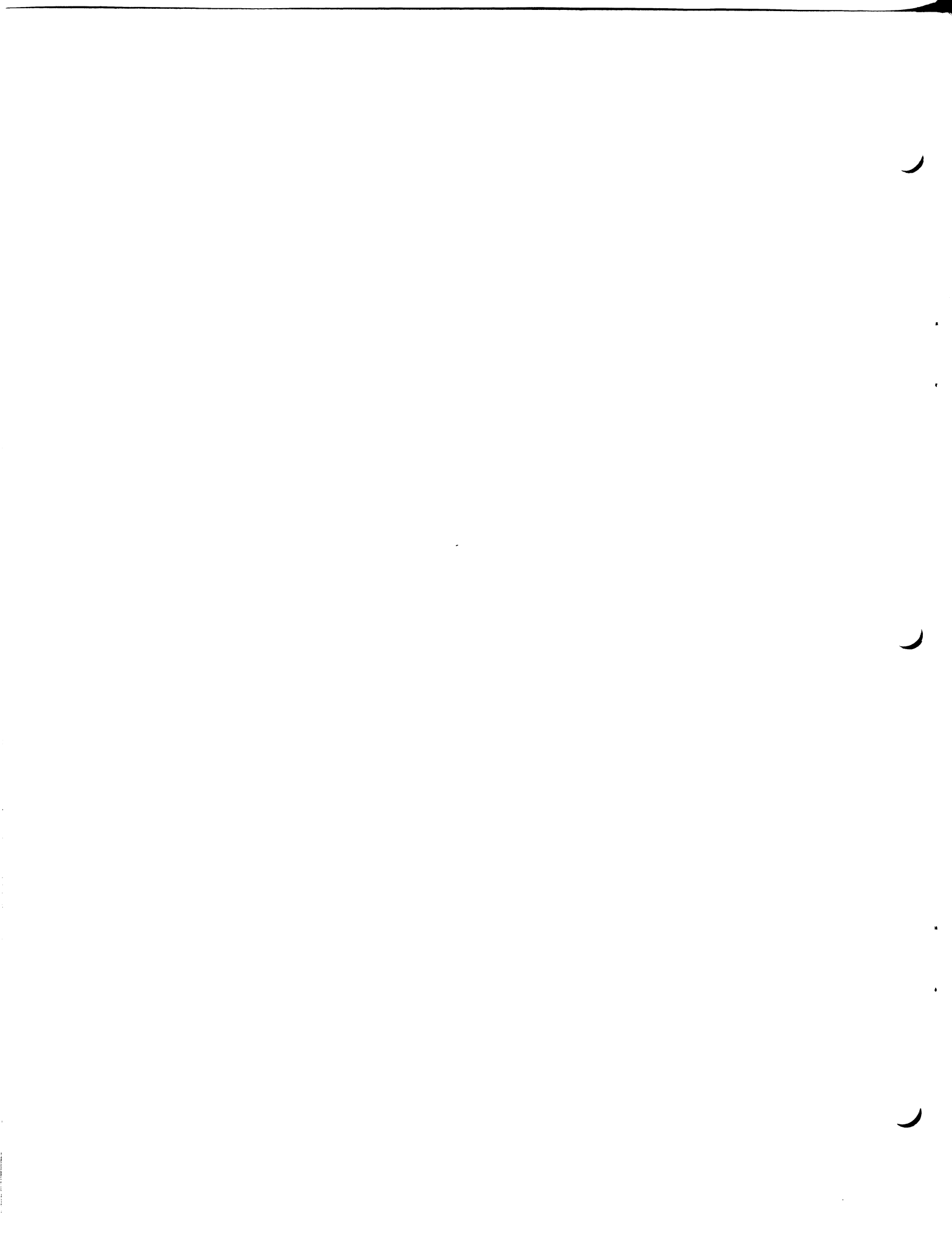WANG

2202
PLOTTING OUTPUT WRITER
REFERENCE MANUAL

SYSTEM 2200

2202

Plotting
Output Writer

Reference Manual
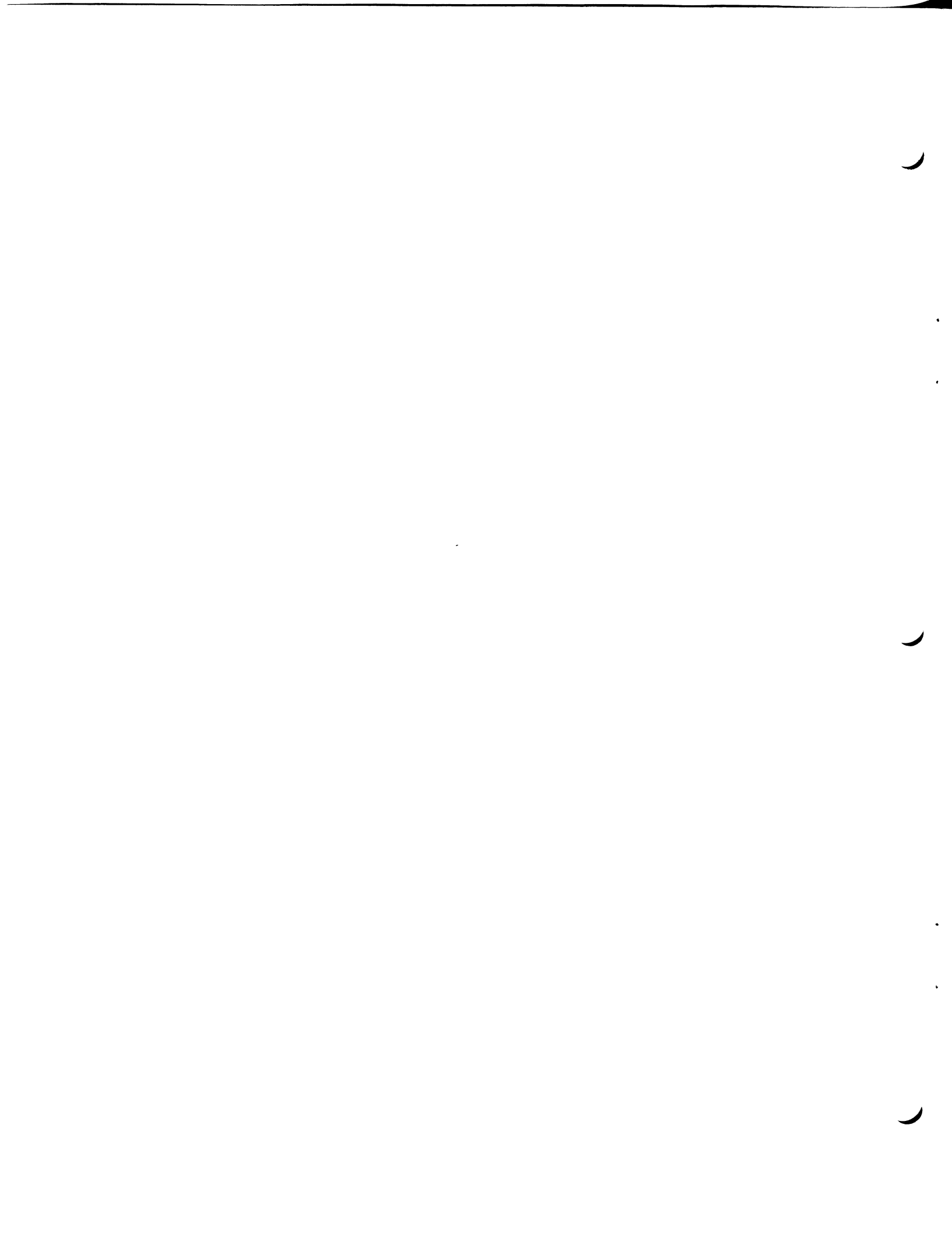
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TABLE OF CONTENTS

HOW TO USE THIS MANUAL

This manual has been written to provide quick answers to questions concerning the operation of the Model 2202 Plotting Output Writer. It is designed for users who are already familiar with the System 2200 and its BASIC language instruction set. For users who are not familiar with the operation of the System 2200, it is recommended that the System 2200 BASIC Programming Manual be read before proceeding with this manual.

