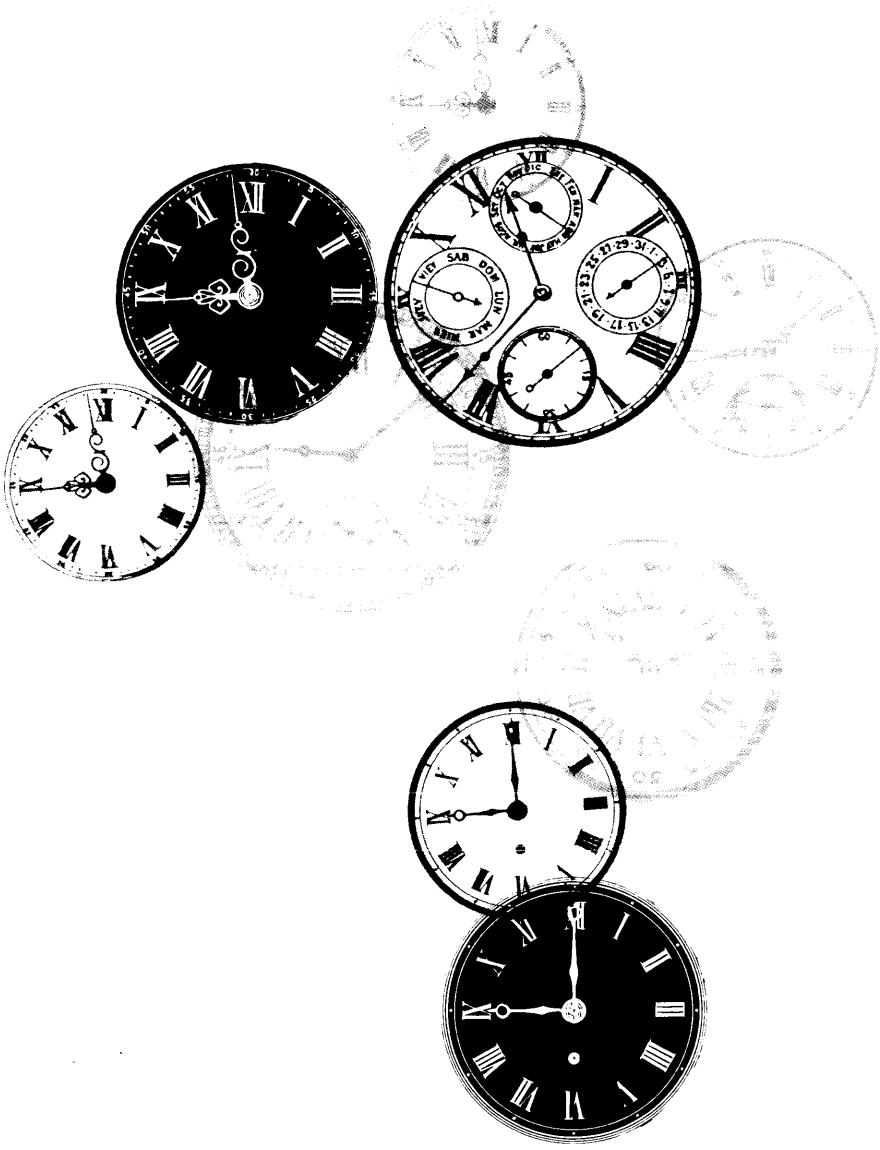

Time-Sharing System Manual

GENERAL ELECTRIC

NOTE

This publication incorporates the latest innovations and improvements to the Computer Time-Sharing Service provided by General Electric. The previous edition may still be used.

CONTENTS

ILLUSTRATIONS

1. INTRODUCTION

The General Electric Computer Time-Sharing System is a new concept in computer service. Time-sharing, or the simultaneous access to a central computer system from many remote locations, is ideally suited for fast definition and solution of problems, and for program updating and editing. Some of the benefits of time-sharing are:

- The personal effectiveness of members of your organization can be increased by giving them immediate access to a computer.
- You gain added efficiency and convenience by placing sending/receiving consoles right in the work area involved.
- Greater efficiency can be gained by utilizing additional office consoles as your requirements increase.
- Even if you have never used a computer before, you can quickly learn the user-oriented BASIC* language required to operate the system.
- FORTRAN and ALGOL are also available for your more sophisticated scientific computations.
- Since you can create, edit, debug, update, and store your programs right at the console, the system lends itself to easy hands-on development of new programs and applications.
- You can expand program utilization and reduce programming effort and file maintenance since users in your organization can store and retrieve common programs and information.
- You can develop additional applications from the common programs available to all system users.
- Your computing costs are reduced since the system facilities are shared by other users.

This manual is intended not only as an introduction to the General Electric Computer Time-Sharing System but also as a reference document for the new user. It includes a description of the hardware configuration and the software system, the System commands and how they are used, and other information such as sample problems and a glossary. The easy-to-use programming languages developed for the System are described briefly. Additional information about them is included in other manuals which are available from your General Electric representative.

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*Developed at Dartmouth College

2. HARDWARE DESCRIPTION

The General Electric Computer Time-Sharing System consists of two central processors--a DATANET-30* and a GE-235; a DS-20 Disc Storage Unit; a master control console and multiple, remote consoles; and a variety of peripheral equipment. The distance between the remote consoles and the central processors is limited only by the accessibility of telephone or Teletype lines. Figure 1 shows the System's configuration which is described in detail below:

- The DATANET-30 is a stored program Data Communications Processor. (See General Electric Computer Department publications CPB-289, DATANET-30 System Manual, and CPB-1019A, DATANET-30 Programming Reference Manual, for additional details.) It is used to control the remote consoles and contains the master executive program. The DATANET-30 also controls the GE-235.

- The GE-235 with its 6 microsecond memory cycle and 16K word storage capacity is the fastest and largest member of the GE-200 line of computers. Its main function is to compile programs and perform floating-point arithmetic. (See CPB-267.)

- The Disc Storage Unit (DS-20) is a large capacity, fast random access storage device which serves as the main path of the data and information transfer in both directions. Either central processor has access to the 18,000,000 character Unit. In addition to its role as a buffer handling information flow between the GE-235 and the DATANET-30, the Disc Storage Unit provides storage for both active and saved programs and for the various compilers and operating systems described in this manual. (See CPB-345.)

  Five areas in the Disc Storage Unit accommodate the following:

  1. The current working stores containing the texts of programs which users are either composing or have retrieved.

  2. Saved programs. Depending on the size of the programs, this area accommodates between 2,000 and 7,000 programs.

  3. A catalog for saved programs.

  4. The operating system and the compilers.

  5. Active programs being swapped in and out.

- The Dual Access Controller is a device operating with the GE-235 and the DATANET-30 so that they can share the same Disc Storage Unit, but not simultaneously. Both central processors are connected to the Dual Access Controller at all times. (See Appendix I of General Electric Computer Department publication CPB-1019A, DATANET-30 Programming Reference Manual.)

