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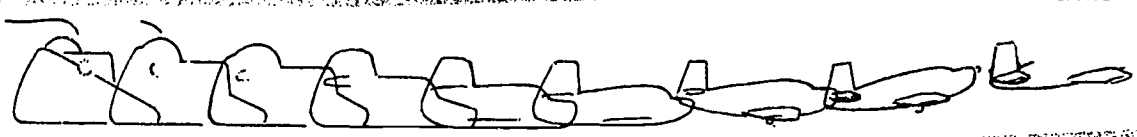
ABSTRACT

Several student-authored computer programs are presented which do advanced plot routines. They are remarkable in that they are able to plot a function expressed in polar coordinates on a teletype. Some plot routines developed by the Project Solo staff are also presented. They are designed to be used with a Hewlett Packard 7200 A plotter connected to a teletype. (JY)

PROJECT SOLO
AN EXPERIMENT IN REGIONAL COMPUTING FOR SECONDARY SCHOOL SYSTEMS*



University of Pittsburgh • Department of Computer Science • Pittsburgh, Pennsylvania 15213

Newsletter No. 12 February 22, 1971

Advanced Plotting Routines

We just received (courtesy of Miss Kavanagh) some examples of student-authored plot routines that are nothing short of ingenious. They were written by John Ernsberger of Fox-Chapel High School, and have solved the almost unsolvable problem of plotting a function expressed in polar coordinates on a teletype. When you realize that the teletype cannot backspace, and that the paper only moves forward, you get some idea of the hurdles that John had to conquer. We're still not quite sure how he did it! John also wrote /SINESJE/ and /POLTU/.

The Hewlett-Packard Plotter

For those of us with not quite the talent that John has demonstrated (including Project Solo Staff), there is hope. By using a more flexible plotting device which can move back and forth in both the X and Y directions, and which can plot hundreds of points (or lines) in a small space, a whole new range of possibilities is opened up. (We don't even dare contemplate what Mr. Ernsberger would do with this tool at his disposal.)

Two examples are attached to illustrate the performance of the HP 7200 A Plotter which can be connected to any teletype. The first example illustrates use of the plotter to draw a cardioid in "point" mode, which means that the pen only makes a "dot" at each (X, Y) position. The angle T (measured in radians) goes from 0 to 6.28 (2π) in steps of 0.05 radians. Thus 6.28/.05 or about 125 points of the cardioid are plotted.

In the second example, the plotter is in line mode, which means that the pen draws lines from one (X, Y) coordinate position to the next. In the example shown (a five leaved rose), we deliberately used a large increment in T so that long line segments are drawn from one point to the next, producing an interesting artistic result.

Since the HP 7200 A is an X-Y plotter, the transformations X=R*COS(T) and Y=R*SIN(T) had to be used in both those examples.

