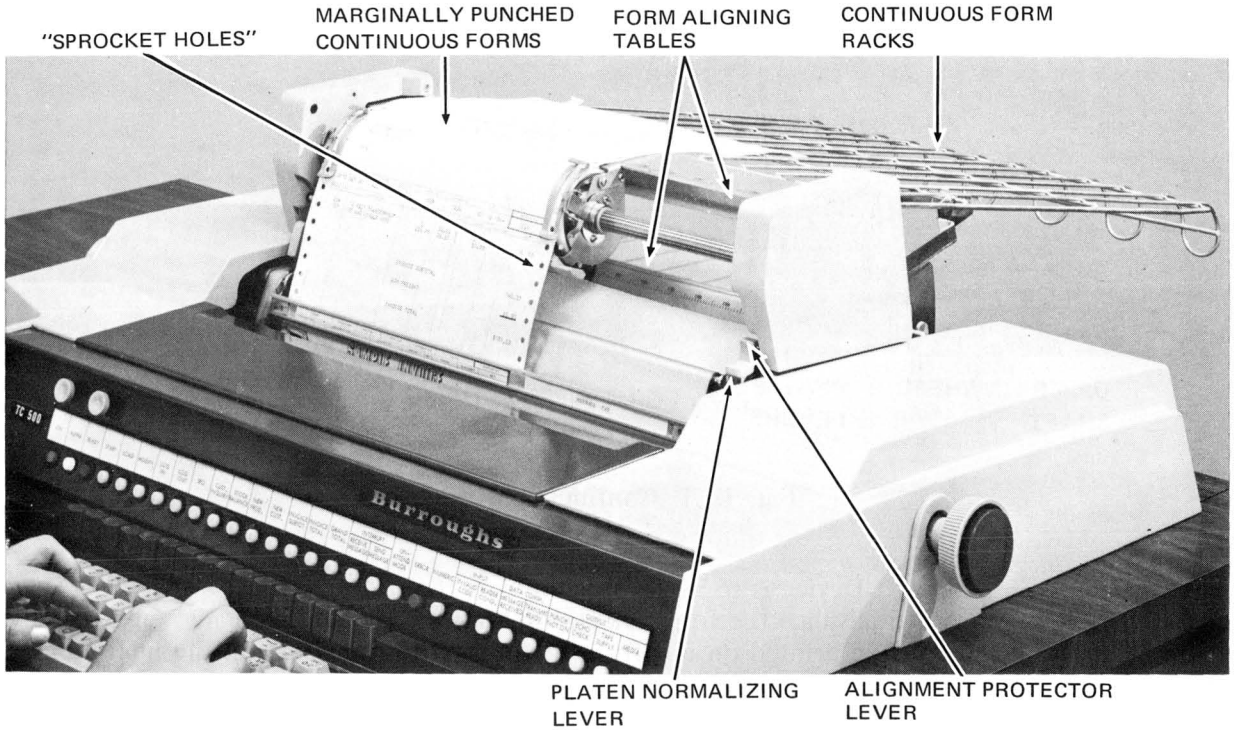


Fig. 7 - 2 Single Pin Feed Device

Vertical spacing is by program instruction. It is not necessary for the forms to physically be on the left side of the Pin Wheel Shaft to be activated by the left spacing instruction; The forms may be located anywhere along the shaft. The number of spaces to advance is specified as part of the program instruction. (See Part II, Section 4.)

This configuration includes one set of continuous form racks (upper and lower) which are removable and one set of snap-on Continuous Form Guides (right and left) which are located on the lower continuous form rack. (See Fig. 7-8.)

The illustration below indicates the spacing action when either a solid platen or a split and normal platen is used with the single, synchronous pin feed device. To cause the pin feed to space, an advance left platen instruction must be programed; an instruction for right to space will not have effect.

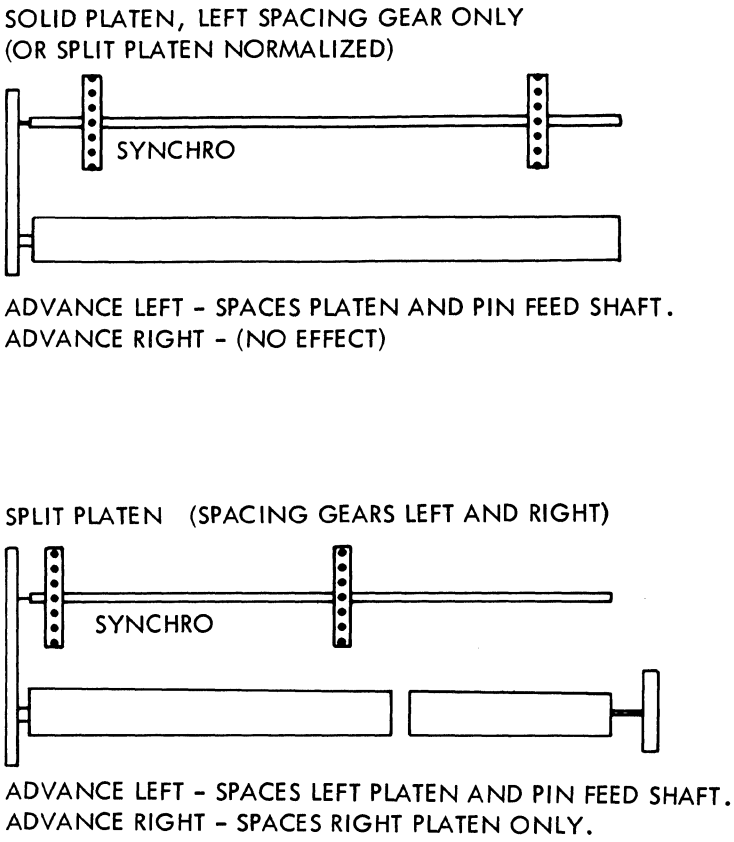


Fig. 7 - 3 Single Synchronous Spacing

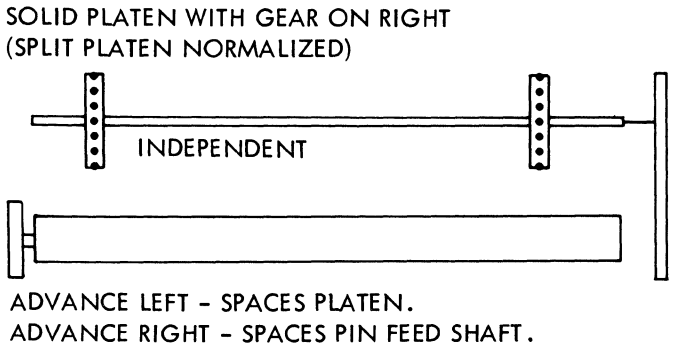
7.2 STYLE PF 2, SINGLE, INDEPENDENT PIN FEED DEVICE

The Style 2 is basically the same as Style 1 except for the following:

Form spacing is obtained from the right platen spacing mechanism.

With the solid platen form advance is independent of platen movement. If a Split platen is used, the continuous forms device will space synchronously with the right platen, independent of the left platen.

If the split platen is normalized (joined to make a solid platen), an "Advance Right" instruction will space only the pin feed device, while an "Advance left" instruction will space the entire platen but not the pin feed device.



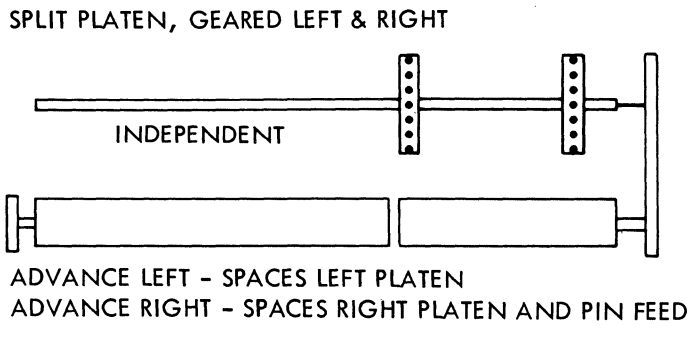


Fig. 7 - 4 Single Independent Spacing

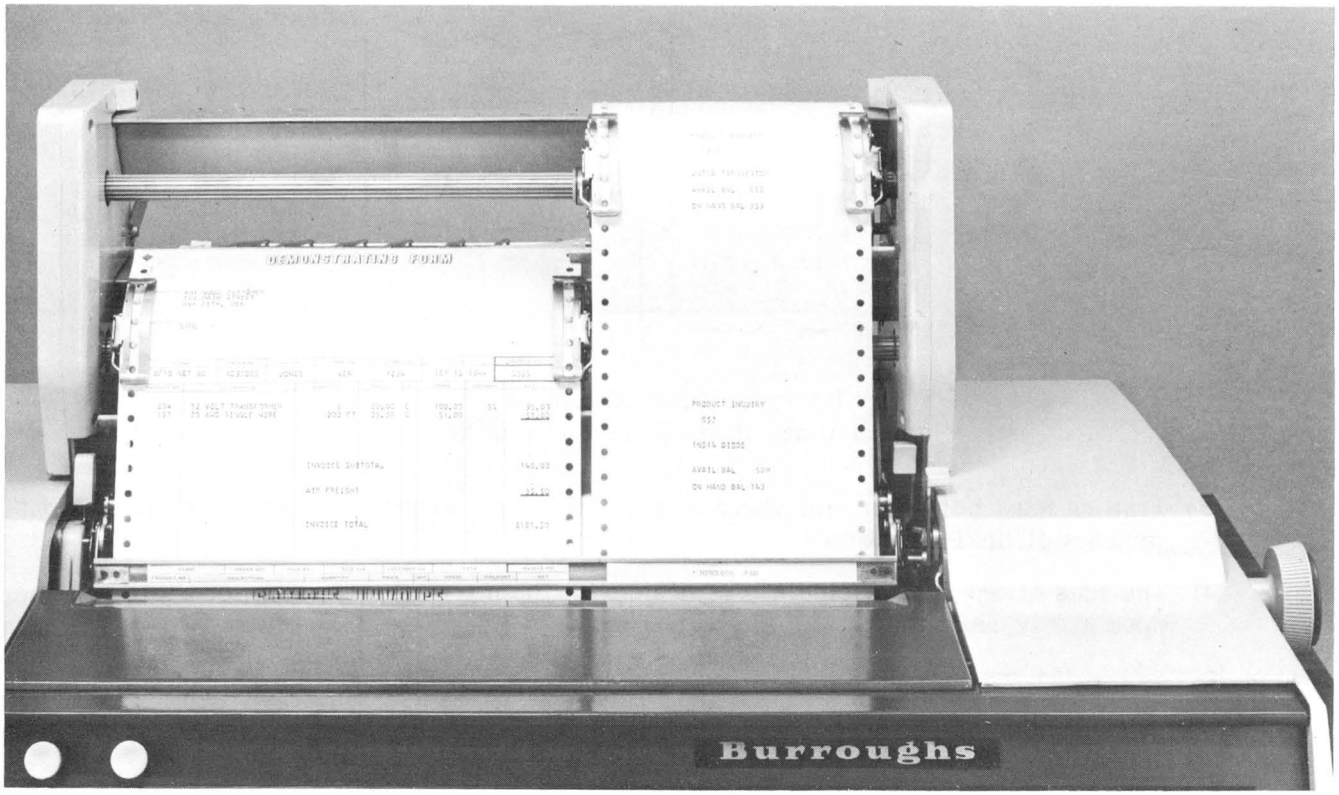


Fig. 7 - 5 Dual Pin Feed Device

7.3 STYLE PF 3, SYNCHRONOUS AND INDEPENDENT DUAL PIN FEED DEVICE

The Style 3 pin feed device includes both Style 1 and Style 2 mechanisms and provides control of 2 separate marginally punched continuous forms.

The two devices utilize two sets of pin wheel assemblies on separate shafts; one is located above the other.

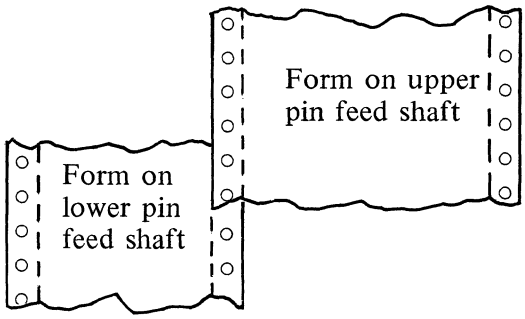
Form spacing (synchronous) is obtained from the left platen advance mechanism. Form spacing (independent) is obtained from the right spacing mechanism.

The dual pin feed device allows great flexibility of forms placement, two separate forms may be located in any area along their respective pin wheel shafts subject to the following considerations:

A) Overlapped forms:

1) Forms may be overlapped so long as the total thickness of both forms is within the specified thickness limit of .035" (see section 8.2).