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*DATANET is a registered trademark of the General Electric Company

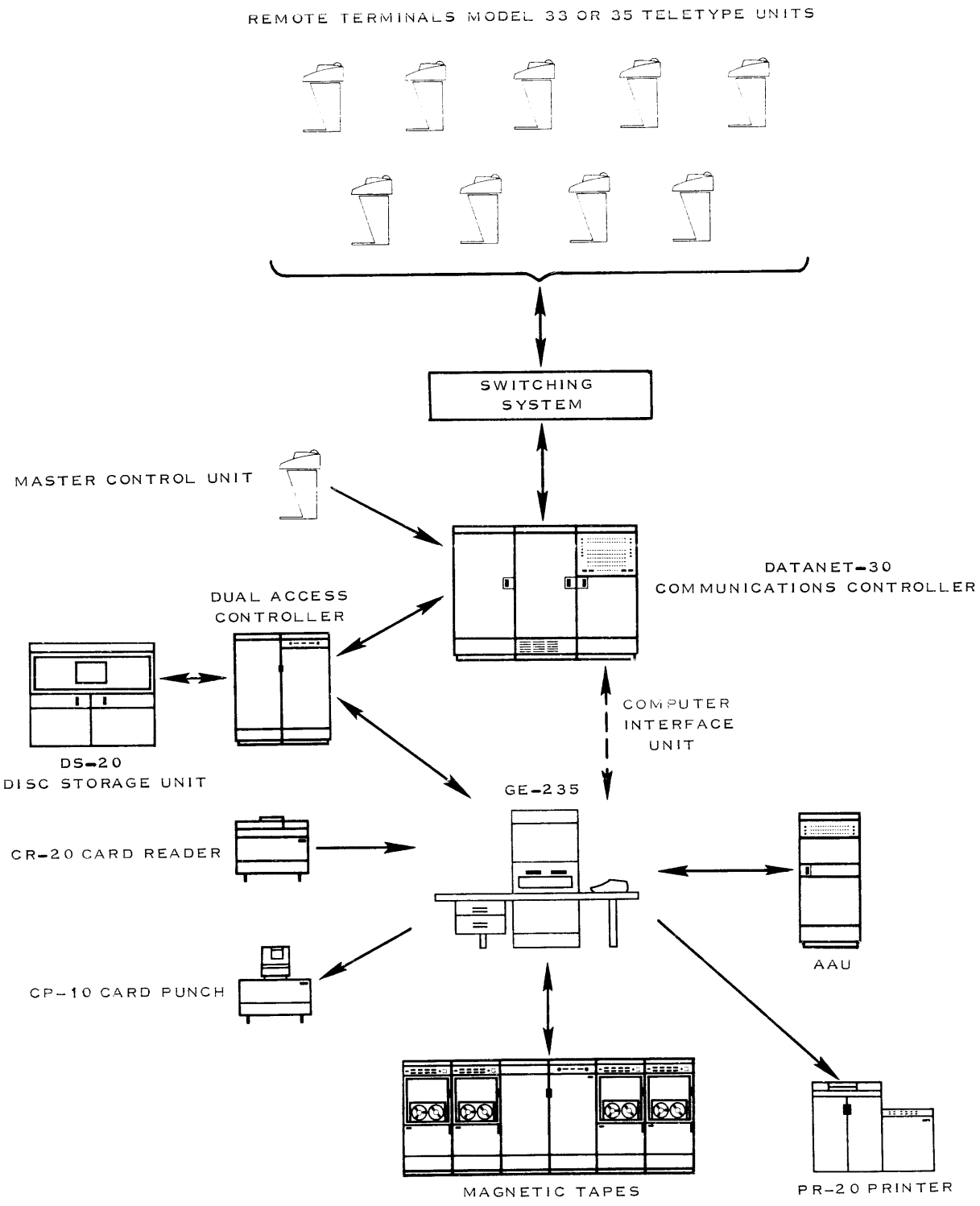

Figure 1. Time-Sharing System Configuration

- The Computer Interface Unit (CIU-930) is a device connecting the GE-235 and the DATANET-30 which exchanges control information so that the DATANET-30 is responsible for the communications half of the System while the GE-235 is responsible for the data processing. (See Appendix E of General Electric Computer Department publication CPB-1019A, DATANET-30 Programming Reference Manual.)

- Consoles. A master control console, located adjacent to the two central processors, serves as a monitor for the entire system. It is used to reload the DATANET-30, to turn the system on and off, and to perform other system maintenance. The master control console and the remote consoles are usually 100 word-per-minute Teletype units (Models 33 or 35). (See Appendix E of this manual for information about the keyboards of these models.) The remote consoles are connected to the DATANET-30 through telephone lines--either private, PBX extensions, or public facilities--using Data-Phone service or TWX service on a dialup basis.

- Peripheral equipment, which includes conventional magnetic tape drives, a card reader, a card punch, and a high-speed printer, complete the General Electric Computer Time-Sharing System. While the System uses these devices for copying data from the Disc Storage Unit files onto magnetic tape and for starting up the System, their primary function is to permit normal batch processing when time-sharing operations are not in process. Because of the flexible nature of the System, however, it does permit a limited use of these peripheral devices for low priority, background jobs.

3. SOFTWARE DESCRIPTION

This chapter discusses the operating system for the General Electric Computer Time-Sharing System and includes a brief description of the scheduling algorithm for the GE-235.

OPERATING SYSTEM

The operating system for the General Electric Time-Sharing System consists of the following four parts: the master executive program; the editing, translating, executing, and bookkeeping programs; the programming languages; and the System library.

- The master executive program is used by the DATANET-30 to control the remote consoles. This program permits the System to operate in two modes: real-time and spare-time.

  1. The real-time portion of the executive program scans the DATANET-30 communication lines for incoming and outgoing data by means of clock-controlled interrupts 110 times per second per active user.

  2. The spare-time part of the program carries out the DATANET-30 spare-time tasks, such as catalog listings. Spare-time tasks are done in the intervals between real-time functioning.

     As the DATANET-30 receives characters from any of the System's Teletype units, it gathers them until it encounters a carriage return (see page 11) at which point the DATANET-30 interprets the message. If the message constitutes a line in the program currently being executed, the DATANET-30 simply continues gathering characters until receipt of the next carriage return. If the message is a command, the System sets up a spare-time task and places it on the spare-time task list. Coordination with the GE-235 is carried out in real-time according to instructions generated in spare-time.

- The editing, translating, executing, and bookkeeping programs are done by the GE-235. The executive routine permits simultaneous use of the card equipment, magnetic tape drives, and high-speed printer, during time-sharing operation.

- Three algebraic languages, BASIC, FORTRAN and ALGOL, are available for the System. These languages are fast, requiring typically one to four seconds for the compilation and execution of a program. Because of this speed and because of the speed with which file changes are made, the program is recompiled at each run. Thus, no special debugging is required, and program development is straightforward and rapid. In addition, both of these languages allow interaction by the user with his program as it is being executed: you can not only obtain results printed out on the Teletype unit, but by using on-line input statements you can read-in values of integers and floating point numbers to control the course of program execution.

For example in BASIC, the statement:

```
100 INPUT I, Y (I)
```

in ALGOL,

```
100 READATA (TELETYPE, I, Y (I))
```

or in FORTRAN

```
INPUT, N, (A(I) ,B(I) ,B(I) ,C(I) ,I=1 ,N)
```

causes a question mark to be printed when the input statement is executed. The System then waits for a list to be typed equal in length to the specified list (in the above example, two numbers) terminated by a carriage return.

1. BASIC is an elementary algebraic language developed specifically for use with the General Electric Computer Time-Sharing System. Easy to learn and to use, BASIC can be applied to a variety of scientific and business problems. See Appendix C of this manual for a summary of BASIC statements and Appendix D for a sample program written in BASIC. The BASIC Programming Manual provides complete instructions in the use of the language.

2. FORTRAN, standing for formula translation, is a mathematically oriented computer language familiar to most engineers and scientists. The GE-265 Time-Sharing FORTRAN is especially adapted for remote terminal and time-shared use.