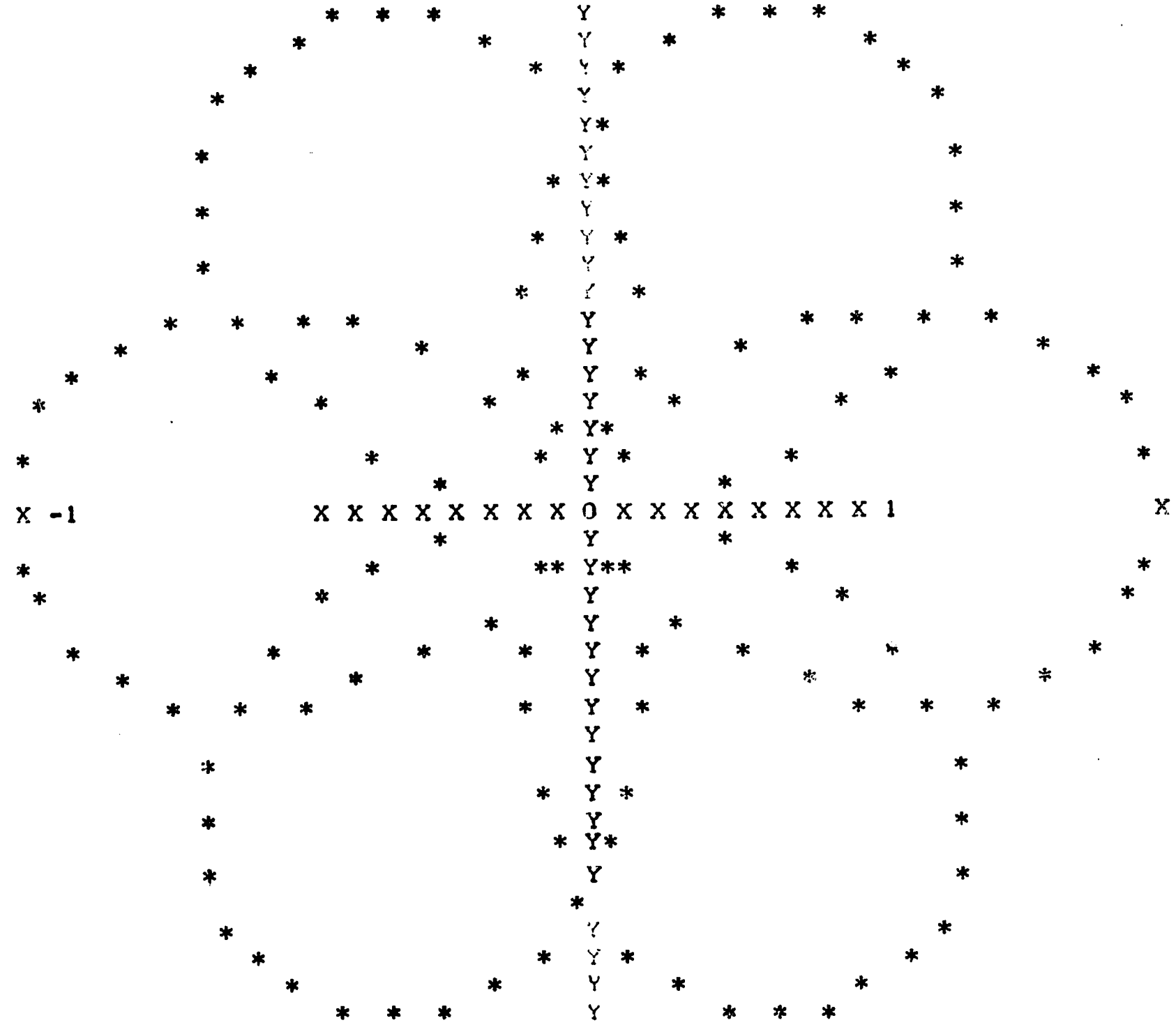
*Supported in part by NSF grant GJ-1077

A listing of /POLAR/

```
10 DIM Y(480),X(480),Z(45,25),B(480),E(480)
20 FOR I=1 TO 480
30 LET A=I*05./180.*3.1415926535
40 LET R=COS(2*A)
50 LET Y(I)=(SIN(A))*R
60 LET X(I)=(COS(A))*R
70 IF I=1 THEN 90
80 IF ABS(Y(I)-Y(1))<0.000010000 AND ABS(X(I)-X(1))<0.000010000 THEN 1
00
90 NEXT I
100 LET I=I-1
110 LET B(C)=ABS(X(C)) FOR C=1 TO I
120 GOSUB 670
130 LET U=B(I)
140 LET B(C)=Y(C) FOR C=1 TO I
150 GOSUB 670
160 LET V=B(1)
170 LET W=B(I)
180 LET P=U/20.
190 FOR G=V TO W STEP P
200 LET D=INT((G-V)/P+1.5)
210 LET L=1
220 LET Z(D,1)=0
230 FOR K=1 TO I
240 IF ABS(G-Y(K))>U/39.9 THEN 270
250 LET L=L+1
260 LET Z(D,L)=X(K)
270 NEXT K
280 IF L=1 THEN 380
290 LET B(C)=Z(D,C) FOR C=1 TO L
300 GOSUB 670
310 LET Z(D,C)=B(C) FOR C=1 TO L
320 FOR Q=1 TO L
330 IF Z(D,Q+1)-Z(D,Q)>U/68. THEN 370
340 FOR A1=Q+2 TO 25
350 LET Z(D,A1-1)=Z(D,A1)
360 NEXT A1
370 NEXT Q
380 NEXT G
390 FOR F=W TO V STEP -P
400 LET J=INT((F-V)/P+1.5)
410 IF ABS(F)<U/39.9 THEN 570
420 IF ABS(F-U)<U/39.9 THEN 600
430 IF ABS(F+U)<U/39.9 THEN 620
440 LET H=1
450 IF Z(J,H)=0 THEN 480
460 PR. TAB(35+Z(J,H)/U*34):"*":
470 GO TO 510
480 IF N>1 THEN 530
490 LET N=2
500 PR. TAB(35):"Y":
510 LET H=H+1
520 GO TO 450
530 LET N=1
540 PRINT
550 NEXT F
560 GO TO 640
570 PR. " X":TAB(3):-1*U:TAB(19):"X X X X X X X X O X X X X X X X X":
```

