RAND DOCUMENT

MULTIPLE TYPEWRITER COMMUNICATION SYSTEM FOR JOHNNIAC ON-LINE USE

T. O. Ellis

September 1962

INTRODUCTION

The Multiple Typewriter Communication system (MTC) provides a communication link between JOHNNIAC and a multiplicity of typewriter I/O stations. The system contains buffering capability and controls necessary to transmit or receive 7-bit alphanumeric characters with several stations simultaneously. Two basic philosophies of system design are apparent within this system.

1) Control of the typewriter is proprietary, i.e., the user may only be given control by the central processor, and the user must give control of the station to the central processor. Neither may usurp control. However, not more than one line of type may be input without relinquishing control.

2) The relationship between the central processor (JOHNNIAC) and the MTC system is one of commands and signals. There are no interrupts or traps built into the hardware. The processor program may command action on the part of the MTC system via a set of machine instructions. The MTC may only set signals which pro-

cessor instructions can sense to note actions or changes of state of the MTC system.

The following short description of the flow of information between the various components will provide a basis for later detailed descriptions. (See Fig. 1)

There is a control register associated with each station from which the JOHNNIAC computer can sense control signals, and into which the computer can set commands or control information.

There are 16 individual line buffers which will hold up to 81 characters each. JOHNNIAC communicates with each line buffer on a fixed block transfer basis wherein all 81 characters of a specific line buffer may be read or written to a given location in the core store. Any line buffer may be assigned to any station. This is done by JOHNNIAC setting a 4-bit assignment field in the desired Station Control Register (SCR). On input, a line of characters composed at a station typewriter is assembled in the assigned line buffer as the characters are struck. As on the typewriter, the space or backspace functions do not write a character but move a character pointer forward or backward within the buffer.*

*A conditional switch at the JOHNNIAC console allows forward spaces to be written. The character pointer is defined further in the section entitled "Line Buffer Details."

Strike-overs will replace the old character with the new.

The contents of a line buffer may be transmitted to the typewriter by a JOHNNIAC instruction setting the "Transmit Line" command (TL) in the SCR. The transmission will start from the first character position of the assigned line buffer and continue until an "end of message" character is encountered. The transmission will terminate after the 81st character if no prior terminating character is encountered.

STATION CONTROL REGISTER

The central equipment of the MTC system contains a magnetic drum store. The drum, in addition to containing 16 line buffers, has an 81-word, 2-ms access storage area. The 81 words are called the Station Control Registers and time-share a common set of dynamic logic. Each SCR controls the status and reflects the control signals of a station as well as controlling the communication between a station and a line buffer.

We will use the JOHNNIAC Accumulator image of the SCR as illustrated in Fig. 2 to describe the function of the various SCR bits. The binary "1" state of each bit will indicate its "set" condition and binary "0" will

indicate "reset," or indicate result of a reset.

The SCRs include three fields. The field extending from accumulator positions 1-6 contains command bit positions which are to be set by a JOHNNIAC instruction, and will be reset automatically when the command is completed by MTC control. The field in accumulator positions 15-18 is for assigning a particular line buffer to a station. The field in accumulator positions 21-27 contains signal bit positions representing certain actions by the station or SCR. The signal bits can be set only by the MTC system but can be reset at any time by a JOHNNIAC instruction. Each signal bit will be reset automatically when its context becomes invalid, i.e., when station control is switched to user, all signals which the station can set are initially reset to 0, so that subsequent JOHNNIAC sensing of these indicators will reflect status of the current context only.

The contents of an SCR may be sensed by copying into the accumulator. In order to reset signal bits and set command bits in the SCR, the contents of the accumulator register may be transferred to an SCR through a mask from the core store. (See the 14.X order class in Fig. 3.) There are no limitations about when the SCRs may be

sensed or set but a safeguard exists in that signals may only be reset and once set, the commands cannot be reset.