3. Dartmouth ALGOL is a mathematical programming language useful for engineering and scientific calculations. Based on ALGOL 60, it is designed to meet the specific requirements of a time-sharing system. For programming instructions see General Electric Computer Department publication CPB-441A, Dartmouth ALGOL for the GE-265 Time-Sharing System. For additional information about ALGOL consult any one of the following:

   C. Anderson, An Introduction to ALGOL 60.
   Addison-Wesley (Reading, Mass., 1964)

   F. L. Bauer and K. Samelson, An Introduction to ALGOL,
   Prentice Hall (New York, 1965)

   E. W. Dijstra, A Primer of ALGOL 60 Programming,
   Academic Press

   D. McCracken, A Guide to ALGOL Programming,
   Wiley (New York, 1962)

   H. Bottenbruch, Structure and Use of ALGOL,
   Prentice Hall (New York, 1965)

   M. Woodger, An Introduction to ALGOL 60,
   Computer Journal, July 1960

- The extensive System Library contains a wide selection of programs available to any user of the System. For information about the library and how to use it see Chapter 4, USING THE SYSTEM, System Library.

SCHEDULING

In order that users actively editing programs have rapid turnaround, a programmed priority system determines how GE-235 time is to be scheduled. Priority is as follows:

1. OLD
2. SAVE
3. LIST
4. Others, including RUN

with OLD having the highest priority. Within a given priority level, the System processes requests on a first-come, first-served basis.

While running, a program receives an interval of time on the GE-235 which terminates--

1) when the output area is filled;
2) when the System prints " ?" to request Input;
3) when the program is concluded; or
4) when the time allotment runs out.

During the course of running a program to completion, the System increases the time allotments depending upon the number of times the GE-235 operates on that particular program. These time allotments are as follows:

Entry	Time Allotted
1, 2	3 sec.
3 through 7	6 sec.
Remainder	12 sec.

Scheduling thus effects a rapid turnaround for program editing in preference to program execution, and it also increases efficiency when programs are swapped during running time. The time allotted per period of run time is a compromise between good response for the average user who has only short runs and for the user with programs having a greater than average computational load where time spent swapping the program in and out needs to be minimized.

4. USING THE SYSTEM

GENERAL

The General Electric Computer Time-Sharing System is remarkably easy to use. You type the word HELLO on the Teletype unit and, as required after all commands, a carriage return. This initiates a series of questions and answers which identify you and your problem. Specifically, you supply your user number and the name of the programming system with which you will communicate, specify whether the problem you are about to name is new or old, and give the problem name. Figure 2 shows a sample Teletype unit typeout of a typical introductory "conversation" between you and the computer.

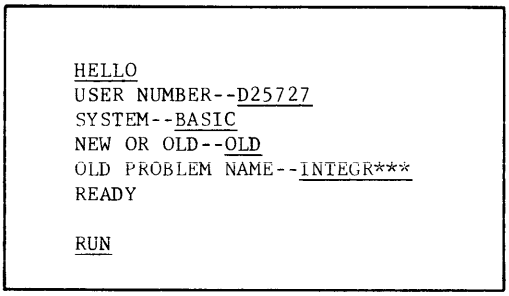

Figure 2. Sample Identification Sequence

In the figure the underlining indicates the words you actually type; the non-underlined words are typed by the Time-Sharing System.

Your program name may consist of any characters, one to six in number, including embedded spaces (spaces between the first and sixth characters). It is recommended, however, that names consist of only alphabetic and numeric characters (with no spaces) and with the first character alphabetic. For example: FLIGHT, SPIRL2, and TAX are typical names.

If you wish to add to or modify a saved program, you indicate OLD in answer to the typeout NEW OR OLD and the computer retrieves it from the appropriate storage area on the Disc Storage Unit. If you wish to write an entirely new program, you indicate NEW.

A program file is built up of records or lines consisting of line numbers as labels separated by one or more spaces from program text. You begin your program statements by typing in a line number of one to five digits. For example: 230 READ D(J,3),D(J,2). Line numbers are in effect editing commands which operate on individual records of the working store file or insert new records. They distinguish program statements from system commands.

The System always edits the program file before responding to the system commands LIST, RUN, or SAVE, so that the lines are in sorted sequence according to the numerical value of the line labels.

By having you type your own line number, the System permits you to insert new lines in the program, to delete unnecessary lines, or to correct lines simply by retyping them. If your original sequence of line numbers was by an increment greater than one, e.g., 10, then new lines can be inserted simply by giving intermediate values of line numbers as appropriate. For example, if the original sequence reads 10, 20, 30, 40, etc., and you wished to insert a new line between 30 and 40 and between 50 and 60, you can add 32 and 52. In addition, automatic renumbering (see page 16) is available. Lines can be deleted simply by typing the line number followed by a carriage return.

When the program has been completed, you type RUN without any line number. This command causes the System to deliver your source program to a translator, to run it, and type out the answer on the Teletype unit.

A user will be disconnected from the time-sharing system if he has not provided input or output and has been in the idle status for ten minutes. When a user is disconnected from the system because of an idle status, the GOODBYE message types out.

SYSTEM LIBRARY

As a user of General Electric's Time-Sharing System, you have at your fingertips an extensive library of programs available within seconds. The program CATLOG*** contains a listing of all the program names in the Library. You select the program you wish, type the program name suffixed by three asterisks, e.g., CIRCLE***, and the System retrieves the program from the Library. It is important to include the asterisks as they instruct the System to look for the program in the System Library rather than under the current user number.

Once you obtain a program from the Library, you can change it to suit your needs, run it, and save it if you wish. To save a System Library program under your own user number, simply type SAVE. (The asterisks are ignored by the System after initial retrieval.) Programs can only be inserted in the library from the master control console.

5. SYSTEM COMMANDS

System commands direct the over-all system to carry out specific actions which you request, e.g., RUN, STOP, CATALOG. You must terminate all lines with a carriage return.

In general, most commands are acknowledged by the word READY when the System is ready for a new command. Exceptions are: RUN which finishes by giving program execution time, and normal line entries, which are acknowledged by a line feed. If the System is busy, it types WAIT before READY. If you are uncertain about the state of your program you can inquire by typing STATUS.

In case of typing errors, you can always delete a complete line by striking the ALT-MODE key (shown as ESC, for Escape, or a control shift (x) on some Teletype machines), or you can delete only the last few characters by backspacing one or more positions by depressing the SHIFT key and striking the key marked ← .

The system commands that are presently available are described below. For ease of use, these commands are summarized and listed alphabetically in Appendix A.

DIRECTIVE COMMANDS

Break*	To cause the computer to stop whatever it is doing with the program when printing is occurring. Requires reset by depressing the BRK-RLS (Break Release) button. Recommended procedure: depress simultaneously the control, shift, and @ sign. This causes transmission of one (and only one) Break character. This procedure prevents any possibility of terminating operations and does not cause the keyboard to lock.
BYE, GOODBYE	These commands (used interchangeably) disconnect your Teletype unit from the Time-Sharing System. If another user is waiting for the machine, however, they should not be given--instead the next user simply types HELLO.
HELLO	To introduce yourself to the System, type this command and strike the carriage return key. This initiates the series of questions and answers which identify you and the action you wish.
NEW or OLD	After you have identified the System, the next question to appear on the Teletype unit is: NEW or OLD--. The usual answer will, of course, be either NEW or OLD, but all other Directive Commands are also permitted.
NEW	If the answer to NEW or OLD-- is NEW, or, in fact, if NEW is typed in at any other time, the System will set aside working store for a new program file and ask that the file be cataloged as NEW PROBLEM NAME--. A new problem is one for which you must supply a name and the necessary program statements.

*Special key on Teletype unit.

OLD

The System response to OLD is to ask OLD PROBLEM NAME--. Next, it retrieves the specified program file from saved store and places it in working store for the user. At this point, you can modify or list the file (see page 17).

Return*

To terminate a program line, cause the System to take action based upon input provided, and act as a normal carriage return.

RUN

When you have finished composing your program file in working store, type RUN. This command causes the program file to be delivered to the previously specified compiler system (BASIC or ALGOL) to be translated into GE-235 instructions and executed. During execution the results of print statements appear on the Teletype unit.