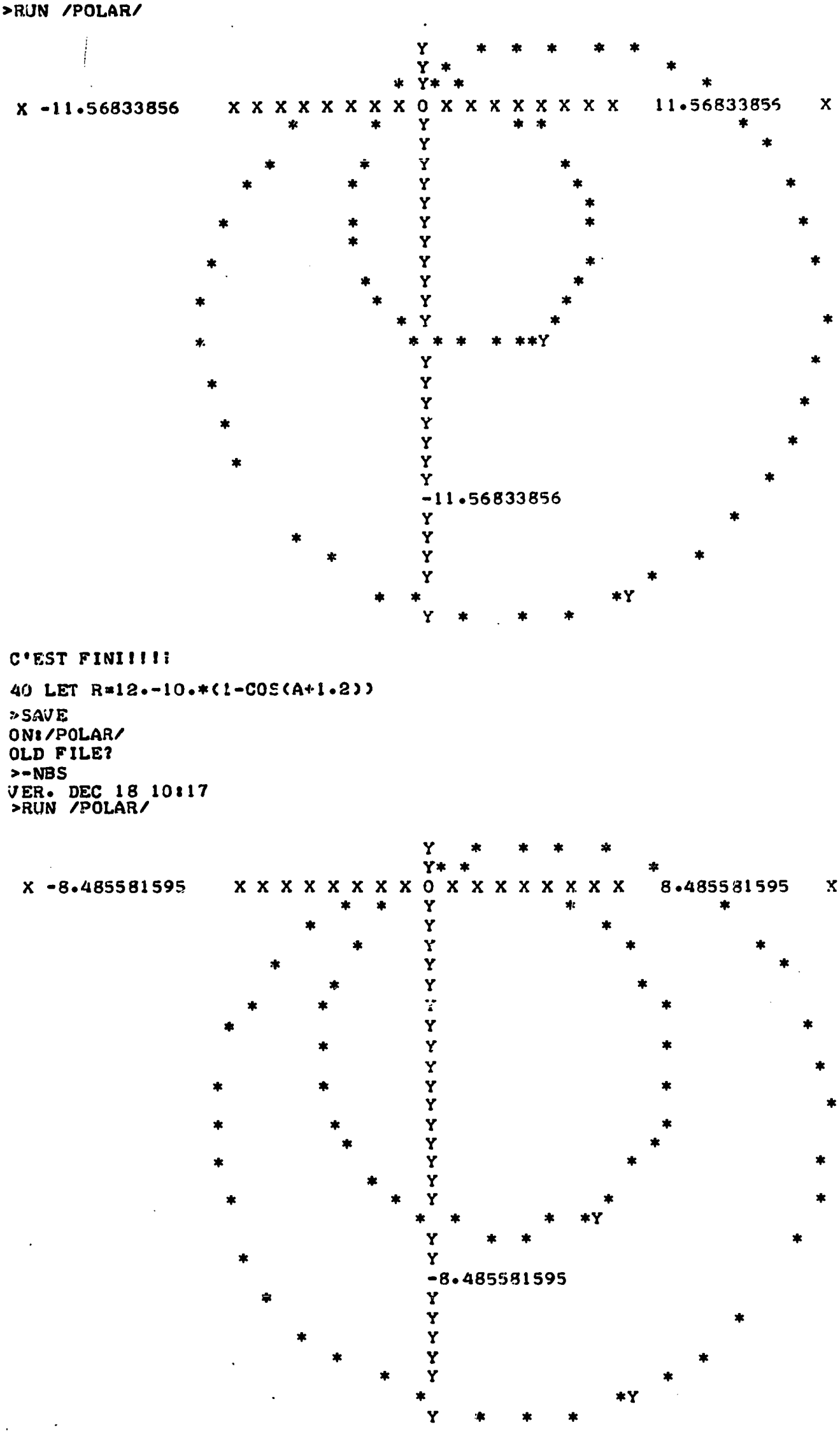
```
580 PR. TAB(54):U:TAB(69):"X"
590 GO TO 550
600 PR. TAB(35):U
610 GO TO 550
620 PR. TAB(35):-1*U
630 GO TO 550
640 PR.
650 PR. "C'EST FINI!!!!"
660 END
670 FOR S=1 TO C-1
680 FOR M=S+1 TO C
690 IF B(S)<B(M) THEN 730
700 LET T=B(S)
710 LET B(S)=B(M)
720 LET B(M)=T
730 NEXT M
740 NEXT S
750 RETURN
```

```
70 LET R=SIN(3*A/2)
>SAVE
ON:/POLAR/
OLD FILE?
>-NBS
VER. DEC 18 10:17
>RUN /POLAR/
```



C'EST FINI!!!!

```
>40 LET R=8.-12.*(1-COS(A+1.2))
>SAVE
ON:/POLAR/
OLD FILE?
>-NBS
VER. DEC 18 10:17
>RUN /POLAR/
```




```
C'EST FINI!!!!
40 LET R=12.-10.*(1-COS(A+1.2))
>SAVE
ON:/POLAR/
OLD FILE?
>-NBS
VER. DEC 18 10:17
>RUN /POLAR/
```