Section I
General Information

INTRODUCTION

This manual provides the user with a clear reference to the operational features of the 2202 Plotting Output Writer. The Model 2202 can be used as a standard Selectric typewriter, or in conjunction with the Wang System 2200, as both a high speed output writer and a Digital Plotter. When using the Model 2202 as a standard Selectric typewriter, tabs cannot be used. The TAB, SET TAB, and CLEAR TAB keys have been replaced with incremental drive motors for the plotter. The breakdown of this manual into several sections is designed to clearly describe these three usages and to assist the user in answering questions that may arise. It is assumed that the user of the Model 2202 is familiar with the BASIC language of the System 2200.

UNPACKING AND INSPECTION

Carefully unpack your equipment and inspect all units for shipping damage. If damage is noticed, do not proceed unpacking. Notify the shipping agency. Check each unit received against the purchase order. Decals specifying Model numbers can be found on all Wang calculators and peripherals, usually on the back of each unit.

INSTALLATION

To install your 2202 Plotting Output Writer System, use the following procedure (see the diagram below):
1. Turn power switches OFF on all equipment.
2. Plug the 2202 Plotting Output Writer into the CPU (Central Processing Unit) chassis. The peripheral connector on the CPU is labeled for the 2202. After plugging in the cord, be sure the lock clips are properly snapped shut.
3. Plug the main power cord of the CPU chassis into the Power Supply Unit.
4. Plug the 2202 power cord into a wall outlet (115 vac ± 10%).
5. Plug the Power Supply Unit into a wall outlet (115 vac ± 10%).
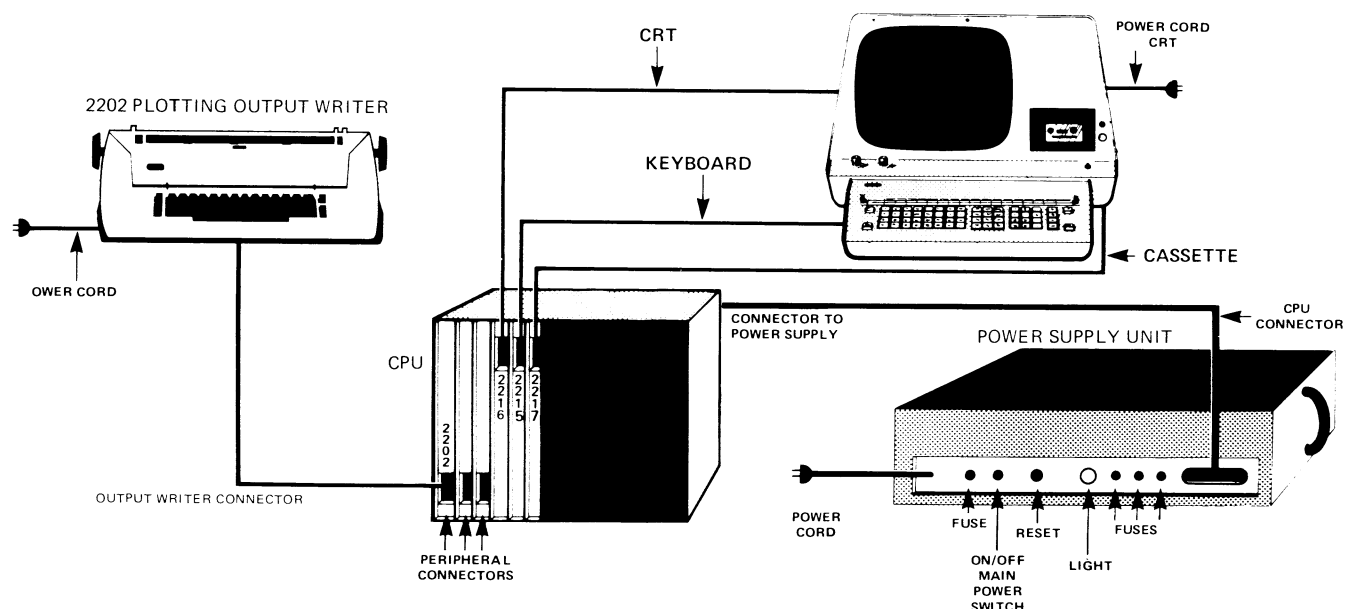
SECTION I GENERAL INFORMATION

POWER-ON PROCEDURE
1. Turn power switches ON on all peripherals. This includes the CRT.
2. Move the main switch on the Power Supply Unit to the ON position (light on Power Supply Unit confirms this step). This step Master Initializes the complete System 2202-2200.

> **NOTE:**
>
> *Turn power switch OFF on the 2202 when not in use.*

The System 2200 is initialized now and the 2202 Plotting Output Writer is ready to be selected for use.
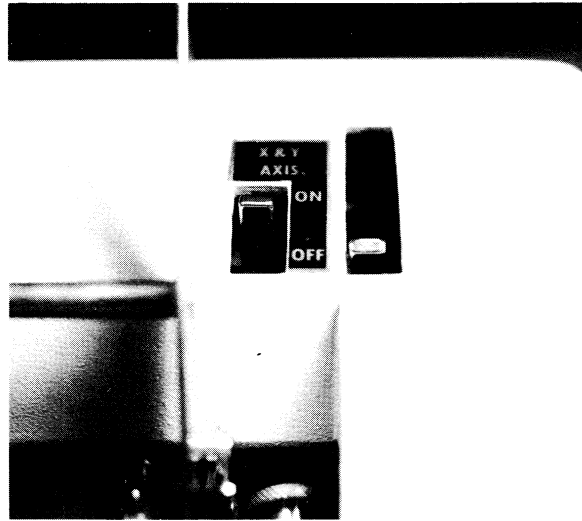
Before operation, two other levers should be checked.
1. The Paper Release lever is set forward if you are using paper with pinholes down both margins. **If not, the release lever is back.** Paper is loaded with the Platen Knob and Pin Feed Clips.
2. To the left of the Paper Release lever is an ON/OFF X & Y AXIS switch. This disengages the plotting motors for the X-axis and Y-axis. This normally is left ON and should be turned OFF only when turning the platen manually by the knobs or when manually sliding the printing mechanism to the left or right. If plotting occurs too far to the left or right, there are two safety cut-off switches which "freeze" the plotter, rather than allow you to type on the pins.

INITIALIZING THE 2202
Initialization must be performed after any one of the following conditions occurs:
1. The power ON/OFF switch on the CPU is turned ON.
2. The 2202 is plugged into the CPU.
3. The MANUAL/AUTO switch on the Selectric Typewriter is changed from MANUAL to AUTO. The 2202 must be in the Auto mode in order to function as a plotter or as an Output Writer.
4. RESET is pressed during plotting.

> **NOTE:**
> *It is strongly recommended that program execution be halted with the HALT/STEP Key, not with the RESET Key. HALT/STEP allows the current BASIC statement to be completed before returning control to the user.*

5. The ON/OFF switch on the 2202 is turned OFF, then ON.

SECTION I GENERAL INFORMATION
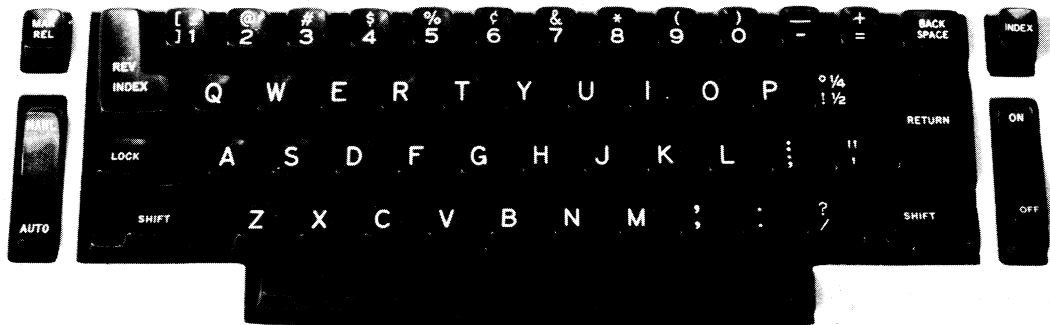
2202 Plotting Output Writer Keyboard

The initialization procedure is:

> 1. Press RESET on 2222 or 2215 keyboard.
>
> 2. Enter the following statement:
>
>   :PLOT $<$, HEX(0E0F)$>$

Note that the Device Address for the 2202 is normally 13. If the Device Address for your 2202 is not 13, use the following initialization procedure:

> 1. Press RESET on 2222 keyboard.
>
> 2. Enter the following:
>
>   :SELECT PLOT 4XX (where XX = Device Address of 2202)
>   :PLOT $<$, HEX(0E0F)$>$

Your System 2200-2202 is now ready to program. The CRT (Cathode Ray Tube) display appears as illustrated below.