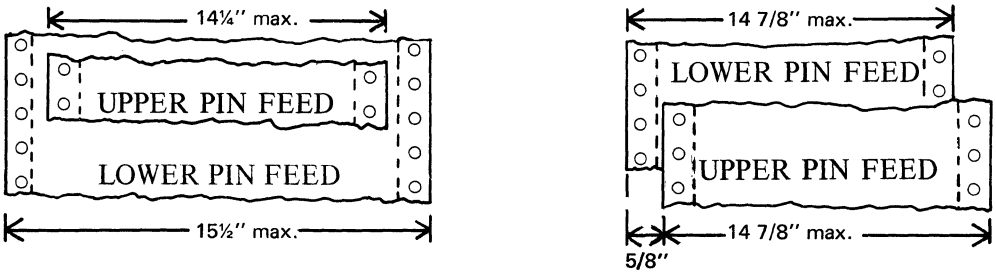
2) When overlapped, the marginal punched holes centerline of the upper form must be at least 5/8" from the marginal punched holes centerline of the lower form. Otherwise, the upper form may become obstructed by a lower pin wheel.



Improper forms placement;
Centerlines of margins directly in line

3) Printing must not occur in the area of the upper form which is directly over the marginal punches of the lower form.

4) The edge of one form should not coincide with the marginal perforation of another form, since it may cause the perforation to tear apart.



Maximum overlapping of forms; Note that maximum sizes do not necessarily correspond to standard sizes available from printing companies.

B) Side by side forms:

The edge of one form should not be exactly flush with the edge of the other form. This condition may cause the advancing of one form to cause drag on and misalignment of the other form.

Two sets of Continuous Form Racks are provided:
The lower set is used for Style 1 (Synchronous).
The upper set is used for Style 2 (Independent).

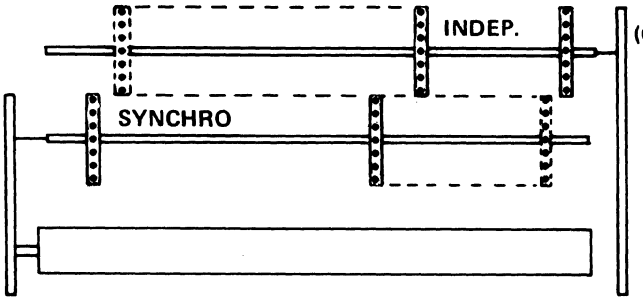
Two sets of Continuous Form Guides are provided.

Four Form Support Disks and Two Form Aligning Tables are provided.

The Tear-Off Blade which is removable (optional) is located on and for the upper pin feed device.

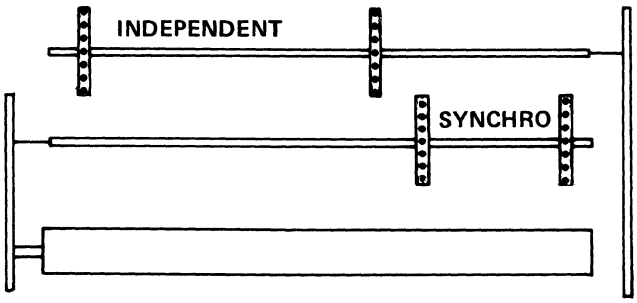
NOTE: When Style 2 (upper set) Continuous Form Racks are used for continuous pin feed forms, then a roll journal cannot also be used.

SOLID PLATEN WITH SPACING GEAR ON RIGHT,
(SPLIT PLATEN, DISABLED)

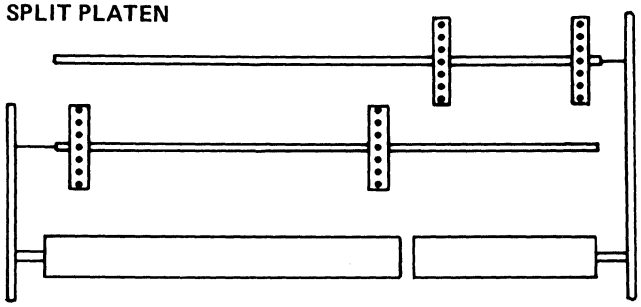


ADVANCE LEFT – SPACES PLATEN AND LOWER PIN FEED SHAFT.
ADVANCE RIGHT – SPACES UPPER PIN FEED SHAFT ONLY.

OR:



SPLIT PLATEN



ADVANCE LEFT – SPACES LEFT PLATEN & LOWER PIN FEED SHAFT.
ADVANCE RIGHT – SPACES RIGHT PLATEN & UPPER PIN FEED SHAFT

Fig. 7 - 6 Dual Pin Feed, Synchronous and Independent Spacing

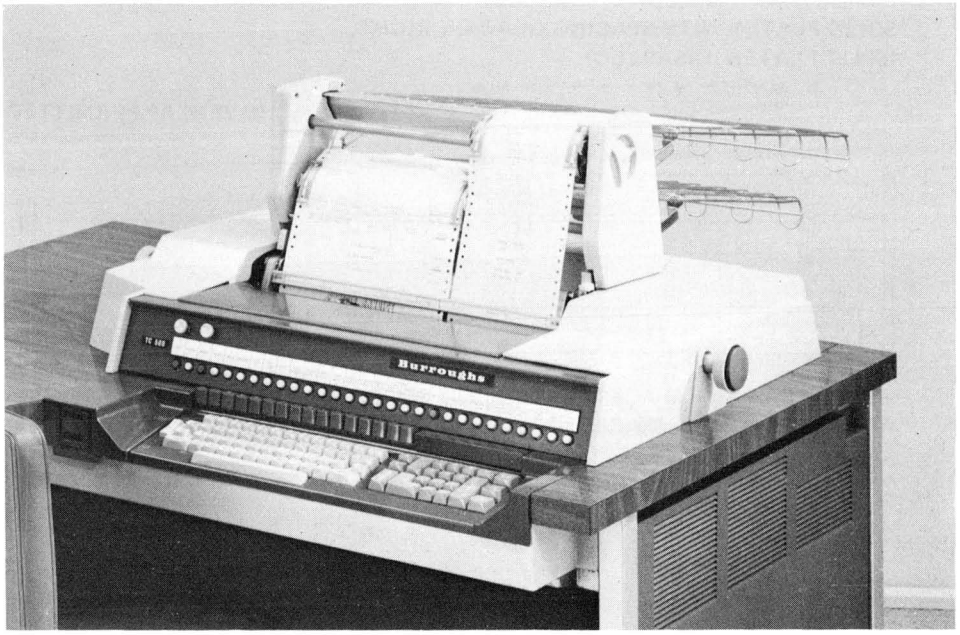


Fig. 7 - 7 Dual Pin Feed Device (Front View)

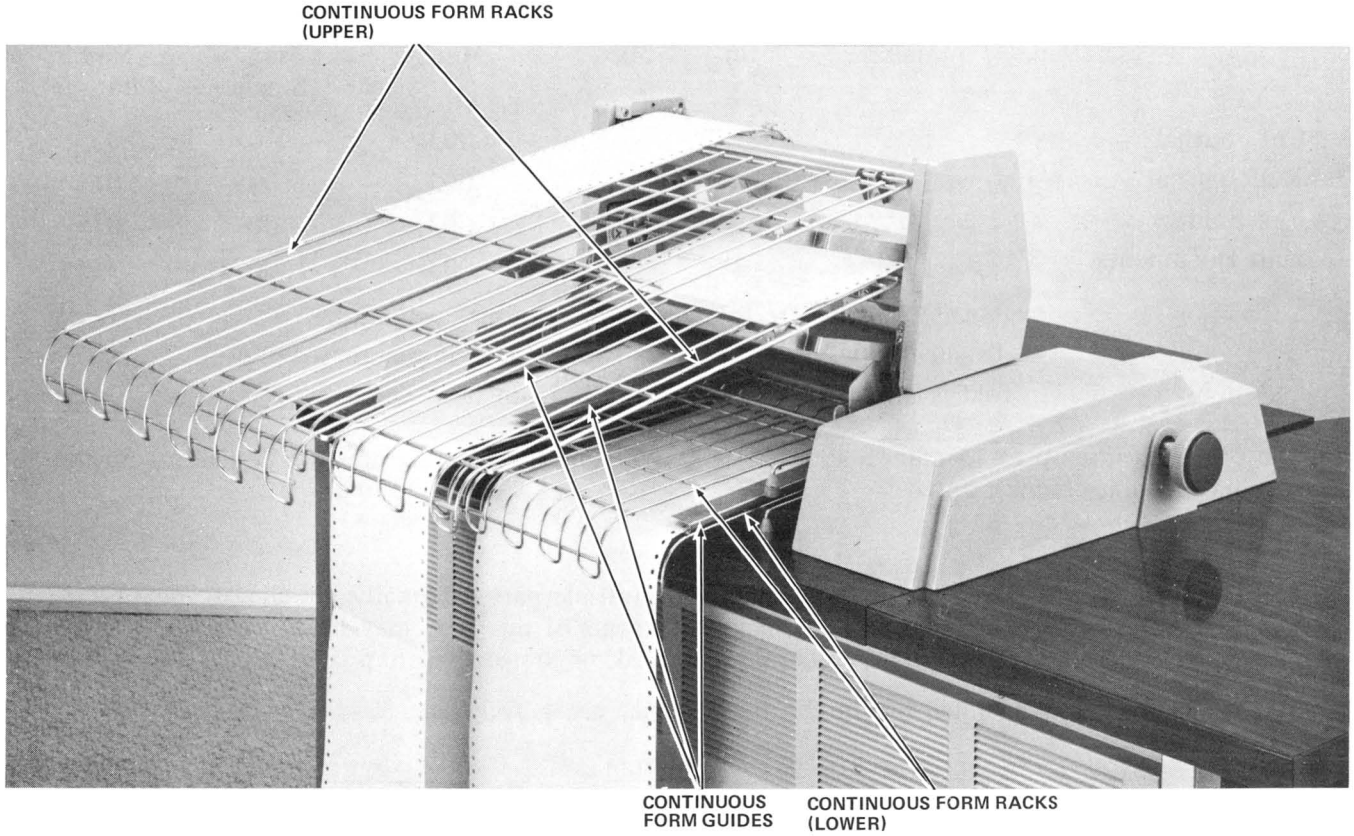


Fig. 7 - 8 Dual Pin Feed Device (Rear View)

8. FORMS CHARACTERISTICS

8.1 FORMS TRANSPORT

The forms transport is capable of receiving, holding, advancing, and releasing single and multiple forms of various lengths and widths, ranging in thickness from a minimum of .003 inch to a maximum of .045 inch.

The forms transport is capable of accommodating, at the same time in two areas, variations of forms ranging from a minimum of .003 inch to a maximum of .045 inch.

The forms dimensions handled by the forms transport are as follows:

Type of Form	Width		Length		Thickness		
	Min.	Max.	Min.	Max.	Min.	Max. Single	Max. Multiple
Cut Journal	3"	15½"	8½"	–	.003	.005	.029
Roll Journal	2¼"	15½"	diameter	3½"	.003	.005	.012
Fan Fold	4"	15½"	3½"	11*	.003	.0075	.035
Unit Documents	3"	15½"	3"	–	.003	.0075	.045

* Fan Fold forms are folded on perforations. Minimum distance between perforations is one inch; minimum fold is 7 inches; maximum fold is 11 inches.

The printer prints up to 15 copies, automatically adjusting the printing pressure depending on the number of copies being printed.

8.2 PIN FEED DEVICE

The Pin Feed Device can accommodate single and multiple part marginally punched forms of varying length, width, composition and thickness. Forms of this type may be of continuous strip or fanfold construction. Individual sets may be glued, or joined by crimp or stapled.

The form dimensions handled by the Pin Feed Device are as follows:

	Minimum	Maximum
* Copies	1	15
Width (including Margin)	5¾"	15½"
Fold	7"	11"
Thickness	.003"	.035"
Hole diameter (nominal)	5/32"	
Hole centers (nominal)	½"	
Edge of paper to center of hole	¼"	
Edge of paper to the perforation	½"	

* The maximum number of forms is not restricted to the number specified, but by the maximum thickness of the multiple part form. Another consideration is the durometer hardness of the platen. (See optional features)

9. OPTIONAL FEATURES

The following optional features are available on the TC 500 Computer:

9.1 DESK TOP

A gray desk top may be substituted for the standard walnut finished desk top.

9.2 GUIDE FOR UNIT TICKETS

The Unit Ticket Guide clips on to the rear of the form guide bail and form heading holder. It permits a single line of posting ½ inch from the bottom of the form to the bottom of the line of print. The Unit Ticket is inserted behind the form heading holder and in front of the Printer carrier print line indicator and limits on the ledge of the form deflector.

The Printer carrier must always be in the area of the unit ticket when inserting or removing the unit ticket. The movement of the Printer carrier must be restricted so that it is always supporting the unit ticket as long as the ticket is in the forms transport.

Before inserting the unit ticket, the transport and Forms Heading Holder must be closed.

The minimum height of the unit ticket is restricted to 2½ inches.

9.3 PLATEN DUROMETER HARDNESS (EITHER SOLID OR SPLIT PLATEN)

When using multiple part forms, the print quality is determined by the type of paper and carbon used and the platen hardness. If the basic platen is not adequate to provide the required print quality, (55 Shore D scale), two different platen hardness options are available, 65 and 80 (Shore D scale).

9.4 JOURNAL ROLL GUIDES

Optional journal roll guide sets are available. The additional guides will accommodate a second roll paper in the forms transport.

9.5 LEGEND STRIP HOLDER

Optional legend stripes of paper and plastic (clear) inserts are available.