EN b1

The command bit EN (b1) will set the SCR and its station to the enabled state. This allows operation of a particular station. The enable light at the station will turn on when the SCR is enabled, if station power is on. This signals the station user that the station may be set "on-line" by the "ON" push button on the station control box (see Fig. 6). When set "on-line," the signal bit ON (b21) will appear in the respective SCR. If the station is set "off-line" by the user, after having been on, by use of the OFF push button at the station, the enable condition will be reset automatically and the OFF (b22) signal bit will be set. If a JOHNNIAC instruction resets the enable condition by use of the

Enable Light

ON Push Button

ON-b21

OFF-b22 Push Button

DS-b2

Disable Command bit (b2), the station will automatically go off-line without the b22 signal being set. As long as the disabled condition prevails the SCR will be held to the cleared state indicated in Fig. 2.

"RED" LIGHT

From the initial or cleared state of the SCR, the station, when set to ON, will come on in the "RED" state, which is signified at the station by a red light, a locked keyboard, and the printing color control in the down (black) position. At this point the JOHNNIAC program has control of the station and may either transmit a line of characters or switch control to the user.

BN (C15-C18)

In order to transmit a line of characters a line buffer must first be assigned and loaded. This is accomplished by a JOHNNIAC instruction setting BN (C15-C18), the buffer

number field in the SCR, and that line buffer loaded with the desired output by a 14.0 instruction. Once set, the BN will remain until changed by JOHNNIAC.

TL-b4

The line may now be transmitted by a JOHNNIAC instruction setting the command bit TL (b4) in the SCR. The SCR will start at the first character position in the line buffer, copy characters at the rate of 10 per second and transmit these to the typewriter. This will continue and TL (b4) will remain equal to 1 until an "end of message" (eom) type of character code is encountered in the buffer. TL will then be reset (=0)

TO b27

and TO (b27) will be set as a signal that transmission is over. If not reset by a JOHNNIAC instruction, TO will be reset by an additional setting of TL.

When a function code is transmitted to the station, a hold condition in the SCR will prevail until the function is completed. When this is true, all control by SCR, except in the turn-off act, is frozen. The ready light at the station will go out to indicate this condition. The hold condition may come about also by depleted paper supply at the station or by the user turning off the ready light at the station. The

Ready Switch

user may turn on the ready light when paper supply has been replenished. The user may turn off the ready light at any time during output to interrupt typewriter action without loss of information. This is done by pressing the lower part of the switch below the ready light. Ready may be turned on again by pressing the upper part of the switch and output will continue. If the hold is

initiated by a variable length "end of message" type character, the TL will be reset at the same time. If an additional output line is desired the line buffer may be reloaded at this time and a new TL set. The action of TL will not be initiated until the hold is finished. The function codes which affect the hold condition are: "tab," "carriage return," and "page." (See Fig. 4 for these character codes.)

RI-b24
IN switch

While the station is in the "red" state, the user may push the IN button on the typewriter control box. This registers locally in an "In Request" light on the control box and in the SCR by setting RI (b24) equal to "1." The RI bit is only a signal for JOHNNIAC program use and does not directly result in any action or control change. The

RI bit may be reset at any time by the JOHNNIAC instruction, but in any case, it will automatically be reset when control is switched to user. Only one request by a station user may be registered in one control cycle (red-to-green states) and once set, the "In Request" light at the station will remain lit until the control is switched to user, even if the SCR-RI signal bit is reset by a JOHNNIAC instruction.

SU-b6 In order for a user to type information into an assigned line buffer, control of the station must be "switched to user" which we shall call the "green" state. This is done by a JOHNNIAC instruction setting the command bit SU (b6). When the SU takes action, it results in a green light at the station (the red light is extinguished).

The keyboard is unlocked, the ribbon color control is switched up, and the SCR is conditioned to place characters in the assigned line buffer as they are transmitted from the remote station. All signal bits except "ON" will be reset by the SU command. If the "In Request" light is on at the station it will be extinguished by the SU act. When a TL and an SU command are simultaneously present in an SCR, the SU action will be delayed until the TL is complete. The SU will also be delayed by the hold condition.

CL-b5

Before the SU, it is normally desirable to clear the assigned line buffer to all space codes and return the character pointer to the first position. This is done by use of the command bit CL (b5). A resident TL again takes precedence over the

CL and will delay its operation until the completion of TL. Therefore TL, CL, SU may be set simultaneously and the MTC control will activate these commands in the proper order.