> READY
>
> :

If a system failure should occur, try to restore operation with the HALT/STEP key on the keyboard. If operation is not restored, depress the RESET button. If normal operation has not yet returned, Master Initialize the system by turning the Power Supply Unit OFF, then ON again. If the system is still non-functional, repeat the installation procedure before calling your Wang Service Representative.

The 2202 should be turned OFF, then ON, if you run into either of the following two problems:
1. If you backspace when the typing element is on the left margin and the spacebar locks.
2. If you key REV INDEX when the typing element is on the left margin and the spacebar locks.

TYPEWRITER CHARACTERS

The standard type face available on the 2202 Plotter is the Prestige Elite 72 (IBM). The number of allowable characters per printed line (121), the number of lines per inch (7) and other specifications for the 2202 are found in Appendix B.

There are certain characters that appear on the CRT viewing screen that are printed differently by the plotter:

CRT	2202
<	[
>	]
↑	!

The three characters, <, >, ↑, are not standard Selectric characters; they are replaced by the [,], and ! symbols on the 2202.

NOTE:

The following sections give detailed instructions and examples how to address and use the 2202. For further details on the PRINT, LIST and SELECT commands, see the Wang BASIC Language Reference Manual.

Section II
Selecting The Plotter

INTRODUCTION

The 2200-2202 system can be used both as a Digital Plotter and as an Output Writer. Both modes can be programmed to graph. What is the difference between the two? The difference is the plotter does not skip a space after each character but, rather, moves in increments of .01 inches. The Output Writer, with its typewriter spacing, is consequently less accurate than the plotter. However, in the ordinary printout of alphanumeric strings, the Output Writer consumes .1 inch per character. The Model 2202 has a special centered dot in addition to the normal period and a programmable Reverse Index (see the HEX(FB) Code and the Reverse Index sections, beginning on page 7).

That the 2202 Plotter is **Digital** means the 2202 prints characters at discrete intervals specified by the user.

How is the plotter addressed and instructed? The printout operation of the 2202 is governed by two commands: the SELECT statement and the PLOT statement.

DEVICE CODES

A three character Device Code is assigned to each peripheral attached to the System 2200. When the System 2200 is Master Initialized, the Device Address 413 is selected automatically for the plotter. The standard device codes for the Model 2202 Plotting Output Writer are:
1. 213 when being used as an Output Writer.
2. 413 when being used as a Plotter.

The following applies only when addressing the output writer. The first character is the Device Type and the last two digits are the Device Address. There are three one-digit Device Types available for the Output Writer:

Type 0 - This Device Type addresses devices that are not indexed normally to the next line when a carriage return is executed. With a Type 0, the System 2200 automatically adds a line feed after each carriage return. The Output Writer automatically executes a line feed when a carriage return is executed. Therefore, if the Device Code 013 is used for the Output Writer, all output is double spaced.

Type 2 - This Device Type addresses devices that normally execute a line feed when a carriage return is executed. Therefore, if the Device Code 213 is used with the Output Writer, all output is single spaced.

Type 4 - The SELECT statement specifies the maximum line length on the Output Writer. Device Types 0 and 2 tell the system to keep a running count of the number of characters used in the current line. When the number of characters equals the specified line length, a carriage return is executed. Choosing Device Code 413, however, suppresses this feature by not executing a carriage return when the number of characters equals the line length. This is helpful when extra characters, such as Backspace or Underline, are required. The carriage return is not executed until the carriage return command is given. If Device Code 413 is used with the Output Writer, all output is double spaced, since the System 2200 automatically adds a line feed after each carriage return (as with Type 0).

THE PLOT STATEMENT

The PLOT statement is of the following general form:

General Form:	PLOT [expression 0] <[expression 1] , [expression 2] , $\begin{Bmatrix} \text{null} \\ \text{literal string} \\ \text{alpha variable} \end{Bmatrix}$ >[, . .]

Where   expression 0:   Represents the "replication factor" or the number of times the values inside the plot enclosures, < >, are plotted.

(1 ≤ expression 0 < 1000)

If omitted, expression 0 is assumed to be 1.

expression 1:   Represents $\triangle X$ increments of .01".

(−1000 < expression 1 < 1000)

If omitted, expression 1 is assumed to be 0.

expression 2:   Represents $\triangle Y$ increments of .01".

(−1000 < expression 2 < 1000)

If omitted, expression 2 is assumed to be 0.

All three expressions are truncated to integers.

"Null" implies move the typing element the $\triangle X$ and $\triangle Y$ distance specified in expressions 1 and 2, without plotting.

Literal string and alpha variables represent the character or characters to be printed/plotted.

When the PLOT statement is executed, it automatically places the Model 2202 in Plot mode and returns the System to Print mode when statement execution is complete.

EXAMPLES OF PLOT STATEMENTS

Example 1:

```
:10  PLOT < 10, 20, "*" >
:RUN
```

Result 1:

Advances $\triangle X$=10 increments (of .01") and $\triangle Y$=20 increments and plots a "*".

Example 2:

```
:20  C=40 : D=50
:30  PLOT < C−10, D+20, >
:RUN
```

Result 2:

Advances $\triangle X$=30 increments and $\triangle Y$=70 increments without plotting.

Example 3:

```
:20  A$= "PRINT THIS"
:30  X = 10
:40  PLOT 2 < X, 10, A$ >
:RUN
```

Result 3:

Advances $\triangle X$=10 increments and $\triangle Y$=10 increments, then prints PRINT THIS. (Note that PRINT THIS occupies 10 spaces X .1 inches = 1 inch in the X direction.) Advances $\triangle X$=10 increments and $\triangle Y$=10 increments, then prints (again) PRINT THIS.

SECTION II   SELECTING THE PLOTTER

```
NOTE:
The word "PRINT" must be entered letter by letter and not
as one keystroke. BASIC keywords may not be entered into
literal strings by pressing single keys.
```

Example 4:

```
:20  N=10
:30  PLOT N < 20,  , "ABC" >
:RUN
```

Result 4:

Advances △X=20 increments and △Y=0 increments.
Prints ABC; repeats this 10 times.

Example 5:

```
:20  PLOT < 10, 20, "*" > , < 20,  , "ABC">
:RUN
```

Result 5:

Does Example 1, then the first loop of Example 4.

THE HEX (FB) CODE

Although the 2202 can plot with any character, the normal plotting character is the centered dot (not to be confused with the period). The centered dot is generated by using the hexadecimal code, HEX(FB), in the PLOT statement. For example,

$$:PLOT <10, 20, HEX(FB) >$$

plots a centered dot.

The following statement, however,

$$:PLOT <10, 20, " . ">$$

plots a standard period, which is not centered.

REVERSE INDEX

Paper can be moved in a reverse direction with the Model 2202. A special key (or HEX CODE) is used under program control to accomplish this. The code is HEX(FA) which moves the paper backwards one line each time the code is used.

```
:100 FOR I = 1 to 20
:200 PRINT HEX(FA);
:300 NEXT I
```

or

```
:200 PLOT 10<, , HEX(FA)>
```

THE SELECT STATEMENTS

The System 2200 automatically selects the Device Address 413 for plotting when the system is Master Initialized (i.e., turned ON). 413 is normally the Device Address code of the Model 2202 Plotter. Hence, the user must use the SELECT statement for Model 2202 plotting if the Device Address is not 413. For example, if the Device Address code of the Model 2202 is 414, the user must enter the following statement before plotting.

$$:SELECT PLOT 414$$

ACTUAL PLOT PROGRAMS

This subsection includes three programs plotted with the System 2200-2202, which provide concrete, visual understanding of the PLOT statement's capability. The 2202 Plotter plots relative to the last plotted point, rather than relative to a fixed origin.