9.6 PROGRAM TAPE CARTRIDGE - STYLE PC 1 (CONTINUOUS LOOP)

Refer to topic 5.7

9.7 CONTINUOUS FORMS PIN FEED DEVICE

Refer to section 7

9.8 ELECTRICAL TRANSFORMERS, VARIOUS VOLTAGE AND CYCLES

Refer to topic 10.2

10. DIMENSIONS, ELECTRICAL AND ENVIRONMENTAL SPECIFICATIONS

10.1 DESK DIMENSIONS

HEIGHT — 29 7/8 inches — floor to upper surface of desk top.

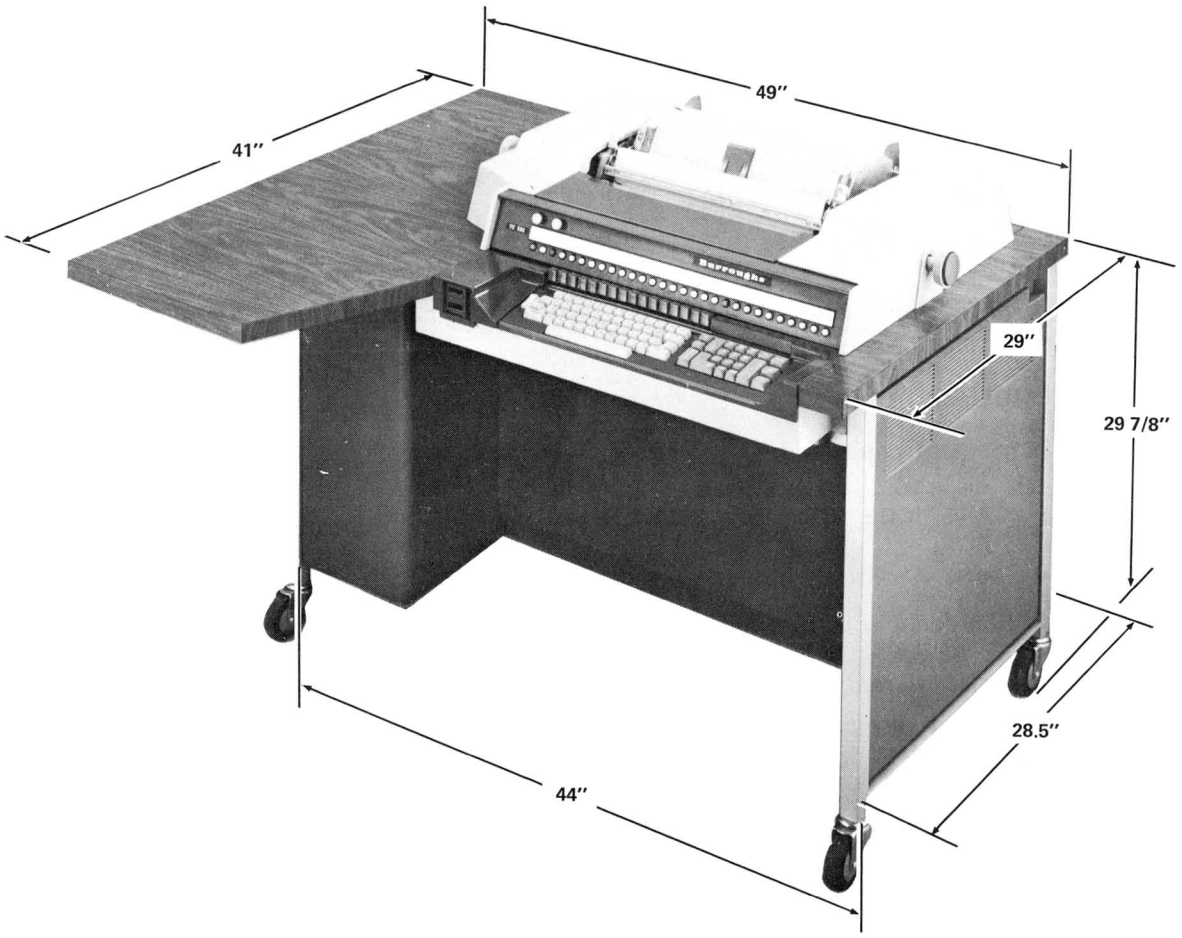
DEPTH — 28.5 inches – from each end of frame, front to back.

WIDTH – 44 inches – from each end of frame, side to side.

DESK TOP – 1¼ inches thick – 49 inches wide – depth, left end is 41 inches, right end is 29 inches (see diagram below)

CASTERS – Four casters, 3 inches in diameter are provided.

WEIGHT – System weighs approximately 400 pounds.



10.2 ELECTRICAL SPECIFICATIONS

The standard electrical specification is 120 volts (range 107 - 127), 60 cycle with a frequency variation of + or - 1%.

Approximately 8 amperes are required for a System with an 80 column Card Reader, Paper Tape Punch and/or Reader.

A three wire non-detachable line cord, 8 feet 6 inches external length, with NEMA wall plus is furnished.

If other than the standard 120 volt, 60 cycles, current is required, one of two types of constant voltage transformer and one type of auto transformer are available:

10.2.01 Constant Voltage Transformer: (Optional Feature)

Voltage		Cycles	
Nominal	Range	Nominal	Range
100	90 - 105	60	±1%
110	99 - 115.5		
115 or 120	103.5 - 126		
127	114 - 133		
208	193 - 220		
220	198 - 231		
230	207 - 244		
240	214 - 254		

10.2.02 Constant Voltage Transformer: (Optional Feature)

Voltage		Cycles	
Nominal	Range	Nominal	Range
100	90 - 105	50	±1%
110	99 - 115.5		
115 or 120	103.5 - 126		
127	114 - 133		
208	193 - 220		
220	198 - 231		
230	207 - 244		
240	214 - 254		

10.2.03 Auto Type Transformer: (Optional Feature)

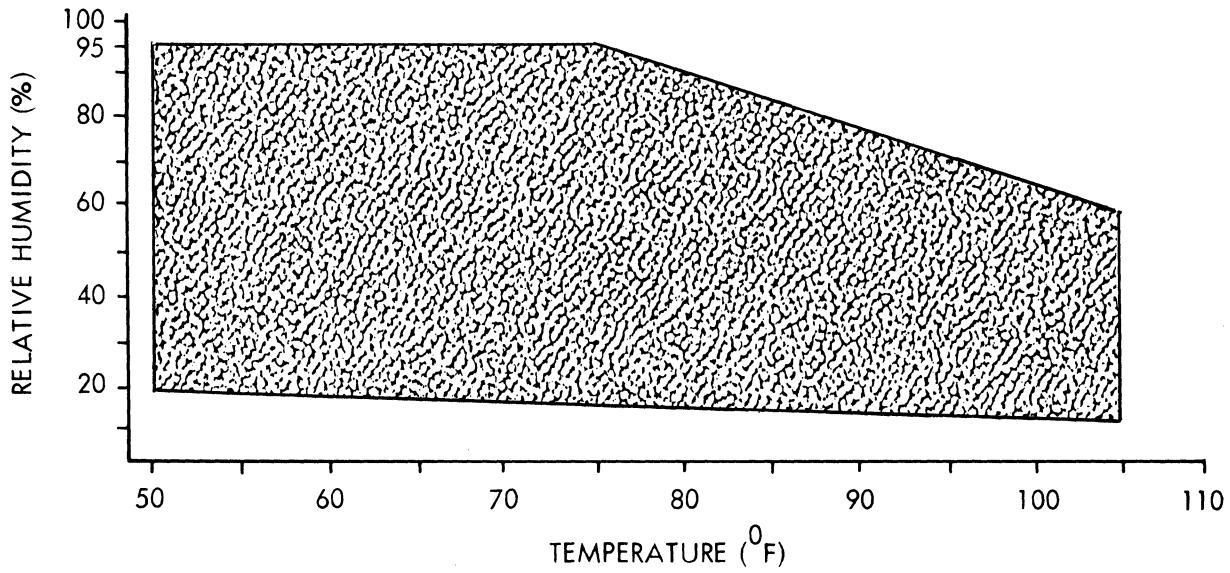
Voltage		Cycles
Nominal	Range	Nominal
100	90 - 105	50/60
110	99 - 115.5	
115	103.5 - 121	
120	108 - 126	
127	114 - 133	
208/220	193 - 231	
230	207 - 244	
240	214 - 254	

10.3 ENVIRONMENTAL CONDITIONS - OPERATING

The System is operable within the ranges of the environmental conditions specified in the following paragraphs:

Temperature		Relative Humidity	
Minimum	50°F,	Minimum	5%
Maximum	105°F.	Maximum	95%

The relative humidity may vary from minimum to maximum within the temperature range shown except that humidity changes from one extreme of the operating range to the other may not be made in less than 4 hours.



Temperature and Humidity Operating Range

Barometric Pressure

32 to 20.58 inches of mercury (sea level to approximately 10,000 feet altitude).

10.4 ENVIRONMENTAL CONDITIONS - NON-OPERATING

As long as the System is not being operated, the following Environmental conditions may exist. Mode of shipment or storage may be affected by these conditions:

Temperature		Relative Humidity	
Minimum	-50°F.	Minimum	5%
Maximum	160°F.	Maximum	100%

Barometric Pressure

32 to 8.88 inches of mercury (sea level to approximately 30,000 feet altitude).

11. PUNCHED PAPER TAPE/EDGE PUNCHED CARD READERS

11.1 A 581 PUNCHED PAPER TAPE/EDGE PUNCHED CARD READER

The A 581 Punched Paper Tape/Edge Punched Card Reader is a small, compact, free standing unit which may be cable-connected to any TC 500 that has Input and Output (I/O) capability. Hereafter, it will be referred to as the "Paper Tape" or "Tape" Reader. It has the ability to read 5, 6, 7 or 8 channel codes based upon a table of code assignments that may be loaded into the memory as a part of the Program Load procedure. In addition, 5 channel code requires separate firmware. The Tape Reader operates at a speed of up to 40 codes per second.

The power for the Tape Reader is provided by the TC 500 System.

The Tape Reader can be a field addition to any TC 500 with I/O capabilities.

11.1.01 General Description

The Style A 581 Paper Tape Reader provides automatic input to the TC 500 System by either paper tape (roll, strips, or fan-fold) or edge punched cards (individual or fan-fold). Reading is enabled when a Read instruction is programed in the TC 500, provided the proper Reader conditions are present. (See 11.1.03, 11.1.05, 11.1.07.)

The alignment of the feed path is on a flat, horizontal (to the desk top) plane and feeding of tape or card is from right to left. The feeding mechanism permits reading codes at the first and last full sprocket hole from the leading and trailing edge of the card. Alternate use of tape or cards is possible without modification of the reader. However, programing may vary.

A malfunction occurring on the Tape Reader that might cause the Reader to become inoperable does not prohibit continued operation of the system with other adjuncts.

11.1.02 Controls

The controls consist of four control keys.

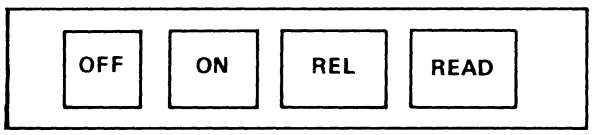


Fig. 11 - 1 PPT/EPC Reader Control Panel

11.1.03 Power On Key

The Power On key is marked "ON". When it is depressed, it turns on power to the Reader and illuminates the read station light.

When a read instruction has been initiated and the Reader power is off, execution of the instruction is halted, the "Reader Condition" indicator light on the TC 500 keyboard is turned on and Reader Condition Flag is set. If power is then turned on and the Read key (see 11.1.06 below) is depressed, it permits the instruction to be executed (other Reader conditions permitting) and the Reader Condition light and flag are turned off and reset respectively.

11.1.04 Power Off Key

The Power Off key is marked "OFF". When it is depressed, it will turn the power off and extinguish the Read Station Light. Turning power off to the Reader does not affect the system until the next Read instruction is initiated. At that time, the Reader Condition indicator light on the TC 500 keyboard would be turned on and Reader Condition Flag would be set (see 11.1.03 above).

11.1.05 Media Clamp Release Key

The Media Clamp Release key is marked "REL". When depressed, it releases the media clamp which holds the paper tape or Edge Punch card in position.

When a read instruction has been initiated and the Media Clamp is open, reading is prevented, the "Reader Condition" indicator light on the TC 500 keyboard is turned on, and Reader Condition Flag is set. Closing the media clamp and depression of the Read key permits execution of the read instruction which will then turn off the Reader Condition light and reset Reader Condition Flag.

11.1.06 Read Key

The Read key is marked "READ". If a "media not present", "media clamp open", or "power off" condition exists on a read instruction, reading is prevented. If the condition is then corrected, depression of the Read key will permit execution of the read instruction.

11.1.07 Media Not Present Detector

This device detects the absence of media in the Reader when a read instruction has been initiated. It will cause the Reader Condition indicator light on the TC 500 keyboard to illuminate and will set Reader Condition Flag. The system remains in a read cycle until the condition has been corrected (see 11.1.06 above). When media is put in position and the media clamp is closed, a depression of the Read key permits reading and causes the Reader Condition light to be turned off and Reader Condition Flag to be reset.