Execution of a RUN is terminated either by its completion or by your command. If the teletype is not printing, you may type STOP to stop the run. Otherwise two methods are open to you. You can hold down both the control key and the shift key while typing the @ sign, or you can press the break key and then the break-release key. On the model 35, this latter procedure unfortunately also sets the terminal to "Tape."

After a RUN has started, but the Teletype unit is not actually printing, the System will still obey the following commands in the usual way: LENGTH, STATUS, TAPE, KEY, TTY, and STOP. The command RUN, after a RUN has already started, will print out the GE-235 time utilized to that moment on the run.

SAVE

The SAVE command puts the program file, as it exists in working store at the moment SAVE is given, into saved store. It also enters the program file name into your individual catalog of saved programs if it is not already there.

Note that if modifications have been made to the program file in working store since the last SAVE, the listing will show these modifications, but the program file in saved store will not. If SAVE and LIST are given in either order without intervening program file modifications, then the listing will agree exactly with the file in saved store.

Program Storage Units are increments of 1500 characters. Programs are composed of 1, 2, 3, or 4 Program Storage Units. Maximum program size is 4 Program Storage Units (6000 characters).

SCRATCH

SCRATCH permits you to erase all the lines in your program, i.e., make the working store empty, without changing the name of the program. RENAME plus SCRATCH, in either order, is equivalent to NEW.

STOP

To cause the computer to stop whatever it is doing with the program except when printing is occurring.

UNSAVE

You should conserve Disc Storage Unit space by "unsaving," whenever possible, program files that are not needed. Thus, the Disc Storage Unit is regularly purged of old, inactive files. The UNSAVE command serves to remove the name of the program currently in working store from your catalog of programs in saved store, without changing the program file contents of the working store itself.

Once you have built up a program file in working store by use of NEW or OLD, certain other commands can logically follow. These are: LIST, SAVE, and UNSAVE.

*Special key on Teletype unit.

User Number

Six characters that identify the user to the system. Assigned by System Operations people. The User Number determines the catalog into which a program is placed. Each time you initiate an OLD, SAVE, CATALOG, or UNSAVE command, the DATANET-30 scans the proper catalog for either the desired entry or for a space into which a catalog entry for the current program can be placed.

EDIT COMMANDS

Alt Mode* or Escape* or Control with X

To delete an input line as if nothing had been typed.

Arrow (←)

To erase the last character(s) typed. SHIFT key must also be depressed . This is the character on the "O" key.

EDIT DELETE
EDIT EXTRACT

The EDIT DELETE command allows you to dispose of unwanted portions of your program without doing it line-by-line. In an EDIT DELETE operation you specify what part of your program you want deleted by giving beginning and ending line numbers of the block to be deleted. Thus, an EDIT DELETE command will look like this: EDIT DELETE N1,N2,N3,N4...(up to 10 pairs of numbers).

This results in each number pair, e.g., 10,40, being taken as the beginning and ending line numbers of a block to be deleted. If there is an odd amount of line numbers, e.g., 10,40,70 the System takes the missing line number to be the last line in the program. In this case the lines between 70 and the last line in the program will be deleted.

The EDIT EXTRACT command is the complement of the EDIT DELETE command, as it retains portions of the program rather than deleting them. The format is the same (up to 6 pairs of numbers) and the same assumption if there is an odd amount of line numbers. However, using the EDIT DELETE command and the same number pair shown on the example above, e.g., 10,40, you can retain program lines 10 through 40. In this case the remainder of the program is deleted.

In both EDIT DELETE and the EDIT EXTRACT commands, all numbers must appear in increasing order. For example: EDIT EXTRACT 100,200

This command would serve to retain the program between and including line numbers 100 and 200 and to delete the remainder of the program. To obtain the same result using the EDIT DELETE command, type: EDIT DELETE 0,99,201,99999

EDIT MERGE

DOES NOT DELETE EXTRA "END" STATEMENTS.

DOES NOT UPDATE CROSS-REFERENCES BETWEEN DIFFERENT PROGRAMS, AS IN "GOSUB xxx", WHERE SUB IS A MERGED PROGRAM

The EDIT MERGE command is used to combine two or more saved programs into a single program. It is important to keep in mind that EDIT MERGE operates only upon saved programs. In EDIT MERGE, you specify a main program and one or more other programs to be inserted into the main program. When the EDIT MERGE command has been executed, the entire new program is resequenced. In addition, you can control where the programs that you name are to be inserted into the main program by inserting a line number (e.g., NN, MM, as shown below).

The general command format is as follows:
EDIT MERGE NAME1, NAME2, NN, NAME3, MM, NAME4...(up to 10 programs) where NAME1, NAME2, NAME3, and NAME4 are names of programs previously saved by the user, and NN and MM are line numbers of statements in NAME1, immediately after which NAME2 and NAME3 are to be inserted, followed by NAME4, etc.

*Special key on Teletype unit

If a number NN or MM is present, it must be preceded by a space; program names (NAME) must not include embedded spaces nor begin with a digit. The minimum necessary portion of the command is: EDIT MERGE NAME1, NAME2

In this case all of NAME1 is copied into working store followed by NAME2, and, finally, the new working store file is resequenced as if the command: EDIT RESEQUENCE 100,0,10 had been given.

Before the EDIT MERGE command can be effective, you must have established some working store even though its initial contents are irrelevant. To establish working store you can call out a program by OLD , or by NEW and name, followed by a statement.

As with other commands, the System indicates READY when the EDIT MERGE command has been executed. At that time, the new merged file will be in working store, and the working store name will be that of the last name given in the EDIT MERGE command; thus, in general, the RENAME command is desirable before SAVE is given. Also, to avoid destroying an irreplaceable file, the wise user will list portions of working store to see that merging and resequencing have occurred to his satisfaction before saving.

EDIT RESEQUENCE

The EDIT RESEQUENCE command allows you to renumber the lines of your program and at the same time to update reference to these lines within your program. You can specify the following items in requesting a resequence operation on your program:

1) The number with which you wish resequencing to begin.
2) The line number in the program where resequencing is to begin. Thus, you can specify that your program be untouched up to a point--a certain line number--and resequenced beyond that point.
3) The increment to be used in assigning line numbers e.g., 2, 10, 15, etc., at your discretion.

These three parameters are included in the actual EDIT RESEQUENCE command as follows: EDIT RESEQUENCE N1, N2, N3, where N1 is item 1) above; N2 is item 2) above; and N3 is item 3) above. It is possible to omit specifying the following:

N3
N3 and N2
N3, N2, and N1

If N3 is omitted, the increment is assumed to be 10; if N2 is omitted, the program is renumbered from the beginning; and if N1 is omitted, resequencing will be started off with a first line number of 100.

In another example, you type:
EDIT RESEQUENCE 10,0,2 (carriage return)

This results in the program being renumbered from the beginning (line 0), by two's, with 10 being used as the new first line number.

LIST
LIST--XXX

At any time except before completion of a previous command, you may type LIST or LIST--XXX, where XXX is a one to five digit line number. (Be sure to insert either two hyphens or two spaces after LIST when XXX is given. If --XXX is missing, its value is taken to be 0.) The LIST command causes the program file currently in working store to be listed beginning with line XXX. The printing of the listing is terminated either by the listing of the last line or by user action. During LIST you can stop printing just as you stop all other printing--by momentarily pushing the "Break" key. If the computer is busy so that active printing is not occurring, you can also type STOP to terminate listing. The combined use of the LIST--XXX and "Break" commands permits you to list easily lines in the middle of your program file.

RENAME

The RENAME command enables you to duplicate your program files. After you have built up a program file in working store by means of either the NEW or OLD command, give the command RENAME. The System response will be NEW PROBLEM NAME--just as if NEW had just been typed. But whereas NEW creates a working store that is empty, RENAME changes only the name of the working store--not its contents. Thus, RENAME permits you to create easily two almost identical versions of the same program: you retrieve the first file, make modifications to it, and then save the modified version under the new name.