SECTION II   SELECTING THE PLOTTER

Example 1:

The purpose of this program is to connect three otherwise separate equations. This example illustrates the actual path taken by the 2202. The program fuses two semi-circles of different radii and a straight line, beginning at the far left of the graph. The necessary statements are:

```
              ⎧ :10  SELECT PLOT 413
SEMI-CIRCLE   ⎪ :20  FOR Y = -6 TO 6 STEP .25
    OF        ⎨ :30  X = SQR (36 - Y ↑ 2)
 RADIUS 6     ⎪ :40  PLOT < X, Y, ":" >
              ⎩ :50  NEXT Y

              ⎧ :60  FOR Y = 5 TO -5 STEP -.25
SEMI-CIRCLE   ⎪ :70  X = SQR (25 - Y ↑ 2)
    OF        ⎨ :80  PLOT < -X, Y, "*" >
 RADIUS 5     ⎩ :90  NEXT Y

              ⎧ :100    FOR Y = 7 TO -7 STEP -.3
              ⎪ :110    X = Y
EQUATION      ⎪ :120    PLOT < X, -Y, "." >
   OF A       ⎨ :130    NEXT Y
   LINE       ⎪ :140    END
              ⎩ :RUN
```

Now examine the corresponding graph. The following steps occurred.

1. Beginning on the far left, labeled A , Y assumes values from -6 to 0 and X becomes more positive until point B, at which Y = 0. At point C the first semi-circle is completed.

2. Also at C the characters change from ":" to "*". Y begins its positive advance with the initial Y = +5. Note in statement 80 that we are plotting -X, hence the plot now advances from right to left. At point D this semi-circle is terminated.

3. The final movement is a straight line, X = -Y, from D to E and back. It returns because Y moves from 7 to -7 in statement 100. The plotting terminates at D.

4. Before listing the program on the 2202, the plotter was placed in the Manual mode (using the MANUAL/AUTO switch), and the typing element was positioned by using the INDEX and RETURN keys on the plotter. Then, the plotter was placed back in the Auto mode and the following was keyed in on the keyboard:

> :SELECT LIST 213
> :LIST

The program was listed then by the plotter on the graph. Note that the characters <, >, and ↑, which appear on the CRT, are printed as [,] , and ! by the plotter. For a complete list of characters which appear on the CRT and the plotter, see Appendix A.

If the RETURN key on the plotter had not been pressed while the plotter was in the Manual mode, statement 10 would have been printed directly below point D, the termination point of the plot. The LIST command would have begun listing at that point. No carriage return would have been executed until statement 10 had been printed, or until the maximum carriage width had been reached.

5. The path A to C looks "lopsided". Why? the PLOT statement truncates expressions 0, 1, and 2. This means that % error of a plot decreases in the size of that plot. Statement 20 was selected to show this feature.
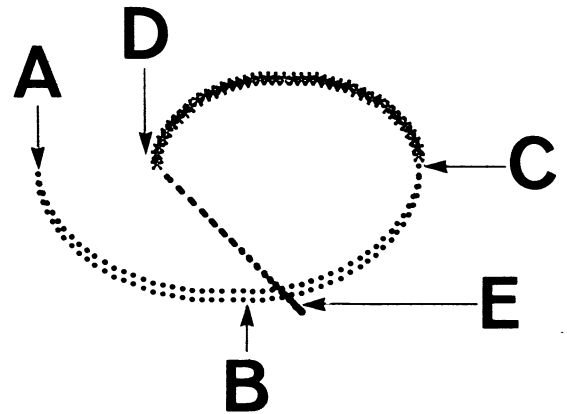
```
10 SELECT PLOT 413
20 FOR Y=-6 TO 6 STEP .25
30 X=SQR(36-Y!2)
40 PLOT [X,Y,":"]
50 NEXT Y
60 FOR Y=5 TO -5 STEP -.25
70 X=SQR(25-Y!2)
80 PLOT [-X,Y,"*"]
90 NEXT Y
100 FOR Y=7 TO -7 STEP -.3
110 X=Y
120 PLOT [X,-Y,"."]
130 NEXT Y
140 END
```

EXAMPLE 1

Example 2:

This program plots a "loop" of a single trigonometric expression and advances from A to B to C to D (see Example 2).

	:10 SELECT PLOT 413
	:20 FOR Y = –2 * #PI TO 2 * #PI STEP #PI/32
PLOTS X	:30 X = SIN(Y) * (3 + 2 * Y)
VERSUS Y	:35 PLOT < X, Y, ":" >
(in radians)	:40 NEXT Y
	:50 END
	:RUN

It should be noted that:

1. The area around point C is darkened from the overlapping of ":" characters. This is because C is the area where X changes very slowly; occasionally, the user may be tempted to push RESET, thinking that the 2202 Plotter is stuck at one position. This often happens in graphs and presents no difficulty. There is a light directly beneath the RESET key on the 2202. This light is ON during execution of a program. Unless it goes OFF, the overlapping area is intended. An exception to this is when the plot is flush against a margin. Then key RESET to stop the plotting.

2. The user may notice that the points A and D are on a line which is parallel to the X-axis. In general this is true only if Y is chosen over a symmetric range (in this case -2π to $+2\pi$). The use of symmetric ranges may assist the user when taking certain measurements from the plot.

3. Again, before the program was listing by the plotter, the plotter was placed in the Manual mode (using the MANUAL/AUTO switch). Using the INDEX and RETURN keys on the plotter, the typing element was positioned to the starting point of the program listing. The plotter was then returned to the Auto mode and the following was keyed in on the keyboard:

<div align="center">

:SELECT LIST 213
:LIST

</div>

The program was then listed as shown in Example 2.
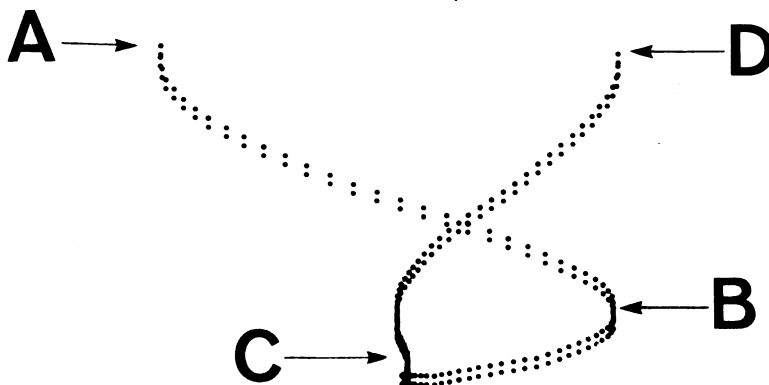

```
10  SELECT PLOT 413
20  FOR Y=-2*#PI TO 2*#PI STEP #PI/32
30  X=SIN(Y)*(3+2*Y)
35  PLOT [X,Y,":"]
40  NEXT Y
50  END
```

EXAMPLE 2

Example 3:

A plot may be used to illustrate the direct sum of two functions. Example 3 illustrates the direct addition of a trigonometric and quadratic function. Suppose the user has separate functions for company sales and capital improvements. It is possible to plot the **joint** picture of these in a manner similar to the following:

Let   Y1 = SIN(Y) * (1 + Y)

Y2 = SQR(4* (#PI ↑ 2) −Y ↑2)

and the user desires X = Y1 + Y2

then (see diagram):

```
:10   SELECT PLOT 413
:20   FOR Y = -2 * #PI TO 2 * #PI STEP #PI/32
:30   X = SIN(Y) * (1 + Y) + SQR (4 * (#PI ↑ 2) −Y ↑ 2)
:40   PLOT < X, Y, ":" >
:50   NEXT Y
:60   END
:RUN
```