After control is switched to user, the TL, CL, and SU commands will be ignored and automatically reset if set by a JOHNNIAC instruction.

RO-b3 "out request" light

The out request light on the station control box may be lighted by a JOHNNIAC instruction setting of the RO command bit (b3). This light will remain lit until control is again switched "RED."

Station Gong

An audible signal (gong) is given at the station when RO is executed. The gong may be excited repeatedly by additional RO commands. The gong also sounds when the SU command switches the station "green."

Out Pushbutton; Carriage Return; Page; TC-b23; RC-b25	The station may be switched "RED" again only by the user at the station. This may be accomplished by any of three keys: Carriage Return and Page, on the typewriter; and "OUT" on the control box. These control keys do not affect the contents of the line buffer although both Page and Carriage Return do return the position pointer in the buffer to the first character position. One of three signal bits will be set in the SCR, as follows: Out - TC (b23), Carriage Return - RC (b25), Page - EJ (b26).
EJ-b26	

LINE BUFFER DETAILS

Each line buffer contains a character pointer for the purpose of keeping track of the character to be sent next on transmission to the station and the position to be entered next when receiving from a station. This pointer is not available to the JOHNNIAC, but has

the following characteristics:

1) The pointer will automatically be returned to the first character position by the following:
   a) By actuation of the CL command bit.
   b) Before a TL command is initiated.
   c) On receipt of a carriage return or page function from the station.
   d) On transmission of a carriage return + eom or page + eom character.
2) The pointer will be advanced just one space by the following events:
   a) Receipt of any printing character code.
   b) Receipt of the tab (the tab will be entered as a single character code) or space.
   c) Transmission of any code (including CR, Page, backspace, tab) except eom.
3) The pointer will move backward one space upon input of the backspace function only.
4) The pointer cannot be moved beyond the limits of the line buffer (81 characters).

JOHNNIAC instruction 14.0 (write LB), access to the line buffer, is locked out only when the buffer is in

use for transmitting. During this time, when TL is set, a 14.0 instruction on the assigned buffer will result in a "hang-up" condition in JOHNNIAC until transmission is complete. The 14.0 instruction will then proceed. There is no lock-out with respect to an assigned buffer when its corresponding station is assembling (inputing) a line, so the programmer should exercise care not to destroy incoming messages at this time.

The SCR clear resulting from a "turn-off" event or "disable" does not affect the assigned buffer in any way. This clear does not affect the buffer assignment in the SCR.

Since there is no limitation to when an SCR may be accessed by the 14.2 instruction, the programmer should take care not to change a buffer assignment during line transmission or while a valid line is being input from the station. A program written to handle a multiple station and multi-line buffer system has many of the freedoms which a telephone operator has in interconnecting the system, including misconnecting the system. More than one station may be assigned a given buffer, but activity ("green state" or "TL"), with respect to that line buffer, should be limited to a single station.

TELEPHONE LINES

The MTC system utilizes a single ordinary telephone line pair to communicate between each station and SCR. The station-to-SCR number mapping may be varied manually at a plug patch panel in the main MTC cabinet. Two types of lines may be used with the system. Private lines are provided by the telephone company from the patch panel to any desired office within RAND. For short-term use, an extension jack may be provided at any hand-set so that dial connections may be made between telephone sets in the JOHNNIAC room and any existing telephone within RAND.

All patch panels to SCR lines except SCR#0 are connected through relay contacts, so that all but the 0 station may be disconnected from the system via a switch at the JOHNNIAC console for single station use.