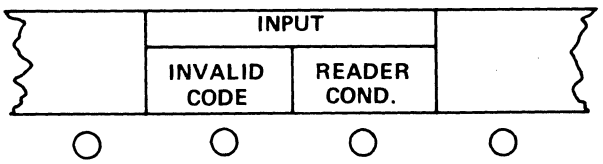


Fig. 11 - 2 TC 500 Keyboard Indicator Lights for Input Adjuncts

11.1.08 Invalid Code

When reading punched paper tape or edge punched cards, the system will detect an invalid code. If an invalid code occurs, the Invalid Code indicator light on the TC 500 keyboard is turned on and Reader Invalid Code Flag is set; however, reading is not inhibited. The Invalid Code light remains lit until the next read instruction at which time it is turned off, or until Reader Invalid Code Flag is reset by the user program.

11.1.09 Media Clamp

The Media Clamp is a device which holds the card or tape firmly against the alignment table when closed. It is manually closed. It may be opened by programing or by the Media Clamp Release key (see 11.1.05).

When a read instruction has been initiated and the Media Clamp is open, reading is prevented, the Reader Condition indicator light is turned on, and Reader Condition Flag is set. The closing of the clamp and depression of the Read key permits execution of the read instruction which then turns off the Reader Condition light and resets Reader Condition Flag.

11.1.10 Tape Feed Wheel

The Tape Feed Wheel is used to manually advance or backspace the paper tape or edge punched card. It is located on the right side of the Reader.

To engage the tape feed wheel with the feed sprocket requires depressing the wheel. The wheel may be turned in either direction: Turning the wheel to the rear (clockwise) will advance the media. Turning the wheel to the front (counterclockwise) will backspace the media.

11.1.11 Read Station

Reading is accomplished by a photoelectric device (using solar cells) and reads frame by frame. The frame in the read station and two frames to the left and two frames to the right of the read station are visible to the operator. In the event of a burnt out bulb in the reading device, the Reader Condition indicator light on the TC 500 keyboard is turned on, and reading and feeding are halted.

11.1.12 Tape System

A supply and rewind mechanism is provided for roll paper tape (refer to optional features). The spindle of the supply mechanism accommodates up to an 8-inch reel or an inside-out cone feeder.

A power driven take-up reel is also provided. The reel may be from 5 to 8 inches in diameter. A roll of paper tape may be removed from the reel without having to remove the reel itself. The reels accommodate tape widths of 11/16 (.686) inch to 1 inch.

When the supply and take-up mechanism is used, it does not in any way interfere with the use of strip tape or edge punched cards.

11.1.13 Tape Guide

The tape guide is located on the right side of the unit. The guide is adjustable and is used when reading punched paper tape.

11.1.14 Edge Punched Card System

Insertion and alignment of edge punched cards is manual and can be accomplished with one hand. Alignment is to a fixed limit.

The Tape Reader will accommodate individual and continuous fan-fold edge punched cards in widths from 3 inches to 5 inches. Fan Fold EPC must have the leading edge trimmed for proper alignment in the reader.

The feeding mechanism permits the reading of codes at the first and last full sprocket holes from the leading and trailing reference edges of the card.

Individual edge punched cards are readable for 500 card passes without deterioration to the card caused by the reader mechanism.

11.1.15 Card Guide

The card guide is located in the front and on the right side of the unit. The guide is used when reading edge punched cards.

11.1.16 Dimensions

The Reader dimensions are as follows:

Width	9.2 inches
Length	11 inches
Height	7 inches
Weight	15 pounds (approximate)

11.1.17 Environmental Conditions

The environmental conditions are the same as specified in Section 10 of this manual for the basic System.

11.1.18 Electrical Specifications

Power for the adjunct is obtained from the TC 500 System, with a cable 9 feet in length. The cable is non-detachable from the reader, and requires service to connect it to the TC 500.

The standard electrical specifications are 120 volts, (range 107-127), 60 cycles -1% frequency variation (A reader used with a TC 500 with 50 cycles requires 50 cycles, also).

11.2 OPTIONAL FEATURES

11.2.01 Edge Punched Card Support

If edge punched cards in excess of 5" wide are required, this optional support is available, and provides for cards up to a width of 11 inches.

11.2.02 Tape Supply and Take-Up Reel

A tape supply and power driven take-up mechanism for reel tapes is provided as an option to the basic Reader. The supply spindle accommodates up to an 8" diameter reel, or an inside-out cone feeder. The take-up mechanism accommodates reels from 5.5" to 8" in diameter. Tape widths from 11/16" to 1" are permitted.

11.3 PUNCHED PAPER TAPE AND EDGE PUNCHED CARD MEDIA SPECIFICATIONS

The A 581 Tape Reader is capable of feeding and reading any of the types and sizes of paper tape and edge punched cards produced by the A 562 Paper Tape Perforator. Refer to subject 12.5 for complete specifications. Paper Tape or Cards produced by other equipment may be read if it meets the specifications listed in subject 12.5.

12. PUNCHED PAPER TAPE/EDGE PUNCHED CARD PERFORATORS

12.1 A 562 Punched Paper Tape/Edge Punch Card Perforator

The A 562 Punched Paper Tape/Edge Punch Card Perforator is a small free standing unit which may be cable connected to any TC 500 System that has Input and Output (I/O) capability. Hereafter, it is referred to as a "Paper Tape" or "Tape" Perforator. It has the ability to punch any 5, 6, 7, or 8 channel code based upon a table of code assignments that may be loaded into memory as a part of the program load procedure. In addition to the table, 5 channel code requires separate firmware.

The Paper Tape Perforator operates at a speed of up to 40 codes per second. The power for the Tape Perforator is provided by the TC 500 System. The Tape Perforator can be a field addition to any TC 500 with I/O capabilities.

12.1.01 General Description

The A 562 Tape Perforator provides automatic output from the TC 500 by punching either paper tape or edge punched cards. The basic tape perforator will accept paper tape, or edge punched cards 3 inches to 5 inches in width. The paper path through the perforator is from left to right and perpendicular to the table top. Alternate use of tape or cards is possible without modification of the perforator. However, programing may vary.

The feeding mechanism permits significant codes to be punched at the first full sprocket hole from the referenced leading edge of the card and the last full sprocket hole from the trailing edge of the card.

The fact that the Tape Perforator is inoperable (power off, etc.) does not prohibit continued operation of the system with other adjuncts.

12.1.02 Control Panel

The control panel is located on the left side of the perforator and contains an indicator lamp and 4 control keys as shown in the following illustration:

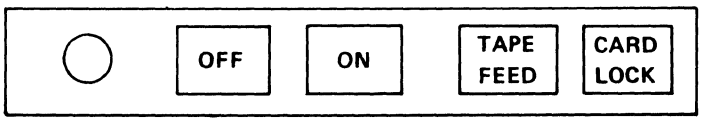


Fig. 12 - 1 PPT/EPC Perforator Control Panel

12.1.03 Power On Indicator Lamp

The Power On indicator lamp color is natural and is illuminated when power is turned on.

12.1.04 Power On Key

The Power On key is marked "ON". When depressed it turns power on to the Adjunct and illuminates the indicator lamp.

12.1.05 Power Off Key

The Power Off key is marked "OFF". When depressed, it turns power off to the adjunct and extinguishes the indicator lamp.

If the power is off and a punch instruction is programed, the punching is inhibited, the "Punch Off" indicator lamp on the TC 500 keyboard is illuminated, and Punch Off Flag is set. If the power is then turned on, the "Punch Off" lamp on the TC 500 keyboard remains on. On the next punch instruction the lamp is extinguished and Punch Off Flag is reset.

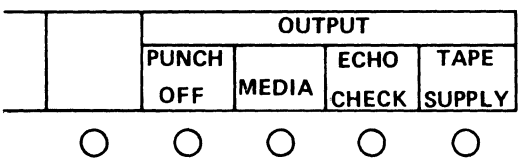


Fig. 12 - 2 TC 500 Keyboard Indicator Lights For Output Adjuncts

12.1.06 Tape Feed Key

The Tape Feed key is marked "TAPE FEED". If the key is depressed it will cause continuous punching of sprocket holes until it is released. It will operate only when power is on. This function can be modified to permit the tape feed key to punch any combination of contiguous codes in the tape feed punch cycle (rather than only sprocket holes) if desired.

12.1.07 Card Lock Key

The Card Lock Key is marked "CARD LOCK". To correct a "Media not present" condition requires that a card be placed in the punch station and the depression of the card lock key. This permits the execution of the punch instruction. (See Edge Punched Card Detector, Section 12.1.09) which turns off the "Media" indicator lamp on the TC 500 keyboard and resets Punch Media Flag.

12.1.08 Tape Presence Detector

This device detects the absence of paper tape when a punch instruction has been initiated. It causes the "Media" indicator lamp on the TC 500 keyboard to be illuminated and sets a Punch Media Flag. The system remains in a punch cycle until the condition has been corrected. When the condition is corrected, punching is permitted, the "Media" indicator lamp is extinguished and Punch Media Flag is reset.

12.1.09 Edge Punched Card Detector

This device detects the absence of an edge punched card on a punch instruction and illuminates the "Media" indicator lamp on the keyboard of the TC 500. The system remains in a punch cycle until the condition has been corrected. (See Card Lock Key, Section 12.1.07.) When an edge punched card is present, the punching of sprocket holes is inhibited.

12.1.10 Echo Check

The Echo Check features assures that the data transmitted from the TC 500 to the punch is the same as that punched. If it is not the same, the Echo Check indicator lamp on the TC 500 is illuminated and Punch Echo Flag is set. The Echo Check feature will not detect a broken punch pin.

Echo Check will not inhibit the punch instruction. The Echo Check indicator lamp remains illuminated until Punch Echo Flag is reset by the user program.

12.1.11 Tape Supply Detector

This device warns the operator that the tape is nearing depletion (approximately 20 feet of tape remains). The "Tape Supply" indicator lamp on the keyboard of the TC 500 is illuminated and Punch Tape Supply Flag is set. This condition does not prevent punching. When the condition has been corrected, the next punch instruction causes the Tape Supply indicator lamp to be turned off and Punch Tape Supply Flag reset.

12.1.12 Tape Feed Wheel

The Tape Feed Wheel is used to manually advance or backspace the paper tape or edge punched card; it is located in the front and center of the perforator. In the normal position, the wheel may be moved freely in either direction without moving the tape. Depression of the Tape Feed Wheel engages the feed sprocket. Turning the wheel to the right (counterclockwise) advances the media; turning the wheel to the left (clockwise) backspaces the media.

12.1.13 Tape System

The tape supply holder will accommodate a full 8 inch roll of unpunched paper tape. A power driven take-up reel is provided which produces a roll of tape 8 inches in diameter with a 3 inch inside diameter. The take-up reel permits the removal of a roll of tape. The reels accommodate tape widths of 11/16 inch to 1 inch, and are accessible to the operator for easy installation and removal of tapes. Optional take-up reels of 5.5" and 7" diameter are available that are compatible with Burroughs Group III Paper Tape Equipment.

A tape tear-off blade is located on the right end of the tape feed gate. The gate is located to the right of the punch station. A tape threading instruction label is located on the cover of the Chad box.

The use of individual or continuous fan-fold edge punched cards is not hindered by the presence of the tape supply and take-up mechanisms.

12.1.14 Edge Punched Card System

The tape perforator accommodates individual and continuous fan-fold edge punched cards in widths from 3 to 5 inches. The insertion and alignment of individual edge punched cards to a fixed limit is a manual operation.

A Supply Tray to supply continuous edge punched cards to the punch, and a stacking tray to hold finished continuous edge punched cards, are available as an option.

When the "Edge Punched Card Detector" has sensed that a card is in the perforator, the punching of sprocket holes is inhibited.

12.1.15 Chad Box

The Chad box is located inside the adjunct and is attached to the front panel. To remove the Chad box, release the lock, a lever on the right side and near the top of the perforator is depressed, which releases the locking device.

The Chad box will hold the chads from an 8" roll of paper tape.

12.1.16 Dimensions

The tape perforator dimensions are as follows:

Width	11 5/8 inches
Length	15¼ inches
Height	6 inches
Weight	21 pounds (approximately)

12.1.17 Environmental Conditions

The environmental conditions are the same as specified for the TC 500 in Section 10 of this manual.

12.1.18 Electrical Specifications

Power for the Adjunct is obtained from the TC 500 through a cable 9 feet in length. The cable is non-detachable from the Perforator, and requires service to connect it to the TC 500.

The Standard electrical specifications are 120 volts, (range 107 - 127), 60 cycles + or - 1% frequency variation.