INFORMATIVE COMMANDS

CATALOG

If you cannot recall the name of a saved program file, type CATALOG. The system then prints out the names of the programs saved under the user number previously identified. If too many have been saved, this fact is noted by a typeout "....." printed after the fortieth name given, and the remaining names are not listed. You can stop CATALOG listing by typing STOP if the printer is not active, or by depressing the "Break" key.

CATLOG***

CATLOG*** is actually a program not a system command. This program, however, will list the names of all programs in the System Library. Any user on the System can request this listing (using his own user number), but additions, changes, or deletions in the Library catalog are made only from the master control console.

STATUS

To request your present relationship to the System, i.e., idle, run, old, list, save, or disconnect (disconnect means you have not typed HELLO).

TTY

To learn which channel of the DATANET-30 is being used for your connection and to print current user number, problem name, system name, and status.

MODE COMMANDS

ALGOL

To denote programming language mode to be used.

BASIC

To denote programming language mode to be used.

KEY

To reset terminal operation to the normal mode after reading in paper tape.

SYSTEM

The command SYSTEM changes the name of the programming language you are using. For example, if you have already typed in BASIC as part of the initial sequence and wish later to use ALGOL, type SYSTEM. When the System responds NEW SYSTEM NAME, you type in ALGOL, and continue in that language.

TAPE

The computer acknowledges receipt of each program file line by sending a line feed. The command TAPE can be used at any time to indicate to the System that the lines of program being read in via paper tape should not be acknowledged by a line feed from the computer as this would confuse the printing.

APPENDIX A
INDEX OF SYSTEM COMMANDS

ALGOL	To denote programming language.
Alt Mode* or Escape* or Control with X	To delete an input line as if nothing had been typed.
Arrow (←)	To erase the last character(s) typed. SHIFT key must also be depressed. This is the character on the "O" key.
BASIC	To denote programming language.
Break*	To cause the computer to stop whatever it is doing with the program when printing is occurring. Keyboard must be unlocked manually afterward. Recommended procedure: depress simultaneously the control, shift, and @ sign. This causes transmission of one (and only one) Break character. This procedure prevents any possibility of terminating operations and does not cause the keyboard to lock.
BYE	To disconnect from the system.
CATALOG	To list a user's catalog of saved programs.
EDIT DELETE	To erase portions of a program.
EDIT EXTRACT	To retain portions of a program.
EDIT MERGE	To combine saved files into working store and to resequence line numbers.
EDIT RESEQUENCE	To resequence line numbers in program in working store.
GOODBYE	To disconnect from the System.
HELLO	To address the System or to change user number.
KEY	To reset terminal operation to normal after reading in paper tape.
LENGTH	To request the number of characters in working copy of program.
LIST	To list the current working copy of a program.
LIST--XXX	To list the current working copy of a program beginning at line X or after (XXX= 1-5 digits).
NEW	To introduce a new program and destroy the working copy of the current program.
OLD	To retrieve from saved store a previously saved file and destroy the working copy of the current program.

*Special key on Teletype unit.

RENAME	To change program name but not working copy contents.
Return*	To terminate a program line, cause the System to take action based upon input provided, and act as a normal carriage return.
RUN	To compile and execute
SAVE	To save permanently the working copy of a program.
SCRATCH	To eliminate from the working copy of a program everything but the program name.
STATUS	To request status of a program.
STOP	To cause the computer to stop whatever it is doing with the program except when printing is occurring.
SYSTEM	To change name of the system under which you are working.
TAPE	To inform the System that paper tape will be read in.
UNSAVE	To release and destroy a previously saved program.
TTY	To request channel number, user number, problem name, system name, and status.
User Number	Six characters that identify the user to the system.

*Special key on Teletype unit.

APPENDIX B
GLOSSARY OF TIME-SHARING TERMS

Background	A time-sharing technique in which batch processing programs can be run concurrently with the time-sharing system when no time-sharing activity is required of the central processor.
Batch Processing	A data processing technique in which like transactions are accumulated until workable "batches" are available for processing on the computer.
Buffer	An area in the computer memory which stores information temporarily during data transfers.
Character	One representation of a numeric digit, letter of the alphabet, or special symbol.
Dialup	The ability to initiate a station-to-station telephone call, using a dial telephone, and effect the station connection desired purely as the result of dialing.
Executive Program	A permanently stored program which provides master control over all functions of the system.
Line Feed	Rotation of a Teletype platen up one line.
Message	A group of characters having meaning as a whole and always handled as a group.
Off-Line	Operation of a terminal or other input/output device not under control of the system.
On-Line	Operation of a terminal or other input/output device as part of the time-sharing system and under system control.
Real-Time	Period of time-sharing operation when the system must perform tasks immediately, for example, scanning of communication lines and communication with the central processor.
Spare-Time	Period of time-sharing operation when the system performs tasks which have previously been set aside for later execution, for example, catalog listings.
TTY	Teletype equipment
Working Store	The area on the disc containing the texts of programs which the users are either composing or have retrieved from saved store.

APPENDIX C
SUMMARY OF BASIC STATEMENTS

In the following summary of the BASIC statements, it is assumed that all statements begin with a line number. A generic example is included for each statement. In the example the parameters are underlined. A specific illustration of each statement is also shown.

ARITHMETIC STATEMENTS

DEF	DEF FN letter (unsubscripted variable) = expression
	10 DEF FNG(Z) = 1 + SQR(1 + Z*Z)
DIM	DIM letter (integer) or DIM letter (integer, integer)
	10 DIM A(17) or 10 DIM B(3,20)
LET	LET variable = expression
	10 LET X1 = Y + Z + (Z/A-B ↑ D1)

MATRIX OPERATIONS

MAT	READ letter (expression,expression)
MAT	READ A (M,N)
MAT	PRINT letter
MAT	PRINT A
MAT	letter = matrix expression
MAT	C = A+B
MAT	C = A-B
MAT	C = A*B
MAT	letter = ZER(expression,expression)
MAT	C = ZER(M,N)
MAT	letter = CON(expression,expression)
MAT	C = CON(M,N)

MAT	letter = IDN
MAT	C = IDN
MAT	letter = IDN (expression, (SAME) expression)
MAT	C = IDN (M,M)
MAT	letter = TRN(letter)
MAT	C = TRN(A)
MAT	letter = INV(letter)
MAT	C = INV(A)
MAT	letter = (expression)*letter
MAT	C = (k)*A

IDENTIFIER STATEMENTS

DATA	DATA number, number, . . . , number
	10 DATA 1,2,-3,7, 123.479,-2.35E-4
END	10 END
REM	REM any string of characters whatsoever
	10 REM THIS IS THE END OF APPENDIX C

INPUT/OUTPUT STATEMENTS

INPUT	INPUT variable, variable, . . . , variable
	10 INPUT X,Y,Z,A1,Q(I,J)
PRINT	PRINT label or PRINT label expression or PRINT expression
	10 PRINT "SINE" or 10 PRINT "X="X(I,K) or
	10 PRINT A+B*COS(Y)
READ	READ variable, variable, . . . , variable
	10 READ X,Y,Z,A1,Q(I,J)
RESTORE	10 RESTORE

LOGIC STATEMENTS

GOTO	GOTO line number
	10 GOTO 17

IF-THEN	IF expression relation expression THEN line number
	10 IF X + Y > 0 THEN 419
STOP	10 STOP

LOOP AND SUBROUTINE STATEMENTS

FOR	FOR unsubscripted variable = expression TO expression STEP expression (with STEP... optional)
	10 FOR X1 = 0 TO 7 STEP 0.5 or 10 FOR I = 1 TO 17
GOSUB	GOSUB line number
	10 GOSUB 110
NEXT	NEXT unsubscripted variable
	10 NEXT X1
RETURN	10 RETURN