X = Y1 + Y2 ——▶ :30

As with the previous two examples, this plot moves from A towards C. Statement 10 is lined up with the other program statements because the Model 2202 was placed in the Manual mode, and indexed and carriage returned to the margin before the LIST key on the keyboard was depressed.
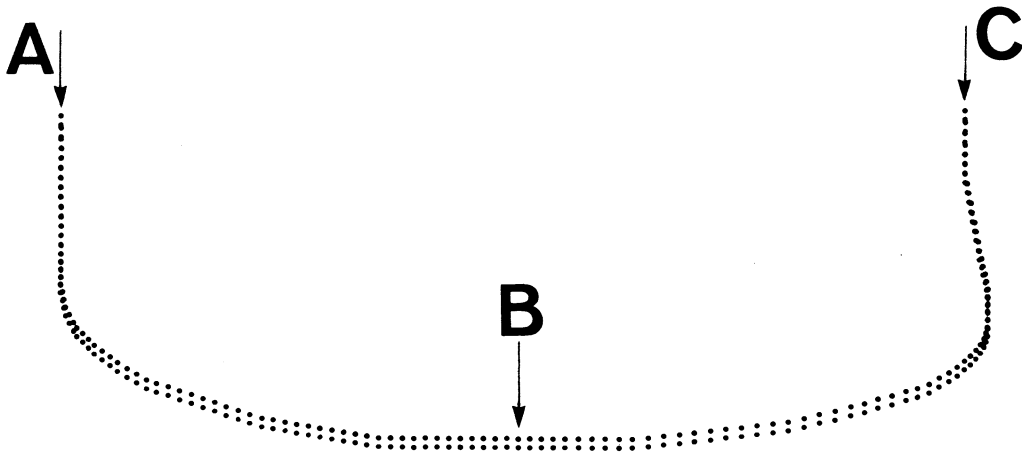

```
10  SELECT PLOT 413
20  FOR Y=-2*#PI TO 2*#PI STEP #PI/32
30  X=SIN(Y)*(1+Y)+SQR(4*(#PI!2)-Y!2)
40  PLOT [X,Y,":"]
50  NEXT Y
60  END
```

EXAMPLE 3

SECTION II   SELECTING THE PLOTTER

USING THE 2202 PLOTTER WITH THE SYSTEM 2200A

The Model 2202 is not designed to work with the System 2200A. However, there are a set of special hex codes on the 2200A that can be used for plotting purposes. Therefore, if a Model 2202 is being used with a System 2200A, by selecting the Model 2202 to PRINT and printing these hex codes a user can move the plotting element up and down, left and right in increments of .01 inches. The table below lists the eight hex codes that control the motion of the Model 2202 typing element.

FUNCTION	HEX CODE
Y – (move carriage .01″ down)	F6
Y + (move carriage .01″ up)	F7
X – (move carriage .01″ left)	F8
X + (move carriage .01″ right)	F9
X – Y – (move carraige .01″ left, .01″ down)	F1
X + Y (move carriage .01″ right, .01″ down)	F2
X – Y + (move carraige .01″ left, .01″ up)	F3
X + Y + (move carriage .01″ right, .01″ up)	F4

Some other codes associated with plotting are available also on all systems. These codes are:

FUNCTION	HEX CODE
Centered Period Character	FB
Change from Print mode to Plot mode	F0
Change from Plot mode to Print mode	F5

SELECTING THE MODEL 2202 FOR PLOTTING ON THE SYSTEM 2200A

1. To use the Model 2202 for plotting on a System 2200A, the user should first select the Model 2202 for PRINT, using a Device Type of 4. Specifying Device Type 4 instead of 2 suppresses the automatic carriage return which normally is issued when the line count (see Section III for a discussion of line count) equals the selected carriage width.

:SELECT PRINT 413

2. After selecting the Model 2202 to print, the Model 2202 must be selected to plot. To place the Model 2202 in the Plot mode, execute the following statement in a BASIC program.

:10 PRINT HEX (FO)

3. Once in the Plot mode, if a sequence of characters is sent to the plotter via a PRINT statement, these characters would be plotted one on top of the other as the typing element does not change its current position unless it receives one of the hex codes (i.e., F1-F9) shown in the previous table. Therefore, it is necessary in the program to intersperse the characters to be plotted with hex codes to move the plotting element before each character is plotted. An example is given below which includes the above two steps. This example plots the function Y = 2X. The values of X range from 0 to 10 in increments of .5. A scale of .5″ per X increment and 1″ per Y increment is used.

SECTION II SELECTING THE PLOTTER

Example:

place in Print mode	:SELECT PRINT 413
place in Plot mode	:10 PRINT HEX (F0)
set scaling factors	:20 S1 = .5 : S2 = 1
	:30 FOR R = 0 TO 10 STEP .5
plot centered period	:40 PRINT HEX (FB);
move in X + direction	:50 FOR X = 1 TO S1/.01 : PRINT HEX (F9); : NEXT X
move in Y + direction	:60 FOR Y = 1 TO S2/.01 : PRINT HEX (F7); : NEXT Y
	:70 NEXT R
	:RUN

SELECTING THE MODEL 2202 FOR PRINTING ON GRAPHS

When documenting graphs (i.e., drawing coordinate axes, labeling points, etc.) the Model 2202 is placed in the Print mode by executing the statement shown below as part of a BASIC program. The Model 2202 must first have been selected for PRINT using a SELECT-PRINT 413 command.

:10 PRINT HEX (F5);

NOTE:
The trailing semicolon holds the carriage at its current position on the graph and suppresses a carriage return.

When in the Print mode, the Model 2202 plotting element moves one character width to the right after typing any characters. Generally, when a completed graph is to be labeled, it is best to change from the Plot mode to the Print mode, as the system automatically spaces the correct distance between characters in the Print mode only.

Section III
Selecting The Output Writer

THE SELECT MODES

The SELECT statement (see 2200 Reference Manual) selects the Model 2202 for output, whether that output is printing or plotting. Section II discusses selecting the plotter; in this section, selecting the Output Writer is described. The Output Writer may be selected for three distinct types of output by using the SELECT parameters PRINT, LIST and CO. The SELECT statement can be keyed in either as in immediate mode statement or as part of a program.

```
:SELECT PRINT 213
```

The above SELECT PRINT command selects the Output Writer with the Device Address code 213 for all program output resulting from the execution of PRINT or PRINTUSING statements. PRINT statements entering in the immediate mode appear on the CRT unless the Output Writer has been selected for the CO mode; that is, unless SELECT CO 213 was the last entered SELECT statement.

Example:

```
:10  SELECT PRINT 213
:20  PRINT "X", "X↑2"
:30  FOR X=1 TO 5
:40  PRINT X, X↑2
:50  NEXT X
:55  END
:RUN
```

RESULTANT 2202 PRINTOUT

X	X!2
1	1
2	4
3	9
4	16
5	25

```
:SELECT LIST 213
```

This SELECT LIST command selects the Output Writer with the Device Address code 213 for all program listings.

SECTION III   SELECTING THE OUTPUT WRITER

Example:

To list the program in the above example on the Model 2202, key in the following on the system keyboard:

:SELECT LIST 213
:LIST

RESULTANT 2202 PRINTOUT

```
10   SELECT PRINT 213
20   PRINT "X", "X!2"
30   FOR X=1 TO 5
40   PRINT X, X!2
50   NEXT X
55   END
```

```
:SELECT CO 213
```

The above SELECT CO command selects the Output Writer with the Device Address code 213 for all console output. No further information is displayed on the CRT. This output includes all system information, for example, the READY message; also, output from the STOP and END statements is printed. In addition, all output from immediate mode operations, TRACE statements and ERROR messages are printed for the convenience of your program files.

Example:

Key   :SELECT CO 213 EXECUTE

RESULTANT 2202 PRINTOUT

:

Key   :RESET

RESULTANT 2202 PRINTOUT

READY

:

NOTE:

Refer to Device Codes in Section II of this manual for additional information on the SELECT 213 statement.

CARRIAGE WIDTH AND COMBINED PARAMETERS

The maximum number of characters allowed on the Output Writer carriage is 121. To accommodate various paper widths and special forms, the length of the output line can be specified by enclosing the desired carriage width in parentheses following the Device Address code in the SELECT statement. This

SECTION III SELECTING THE OUTPUT WRITER

---

number is stored within the System 2200 and indicates to the system what the effective carriage width of the selected device is to be. For example:

SELECT PRINT 213 (100)   (selects Model 2202 for printing, sets carriage width to 100)
SELECT LIST 213 (80)   (selects Model 2202 for listing, sets carriage width to 80)
SELECT CO 213 (112)   (selects Model 2202 for console output, sets carriage width to 112)

If a carriage width is not specified for PRINT, LIST or CO, the last carriage width selected for these operations is used. Master Initialization sets this carriage width to 64 characters.