12.2 TAPE/EDGE PUNCHED CARD MEDIA

12.2.01 Tape Stock

The Perforator is capable of feeding and perforating the following tape stock in widths of 1.000 inch (8 channel) and .686 inch (5 channel):

a) Oil impregnated tape
b) Resin impregnated tape
c) Any style of Burroughs punch tape or any comparable tape
d) Dry tape
e) One or two ply mylar tape
f) Aluminized mylar tape
g) Fan-fold tape

12.2.02 Tape Dimensions (8 channel)

Following are the Standard 8 channel 1 inch tape dimensions (these conform to the proposed USASA standards):

a) Tape width 1.000" ± .003 inch
b) Tape thickness .004" ± .0003 inch
c) Code hole .072" ± .002 inch
d) Sprocket hole .046" + .002 or - .001 inch
e) Horizontal distance from center to center of adjacent code holes .100" ± .002 inch
f) Vertical distance from center to center of adjacent holes .100" ± .002 inch
g) Center line of sprocket holes to reference edge (bottom, or 3-track edge) of tape .392" ± .003 inch
h) Cumulative spacing error:
   Up to ±.015" in 6.0 inches

12.2.03 Tape Dimensions (5 channel)

Following are the standard 5 channel tape dimensions (these conform to the proposed USASA standards):

a) Tape width .686" ± .003 inch
b) Center line of sprocket hole to reference edge (bottom or three-track edge) of tape .392" ± .003 inch
c) Other dimensions are the same as for the 8 channel tape

12.2.04 Edge Punched Cards

The perforator is capable of feeding and perforating the following types of Edge Punched Cards; if the card stock contains pre-punched sprocket feed holes:

a) Friden Type Edge Punched Cards, 3 X 7 inches
b) Hollerith Edge Punched Cards, 3.250 X 7.375 inches
c) Visi-Record type of Edge Punched Cards, 4½ or 5 X 10 inches
d) Fan-fold cards of type "a" above joined together at a perforation
e) Mylar reinforced Edge Punched Cards of type "a" above
f) Edge Punched Cards (ledger cards) wider than those listed above up to 11 X 14 inches with the punching along the 14 inch edge.

12.2.05 Edge Punched Card Specifications

The distance from the center line of the sprocket holes to the reference edge of the card is .392". The thickness of edge punched cards can vary from .005 inches to .0075 inches and applies to a, b, c, d, e, and f above.

When continuous edge punched cards are used, it is necessary to trim the leading edge of the first card. The edge punched card trimmer will trim the leading edge of the card exactly .0875 inch from the first complete sprocket hole.

In the use of single edge punched cards, if precision die cut cards are used, trimming is not required.

12.3 OPTIONAL FEATURES:

12.3.01 Tray, Supply and Stacker for Continuous Edge Punched Cards

This device provides a tray to supply continuous edge punched cards to the perforator and a tray for stacking the finished cards. It is removable and is located on the top of the perforator (without roll paper tape). The supply and stacker will each accommodate 250 continuous edge punched cards. Each card may have a maximum length of 7 inches.

When individual edge punched cards exceed 7 inches in length, the stacker portion of the tray can be used to support the finished edge punched card.

13. STYLE A 595 80-COLUMN CARD READER

13.1 GENERAL DESCRIPTION

The Style A 595 Card Reader provides automatic input of transaction and program data in 80-column card format to any TC 500 that has Input/Output (I/O) capability. It is a free standing unit cable connected to the TC 500. It can be a field addition to any TC 500 with I/O.

It consists of a Feed Hopper, a Read Station, a Stacker and a Transport mechanism to move the card from the Feed Hopper through the Read Station and into the Stacker.

The TC 500 Firmware provides the ability to read 80-column cards punched in Hollerith, USASCII, BCL or other specified codes by means of a Table of Code Assignments which converts the input card code into the TC 500 internal code. The table may be loaded with the user program.

Card reading is at the rate of 100 cards per minute column by column serially. An output signal is provided for each card column, from a series of solar cells. Decoding and formatting of data is provided by TC 500 Firmware.

A single 80-column card is read by means of a card read instruction in the user program, and the codes for all 80 columns of the card are stored in memory. The input area of memory is designated by the card read instruction.

A malfunction occurring in the Card Reader that might cause the reader to be inoperable does not prohibit continued operation of the system with other adjuncts.

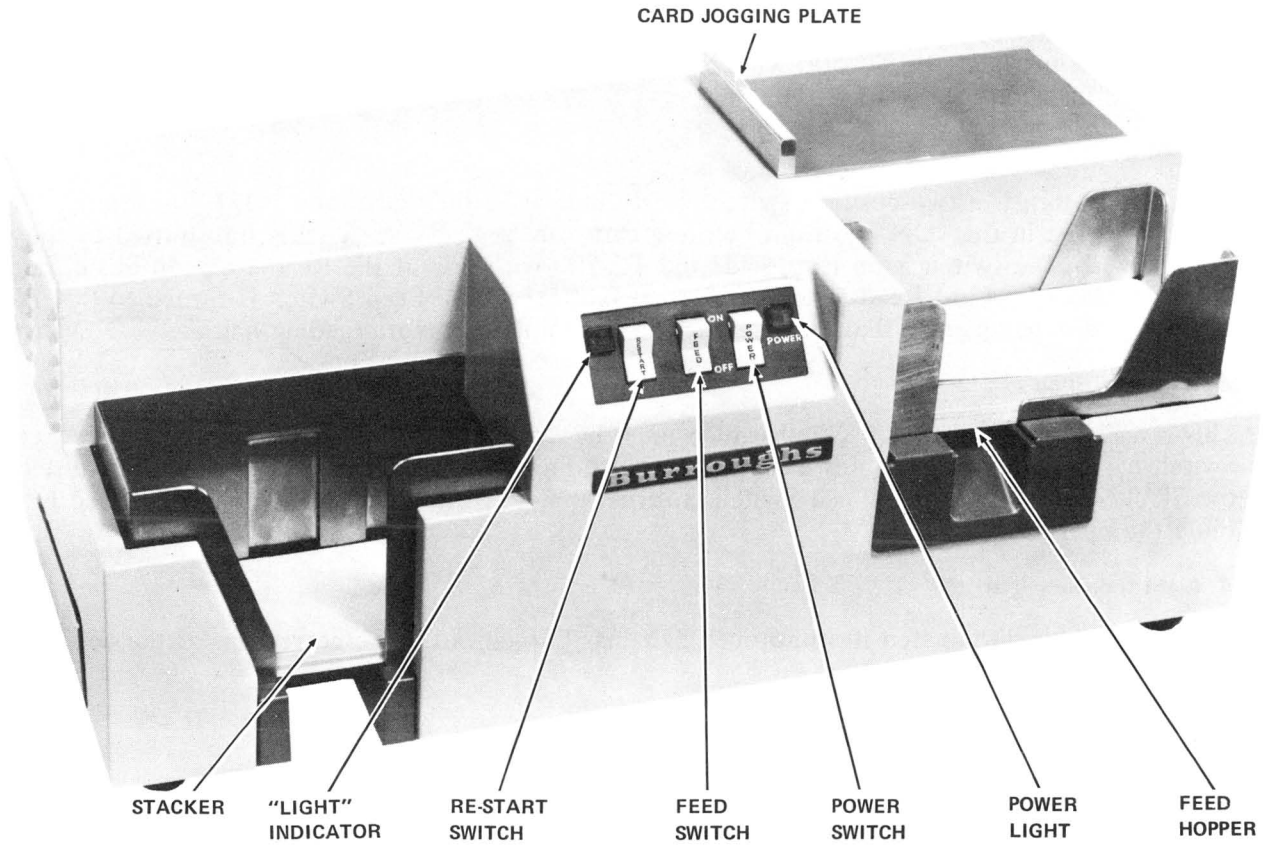


Fig. 13-1 A 595 Card Reader

13.2 CARD READER CONTROLS AND INDICATORS

The control panel, located on the front of the Card Reader below the Feed Hopper is illustrated below:

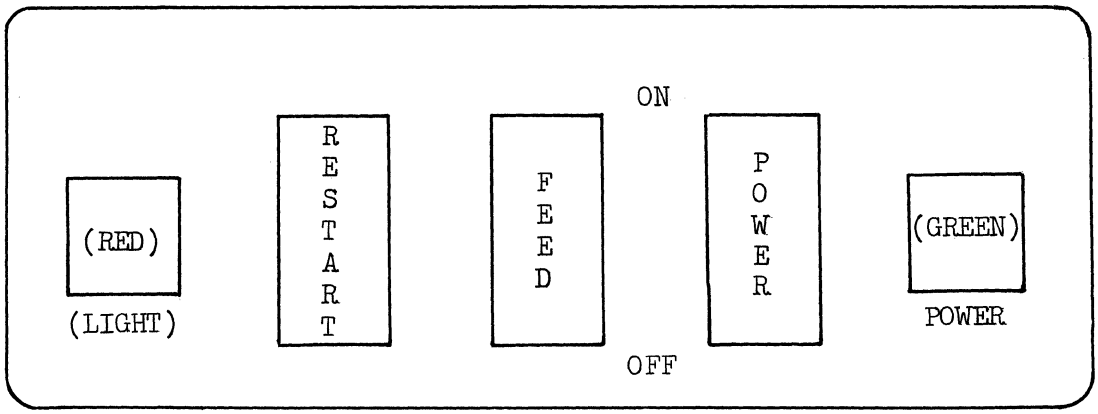


Fig. 13-2 Reader Control Panel

13.2.01 Power On Switch and Indicator (green)

The Power On Switch is a two-position switch clearly indicating the "ON" and "OFF" positions. The Power On Indicator is illuminated when the switch is "ON" and extinguished when it is "OFF". Power is supplied by the TC 500. A signal is transmitted to the TC 500 processor when the switch is "ON"; this provides the TC 500 with one of the Reader conditions during the execution of a Card Read instruction (see 13.3.01).

13.2.02 Feed Switch

The Feed Switch is a two-position switch clearly indicating the "ON" and "OFF" positions. This switch must be in the "ON" position before a card can be read. A signal is transmitted to the TC 500 when the switch is on to provide the TC 500 with one of the Reader Conditions during the execution of a Card Read instruction (see 13.3.01). If the Feed Switch is turned to "OFF" while a card is being read, that read instruction is completed before feeding halts.

13.2.03 Re-start Switch

This is a momentary Contact Switch which must be depressed to initiate reading after the "Feed" Switch has been turned on. For example; to unload a filled Stacker, the Feed Switch is turned off, the Stacker is unloaded, the Feed Switch is turned on, and the Re-start Switch is depressed to continue the operation.

13.2.04 Light Indicator (red)

This indicator is illuminated if a photocell light has burned out. The correction of the condition turns off the indicator.

13.3 READER CHARACTERISTICS

13.3.01 Conditions Required to Read

The following conditions permit reading to occur:

1) The Reader Switch must be "ON". Power is supplied from the TC 500, whose power must be on. No separate line cord is used.

2) A "Read" instruction must be executed by the internally stored program.

3) A card must be present in the Read Station and the Feed Switch must be in the "ON" position. If the Reader Condition Indicator* is lit, the read instruction is held up. The subsequent placing of cards in the Feed Hopper and depression of the Re-Start Switch on the Card Reader causes the Read instruction to be executed.

* located on the console of the TC 500

13.3.02 Media Detector

A Media Detector has been provided to detect if a card has not been transferred to the Read Station on a card read instruction. When the reader fails to transfer a card to the Read Station during execution of a card read instruction, a signal is sent to the TC 500 which halts execution of the instruction, turns on the "Reader Condition" indicator located on the keyboard of the TC 500, and sets the Reader Condition Flag.

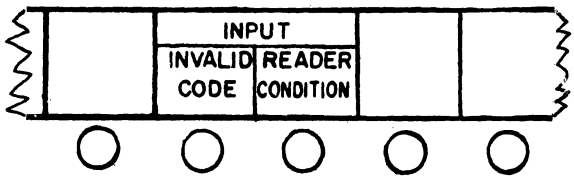


Fig. 13-3 TC 500 Keyboard Indicator Lights for 80 Column Card Input

After placing cards in the Feed Hopper and turning the Reader ON, a depression of the Re-Start Switch completes the execution of the card read instruction. Reader Condition Flag is then reset and the light is turned off.

13.3.03 Feed Hopper

The Feed Hopper consists of a card feed mechanism for a standard size 80-column card and the mechanism to prevent release of the card to the Read Station until a card feed signal is received. 51 and 66-column cards are not accommodated. Cards are placed in the Feed Hopper face down with the column 1 end leading. Cards are fed from the bottom of the stack.

The Feed Hopper permits manual card feeding and also the re-supplying of cards to enable uninterrupted card feeding. It has a capacity of 350 cards.

13.3.04 Read Station

The Read Station is a single column Data Reader which reads a card serially, column by column. Solar cells simultaneously read the 12 punch positions in a card column and send codes to the TC 500 which interprets the codes according to the Table of Code Assignments loaded in the memory of the TC 500. Failure of a Solar cell turns on the "Light" indicator (red) on the Control panel of the Card Reader.

13.3.05 Feed Mechanism

The single feed path mechanism transports cards from the Feed Hopper through the Read Station into the Stacker. A card moves from the Feed Hopper when a Card Read instruction is executed. The feed mechanism moves the card through the Reader at the rate of 100 cards per minute.

13.3.06 Stacker

The Stacker is a receiving hopper for stacking cards as they leave the Read Station. The cards are stacked by a gravity method in the same sequence in which they are fed. It has a capacity of 350 cards.

13.4 PUNCHED CARD SPECIFICATIONS

The A 595 card reader uses standard 80-column tabulating cards. Other lengths are not acceptable.