APPENDIX D
SAMPLE PROGRAMS

BASIC

```
HELLO
USER NUMBER--D25727
SYSTEM--BASIC
NEW OR OLD--OLD
OLD PROBLEM NAME--INTEGR***
WAIT.
READY.

LIST


INTEGR      9:45

1 PRINT "DO YOU WANT INSTRUCTIONS(YES=0,NO=1)";
100 INPUT Z
110 IF Z=1 THEN 170
120 PRINT "THE INTEGRAND IS INSERTED AS STATEMENT 1000."
130 PRINT"I.E. 1000 DEF FNA(X)=2*(X↑2)"
135 PRINT"CHANGES MAY BE MADE ONLY ON THE RIGHT OF THE EQUAL SIGN."
137 PRINT "TO DO INTEGRATION RUN PROGRAM TAKING 'NO' BRANCH."
140 PRINT"THE PROGRAM WILL REQUEST THE UPPER AND LOWER LIMITS WHEN NEEDED
150 GO TO 99999
160 REM READ IN THE NUMBER OF POINTS
170 READ N
180 FOR I=1 TO N
190 READ U(I),R(I)
200 NEXT I
210 PRINT "WHAT ARE THE LOWER AND UPPER LIMITS";
220 INPUT A,B
230 LET S=0
240 FOR I=1 TO N
250 LET X = A + (B - A) * U(I)
260 LET  S = S + R(I) * FNA(X)
270 NEXT I
280 PRINT "THE ANSWER IS " S*(B-A)
300 DATA 7
310 DATA .025446,.064742,.129234,.139853
320 DATA .297077,.190915,.500000,.208980
330 DATA .702922,.190915,.870766,.139853
340 DATA .974554,.064742
1000 DEF FNA(X)=2*X
99999END
```

ALGOL

```
OLD
OLD PROBLEM NAME--POLYNO***
WAIT.
READY.

LIST


POLYNO      9:47

100 BEGIN
110 INTEGER I; REAL ARRAY A[0:20]; REAL X,Y;
115 REAL XO,DELTA, MAX;
116 INTEGER N;
120 COMMENT READ IN DEGREE OF POLYNOMIAL;
125 PRINT("WHAT IS THE DEGREE OF THE POLYNOMIAL","");
130 READATA(TELETYPE,N);
140 COMMENT READ IN COEFFICIENTS;
150 FOR I:=0 STEP 1 UNTIL N DO BEGIN
152 PRINT("WHAT IS THE COEFFICIENT OF X↑",I,"");
153 READATA(TELETYPE,A[I]) END;
160 COMMENT READ IN INITIAL X AND DELTA X AND X MAX;
165 PRINT ("","WHAT IS THE INITIAL VALUE OF X","");
167 READATA(TELETYPE,XO);
168 PRINT("","WHAT IS THE VALUE TO INCREMENT X","");
169 READATA(TELETYPE,DELTA);
170 PRINT("","WHAT IS THE MAX. VALUE OF X ","");
172 READATA(TELETYPE,MAX);
175 PRINT("X","Y");
177 XO:=XO-DELTA;
180  COMMENT EVALUATE POLYNOMIAL;
190 FOR XO := XO+DELTA WHILE XO<=MAX DO BEGIN
195 Y:= A[N];
200 FOR I:=N-1 STEP -1 UNTIL 0 DO Y:= Y*XO + A[I];
210 PRINT(XO,Y);
230 END;
9999END
```

APPENDIX E
TELETYPE EQUIPMENT INSTRUCTIONS

The Computer Time-Sharing System is easy to use because the Teletype keyboard is similar to a typewriter but without lower case letters. Figure 3 illustrates a Model 33 Teletype unit and Figure 5 a Model 35.

To Connect the Teletype Unit

- Press ORIG key.
- After ORIG has been depressed, you will hear a dial tone. Dial the correct number to connect your Teletype unit with the System.

To Disconnect

- Depress CLR key.
- When the System commands BYE or GOODBYE are typed, the Teletype unit shuts itself off. In this case it is not necessary to press CLR.

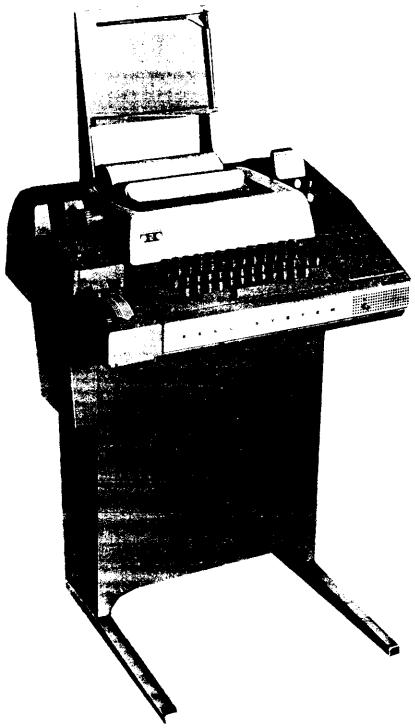

Figure 3. Model 33 Teletype Unit

MODEL 33 TELETYPE UNIT

The principal parts of the Teletype unit are the Control Unit, Keyboard, Paper Tape Punch (optional), and Paper Tape Reader (optional).

Control Unit,
Keyboard,
Paper Tape Punch (Optional), and
Paper Tape Reader (Optional)

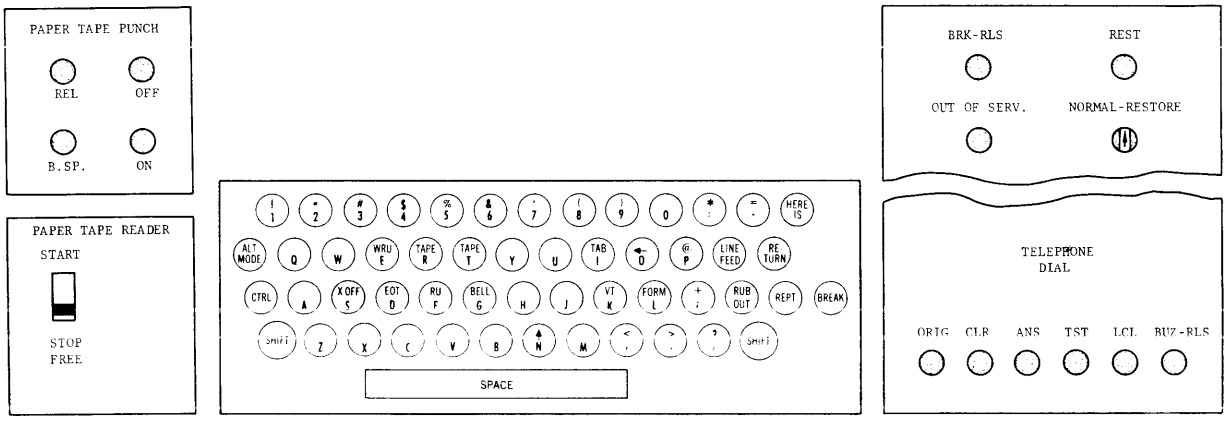

Figure 4. Model 33 Keyboard and Teletype Unit Controls

Control Unit (Modes of Operation)

Rotary Dial	-for dialing telephone numbers.
ORIG (Originate)	-button is depressed to obtain a dial tone.
CLR (Clear)	-button is depressed to turn off Teletype unit.
LCL (Local)	-this button is depressed to perform local off-line work such as tape punching. This mode cannot connect with the computer.
BUZ-RLS (Buzzer Release)	-buzzer sounds when paper supply is low. Key is depressed to silence buzzer. Replace paper roll & push "CLR."
BRK-RLS (Break Release)	-button is depressed to free keyboard after a "break" signal. (Signal causes keyboard to lock until this button is depressed.)
NORMAL-RESTORE	-should always point to NORMAL
Loudspeaker	-usually located under the keyboard at the right. A volume control knob permits adjusting of the volume of the loudspeaker. (In some cases a handset may be provided.) If button is turned as far as possible clockwise no dial tone will be audible.