The carriage width setting is used by the system to generate an automatic carriage return when a line exceeds the specified carriage width and when no carriage return is supplied by the program. This prevents text from being lost or printout from being typed over. As a line of output is typed on the Model 2202 Output Writer, the System 2200 keeps a count of the number of characters sent to the Model 2202. If this line count equals the current value of the carriage width before the output line is complete, a carriage return is executed; the line count then is reset to zero, and the unfinished output is continued on the next line. If the output is completed and a carriage return is transmitted before the line count equals the carriage width, the system automatically resets the line count to zero for the start of a new line. The line count is reset also to zero if any one of the following conditions occurs:

1. The line count equals the carriage width.
2. A carriage return is executed whenever a PRINT or PRINTUSING statement without trailing punctuation is executed (printing a HEX(0D) does *not* reset the line count).
3. RESET is keyed.
4. A CLEAR command is executed.
5. The System 2200 is Master Initialized.
6. The Model 2202 is reselected for LIST, PRINT, or CO (Console Output).

The following example illustrates the automatic carriage return generated by a selected carriage width.

Example:
:SELECT PRINT 213(5) (A carriage width of 5 is selected)
:10 PRINT "THE QUICK BROWN FOX JUMPS."
:RUN

The following output is printed on the Model 2202:

```
THE Q
UICK
BROWN
 FOX
JUMPS
  .
```

It is possible also to combine parameters within a SELECT statement

Example:
SELECT PRINT 213(100),LIST 213(80),CO213(121)

SECTION III   SELECTING THE OUTPUT WRITER

SHORTCUT SELECTION METHOD

The Model 2202 Output Writer may be selected for all System 2200 printout by the following procedure:

```
:SELECT CO 213
:CLEAR
```

The CLEAR command automatically assigns the PRINT and LIST parameters to the current Console Output device.

```
NOTE:
The CLEAR command automatically clears memory; there-
fore, the shortcut method should not be used when a pro-
gram that is to be saved is in the System 2200 memory.
```

DESELECTING THE OUTPUT WRITER

The 2202 Output Writer can be deselected by:

1. Selecting another device for PRINT, LIST, or CO; for example, SELECT CO 005 deselects SELECT CO 213 and shifts output from the Model 2202 to the CRT (note that 005 is the Device Address code for the CRT).
2. Master Initializing the System 2200 (turning main power switch OFF, then ON). The Primary Console devices, of which the CRT is one, are selected automatically for I/O (Input/Output operations).
3. Entering a CLEAR command with no parameters deselects the LIST and PRINT functions and returns operation to the Primary Console devices.

```
NOTE:
The SELECT CO mode is not deselected with the CLEAR
command; method one or two must be used to deselect the
CO mode.
```

PRINT AND PRINTUSING STATEMENTS

The PRINT and PRINTUSING statements are used in the same manner with the Output Writer as they are with the CRT. The only difference is the maximum number of zones available on the Output Writer. The carriage width of all output devices is divided into as many zones of 16 characters as possible.

The 2202 has a maximum carriage width of 121 characters, which is divided into seven zones of 16 characters each, plus one zone of 9 characters. The zones constitute columns 0-15, 16-31, 32-47, 48-63, 64-79, 80-95, 96-111, 112-121.

When commas are used to separate elements in a PRINT statement, then each element begins at the start of a new zone. If semicolons are used, then this zoned format is ignored and the output appears in packed format. (See the Wang BASIC Language Reference Manual for a detailed discussion of zoned and packed format.)

SECTION III SELECTING THE OUTPUT WRITER

THE TAB FUNCTION

The TAB function is used in the same manner with the Model 2202 Output Writer as with the CRT. When a PRINT statement containing a TAB expression is executed, the Output Writer typing element spaces over to the column specified by the integer portion of the TAB expression. The System 2200 calculates the number of columns to move the carriage by subtracting the current line count from the evaluated TAB expression.

Example:
```
:SELECT PRINT 213 (100)
:10 PRINT "ANSWER="; TAB (20); X↑2
```

After ANSWER= has been printed, the line count equals 7. When TAB(20) is executed, the carriage is moved 13 spaces (i.e., 20-7) and begins printing the value of X↑2 in column 20.

An unexpected tabbing result can occur if printed information is underlined before executing the TAB expression. This is because the line count is incremented by the underline command, since the TAB expression uses the current line count to calculate the number of spaces to move the typing element. The current line count includes the underline characters and can result in the execution TAB expression being short of the desired column (see following example).

Example:
```
:SELECT PRINT 213 (100)
:10 PRINT "ANSWER="; HEX (080808080808085F5F5F5F5F5F); TAB(20); X↑2
```

This example is intended to print ANSWER=, backspace 7 characters and underline ANSWER before tabbing to column 20 to print the value of X↑2 (BACKSPACE=HEX(08), UNDERLINE=HEX(5F)). After printing ANSWER=, the line count equals 7. The eight BACKSPACE commands do not alter the line count, but the 6 UNDERLINE characters increment the line count to 13. The carriage is now located in column 6. When TAB(20) now is executed, the carriage is moved 7 columns (i.e., 20-13) from its current location to column 13. The value of X↑2 is printed in column 13 instead of column 20 because of the additional characters added to the line count (i.e., the 6 UNDERLINE characters).

The above example can be altered to produce the intended result either by altering the argument of the TAB expression or by replacing the TAB function with spaces enclosed in quotation marks.

Example:
```
:SELECT PRINT 213 (100)
:PRINT "ANSWER="; HEX (080808080808085F5F5F5F5F5F); TAB(27); X↑2
```
or
```
:SELECT PRINT 213 (100)
:10 PRINT "ANSWER="; HEX(080808080808085F5F5F5F5F5F); "(14 spaces)";X↑2
```

UPPER AND LOWERCASE LITERALS

Literal character strings and string variable values can be printed on the Output Writer in either upper or lowercase.

A special form of literal string is available for specifying lowercase characters; the literal string is enclosed within single quotes.

Example:
```
:SELECT PRINT 213
:10 PRINT "J"; 'OHN'; " "; "D"; 'OE'
:RUN
```

SECTION III   SELECTING THE OUTPUT WRITER

RESULTANT MODEL 2202 PRINTOUT

John Doe

Example:
```
:SELECT PRINT 213
:20 N$ = 'ABCDXYZ'
:30 E$ = "EXAMPLE ="
:40 PRINT E$; N$
:RUN
```

RESULTANT MODEL 2202 PRINTOUT

EXAMPLE = abcdxyz

There is another method of outputting lowercase literals if the Model 2222 ALPHANUMERIC keyboard is used. When the toggle switch on the Model 2222 is in the 'A/a' position, the keyboard acts like a standard typewriter keyboard. When a key is touched, lowercase type is generated. Lowercase literals can be entered into string variable values this way. The SHIFT key is used to obtain uppercase literals.

Example:
```
:10 INPUT A$
:20 SELECT PRINT 213
:30 PRINT A$
:RUN
```

On the 2222 keyboard, keying in:

       ? J O H N   EXECUTE (without shfiting)

prints the following on the Output Writer:

john

The following characters are valid for use in lowercase literals on the Model 2222 keyboard:

LETTERS:	**ABCDEFGHIJKLMNOPQRSTUVWXYZ**
	abcdefghijklmnopqrstuvwxyz
Digits:	**0123456789**
Special Characters:	**! @ # $ & ( ) – + = ? / : ;**

NOTE:
Lowercase literals can also be printed using HEX Codes (see Section IV).

Section IV
The Hex Function

HEX CODES

The hexadecimal function (HEX) is a form of literal string that enables a user to use any 8-bit code in a BASIC program; the HEX function can be used wherever literal strings enclosed in double quotes can be used. The HEX function can be used to output characters that do not appear on the Model 2215 or 2222 keyboard. It can be used also to output control commands to the Model 2202 Output Writer (LINE FEED, BACKSPACE, etc.).

General Form:	HEX (hexdigit hexdigit [hexdigit hexdigit . . .])
Where:	hexdigit = a digit 0-9, or a letter A-F

The more useful hex command codes for the Output Writer are shown in the following table:

HEX(08) — Backspace
HEX(09) — Tab
HEX(0A) — Line Feed
HEX(0D) — Carriage Return
HEX(1E) — ¢
HEX(1F) — °(degree)
HEX(5F) — Underline

A complete list of hex codes is given in Appendix A.

Example:
:SELECT PRINT 213
:10 PRINT HEX (74657374)
:20 PRINT HEX (08080808); HEX(5F5F5F5F)

This example prints "test" in lowercase on the Model 2202 Output Writer, then backspaces to the beginning of the word and underlines it.