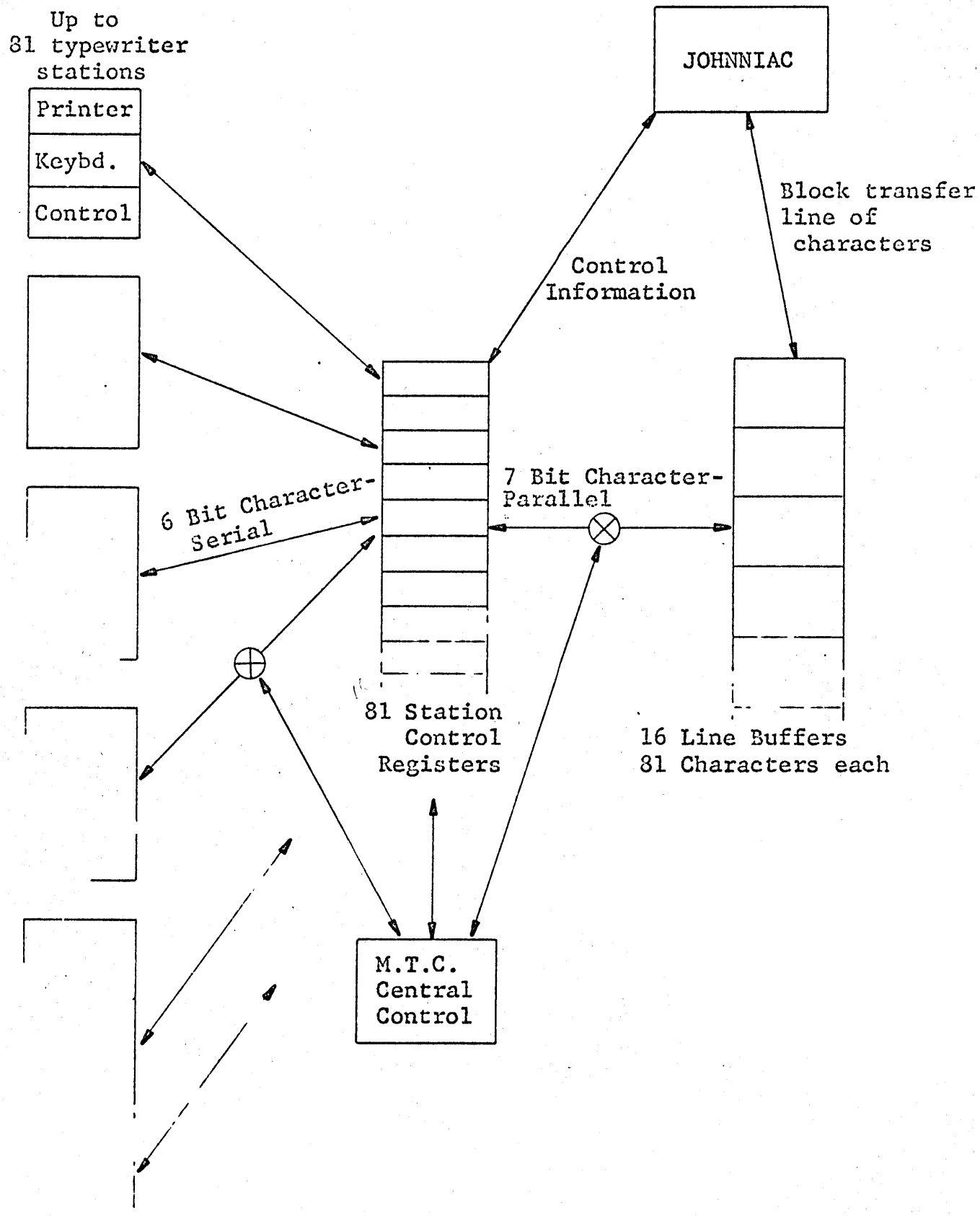


Fig. 1--JOSS Communication System

	Commands											Signals													
Abbrev.	F	EN	DS	RO	TL	CL	SU	-BN-				ON	OF	TC	RI	RC	EJ	TO							
Accum.		b	b	b	b	b	b	c	c	c	c	b	b	b	b	b	b	b	t	t	t	t	t	t	t
Position	0	1	2	3	4	5	6	15	16	17	18	21	22	23	24	25	26	27	33	34	35	36	37	38	39
Cleared State		0	0	0	0	0	0	X	X	X	X	0	X	0	0	0	0	0							
Can be set by: MTC												X	X	X	X	X	X	X							
JOHNNIAC		X	X	X	X	X	X	X	X	X	X														
Can be reset by: MTC		X	X	X	X	X	X					X	X	X	X	X	X	X							
JOHNNIAC								X	X	X	X	X	X	X	X	X	X	X							
	Flag for Unsuccessful Search	Enable	Disable	Request Out	Transmit Line	Clear Line Buffer	Switch to User	Line Buffer Assignment				Turn On	Turn Off	Take Control (Out)	Request In	Carriage Return	Page	Transmission Over	Station Number (Permanent)						

Fig. 2--Station Control Register--Accumulator Mapping

14.0, M - (2.1ms-36ms) Write line buffer number Ac from memory block starting at address M

14.1, M - (2.1ms-36ms) Read line buffer number Ac into memory block starting at address M

The line buffer number Ac resides in the accumulator positions C15-18 as in Fig. 2.