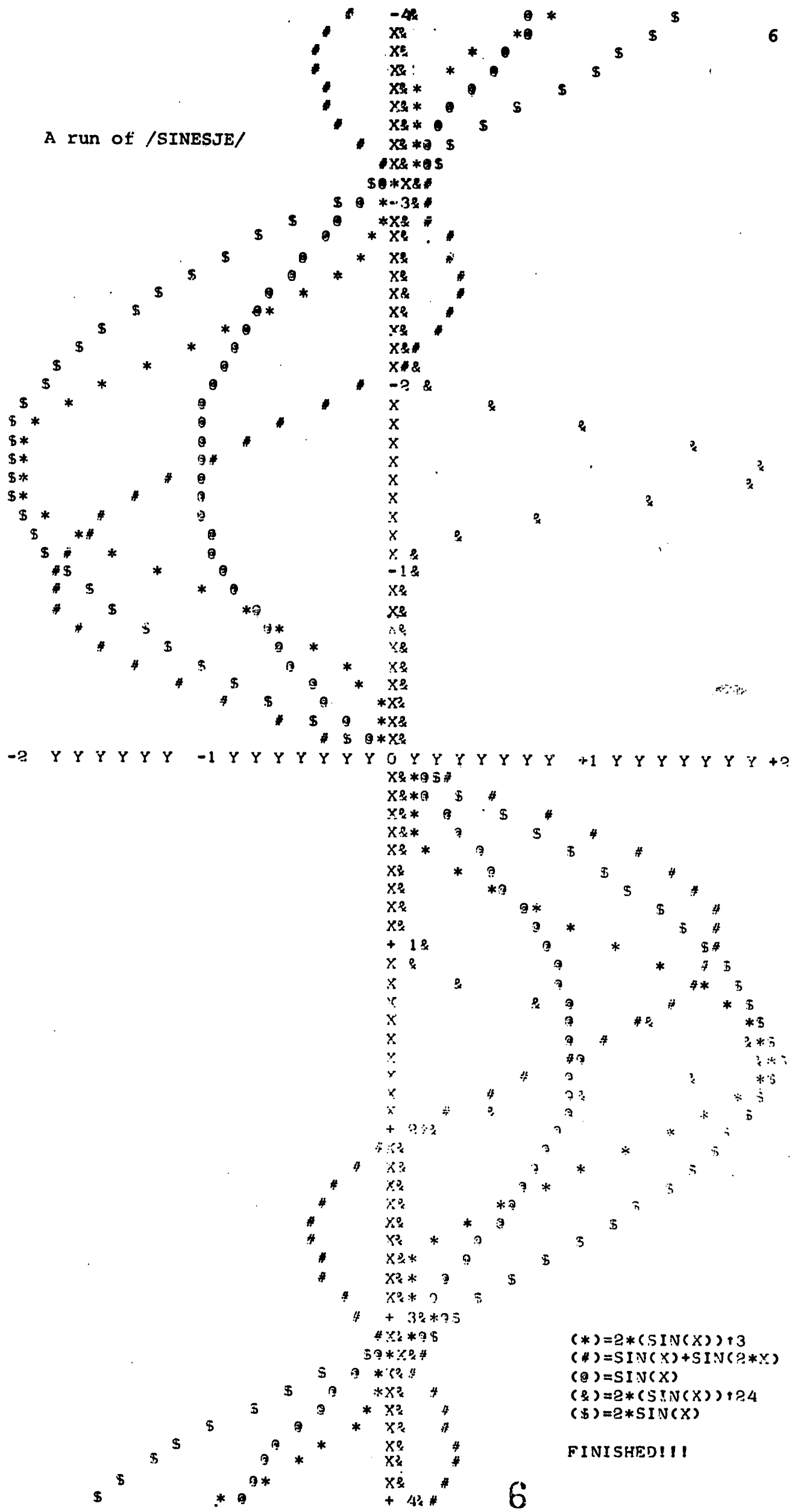


```
C'EST FINI!!!!
```

```
5  DIM A(6),Y(6)
10 FOR X=-4 TO 4.01 STEP 0.1
20 IF ABS(X)>0.01 THEN 50
30 PRINT " -2  Y Y Y Y Y Y  -1 Y Y Y Y Y Y Y 0 Y Y Y Y Y Y Y  +1 Y Y Y
 Y Y Y Y +2"
40 GO TO 310
45 GOSUB 500 GO TO 150
50 LET Y(1)=2.*SIN(X)
60 LET Y(2)=2.*(SIN(X))↑3
70 LET Y(3)=2.*(SIN(X))↑24
80 LET Y(4)=SIN(X)+SIN(2*X)
90 LET Y(5)=SIN(X)
100 LET Y(6)=0
110 LET A(I)=Y(I) FOR I=1 TO 6
120 FOR Q=1 TO 5
130 FOR J=Q+1 TO 6
140 IF A(Q)>A(J) THEN 45
150 NEXT J
150 NEXT Q
170 FOR K=1 TO 6
175 FOR I=1 TO 6
180 IF A(K)=Y(I) THEN 195
182 NEXT I
185 ON I GOSUB 690,610,630,650,670,535
300 NEXT K
305 PRINT
310 NEXT X
320 PRINT "(*)=2*(SIN(X))↑3"
330 PRINT "(#)=SIN(X)+SIN(2*X)"
340 PRINT "(@)=SIN(X)"
342 PRINT "(&)=2*(SIN(X))↑24"
344 PRINT "($)=2*SIN(X)"
350 PRINT
360 PRINT "FINISHED!!!"
370 END
500 LET T=A(Q)
510 LET A(Q)=A(J)
520 LET A(J)=T
530 RETURN
535 FOR R=-4 TO -1
540 IF ABS(X-R)<0.01 THEN 583
542 NEXT R
548 FOR S=1 TO 4
550 IF ABS(X-S)<0.01 THEN 570
555 NEXT S
560 GO TO 590
570 PRINT TAB(35):" ":
580 GO TO 700
583 PRINT TAB(35):"0":
587 GO TO 700
590 PRINT TAB(35):"X":
600 GO TO 700
610 PRINT TAB(Y(I)*17+35):"*";
620 GO TO 700
630 PRINT TAB(Y(I)*17+35):"@":
640 GO TO 700
650 PRINT TAB(Y(I)*17+35):"#":
660 GO TO 700
670 PRINT TAB(Y(I)*17+35):"@":
680 GO TO 700
690 PRINT TAB(Y(I)*17+35):"$":
700 RETURN
```