SPECIAL CODES

There are special hex codes available for the System 2200-2202. They include SPACE, BACKSPACE, LINE FEED, SHIFT, CENTERED PERIOD, and CARRIAGE RETURN.

There are also eleven hex codes available on all systems associated with plotting (see Section II, using the Model 2202 Plotter with the 2200A system). Two of these codes, Y + HEX(F7) and Y − HEX(F6) can be useful in moving the Model 2202 typing element up or down in increments of .01". This can aid in the typing of special forms where half or quarter line spacing is required. To use these codes, the Model 2202 first must be placed in PLOT mode by executing the following statement in a program:

:10 PRINT HEX(F0);

20

SECTION IV   THE HEX FUNCTION

Thereafter, each time a HEX (F7) or HEX(F6) command is printed the Model 2202 carriage is moved up or down respectively by .01". When the carriage is positioned in the desired location, the Model 2202 can be placed back in PRINT mode by executing a PRINT HEX(F5) statement. The HEX (F6) and HEX(F7) codes increment the line count if the Model 2202 has been selected with a device type of 2.

NOTE:
HEX codes can be combined:
:10 PRINT HEX(0D)
:20 PRINT HEX(0A)
These statements are equivalent to:
:25 PRINT HEX (0D0A)

                              Example:
                              :SELECT PRINT 213
CR/LF and LF ──────────▶ :10 PRINT HEX (0D0A)
PRINT "WANG" ─────────▶ :20 PRINT "W"; 'ANG';
                              :30 FOR I = 1 TO 4
BACKSPACE ──────────────▶ :40 PRINT HEX (08);
                              :50 NEXT I
                              :60 FOR I = 1 TO 4
UNDERLINE ──────────────▶ :70 PRINT HEX (5F);
                              :80 NEXT I
PRINT "Labs." ───────────▶ :90 PRINT HEX (204C6162732E);
                              :100 PRINT HEX (08080808085F5F5F5F5F)

Executing this program causes the Model 2202 to print the following:

RESULTANT MODEL 2202 PRINTOUT

Wang Labs.
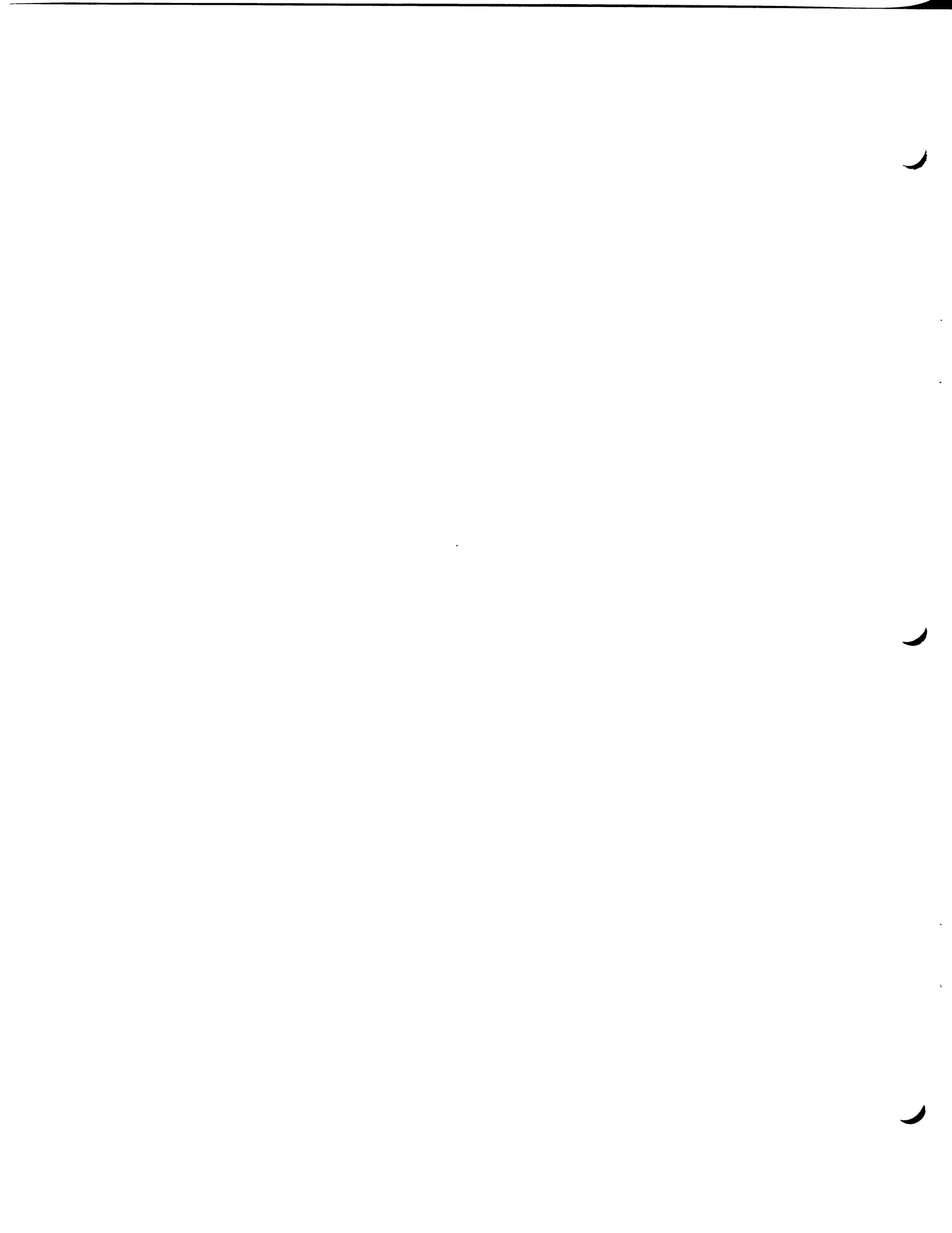
Appendices

APPENDIX A   HEXADECIMAL CODES

HEX CODE	2202 CHARACTER		CRT CHARACTER
HEX(01)	Not Available		Cursor home
HEX(03)	Not Available		Clears screen and cursor home
HEX(08)	Backspace		Backspace
HEX(0A)	Line Feed		Cursor down (line feed)
HEX(0C)	Not Available		Cursor up (reverse index)
HEX(0D)	CR/LF		CR/LF
HEX(0E)	Shift	*	Not Available
HEX(0F)	Shift Off	*	Not Available
HEX(1E)	¢	*	Not Available
HEX(IF)	°(degree)	*	←
HEX(20)	Space		Space
HEX(21)	!		!
HEX(22)	"		"
HEX(23)	#		#
HEX(24)	$		$
HEX(25)	%		%
HEX(26)	&		&
HEX(27)	'		' (apostrophe)
HEX(28)	(		(
HEX(29)	)		)
HEX(2A)	*		*
HEX(2B)	+		+
HEX(2C)	,		, (comma)
HEX(2D)	–		– (minus)
HEX(2E)	.		.
HEX(2F)	/		/
HEX(30)	0		0
HEX(31)	1		1
HEX(32)	2		2
HEX(33)	3		3
HEX(34)	4		4
HEX(35)	5		5
HEX(36)	6		6
HEX(37)	7		7
HEX(38)	8		8
HEX(39)	9		9

*Designates Codes that are different on the CRT than on the 2202.

APPENDIX A HEXADECIMAL CODES

HEX CODE	2202 CHARACTER		CRT CHARACTER
HEX(3A)	:		:
HEX(3B)	;		;
HEX(3C)	[	*	<
HEX(3D)	=		=
HEX(3E)	]	*	>
HEX(3F)	?		?
HEX(40)	@		@
HEX(41)	A		A
HEX(42)	B		B
HEX(43)	C		C
HEX(44)	D		D
HEX(45)	E		E
HEX(46)	F		F
HEX(47)	G		G
HEX(48)	H		H
HEX(49)	I		I
HEX(4A)	J		J
HEX(4B)	K		K
HEX(4C)	L		L
HEX(4D)	M		M
HEX(4E)	N		N
HEX(4F)	O		O
HEX(50)	P		P
HEX(51)	Q		Q
HEX(52)	R		R
HEX(53)	S		S
HEX(54)	T		T
HEX(55)	U		U
HEX(56)	V		V
HEX(57)	W		W
HEX(58)	X		X
HEX(59)	Y		Y
HEX(5A)	Z		Z
HEX(5B)	[		>
HEX(5C)	Not Available	*	\
HEX(5D)	]		<
HEX(5E)	!	*	↑
HEX(5F)	_ (Underline)	*	←

*Designates Codes that are different on the CRT than on the 2202.