Keyboard

The keyboard operates like a standard typewriter with the following exceptions: (Special keys on the keyboard which are not used by the Time-Sharing will not be discussed.)

Letters of the alphabet are printed in capital letters only - there are no small letters.

The shift and control keys are non-locking and must be held depressed when typing. The characters (,), and ↖ used in ALGOL are shifted with K, M, and L respectively.

RETURN - returns the carriage to the left margin.

LINE FEED - moves the paper up one line at a time.

REPT (Repeat) - to repeat the same character this key is held depressed while the desired character key is operated. The latter is released and the REPT key is held until the desired number of characters have been typed. (If it is an upper case character, the shift key must be held along with the REPT key.)

RUBOUT - this key has a non-printing function and is used following operation of the Return key to end a program line of paper tape input. It can also be used in conjunction with the backspace button on the tape punch to delete errors in punching tape.

ALT MODE - causes line currently being typed to be deleted. Some Teletype units do not have an ALT MODE key; use ESC (Escape) or CTRL-X key instead.

Paper Tape Punch

For perforating tape from the local keyboard or from a remote location, the punch generates a row of holes for each character (including the non-printing functions) on the Teletype unit. (Located on upper left side of Teletype unit.) It produces one inch (8 level) fully perforated tape. The eighth level is always punched with any keyboard generated code.

ON and OFF buttons

Any typed or printed information may be punched on paper tape simply by turning the punch unit "ON" (despressing the "ON" button). It then punches all information until the "OFF" button is depressed to turn it off.

B.SP. (backspace)

Each time this button is depressed the paper tape is moved backwards one character. This button is used with the RUBOUT key to delete errors in the tape. The character (or characters) in error are each moved back under the punch and then for each character to be deleted the RUBOUT key is hit.

REL (Release)

This button frees the tape so that one can manually pull blank tape through the punch. (This tape cannot be read through the tape reader).

To Prepare Paper Tape:

1. Always hit the RUBOUT key several times to be sure that there is clean tape when starting to punch every tape.
2. To punch a paper tape off-line, depress LCL key to turn on the Teletype unit and then depress paper tape ON key.
3. When preparing a paper tape off-line, you must press at the end of each line CR (Carriage Return), LF (Line Feed), and RUBOUT in that order or the message will not send accurately.

4. When sending tape to the computer, you must indicate this fact by typing TAPE and tell the computer to return to normal keyboard operation by typing KEY.

Paper Tape Reader

The reader is located at lower left side of the Teletype unit and used for transmitting information via paper tape. The tape reader has one control switch:

1. START - forward position - starts the tape moving through the reader.
2. STOP - bottom position - stops the tape reader.
3. FREE - locked bottom position - permits the tape to be pulled manually through the reader.

To Position tape in the tape reader:

1. Open the clear plastic tape gate by pushing the gray lock on the right side to the right.
2. Place the tape surface facing upward with the tape feed holes (small holes) over the tape feed wheel (the smaller side of the tape to the left).
3. The code holes of the first character to be READ should be placed slightly behind the sensing pins, and preceded by any number of RUBOUT characters.
4. Close and lock the tape gate by pushing down. When ready to READ, put the tape read switch in the "start" position. The operator must "start" the tape for each transmission to the computer. (NOTE: Before "starting" use System Command TAPE.)

The tape will stop when the last punched character is read.

X-ON FEATURE. On requests for input to a running program, the question mark is followed by an X-ON. This allows the computer to activate the paper tape reader on all Model 35 ASR and some 33 ASR teletypes. The method of using this feature is shown in the following example:

It is desired to compute and print the sum of four numbers input to the program on paper tape. A BASIC program to do so might take the following form:

```
 5    LET B=0
10    FOR I = 1 to 4 STEP 1
20    INPUT A(I)
30    LET B = B+A (I)
40    NEXT I
50    PRINT B
60    END
```

Assuming the input numbers are 1,1.5,2,2.5, then the paper tape input to the above program is punched as follows:

1 LF (X) (R) RO 1.5 LF (X) (R) RO 2 LF (X) (R) RO 2.5 LF (X) (R) RO

Where:

LF = Line Feed
(X) = X-OFF
(R) = Carriage Return (signal for computer to act on previous characters)
RO = Rubout

The sequence of characters after each number assures that the paper is spaced after each line, and that the reader is turned off after each number is read in.

If teletype is not set for paper tape input (KT button pushed on the Model 35) the X-ON will have no effect.

MODEL 35 TELETYPE UNIT

The principal parts of the Teletype unit are the Control Unit, Keyboard, Paper Tape Punch, and Paper Tape Reader.

Control Unit (Modes of Operation)

Rotary or Touch Dial	-for dialing telephone numbers.
ORIG (Originate)	-button is depressed to obtain a dial tone to dial a number.
CLR (Clear)	-button is depressed to change from one mode to another, or to turn off Teletype unit when using Local Mode.
LCL (Local)	-this button is depressed to perform local off-line work such as tape punching. This mode cannot connect with the computer.

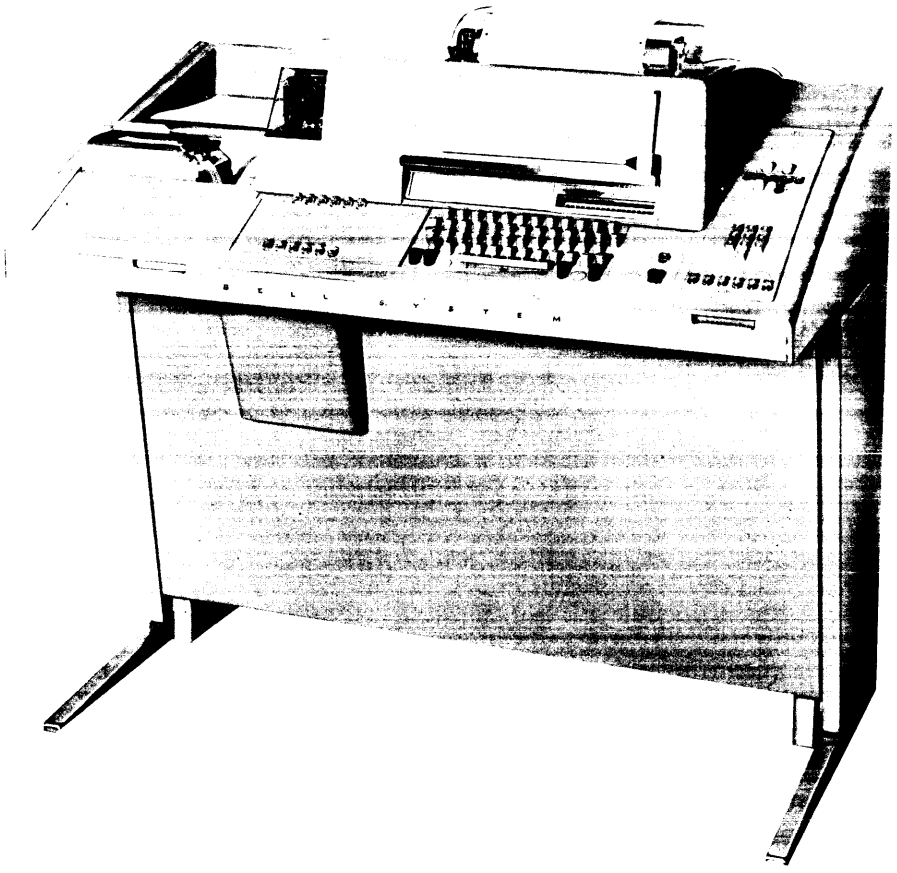

Figure 5. Model 35 Teletype Unit

BUZ-RLS (Buzzer Release) -buzzer sounds when paper supply is low. Key is depressed to silence buzzer. Replace paper roll and push CLR.