The above instructions will block transfer one character per word for 81 words in the following format:

```
-,--- ---, --- --- --- ---,--- --- ---,--- --C CCC CCC
                                    Pos No.  3 333 333
                                             3 456 789
```

14.2, M (.1ms to 2.1ms) - Write SCR #At from Ab, Ac through mask in M

14.3, (.1ms to 2.1ms) - Read SCR #At into Ab, Ac

14.4, M (.1ms to 2.4ms) - Search all SCRs for Match with Ab,Ac bits designated by the mask in cell M

14.5, M (.1ms to 2.4 ms) - Search all SCRs for Mismatch with Ab,Ac bits designated by the mask in cell M

The two search instructions start at t = 0 and will read the entire SCR of first success to Ab,c,t. If no success in search, the instruction will clear accumulator and set A_0 equal to 1. (See Fig. 2 for explanation of Ab, Ac, At.)

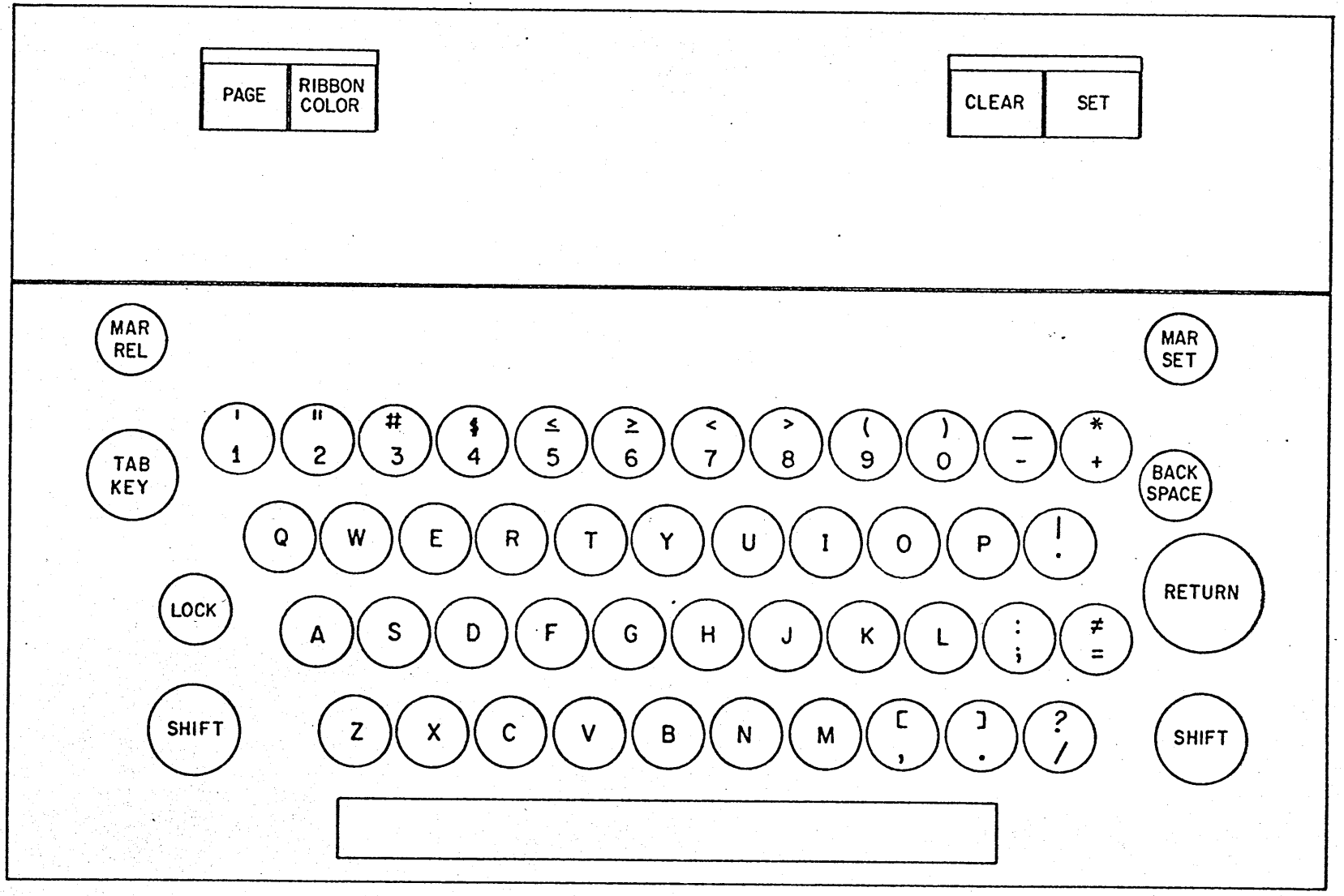
Until the demand is increased only the first 13 SCRs (0-12) will be active and the search is terminated following SCR #12. The instruction time above is quoted for these conditions.