APPENDIX A   HEXADECIMAL CODES

HEX CODE	2202 CHARACTER		CRT CHARACTER
HEX(61)	a	*	A
HEX(62)	b	*	B
HEX(63)	c	*	C
HEX(64)	d	*	D
HEX(65)	e	*	E
HEX(66)	f	*	F
HEX(67)	g	*	G
HEX(68)	h	*	H
HEX(69)	i	*	I
HEX(6A)	j	*	J
HEX(6B)	k	*	K
HEX(6C)	l	*	L
HEX(6D)	m	*	M
HEX(6E)	n	*	N
HEX(6F)	o	*	O
HEX(70)	p	*	P
HEX(71)	q	*	Q
HEX(72)	r	*	R
HEX(73)	s	*	S
HEX(74)	t	*	T
HEX(75)	u	*	U
HEX(76)	v	*	V
HEX(77)	w	*	W
HEX(78)	x	*	X
HEX(79)	y	*	Y
HEX(7A)	z	*	Z
HEX(FA)	Reverse Index	*	Not Available
HEX(FB)	Centered Dot	*	Not Available

*Designates Codes that are different on the CRT than on the 2202.

APPENDIX B   SPECIFICATIONS FOR THE MODEL 2202

Stepping Rate	400 steps/sec approx (X or Y axis)
Stepping Increment	0.01 in. (0.0254 cm) per step
Plotting Time	0.1 sec between points (min)
Accuracy	± 0.01 in. plus 0.003 in./in. (± 0.0154 cm plus 0.003 cm/cm)
Paper Width	13 5/8 in. (34.6 cm)
Width of Printing Area	12 1/4 in. (31.1 cm)
Printing Density	APPROX 7 lines/in. (0.14 in./line) (2.75 lines/cm) (vertical) 10 characters/in. (3.94 characters/cm) (horizontal)
Type Face	IBM Prestige Elite 72 (code 012)
Maximum Printing Speed	13 characters/sec
Operation Speeds (approximate)	
Space (backspace)	0.030 sec
Index	0.050 sec
Carriage Return	0.15 sec + 0.060 sec/in. (0.15 sec + 0.023 sec/cm)
Size	
Height	33 in. (83.8 cm)
Width	28 1/2 in. (72.4 cm)
Depth	18 in. (45.7 cm)
Weight	96 lb (43.6 kg)
Power Requirements	115 VAC or 230 VAC ± 10% 50 or 60 Hz ± 1/2 cycle 125 Watts
Connecting Cables	8-ft (2.44 m) cable with connector to calculator output jack.
Pin Feed Platen	Pins are vertically spaced 1/2 inch apart. Pins are horizontally spaced 13 inches (33 cm) apart.
Operating Environment	50° F to 90° F (10° C to 32° C) 40% to 60% relative humidity

APPENDIX C PREVENTIVE MAINTENANCE INFORMATION

EQUIPMENT MAINTENANCE

GUARANTEE

This equipment is guaranteed from defects in materials and workmanship for a period of ninety days (one year for State and Federal Governments).

MAINTENANCE

It is recommended that your equipment be serviced Quarterly. A Maintenance Agreement is available to automatically assure this servicing. If no Maintenance Agreement is acquired, any servicing must be arranged for by the customer. A Maintenance Agreement protects your investment and offers the following benefits:

Preventive Maintenance: Quarterly your equipment is inspected for worn parts, lubricated, cleaned and updated with engineering changes, if any. Preventive maintenance minimizes "downtime" by anticipating repairs before they are necessary.

Fixed Annual Cost: When you buy a Maintenance Agreement, you issue only one purchase order for service for an entire year and receive one annual billing, or, more frequent billing, if desired.

Further information regarding Maintenance Agreements can be acquired from your local Sales Service Office.

> **NOTE:**
>
> *Wang Laboratories, Inc. will not guarantee or honor Maintenance Agreements for any equipment modified by the user. Damage to equipment incurred as a result of user modifications will be the financial responsibility of the user.*
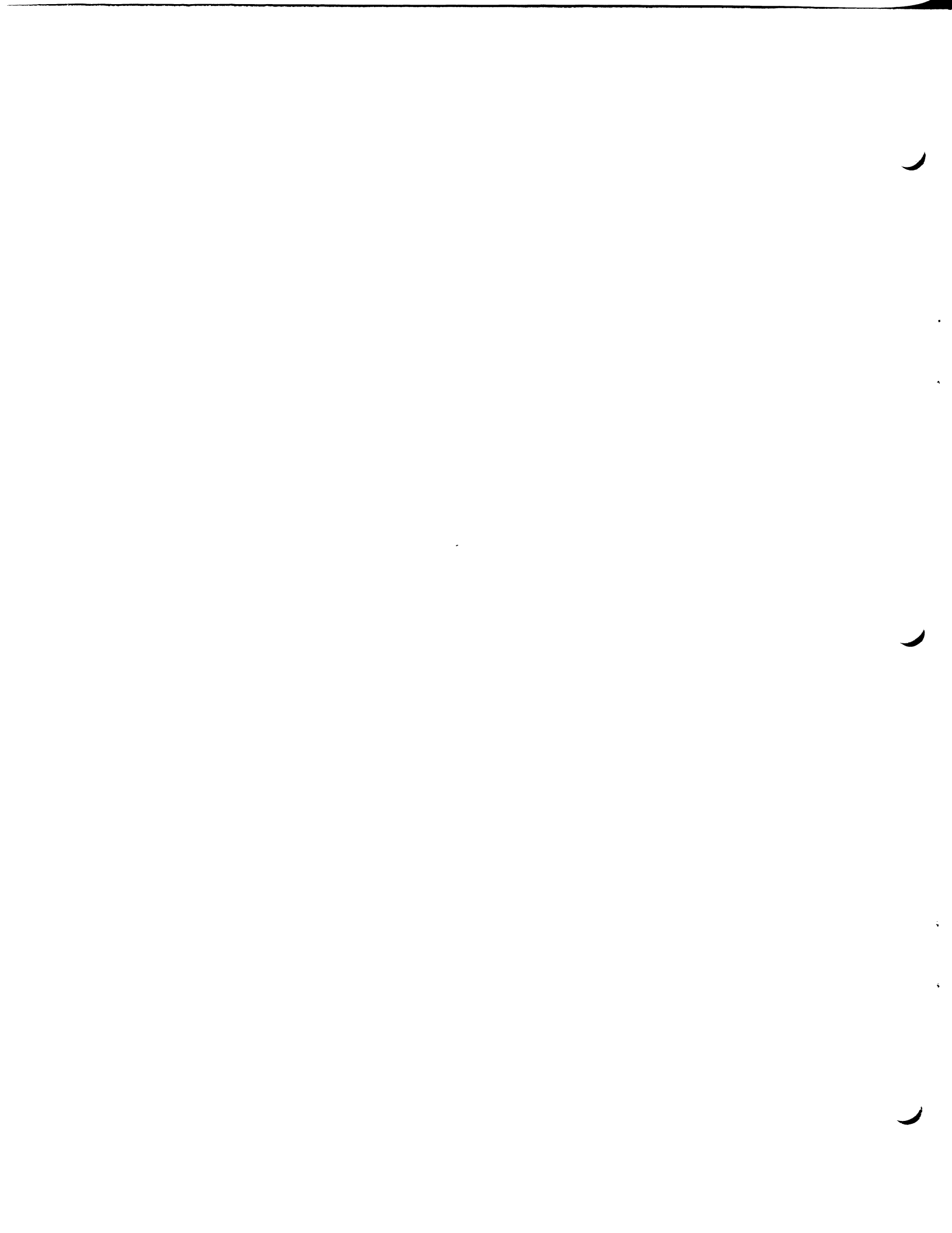
To help us to provide you with the best manuals possible, please make your comments and suggestions concerning this publication on the form below. Then detach, fold, tape closed and mail to us. All comments and suggestions become the property of Wang Laboratories, Inc. For a reply, be sure to include your name and address. Your cooperation is appreciated.

700-3146B

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