Program listing
of /SINESJE/

A run of /SINESJE/

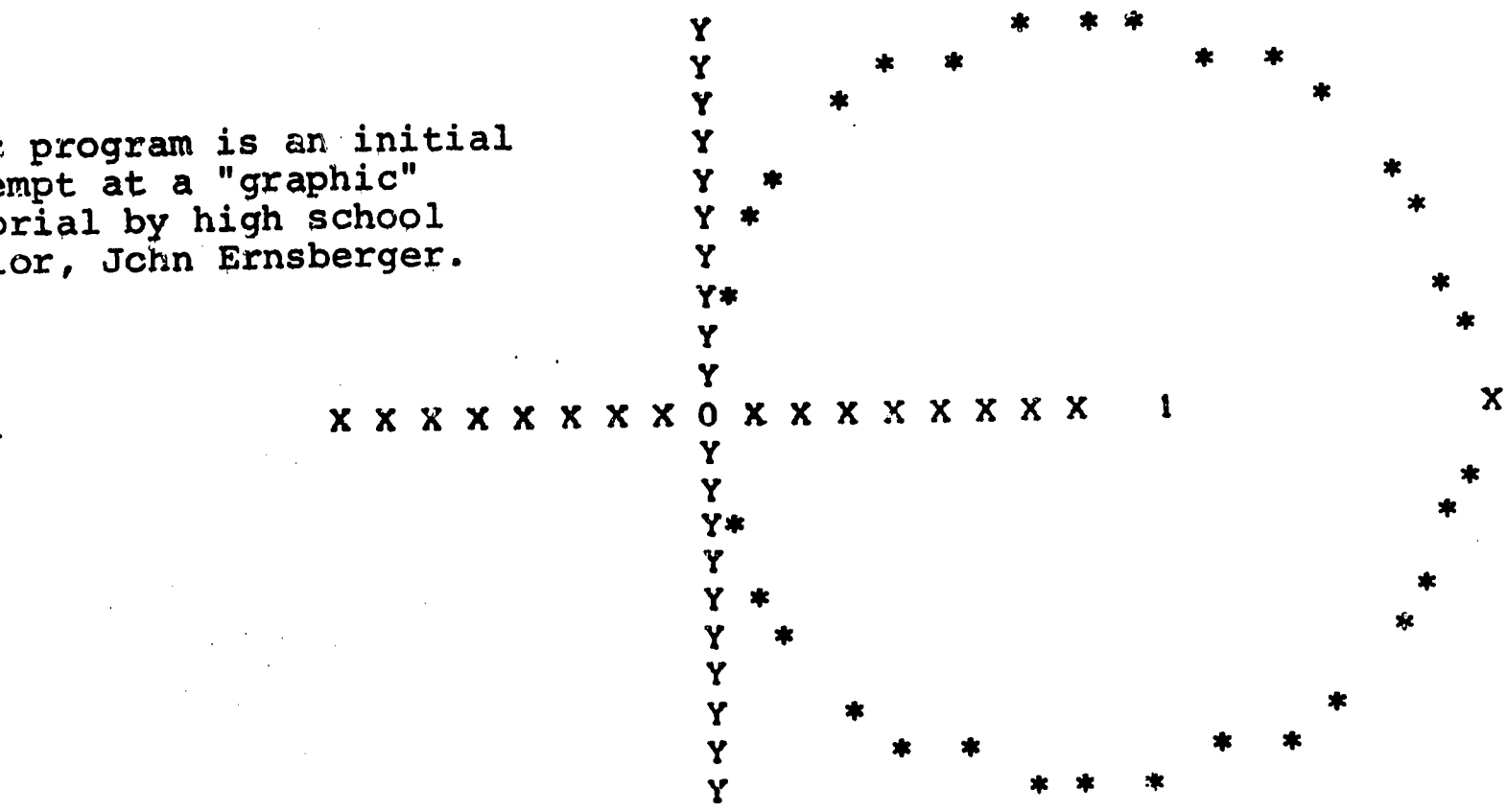


(*)=2*(SIN(X))↑3
(#)=SIN(X)+SIN(2*X)
(@)=SIN(X)
(&)=2*(SIN(X))↑24
($)=2*SIN(X)

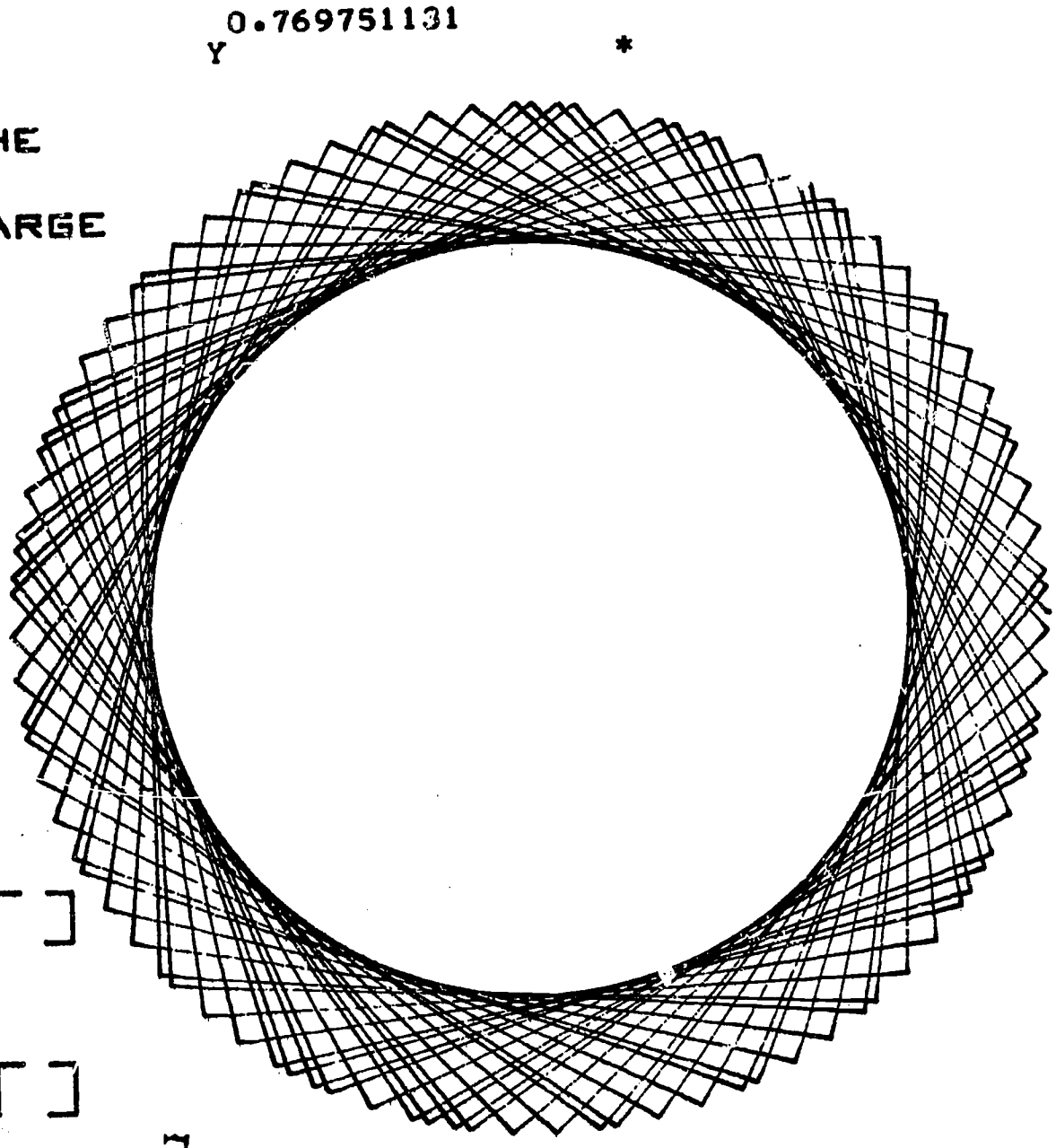
FINISHED!!!

```
>RUN /POLTU/
```

This program is an initial attempt at a "graphic" tutorial by high school senior, Jchn Ernsberger.




```
TYPE THE EQUATION THAT YOU THINK HAS JUST BEEN GRAPHED.
?R=COS(A)
GOOD
C'EST FINI!!!!
```