Dimensions – Width of cards is 3.250" (+.007" or -.003"); length of cards if 7.375" (+.005"); thickness of card paper stock is .007" (+.0004").

Corner Cuts – The Style A 595 places no restrictions on standard corner cuts or standard rounded corners.

Edge Characteristics – The leading edge of punched cards should be clear (free of notches, indentations, or protrusions) in an area .470" high in the center of the card (between an area slightly above the "3" row punch and slightly below the "4" row punch). Notches within this area of the leading card edge may cause feed jams. The trailing edge of the cards, for the same reasons as above, should be clear in an area .126" in the center of the card. Notches in this area may cause improper reading of cards. Although all notches in the card edges are somewhat susceptible to "dog-earing", which may cause problems, this should not be a problem with reasonable handling.

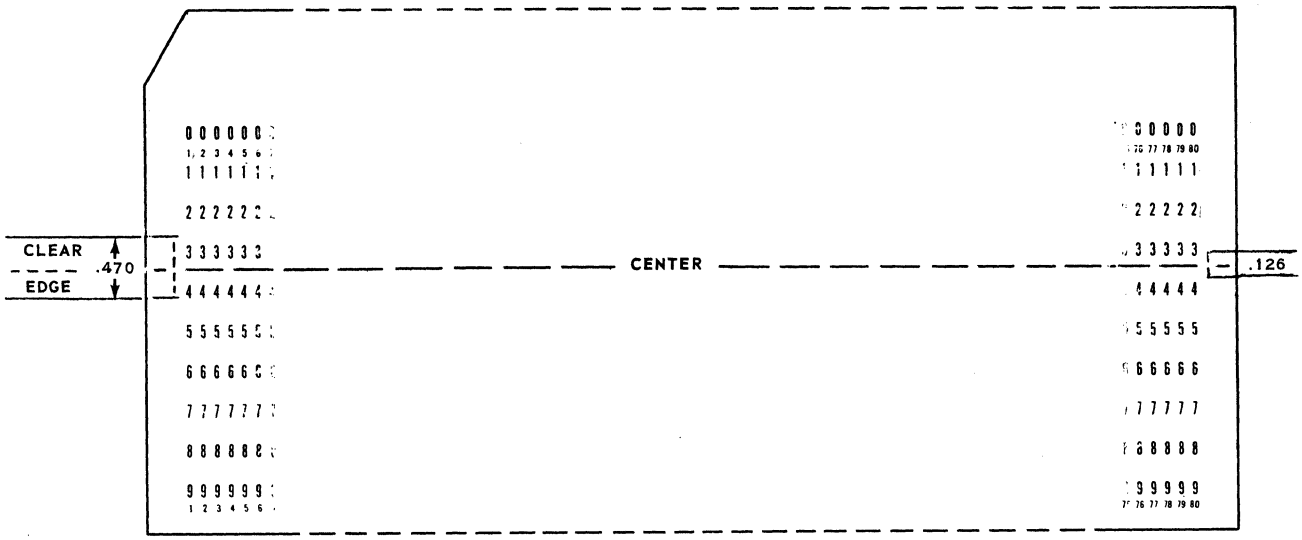


Fig. 13-4 A 595 Card Reader: Card Edge Clear Area

13.5 DIMENSIONS

The dimensions of the A 595 Reader are as follows:

Depth	10½"
Width	24½"
Height	10 3/8"
Weight	45 lbs.

13.6 ENVIRONMENTAL CONDITIONS

The environmental conditions are the same as specified in Section 10.

13.7 ELECTRICAL SPECIFICATIONS

Power for the Reader is obtained from the TC 500 System, with a 9-foot cable. The cable is non-detachable from the Reader, and requires service to connect it to the TC 500.

The standard electrical specifications are 120 volts (range 107-127), 60 cycles ±1% frequency variation. Options for voltage and cycles that apply to the TC 500 also apply to the Reader, as the Reader must be compatible.

15. DATA COMMUNICATION PROCESSOR

The operation of the TC 500 as a terminal in a communication network is accomplished by means of a special Data Communication Processor. This processor operates independently of and concurrently with the Main Memory (arithmetic) processor. It utilizes 8 tracks (256 words) of memory which are separate from the main memory area of the disk.

All communication control procedures are implemented for the TC 500 by special firmware stored in the Data Communication Processor portion of memory. Thus, transmission or receipt of messages may take place automatically with the Data Communication Processor while other work is being performed concurrently in the Main Memory Processor.

TRANSMIT AND RECEIVE BUFFERS

Two buffers, located in the Data Communication Processor part of memory, are used for the receipt and transmission of all messages. They each have a capacity of 256 characters. Messages sent to the TC 500 are received directly in the Receive Buffer. Messages transmitted from the TC 500 are placed in the Transmit Buffer.

15.1 DATA COMMUNICATION PROCESSOR INTERFACE CHARACTERISTICS

The Data Communication Processor provides the interface to a communication network, which may be controlled by a Burroughs B 8500, B 7500, B 6500, B 5500, B 3500, B 2500, B 500, or a B 300 System.

Signaling Speed	1200 bps
Clock (Asynchronous)	Provided in interface
Character length	7 data bits, 1 parity bit (even)
Start Bit	1 bit
Stop Bit	1 bit
Data Code	USASCII X3.4 – 1967
Bit Sequence	LSB first
Longitudinal Parity	Even 7 bits (excludes parity track) Even parity on BCC
Data Sets	Western Electric 202D on 4 wire private line (non-simultaneous), or 2 wire line; Western Electric 202C on 2 wire switched line

15.2 SYSTEM CONFIGURATION

A wide variation of system configurations is possible with the TC 500 Terminal Computer.

One or several TC 500's may be connected to a single Data Set at a remote location. The Data Set may be the only station, or one of several stations in a multi-drop communications channel.

15.2.01 Several TC 500's Connected to One Data Set

This is accomplished by connecting the line from the receptacle on one of the TC 500's to the Data Set, then connecting a line from a second receptacle on that TC 500 to another TC 500 and that TC 500 to another, etc., forming a "concatenation" of terminals to the Data Set.

The number of TC 500's using one Data Set can be increased at any future time by connecting in one or more TC 500's and establishing addresses in the polling system for these additional TC 500's.

If any of the TC 500's connected to a Data Set are operating in an off line mode, it does not affect the other TC 500's connected to the same Data Set which may be operating on-line to the data center.

15.2.02 Several Data Sets Connected to a Multi-Drop Line

Data Sets from several terminal sites may be connected to a multi-drop communication channel through a Central Office Bridge. This Central Office Bridge may, in turn, be connected to other central office bridges, all connecting into a single multi-drop line (refer to Fig. 15-1).

The number of TC 500's and Data Sets connected in this manner is limited only by the requirement to provide an acceptable response time for transactions handled by all TC 500's on that particular circuit, including those terminals at other sites connected to the same line with a central office bridge(s). Thus, only the volume of transactions need be considered in determining the number of terminals that may be placed on one line.

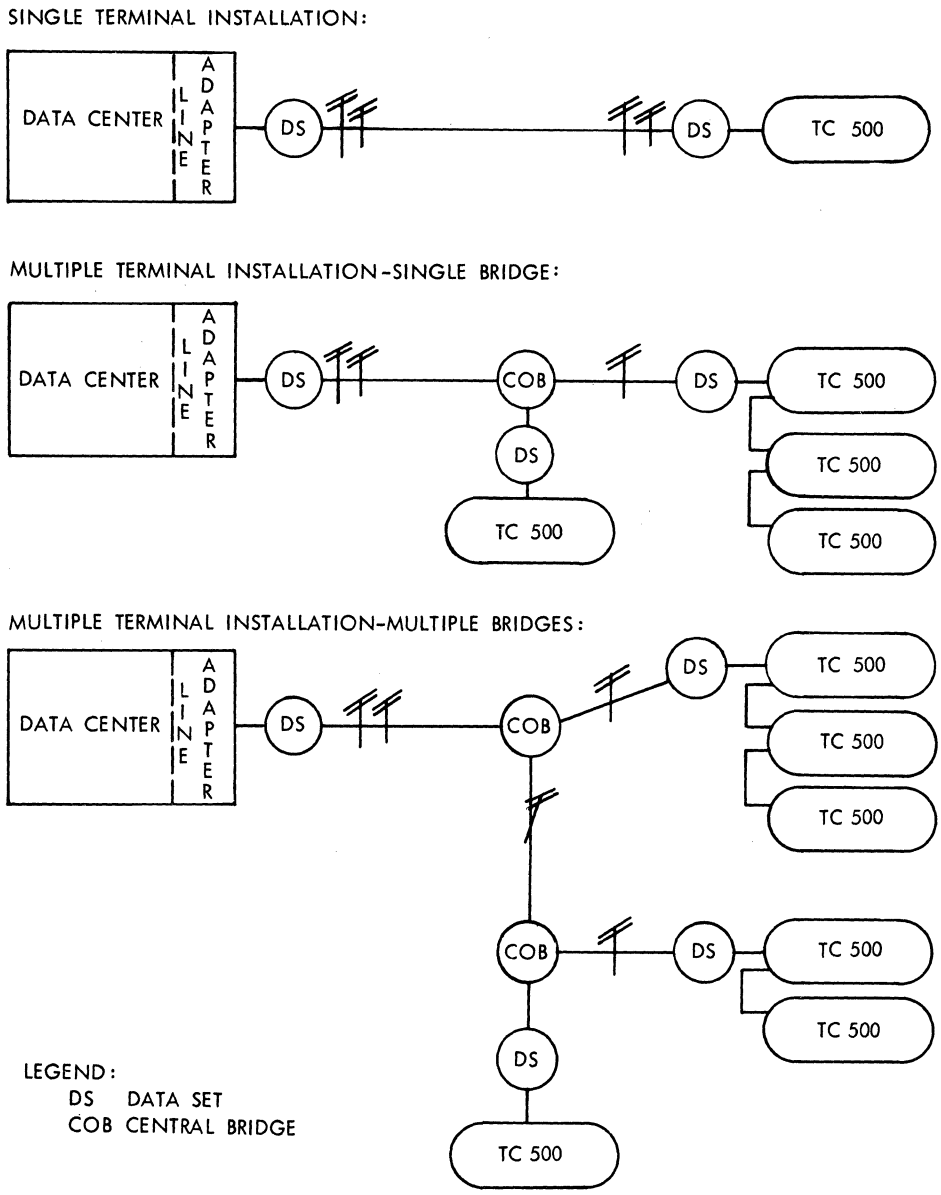


Fig. 15-1 System Configurations

15.2.03 Direct Connect

TC 500's may be connected directly into the data center through a four (4) wire line, thus eliminating the need for telephone data sets and private telephone lines with such terminals. Up to 9 terminals may be connected to a multi-drop line. The total cable length to all terminals on one direct line is 1000 feet. A Line Adapter is required at the data center to connect this line to the central system. The Line Control procedures for the TC 500 in this mode are exactly the same as for TC 500's connected to leased telephone services.

15.3 POLLING/SELECTING

The TC 500 Data Communication Processor is designed for use in a Polling/Selecting environment utilizing multi-drop points on a circuit of private lines or switched lines. Central Office bridging is permitted and is expected to be a normal part of the operation of this system.

Polling, directed from the data center, is to be continuous. The frequency of polling is a function of the Data Center. The polling frequency can be made to vary during the day without affecting the TC 500's basic operation other than to change the frequency of transmitting and receiving messages.

The TC 500 has a maximum response time of 70 milliseconds to Polls and Selections. This covers the time from receipt of the last bit of the ENQ character (see 15.6) that terminates the Poll or Selection message to the turning on of the carrier to reply from the terminal.

The user program assembles messages in the TC 500 memory. When the message is complete and the system is in a Transmit Ready condition, it waits for a Poll from the data center to activate the transmission of this message.

A message from the data center is received by the TC 500 if it is in a Receive Ready condition, and is stored in memory; printing and/or processing of the received data is delayed until the incoming message is complete and has been parity checked.

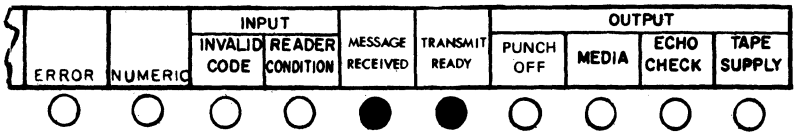
Batches of data, (punched paper tape or punched cards,) may be transmitted to the data center by reading the data into the TC 500 memory (in groups based on available memory) and storing it until the TC 500 is polled. As memory is cleared by successful transmission, additional punched paper tape or cards are read and stored, ready for the next poll.

TC 500's and their peripheral devices such as card or tape readers, when connected to a communication network, can be operated in an unattended mode. After loading media into the input device, the user program in the Normal area of memory in the TC 500 can cause the unattended transmission of that data as Polls are received from the data center.

A TC 500 operating on a program which is dependent on transmission to or receipt of data from the data center is in an on-line mode. If a TC 500 is operating on a program that does not require communication with the data center, even though the data center is operating, it is in an off-line mode. A TC 500 in this mode is capable of acknowledging a selection and of receiving a message. This can be brought to the attention of the TC 500 operator to initiate the printing and/or processing of the message when convenient; or, the received message can be automatically processed immediately. The user program must make these provisions. The TC 500, when operating on programs independently of the data center, is not inhibited in any of its functions by the fact that it has the capability to also function on-line.