Fig. 3--JOHNNIAC--MTC Instruction Set

		L.C.	U.C.			L.C.	U.C.
1)	000 000				100 000	. (Mult.)	|
	000 001	1	'		100 001	j	J
	000 010	2	"		100 010	k	K
	000 011	3	#		100 011	l	L
	000 100	4	$		100 100	m	M
	000 101	5	≤		100 101	n	N
	000 110	6	≥		100 110	o	O
	000 111	7	<		100 111	p	P
	001 000	8	>		101 000	q	Q
	001 001	9	(		101 001	r	R
1)	001 010				101 010	Carriage Return & eom	
1)	001 011				101 011	=	≠
1)	001 100				101 100	-	¯
1)	001 101				101 101	eom (End of Message)	
	001 110	Space			101 110	Carriage Return	
1)	001 111				101 111	Back Space	
	010 000	;	:		110 000	0 (zero)	)
	010 001	a	A		110 001	/	?
	010 010	b	B		110 010	s	S
	010 011	c	C		110 011	t	T
	010 100	d	D		110 100	u	U
	010 101	e	E		110 101	v	V
	010 110	f	F		110 110	w	W
	010 111	g	G		110 111	x	X
	011 000	h	H		111 000	y	Y
	011 001	i	I		111 001	z	Z
1)	011 010	Out (TC)		1)	111 010		
	011 011	.	]		111 011	, (Comma)	[
1)	011 100				111 100	+ (Plus)	⅄
1)	011 101				111 101	Tab	
	011 110	Eject + CR & eom			111 110	Shift Upper Case	
	011 111	Eject + CR			111 111	Shift Lower Case	

1) Codes which will result in no action at the station.