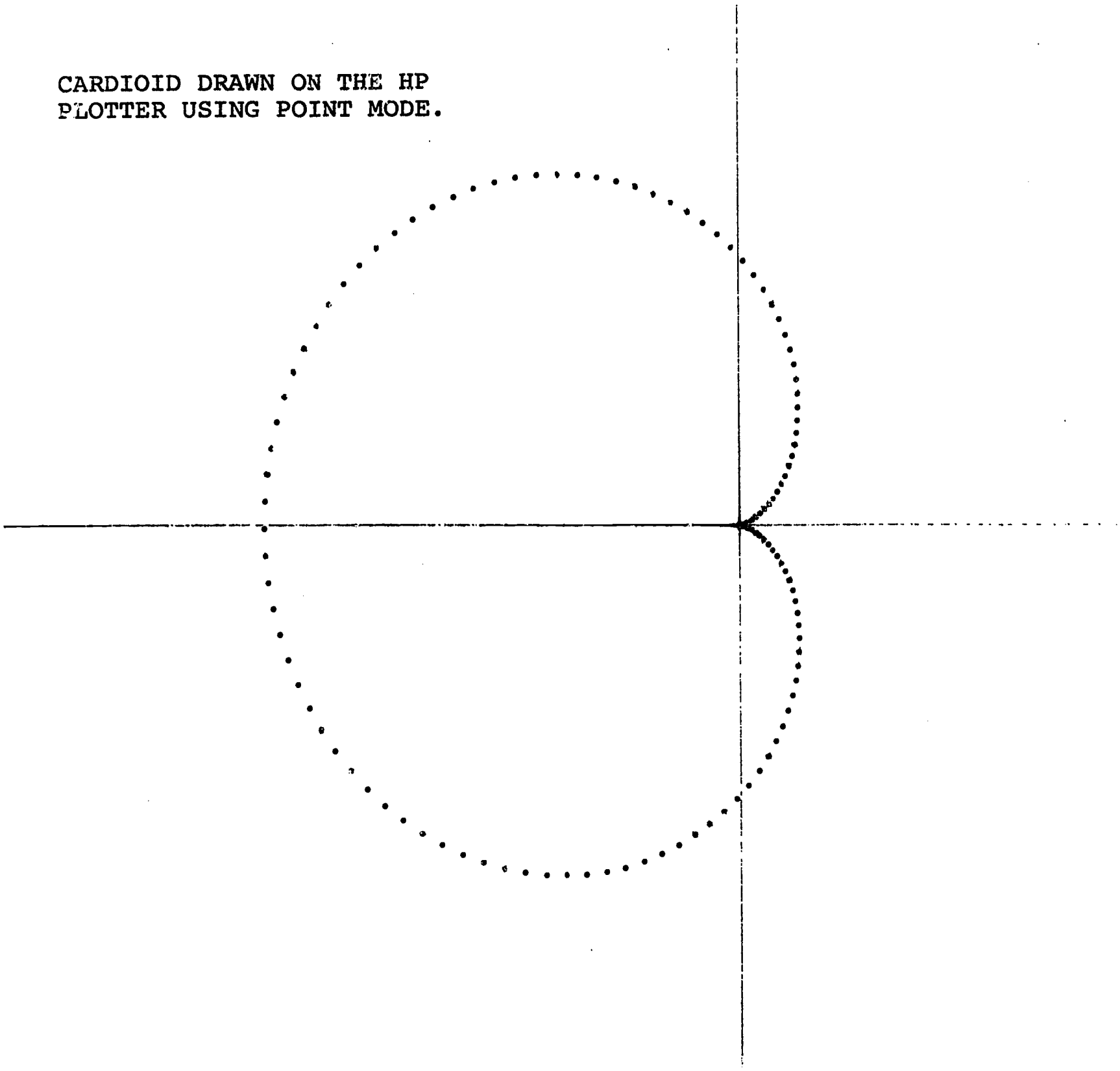


CIRCLE DRAWN ON THE H-P PLOTTER USING LINE MODE AND A LARGE INCREMENT FOR T

Y=R*SIN[T]