15.4 DATA COMMUNICATION INDICATOR LIGHTS

Two lights are provided on the TC 500 keyboard which indicate the status of this terminal when operating in an on-line mode. The lights, located as indicated in the diagram below, are the MESSAGE RECEIVED light and the TRANSMIT READY light.



15.4.01 Message Received Light

This light is turned on automatically by the main memory firmware after interrogating a Flag set by the Data Communication processor which indicates having successfully received a good message (correct parity and proper control characters). In addition, a Message Received Flag associated with this light is set which permits the user program in the TC 500 to determine when a message has been received so that it may proceed with processing and/or printing the message data. The Message Received light is turned off as a by-product of resetting the Message Received flag by the user program.

15.4.02 Transmit Ready Light

This light is turned on automatically as a by-product of setting the Transmit Ready Flag. The Transmit Ready Flag is set by the user program when it is known that a message has been completed and is ready for transmission. The light remains on until a Poll is received from the data center and the Data Communication processor completes a successful transmission. The Transmit Ready flag is reset and the light is turned off automatically by the main memory firmware after interrogating a flag set by the Data Communication Processor which indicates a successful transmission.

15.5 MESSAGE TRANSMISSION CODE

The USASCII 7-bit code is the standard transmission code set for the TC 500 system. These codes consist of two general categories: Graphic Characters and Control Characters. There are 32 control codes, 95 graphic characters, and the code DEL (delete). The 95 graphics include both upper and lower case alphabetic characters, the numerals zero to nine, 32 punctuation marks and special symbols, and SP (space). Ten of the 32 control codes are reserved for use in communication control and are designated Communication Control Characters.

15.5.01 Communication Control Characters

Communication Control Characters can be separated into two groupings: Message Format characters and Intra-Line Control characters. A brief description of the function of the Communication Control Characters implemented in this system follows:

a. Message format characters: There are three message format characters in USASCII. A complete description of their USASCII defined functions can be found in ASA publication X3.3.4/121. Their functions in this system are as follows:

   SOH – Start of Heading: The SOH character appears as the first code in all messages, except polling, selection and single character messages. Note: The heading is defined as that portion of the message that begins with SOH and includes a sequence of characters which constitute the address of a remote or routing information.

   STX – Start of Text: The STX character appears as the first code following the heading in all messages containing text. STX identifies all characters that follow, up to but not including ETX, as the text of the message.

   ETX – End of Text: The ETX character serves to terminate the text portion of all messages containing text. The ETX character always precedes the BCC (block check character).

b. Intra-link Control Characters: There are 7 intra-link characters in USASCII. A complete description of their ASCII defined functions can be found in ASA publication X3.3.4/121. Those used by the TC 500 and their function in this system are as follows:

ACK – Acknowledgement: The affirmative response to selections and messages directed to the TC 500 is the transmission of a message containing an ACK character. Messages transmitted by the TC 500 to the data center are acknowledged by the data center. The TC 500 recognizes and takes action on messages containing an ACK character received from the data center.

NAK – Negative Acknowledge: The TC 500 transmits a message containing an NAK character when any of the following conditions prevail: A selection is recognized and the TC 500 is not ready to receive. A message containing text is received but does not check. The TC 500 recognizes and takes action on messages containing an NAK character received from the data center.

ENQ – Inquiry: This character is always used to end a poll or selection message and requires a reply from the remote station. It may not be sent by a remote.

EOT – End of Transmission: This character normally indicates the end of a transmission. However, in this control procedure, it is used as the first character in a poll or selection message. The data center (which is designated as the control station), by transmitting this code, sets all remotes in the control state (that is, listening for a poll or selection). If a TC 500 is polled and is not ready to transmit it responds with EOT.

UNITED STATES OF AMERICA
STANDARD CODE FOR INFORMATION INTERCHANGE
(USASCII)

Bits b_7 b_6 b_5				Column →	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4	b_3	b_2	b_1	Row ↓	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	—	o	DEL

The standard 7-bit character representation is shown below; b_7 is the high order bit, and b_1 is the low order bit:

b_7	b_6	b_5	b_4	b_3	b_2	b_1
1	0	0	1	1	0	1

The example above shows the bit representation for the character "M", located in column 4, row 13. "M" may also be represented by its position in the code table by the notation "column 4, row 13" or simply as "4/13". The column number is formed by the decimal equivalent of the binary number for bits b_7, b_6, and b_5; the row number is formed by the decimal equivalent of the binary number for bits b_4, b_3, b_2, and b_1. Columns are sometimes referred to as "sticks".

Fig. 15-2 USA Standard Code for Information Interchange (USAS X3.4-1967)

15.5.02 Special Instruction Codes

These codes, selected from the graphics of the USASCII set, have a special meaning when they appear in specified messages. Their designation and functions in this system are as follows:

a. Poll Character (lower case letter "p"): This character is part of a Polling message, and it inquires of an addressed remote location whether it is ready to transmit to the data center (Are you ready to send?). It is ignored by all but the addressed remote and causes that station to reply with an EOT if it is not ready to transmit, or with the message if it is ready to transmit.

b. Selection Character (lower case letter "q"): This character is part of a selection message, and it inquires of an addressed remote location whether it is ready to receive a message from the data center (Are you ready to receive?). It is ignored by all but the addressed station and causes that station to reply with a negative acknowledgement (NAK) if it is not ready to receive a data message from the data center, or with an ACK, if it is ready to receive a message.

15.5.03 Terminal Address (AD1, AD2)

A two-character identification address or "number" for each terminal is included in all messages. This permits a terminal to identify messages directed to it, and permits the data center to identify which terminal is sending a message to it. The address of a TC 500 is established by the user program operating in Normal memory. As such, it can be changed at any time by the user program. Provisions are included to permit use of separate addresses for Polls and Selections when desired.

AD1 and AD2 are not unique USASCII codes in themselves, but represent the 2 characters of a terminal address. They may consist of any USASCII characters in columns 2 through 6, except the "circumflex" (column 5, row 14) or "underline" (column 5, row 15) characters (refer to Fig. 15-2). This provides 78 unique characters or a potential of 6,084 terminal addresses on a single communications channel.

15.5.04 Block Check Character (BCC)

The Block Check Character is included in all data messages. It is used for error detection in the transmission of a data message to check the longitudinal parity of the characters. The BCC is not a unique character since it is generated based on a binary summation and, therefore, may become any character.

BCC is generated by independently summing each of the 7 individual levels (channels) of the codes transmitted. The BCC causes the sum of the number of "on" bits in each of these levels of the transmitted codes to be even. Longitudinal parity is, therefore, even. A character parity bit is then generated for the BCC which is even, conforming to the individual character parity scheme being employed by the TC 500. The summation to obtain BCC starts with the first character following SOH in the message being transmitted. With the exception of SOH, all characters in the message are included in the summation. BCC follows the ETX character and always appears as the last character in a data message. Generation of BCC is an automatic function of the TC 500 Data Communication Processor for all data messages transmitted to the data center; checking the BCC on all data messages received from the data center is likewise an automatic function.

15.6 MESSAGE FORMATS AND LENGTH

15.6.01 Poll Messages

The purpose of the Poll Message is to inquire of the terminal if it is ready to transmit a message. The terminal must receive a poll before it can begin transmission. The Poll Message starts with EOT, followed by the address of the terminal (AD1, AD2), followed by the Poll character (POL = p), and is terminated with ENQ.

15.6.02 Select Messages

A Select Message inquires of the terminal if it is ready to receive a message from the data center. It begins with EOT, followed by the address of the terminal (AD1, AD2), followed by the Select character (SEL = q), and is terminated with ENQ.

15.6.03 Data Messages

Messages containing data that are transmitted to the data center or are received from the data center. Data Messages begin with Start of Header (SOH), followed by the terminal address (AD1, AD2),

the transmission number (TR#), Start of Text (STX), the text of the message, and are terminated with End of Text (ETX) and the Block Check Character (BCC).

15.6.04 Message Length

Poll and Selection messages have a defined length of 5 characters.

Data Messages have a defined number of control and format characters of from 7 to 9 characters. The text of a message may contain from 1 to 255 characters; the text portion consists of everything following STX up to ETX (does not include ETX and BCC).

Certain response messages will consist of a single character.

15.7 MESSAGE CONVENTIONS

Polling and Selecting is directed by the data center, and consists of the data center transmitting a Poll Message or a Select Message to the terminal.

A remote will ignore any poll or selection that is not addressed to it or that contains a parity error.

A remote that is anticipating a single character response will ignore any single character message received (ACK, NAK or EOT) that contains a parity error.

If the data center is anticipating a single character response and it fails to receive a good character, it will time out, terminate the sequence and reinitiate the transaction.

15.7.01 Poll

A Poll will be acknowledged by the terminal transmitting a data message if the remote is output ready. A Poll to a terminal that is not output ready will result in the automatic transmission of EOT by that TC 500.

Data messages transmitted to the data center will be acknowledged by a single character ACK if received properly or by a single character NAK if not properly received.

Receipt by the remote of a single character ACK from the data center (resulting from receipt at the data center of a good data message) will cause the remote to transmit a single character EOT. When the data center receives this it will transmit EOT and re-initiate the polling/selection routine.

Receipt by the remote of a single character ACK from the data center (resulting from receipt of a good data message) will cause the remote to reset the Transmit Ready condition flag, thus freeing the output buffer for reloading by the operator (user program).

Receipt by the remote of a single character NAK from the data center (resulting from failure of the data center to receive a good data message) will cause the remote to re-transmit the message. The remote will re-transmit the message as many times as it receives a NAK from the data center. The data message will be retained in the Transmit buffer by the remote and the Transmit Ready Flag will not be reset until receipt of ACK from the data center.

Failure of the data center to receive a message or an EOT from a polled remote will result in the data center timing out, ending the sequence and transmitting an EOT, either as a single character or as a part of a new poll or selection. If the polled remote had been Transmit ready, it will still have its assembled message and will be ready to transmit when next polled.

15.7.02 Select

A selection will be acknowledged by a remote transmitting a single character ACK if it is receive ready. A remote may, by the user program, not acknowledge a selection. This allows a selected remote to indicate that it requires a poll.

Selection of a remote that is not receive ready will result in the transmission of a single character NAK by the remote. This will cause the data center to transmit an EOT character either as a single character or as it continues its polling and/or selecting routine.

Data messages transmitted to the remote will be acknowledged by a single character ACK if received properly, or by a single character NAK if not properly received.

Receipt by the data center of a single character ACK from a remote resulting from receipt at the remote of a good data message will cause the data center to re-establish the control state by transmitting a single character EOT or an EOT that is the first character of a poll or selection. The other remotes in this same network will now become sensitive to the polling/selection routine which will now be reinitiated by the data center.

Receipt at the data center of a single character NAK from a remote resulting from failure of a remote to receive a good data message following selection will cause the data center to re-transmit the message. Continued re-transmission resulting in receipt of NAK's up to "n" times, by data center count, will result in transmission by the data center of EOT either as a single character or as part of a poll or selection.

Failure of the data center to receive an ACK or a NAK in a specified period of time from a remote following selection results in the data center timing out and transmitting EOT either as a single character or as the first character of a re-selection, or a new poll or selection.

Failure of the remote to receive a message from the data center following selection will mean that the remote will not transmit either ACK or NAK. The absence of this reply will be detected at the data center and the remote will be re-selected.

15.8 TRANSMISSION NUMBERS (TR#)

As an optional convention, all data messages transmitted to and from a TC 500 may contain a transmission number to permit verifying that all messages are sent or received in sequence. The Transmission Number may consist of from 1 to 3 characters and is located in the header portion of the data message, following the terminal's address and preceding the STX character:

Example: SOH, AD1, AD2, TR#(up to 3 char.), STX, (..text..), ETX, BCC

The Transmission Number utilizes the USASCII numerals 0 to 9.

Polling, Selecting, or single character messages do not use a transmission number.

When transmission numbering is not desired in a system, it is omitted by a firmware option.

15.8.01 Send Transmission Number

In this convention, all messages transmitted by the TC 500 to the data center are given a transmission number by the Data Communication processor. When the transmission is successful (TC 500 has received "ACK" from data center), the number is automatically incremented by one (1). Retransmissions of the message (receipt of "NAK" or no response from the data center) do not increment the number. It is the function of the data center for checking this number to assure that messages are received in sequence. If the number is not in sequence, the data center would so notify the terminal. Program instructions are provided for the TC 500 user program to both check the present number and load a new number.

When the send transmission number has been incremented to its limit (9, 99 or 999 depending on the number of characters implemented by the Data Communications firmware), the next incrementation automatically resets the number to zero.

15.8.02 Expected Transmission Number

In this convention, the Data Communication processor maintains an "Expected Transmission Number" which it compares to the actual number contained in messages received from the data center. If the "actual" transmission number agrees with the "expected" number, the expected transmission number is then incremented by one (1) automatically by the Data Communication Processor, if the message is correct in other respects. If the two numbers do not agree, the expected transmission number is not incremented, and the Transmission Failure Flag is set (Flag D2 in the Data Communication Processor). In this case, the message is still allowed to be received and the Data Communication processor will send an ACK to the data center (if the message is correct in other respects).