Fig. 4--MTC Standard Character & Function Codes



JOSS TYPEWRITER KEYBOARD
FIG. 5

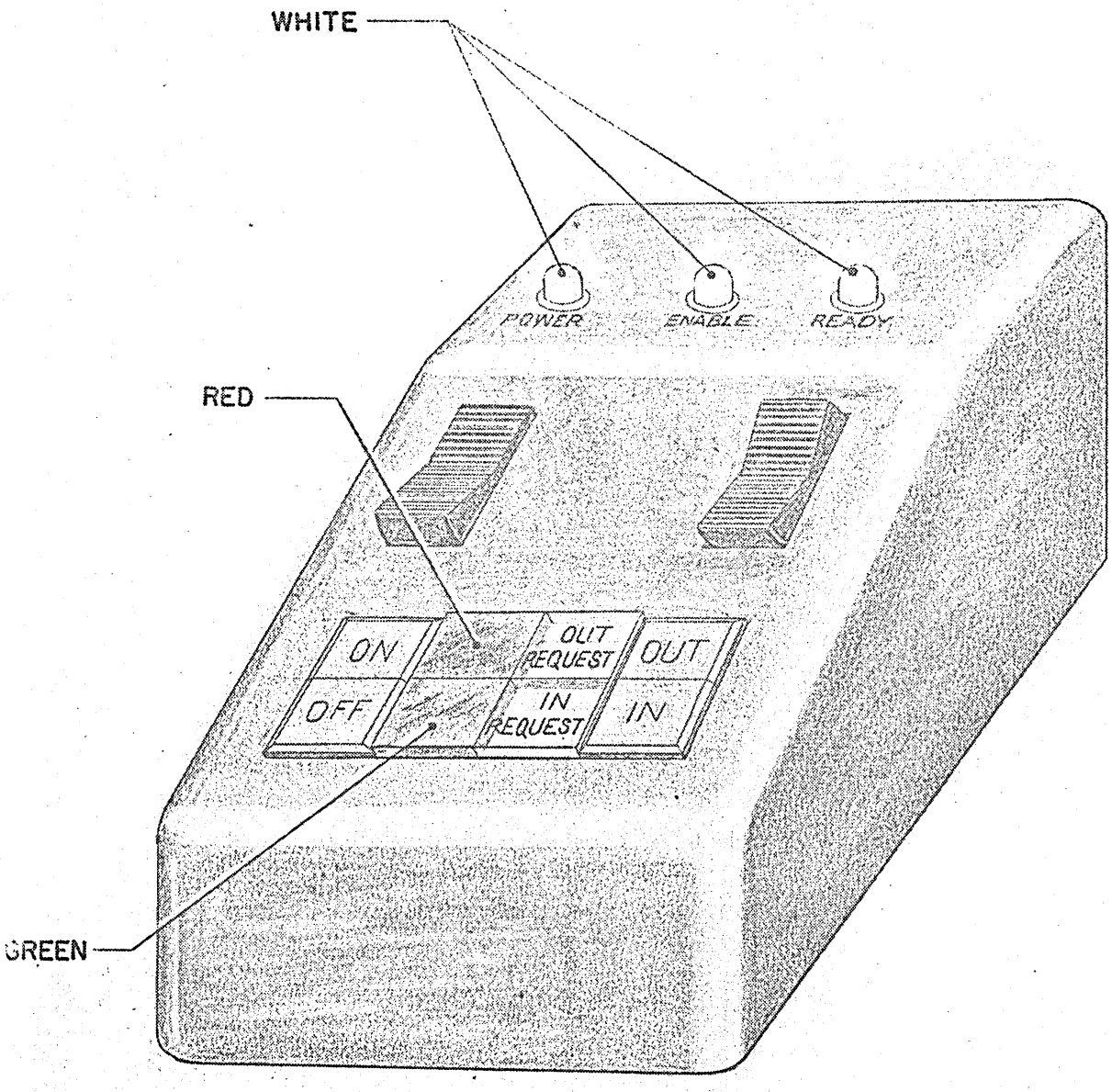
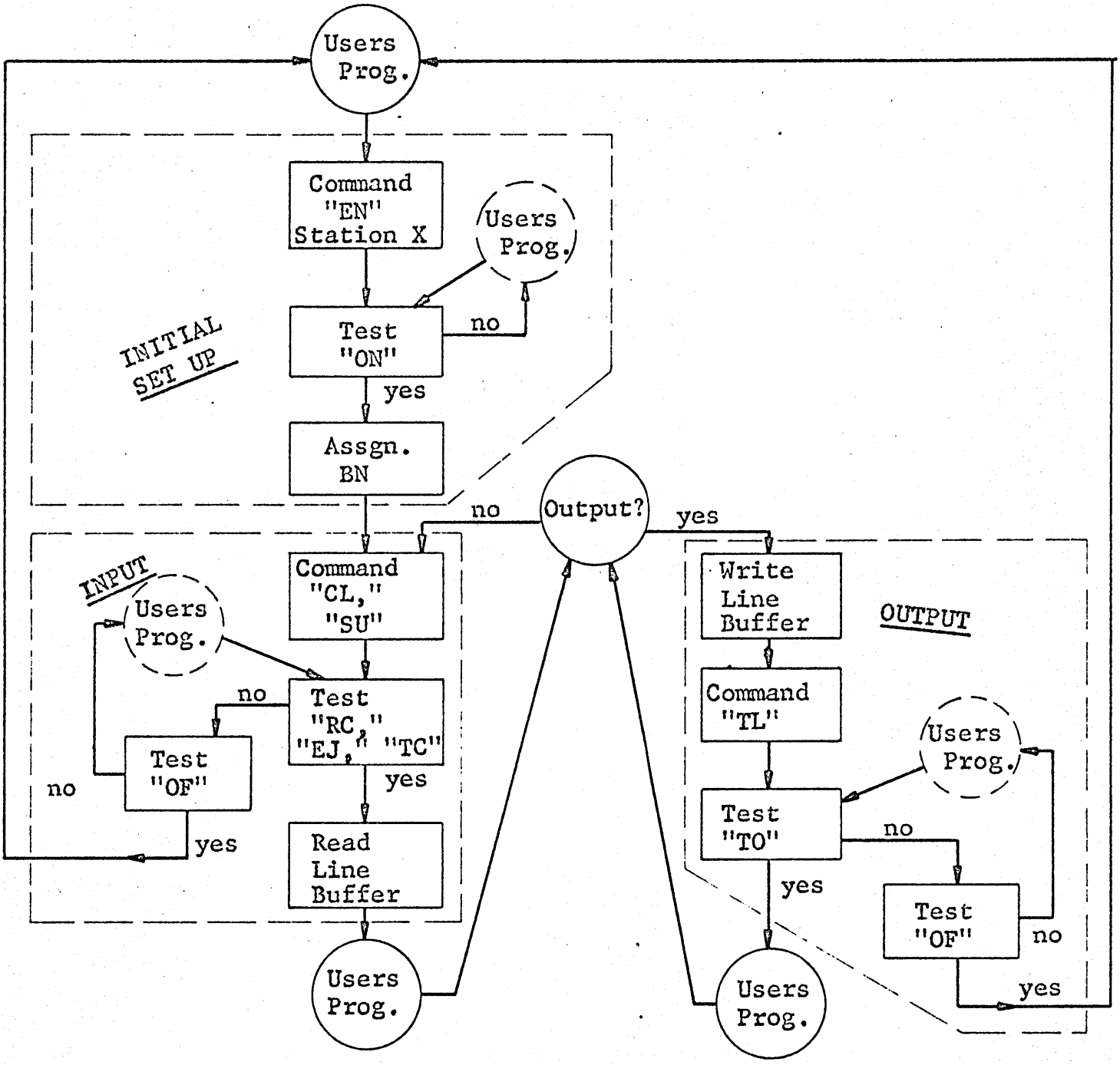