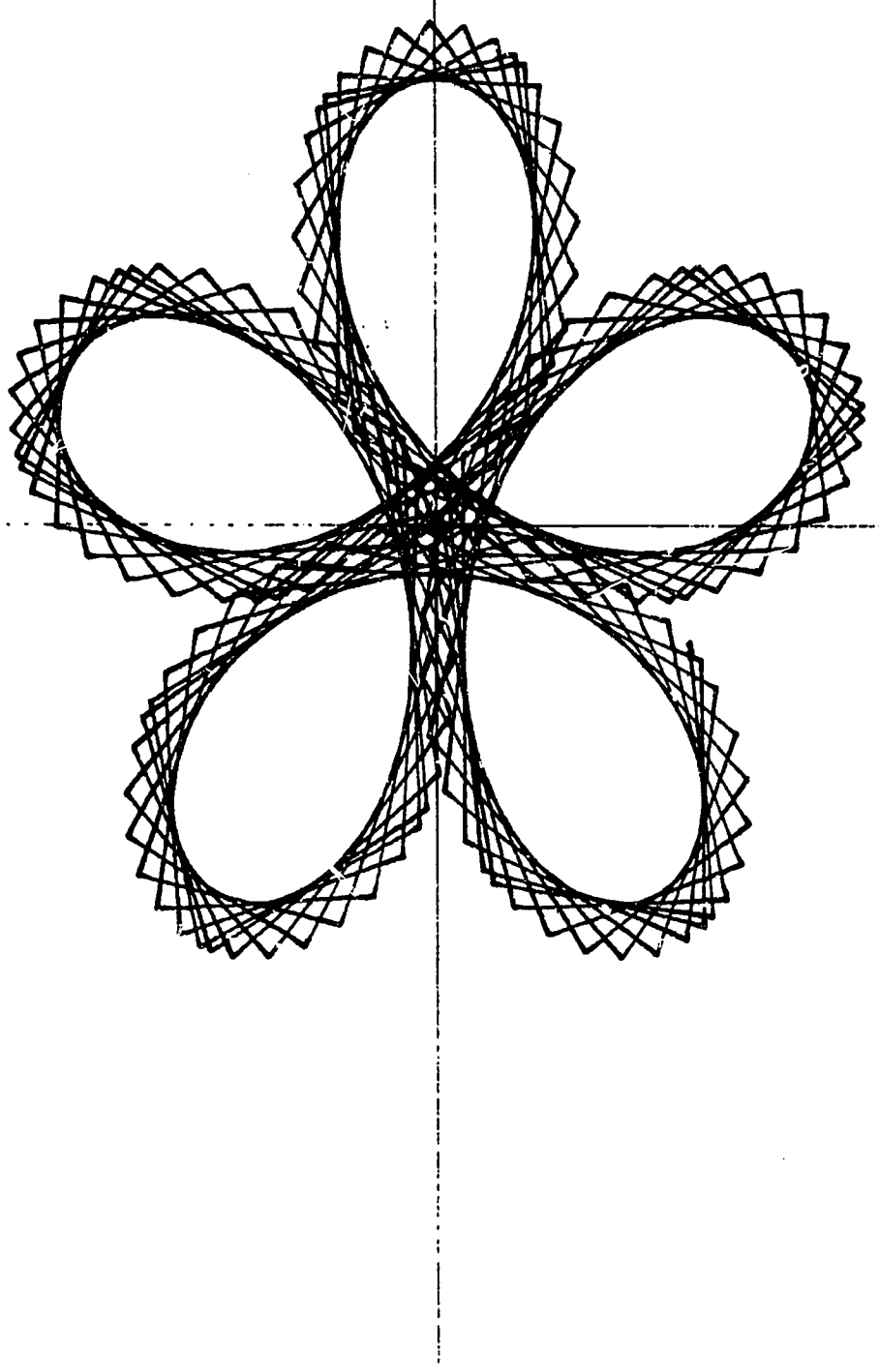
X=R*COS[T]

CARDIOID DRAWN ON THE HP PLOTTER USING POINT MODE.



```
10 PRINT "PLTP"
15 T = 0
20 A = 4.
30 R = A*(1. - COS(T))
40 X = R*COS(T)
50 Y = R*SIN(T)
60 PR. INT( (2./3.)* X*500 + 5000); INT( Y*500 + 5000)
70 T = T + .05
80 IF T > 6.28 GOTO 99
90 GOTO 30
99 PRINT "PLTL"
100 PR. 0000; 5000:"↑"
105 PR. 5000;5000
110 PR. 9999; 5000
115 PR. 5000; 9999:"↑"
120 PR. 5000; 5000
125 PR. 5000; 0000
130 END
```

FIVE-LEAF ROSE DRAWN ON THE HP PLOTTER USING LINE MODE.



```
10 PRINT "PLTL"
15 T = 0
20 A = 4.
30 R = SIN(5.*T/3.)
40 X = R*C0S(T)
50 Y = R*SIN(T)
60 PR. INT( (2./3.)*X*2500+ 5000); INT( Y*2500+ 5000)
70 T = T + .5
80 IF T > 75.  G0T0 99
90 G0T0 30
99 PRINT "PLTL"
100 PR. 0000; 5000:";"
105 PR. 5000;5000
110 PR. 9999; 5000
115 PR. 5000; 9999:";"
120 PR. 5000; 5000
125 PR. 5000; 0000
130 END
```