Program Instructions are provided for the TC 500 user program to examine the present expected transmission number, to load a new number, and also to check the status of the Transmission Failure Flag. It is the function of the user program to check that messages are received in sequence, and to notify either the operator or the data center in the event that the sequence has been broken.

When the Expected Transmission number has been incremented to its limit (9, 99 or 999 depending on the number of characters implemented by the Data Communications firmware), the next incrementation automatically resets the number to zero.

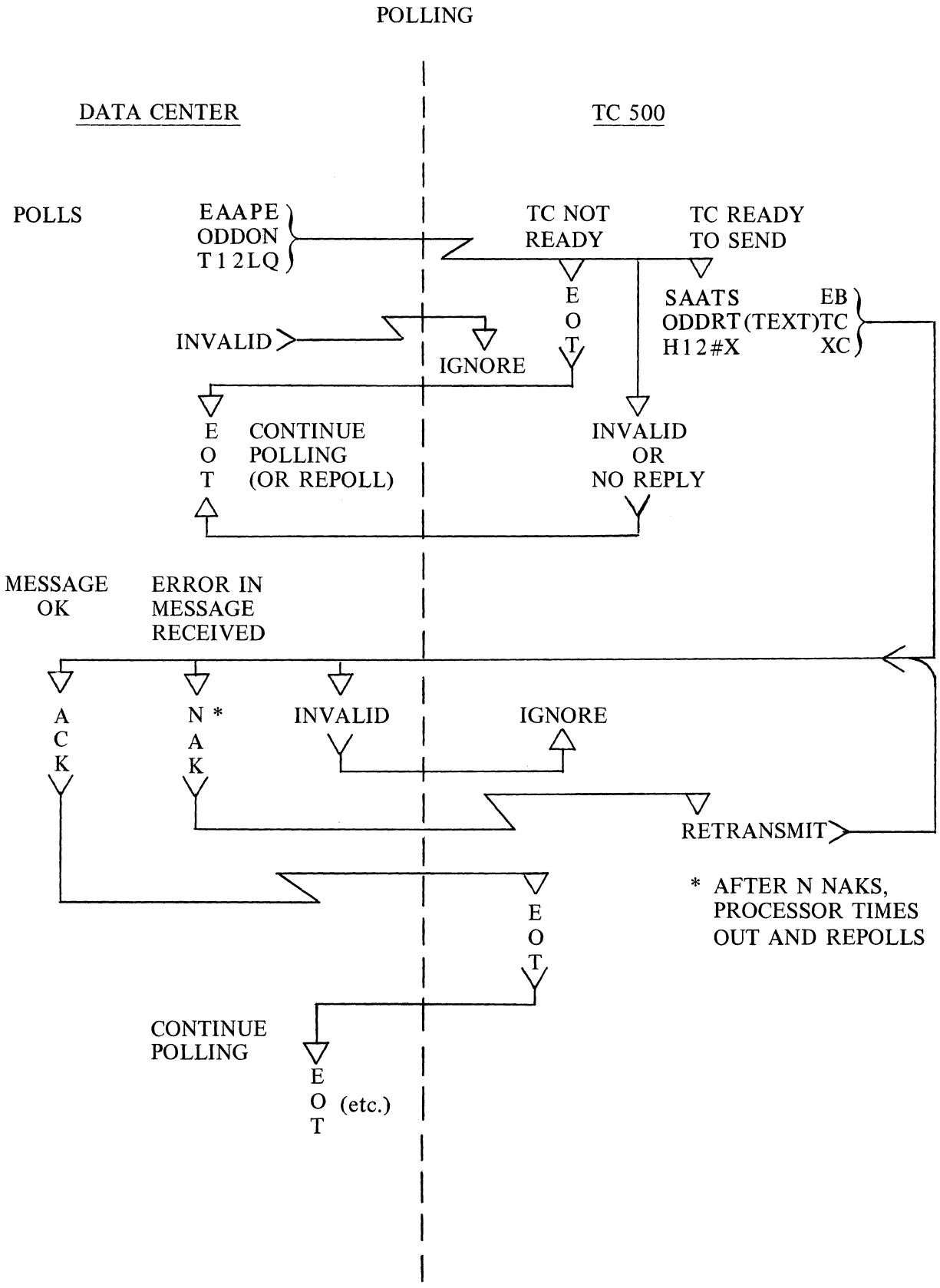


Fig. 15-3 Polling

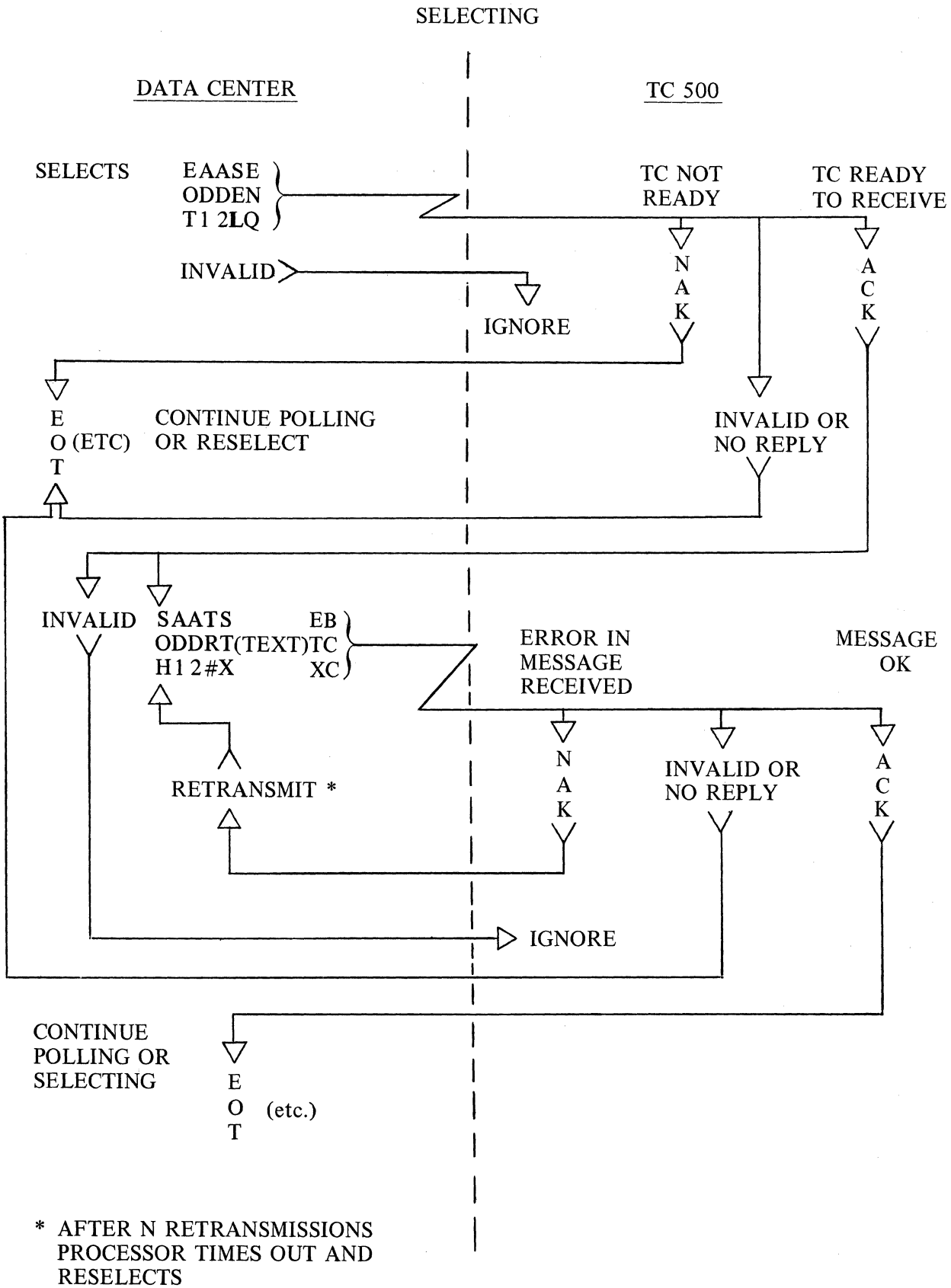


Fig. 15-4 Selecting

15.9 CHECKING AND ERROR DETECTION FUNCTIONS

Each message is examined by the Data Communication Processor to determine if it is intended for this TC 500. If the message cannot be identified as being for this TC 500, it will be ignored. A message once identified is examined to see if it is a poll, selection, or data message.

All characters in a message are parity checked by the TC 500. Data messages (those beginning with SOH) will also be checked for longitudinal parity (BCC).

15.9.01 "Ready to Receive Poll" State

If a poll is received, the Data Communication Processor checks the following and reacts as indicated.

Is the Poll for this TC?	Do All Characters Parity Check?	Is the TC 500 Transmit Ready?	TC 500 Reaction
Yes	Yes	Yes	Transmit Data message & go to "polling message response" state.
Yes	Yes	No	Send EOT & stay in "Ready to receive Poll" state.
Yes	No	----	Ignore & stay in "Ready to receive Poll" state.
No	----	----	Ignore & stay in "Ready to receive Poll" state.

Note: A polling or selecting sequence must be received in one continuous transmission. It will be invalid if any of the 5 characters are separated by a stop bit, longer than one bit time.

If a selection is received, the Data Communication processor checks the following and reacts as indicated.

Is the Selection for this TC?	Do All Characters Parity Check?	Is the TC 500 Receive Ready?	TC 500 Reaction
Yes	Yes	Yes	Send ACK & go to "select message" state.
Yes	Yes	No	Send NAK & remain in "ready to receive Poll" state.
Yes	No	----	Ignore & remain in "ready to receive Poll" state.
No	----	----	Ignore & remain in "ready to receive Poll" state.

Note: User programing may inhibit any responses to selections.

15.9.02 "Polling Message Response" State

Following the transmission of a data message to the Data Center, the remote is in the "polling message response" state. In that state, it anticipates receipt of an acknowledgement (ACK or NAK). If any other type of message is received, the terminal returns to the "ready to receive poll" state and attempts to interpret the message just received.

Response Received	Do All Characters Parity Check?	TC 500 Reaction
ACK	Yes	Reset transmit ready flag, send EOT & return to "ready to receive poll" state.
NAK	Yes	Retransmit* "n" times
Poll	Yes	Retransmit*
Select	Yes	Refer to 15.9.01
Invalid Message of any kind (See 15.9.04 for break function)		Ignore

*Note: Data is retained in the Transmit buffer until ACK received. Retransmission will contain original message number and if original transmission was received, the Data Center can detect this and take appropriate action.

"n" is dependent on the number of NAK's transmitted by the Data Center.

15.9.03 "Select Message" State

Following the selection of a remote by the Data Center and the remote having indicated its ability to receive, by sending ACK, it will check the message sent by the Data Center and react as follows:

Is the Message for this TC?	Do All Characters Parity Check?	Is BCC Okay & No Character Time Outs Have Occurred?	TC 500 Reaction
Yes	Yes	Yes	Send ACK, Set message received flag & return to "ready to receive Poll" state.
Yes	Yes	No	Send NAK & stay in "select message" state
Yes	Heading Yes/ Text No	----	Send NAK & stay in "select message" state
No or	Heading No	----	Ignore & return to "ready to receive Poll" state.

If a remote is operating on a program where it is independent of the Data Center and it is polled by the Data Center, an automatic EOT will be sent provided the send ready flag is not set.

If a remote is operating on a program where it is independent of the Data Center and it is selected by the Data Center and the receive buffer is available, the remote will transmit ACK and the data message can be received. When properly received the message received lamp will be lit and, if the user Program is so programed, the audible alarm will sound. If the receive buffer is not available when selected (receive ready flag not set) the remote will transmit NAK to the Data Center.

If a polled remote is output ready and replies to a poll by transmitting a data message and that message is not received by the data center, the center can repoll that location. However, the remote is in the state where it anticipates receiving ACK or can detect NAK to cause retransmission. If the data center sends a poll to cause retransmission, the remote is also capable of detecting the EOT character beginning the poll while in the Polling Message Response state and will retransmit the message. A similar condition applies in a selection sequence following transmission by a remote of the ACK to the selection control message. If that ACK is lost and the data center reselects the remote, the fact that this message, which begins with EOT, is another selection and not a data message is recognized and the ACK is retransmitted.

Turning power on and bringing the TC 500 to the Ready mode puts the Data Communication Processor on-line and includes the resetting of both the transmit ready and the message received flag (both lamps are off). The terminal is not ready to send but is ready to receive. Upon commencing the execution of the user program, the use of the "Ready" button to return the base machine to the Ready Mode will not change the state of the flags.

15.9.04 Break Function

For the event that a remote is transmitting and the data center wishes to terminate the transmission, or shut off the remote, the TC 500 is sensitive, though transmitting, to the carrier signal from the data center going to continuous spacing for a period of 25ms. This causes the TC 500 to return to the Ready to Receive Poll state. The message is retained and can be retransmitted with the same transmission number. Receipt of a new poll or selection beginning with EOT is anticipated.