FIG. 6 – STATION LOCAL CONTROL BOX



(Users' program includes incoming message line assimulation or outgoing message line assembly in store.)

Fig. 7--Example of Simple Single Station I/O Procedure

MEMORANDUM

15 Rev. (7-55)

TO: Paul Armer, Willis Ware

DATE: 4/30/62

MEMO NO.:

FROM: Keith Uncapher

SUBJECT: JOSS USERS

COPIES TO: M. Bernstein, R. Blechen, M. Davis, T. Ellis, G. Mealy, W. Myers, I. Nehama, A. Newell, R. Reinstedt, C. Shaw, R. Stahl, J. Tupac

The following JOSS users have been tentatively selected for the initial phase of the system's operation.

Bill Sibley

Art Smith - Physics

Norm Shapiro

Cliff Shaw

JOHNNIAC

Cliff feels these users will provide the most appropriate early feedback on JOSS performance. Reassignment of stations can be made at any time. Further, we expect additional stations to be available soon after the system becomes operational.

We contemplate having the five station system operational in June. Formal plans for announcing JOSS within RAND are not firm.

In order to prepare for moonlight use of the JOSS communication system, the following CSD seminars will be given.

May 18 -- An Introduction to JOSS Hardware. A demonstration of the hardware is also planned.

May 25 or early June -- An Introduction to the JOSS language.

If a sufficient number of people are interested in moonlight JOSS operations, we will plan an informal training class for new JOHNNIAC users. Mort has suggested this might be in order and has volunteered to instruct the class.

Keith

Keith

KWU/al