BRK-RLS (Break Release) -button is depressed to free keyboard after a "break" signal. (Light indicates that keyboard is in locked position.)

NORMAL-RESTORE -should always point to NORMAL

Loudspeaker -usually located under the keyboard at the right. A volume control knob permits adjusting of the volume of the loudspeaker. (In some cases a handset may be provided.) If button is turned as far as possible counterclockwise - no dial tone will be audible.

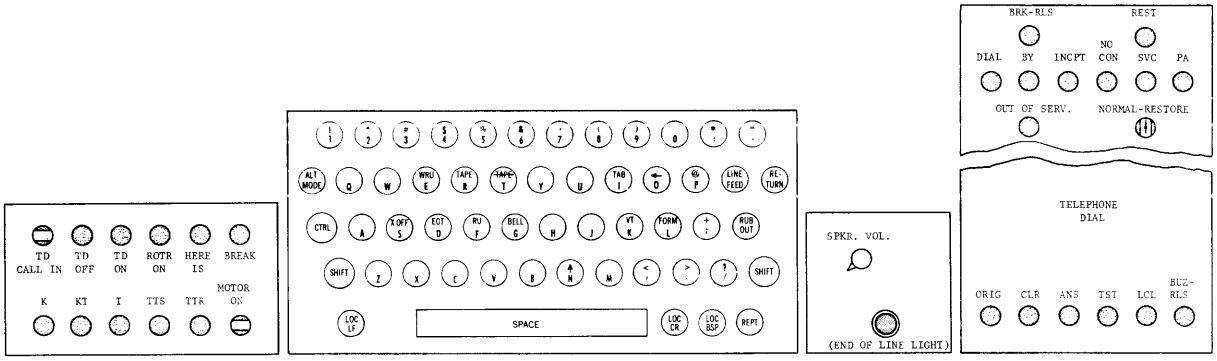

Figure 6. Model 35 Keyboard and Controls

There are six lights on the upper right side of the unit which are not used by the Time-Sharing System. These are:

DIAL, BY, INCPT, NO CON, SVC, PA.

Column Indicator - (located at upper right side of keyboard) metal pointer on scale indicates which column has just been printed (typed/punched).

End of Line (Red Light) - indicates when end of line is approached and has no effect on computer or Teletype Unit.

Control Buttons - (located to the left of the keyboard - all equipped with lights.)

TD CALL IN -not used

TD OFF -turns local tape reader off (in KT, T, or TTS modes)

TD ON	-starts local tape reader (in KT, T, or TTS modes)
ROTR ON	-not used
HERE IS	-transmits and prints whatever is on your answer-back drum
BREAK	-see list of System Commands in Chapter 5.

Control Modes-

K (keyboard)	-for obtaining page copy only
KT (keyboard-tape)	-for obtaining page copy and perforating tape simultaneously or for transmitting, punching a copy tape and page copy simultaneously.
T (Tape)	-for perforating tape only or transmitting tape with page copy.
TTS (Tape to Tape Send)	-transmits tape without page copy.
TTR (Tape to Tape Receive)	-perforates tape from a remote source without page copy.
MOTOR ON	-permits punching tape locally (without page copy) without placing station in the LOCAL mode.

When originating a call, the station is automatically switched to the Tape (T) mode. If a request to the computer is to be made the user must depress the K button before any transmission can be effected , and must depress K to release the keyboard after a break.

Keyboard

The keyboard operates like a standard typewriter with the following exceptions: (Special keys on the keyboard which are not used by the Time-Sharing System will not be discussed.)

Letters of the alphabet are printed in capital letters only - there are no small letters.

The shift key is non-locking and must be held depressed when typing characters in upper case positions.

RETURN - returns the carriage to the left margin.

LINE FEED - moves the paper up one line at a time.

HERE IS - used in conjunction with the tape punch - generates 2 inches of blank tape - i.e., a header or trailer for a paper tape.

REPT (Repeat) - to repeat the same character this key is held depressed while the desired character key is operated. The latter is released and the REPT key is held until the desired number of characters have been typed. (If it is an upper case character, the shift key must be held along with the REPT key.)

RUBOUT - this key has a non-printing function and is used following operation of the Return to end a program line of paper tape input. It can also be used in conjunction with the back-space button on the tape punch to delete errors in punching tape.

ALT MODE - causes line currently being typed to be deleted. Some Teletype units do not have an ALT MODE key; use ESC or CTRL-X key instead.

The XOFF key is operated in conjunction with the control key. It is a non-printing, operational function. By holding the CTRL (Control) key depressed and then depressing the XOFF key, this function is activated.

XOFF - (control and S key) when perforated in tape turns tape reader off at the time it is read by the tape reader. Must always be followed by at least one "rubout" character. Has no effect when typed "on-line." Control and "Q" can be used to turn on the tape reader.

Four red keys, two on each side of the space bar, are used for local action only. They do not generate any code on a paper tape or transmit a code to the computer.

From left to right:

LOC B.SP.	-backspaces the paper tape in the punch, one space for each time it is depressed.
LOC LF	-spaces the carriage up one line.
LOC CR	-returns the carriage to the left margin.
REPT	-explained in previous section.

Paper Tape Punch

For perforating tape from the local keyboard or from a remote location, the punch generates a row of holes for each character (including the non-printing functions) on the Teletype unit. (Located at the upper left side of the keyboard.) It produces one inch (8 level) fully perforated tape. The eighth level is always punched with any keyboard generated code.

To Prepare Paper Tape:

1. Place the Teletype unit in LOCAL (LCL) and the "KT" mode for punching tape. (It also punches tape in the "T" mode but does not generate a page copy.)
2. Always hit the RUBOUT key several times to be sure that there is clean tape when starting to punch every tape.
3. To punch a paper tape off-line, depress LCL key to turn on the Teletype unit and then depress paper tape ON key.
4. To prepare a paper tape off-line press RETURN (Carriage Return) and LINE FEED at the end of each line. For clean copy follow LINE FEED with RUBOUT.
5. When sending tape to the computer, indicate this by typing TAPE. Type KEY to tell the computer to return to normal keyboard operation.

6. Deleting errors on the tape - Press the LOC B.SP. button for each character to be deleted, then hit the RUBOUT key for each character. (The RUBOUT generates a row of 8 punches which is ignored by the tape System.)

Paper Tape Reader

The reader is located on the far left of the Teletype unit and is used for transmitting information via paper tape. The reader is controlled by a tape read switch which has two positions:

FREE	-for freewheeling, to insert tape without raising the tape gate. This is a non-locking position of the switch - it must be held in this position.
RUN	-regular position of the switch.

Control of the tape reader is by means of the buttons TD ON and TD OFF. The Teletype unit must be in the KT, T, or TTS mode to operate the tape reader.

To position tape in the tape reader:

1. Press the square button to release the tape gate.
2. Place the tape surface facing upward with the tape feed holes (small holes) over the tape feed wheel (the smaller section of tape facing away from the operator.)
3. Place the code holes of the first character to be read slightly behind the sensing pins; these can be preceded by any number of RUBOUT characters.
4. Close and lock the tape gate by pushing down. When ready to READ, put the tape read switch in the START position. The operator must start the tape for each transmission to the computer. (NOTE: Before starting use System Command TAPE.)

The tape will stop when the last punched character is read.

X-ON FEATURE. Refer to page 30.

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Dallas, Texas 75247
Ph: 214-631-0910

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